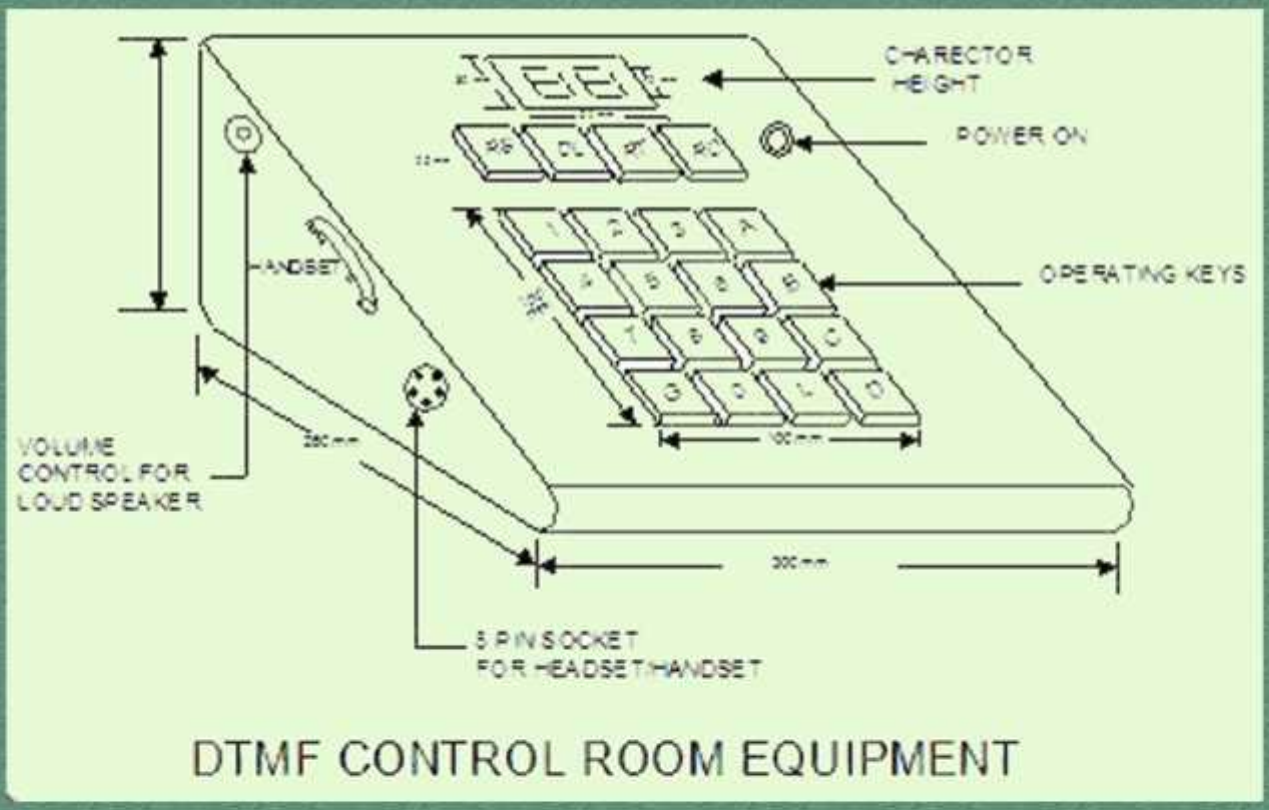
इरिसेट IRISET

TC6

TRAIN TRAFFIC CONTROL



DTMF CONTROL ROOM EQUIPMENT

Indian Railways Institute of
Signal Engineering and Telecommunications
SECUNDERABAD - 500 017

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TRAIN TRAFFIC CONTROL

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INDIAN RAILWAYS INSTITUTE OF SIGNAL ENGINEERING & TELECOMMUNICATIONS, SECUNDERABAD - 500 017

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TRAIN TRAFFIC CONTROL

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CHAPTER-1

GENERAL PRINCIPLES OF CONTROL WORKING

1.1 Introduction to Control Working

Control or Train Traffic Control in Indian Railways is the name given to the Train Operations System which is setup specifically for the purpose of running the trains punctually and efficiently. This is achieved by closely monitoring and controlling individual train movements and also by regulating the overall traffic movement.

1.2 The Control Setup

The Control setup is implemented on divisional basis. For this purpose first, a Control Office is setup at the **Divisional Head Quarters** and the total track area under the divisional jurisdiction is divided into smaller segments called **control sections**. The movements of the train traffic in each of these control sections is individually monitored and regulated from the control office with an intention to provide an effective and efficient train operating system. The control office is meant for giving necessary directions and suggestions to the track side railway stations, signal cabins etc. in regard to the train and traffic movements.

1.3 Means of Control

The control over the train traffic movements is exercised by means of a direct telephone communication between the Control Office and the way side train working agencies like railway stations, signal cabins etc.

S&T department provides the telephone communication facility required between the control office and all track side Stations and other agencies connected with train working. This speech communication system between the Control Office and track side stations is known as Control **Communication System**.

1.4 Objects of Control

Control over the movement of trains over a section of the Railway is exercised round the clock to achieve the following: -

(a) Cohesion in moving train traffic
(b) To avoid delay to trains and traffic
(c) To effect economy in working of trains
(d) To improve the general working of trains and
(e) To increase the efficiency in working of trains.

1.5 Functions of Control

The functions of the control may be best described under the following three heads:

(a) Train control
(b) Traffic (Deputy) control
(c) Power control

1.5.1 Train Control:- The objectives of train control are as under:

i. Ensuring the punctual running of Mail, Express & Passenger trains.
ii. Running Goods trains to best possible paths and with the least possible detention enroute.
iii. Arranging the running of engineering material trains to the best possible advantage of Engineering department.
iv. Arranging Engineering and/or Power blocks in such a way as to involve the minimum disturbances to train running
v. Arranging relief and regulating trains in the event of accident

1.5.2 Traffic (Deputy) Control:- The objectives of deputy control are as under:

I. Allotment and distribution of coaching and Goods stock in stations.
II. Securing maximum utilization of rolling stock.
III. Maintaining fluidity of Marshalling yards.
IV. Regulating traffic for fulfilling interchange commitments.
V. Securing maximum workable load for each train, compatible with the type of engine utilized and the special characteristics of the section over which the train is to be worked.

1.5.3 Power Control:- The objectives of power control are as under:

I. Requisitioning locomotive power, i.e. Engines, direct from locomotive running sheds for all operating requirements, viz. train working, shunting and banking.
II. To ensure the most economical use of engine power available.
III. To ensure the return of engine to Home running sheds at regular intervals for wash-outs and other maintenance requirements.
IV. Managing the traction power supply and OHE system

1.6 Elements of a Control

The basic elements involved in the train control system are

1) Control Offices,
2) Way Stations, and
3) Communication between Control office and Way stations

1.7 The Control Offices

The Control office is the central place from where the movements of all the trains are controlled and regulated. The Control Office setup at the divisional headquarters play key role in train operations. In addition to these, there also exist other control offices which either operate over a smaller area of control or play a role of a coordinating agency between control offices. The following are the different types of control offices that may be provided in a railway zone.

1.7.1 Divisional Control Office:

The divisional control office may be described as the nerve center of the Divisional operating organization. Every Divisional Headquarter has a control office.

Apart from the Divisional control office, the following places that are lying within the Division's jurisdiction are also provided with sub-control offices subject to the following conditions:

(a) **Area Control:** Areas of exceptional industrial or commercial importance are provided with subsidiary control offices called as Area Control.

(b) **Sub-control:** Sometimes, Sub-control offices are provided to control a limited portion of the division, where the traffic density and/or difficulties in providing effective communication right up to divisional control justifies separate organization for controlling and regulating traffic.

1.7.2 Central Control Office:

Above all the divisional control offices there is a Central Control Office situated at the zonal Headquarters. It is connected with all Divisional control offices and with important stations/yards with a view to regulate the traffic over entire zone and to co-ordinate with adjoining railways.

It functions under the overall charge of a Chief controller who is assisted by a Deputy Chief Controller. The central control office performs the following -

i) Maintains detailed operating position and oversees the daily performance.
ii) It maintains various operating records for reference and keeps the Headquarters offices informed of the latest position.
iii) The stock section of the central control collects various informations and prepares detailed position of day-to-day operating performance.
iv) Its Mechanical and Electrical wings assist in assessing the performance of their respective departments in every day's operation and in calculation of kilometerage and punctuality.

1.8 The Control Office Organization at Divisional Headquarters

1.8.1 The control organization generally consists of a special officer deputed for the purpose and the following staff:

Chief Controller (CTNL): He is the executive authority in charge of the control office and is responsible for the efficient operation of the control office.

Deputy Chief Controller (Dy.CTNL): He directly supervises the work of the section controllers, assists them during their work and also scrutinizes the control charts.

Section/Train Controller (ATNL): He deals with the actual movement of the trains in his section. His main duties include:

- Ensuring efficient running of the trains over the section that he controls by arranging judicious crossing and precedence,
- Giving clear and concise orders to stations well in advance and
- Plotting neatly and clearly the movement of all trains on the Control Chart.

In view of the arduous nature of their work, the duty hours of train controllers are generally restricted to 6 hours working per day.

In addition to these there may be other controllers as mentioned below depending on the needs of the division.

Power Controller: For Looking after and arranging of engines and engine crew requirements in the division by contacting loco sheds. In electrified sections the power controller is called as **Traction Loco Controller (TLC).**

Traction Power Controller: A TPC is also provided in electric-traction areas for the purpose of managing the traction power supply and OHE system.

1.8.2 Each Divisional Control Office is divided into one or more sections. Each section is provided with a separate control communication circuit and separate control office communication equipment. Each control section is manned round the clock by the Section Controllers in shift duties. The work of Section Controllers is supervised by Deputy Chief Controllers, who also perform the shift duties.

1.8.3 The Section Controller of each section is provided with telephone communication facility for contacting stations, important cabins, Loco sheds, etc. in the section. For the guidance of the section controller, a diagram showing the layouts of stations and yards, loop capacities, gradients and the layouts of sidings is exhibited in front of him. In electrified areas, the diagram showing various OHE sections, sub-sections and elementary sections is also exhibited.

1.8.4 A typical layout showing the various section controls of a Division is given in the fig.1.1.

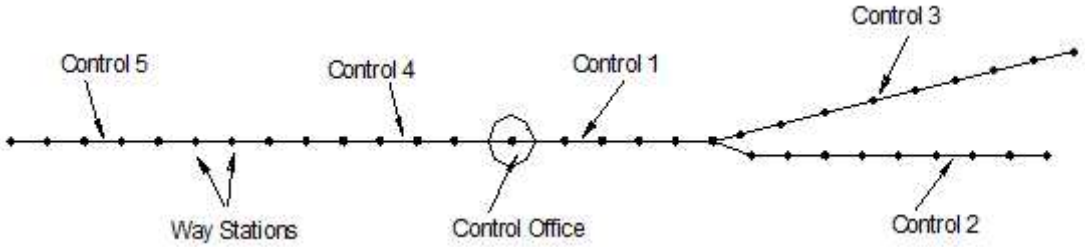


Fig.1.1- Control Section in a Division

1.9 Way Stations

The length of the control section is determined purely on traffic considerations, so that from the transmission point of view the best conditions are not always obtained. Communication is normally required with:

(a) Railway station
(b) Signal Cabin
(c) Loco shed
(d) Sidings (in special cases)
(e) Officer's rooms (as per requirement)
(f) Officer's residences (as per requirement)
(g) Residences of other emergency staff.

The above are generally referred to as '**way stations**'. Facilities should exist for the way station to be "rung" to establish communication. In cases where ringing facilities are not given, the way station is referred to as a '**speaking extension**'.

1.10 Communication Between Control Office & Way Stations

The Communication plays an important role in control working because the means of train control is only through the speech communication between the controller and all way side stations. Hence, the efficiency of the control working mainly depends on the performance of the communication system provided between the control office and all the way side stations in the division.

1.11 Train Control Charts

The train control charting is exercised adopting graphical plotting method. In this method of train control, a **graphical chart** for 8 hours duration is provided in which the distance is indicated on the Y-axis and the time on X-axis. The smallest sub-division of time axis may be 1 or 2 or 4 minutes depending on the density of traffic. The distance axis gives the overall length of the section with names of the stations and the distances between stations.

Each section controller shall record on control chart the movement of all trains over his section on receipt of information from each station during his period of duty. In plotting movements of various classes of trains on the control chart, pencils of the following colours shall be used.

(a) Red: for Expresses and other top priority trains
(b) Blue: for other passenger trains
(c) Green: for Military specials and Fast Goods
(d) Black: for other Goods trains

A typical chart is shown in figure-1.2. The oblique lines indicate the movement and the horizontal lines the detention of trains. The chart is provided with a border on all the four sides to record other particulars regarding the trains, reasons for undue detention etc. Presently, **Train Charting** is being done by computers in place of manual charting.

1.11.1 Master Charts

Master charts are basically similar to train control charts but are prepared for 24 hours duration instead of 8 hours according to the scheduled running of trains as per the working time table in force. These are useful in revision of time tables and planning the running of any extra trains.

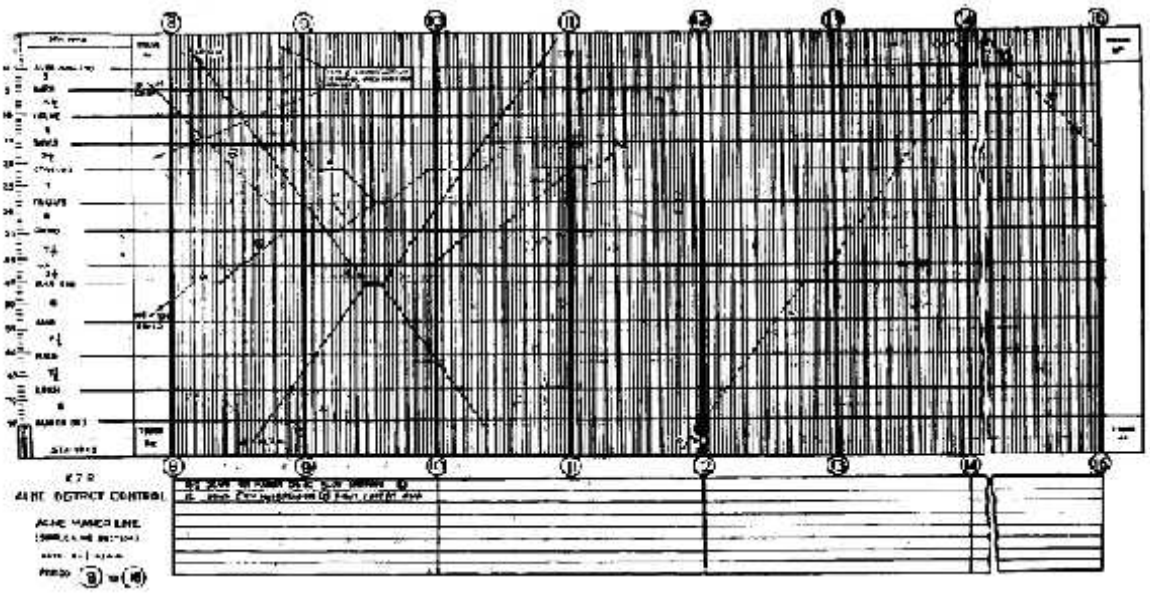


Fig.1.2. Train Control Chart

Objective Questions

1) Control or Train Traffic Control means _____
2) The means by which control of train traffic is exercised _____
3) Role of S&T in Control working _____
4) The function of proper utilization of rolling stock comes under _____control
5) Efficient utilization of Engine power falls under _____ control
6) Power Controller in electrified sections is called as _____Controller.
7) Trains movements information of a particular day can be had from _____.

Subjective Questions

1) What is the meaning of Control and what are its objects?
2) What is Central Control office?
3) Write about control organization at divisional headquarters.
4) Write about different types of Controllers available in a Control Office.
5) What are the functions of control? Write about any function.
6) What do you understand by a Way station? Which are all called as way stations?
7) Explain about Train Control Chart?

CHAPTER-2

CONTROL COMMUNICATION SYSTEMS

2.1 Control Communication

The speech communication facility provided between a divisional control office and all the way side stations falling under its jurisdiction for the purpose of facilitating **supervision** and **control** of train traffic movements is generally known as the **control communication**.

2.2 Control Circuit

Every section controller in the control office is provided with **an independent speech communication link** which enables him to speak with any way side station in his control section. This independent speech or telephone communication link is called a **Control circuit.** Hence the control communication contains number of such control circuits to cater to the communication needs of various controllers/sections present in the control office.

2.3 Generally, the following types of circuits are possible for providing speech communication.

(a) **Point-to-Point Circuit:** Point-to-point communication circuit is generally used between two subscribers, when secrecy is to be maintained. The number of lines will be proportional the number of subscribers. This circuit is not economical for train control working in view of the large number of lines required to be drawn between control office and way stations.

(b) **Party Line Circuit:** In a party line circuit, more than two subscribers are connected to a single line and the individual subscribers are called by a system of coded ringing. Generally magneto ringing is used in this system and the code consists of combinations of long and short rings. Combinations in this method are limited since a multiplicity of codes leads to confusion and the required number is not always obtained due to incorrect decoding of the signals especially when they are combinations of short and long rings. Hence, this circuit is normally limited to 4 subscribers for efficient working. In view of the large number of way stations in a control circuit, this system is also not suitable for train control working.

(c) **Omnibus Circuit: (2 wire or 4 wire):** In an omnibus circuit all the users or subscribers are connected to a single speech channel or circuit. For calling any individual subscriber, a unique selective calling code is implemented. This circuit is suitable for railway control working because it can accommodate large number of subscribers or way stations on a single control circuit.

For this reason the **omnibus circuit** configuration is adopted for all railway control circuits. On this type of line, secrecy cannot be maintained among the individual subscribers but this is not at all a problem since railway control circuits are meant for official communication related to trains working.

2.4 Railway Control Circuits: Railway Control Circuits are omnibus telephone circuits which provide communication with each train working point, thus facilitating efficient train operation. They should provide satisfactory and reliable communication between the controller and the various way-side stations, important signal cabins, loco sheds, yard offices etc.

2.5 Types of Communication arrangement for efficient train operation: According to traffic requirements and to cater to the needs of an Electric Traction area or a Non-Electric Traction area, following Railway Control Circuits is provided:

Types of Communication Circuits

Non-RE Area

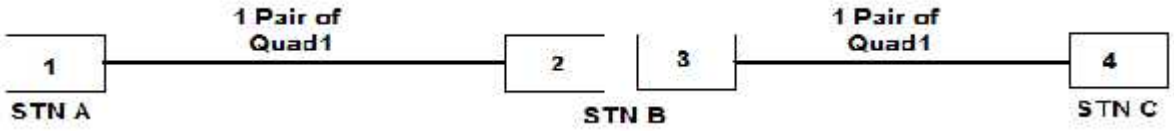
a. Block
b. Section Control
c. Deputy Control
d. Emergency Control
e. LC gate phone
f. BSNL phone
g. Railway phone
h. 25 watt VHF communication
i. S&T control

RE Area

a. Block
b .Section Control
c. Deputy Control
d. Engineering Control (optional)
e. Emergency Control
f. Traction Power Control
g. Traction Loco Control
h. Remote Control
i. S&T Control (MOW)
j. 25 watt VHF Communication
k. Railway phone
l. BSNL Phone
m. MTRC
n. IB Phones
o. LC gate phones

a) Block Circuit:

1. It is a point to point communication circuit.
2. Provided between adjacent stations for speech and bell circuit.
3. It is interconnected with gate signal.
4. Quad no.1 is allotted for this circuit.

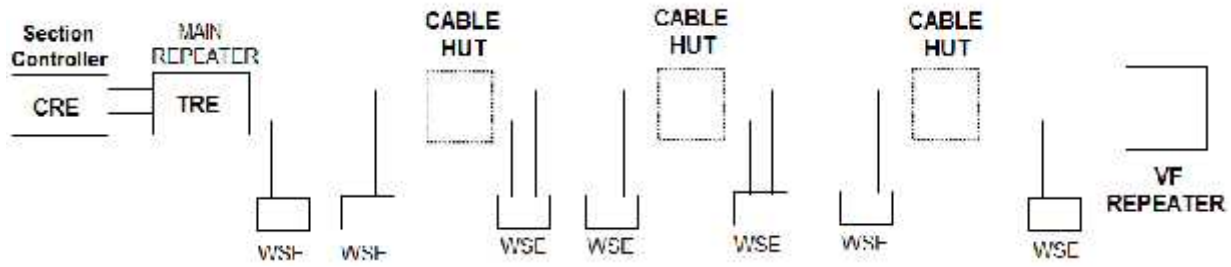


NOTE:-

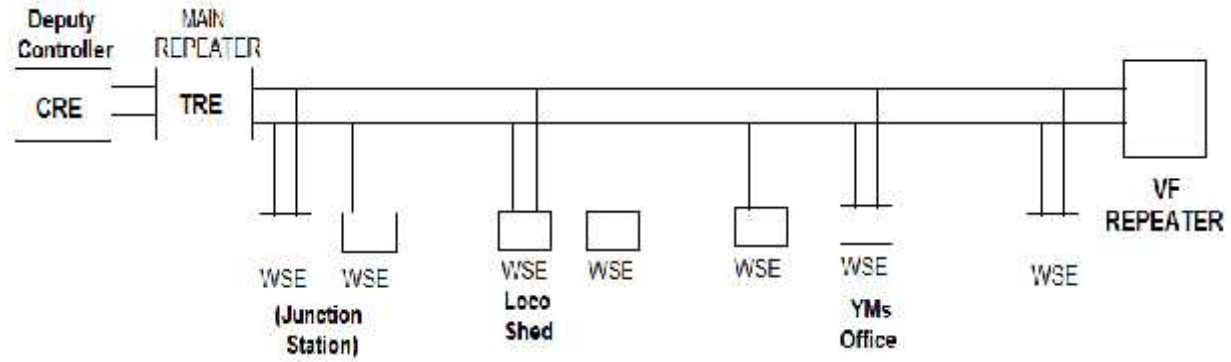
1. Block instument towards Station B
2. Block Instrument towards Station A
3. Block Instrument towards Station C
4. Block Instrument towards Station B

b) Section Control: This is provided for communication between the Section Controller in the control office and all wayside stations, junction stations, block cabins, loco sheds and yards in a control section for the control of train movements and effective utilization of section capacity.

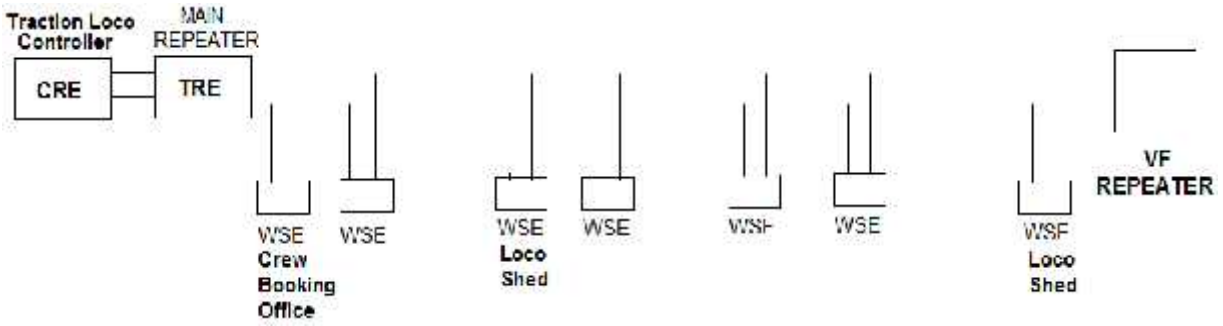
I. Section Control is provided mainly to control the movement of trains within the control section given.
II. Every division contains such section control circuits.
III. The locations connected in the section control circuits are all track side railway stations, yards, Loco sheds, Goods sheds and residences & chambers of important officials concerned.
IV. The section control circuits are provided both in RE and Non-RE Sections.



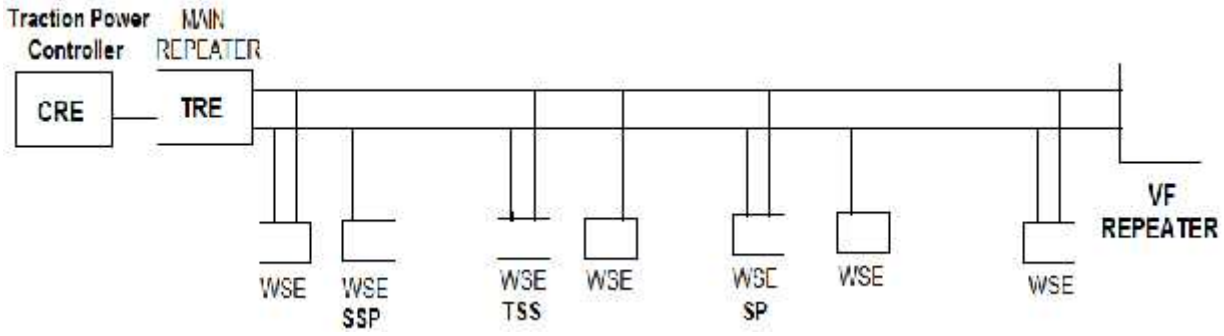
c) Deputy Control: This is provided for communication between the Deputy Controller in the control office and Way Station Equipments at important stations, junctions & terminal stations, yard master's offices, loco sheds and important signal cabins in a division for supervisory control of traffic operation in general and for collecting particulars such as yard reports and mid-night figures, for getting information on the movements of rolling stock, train ordering, etc. in particular.



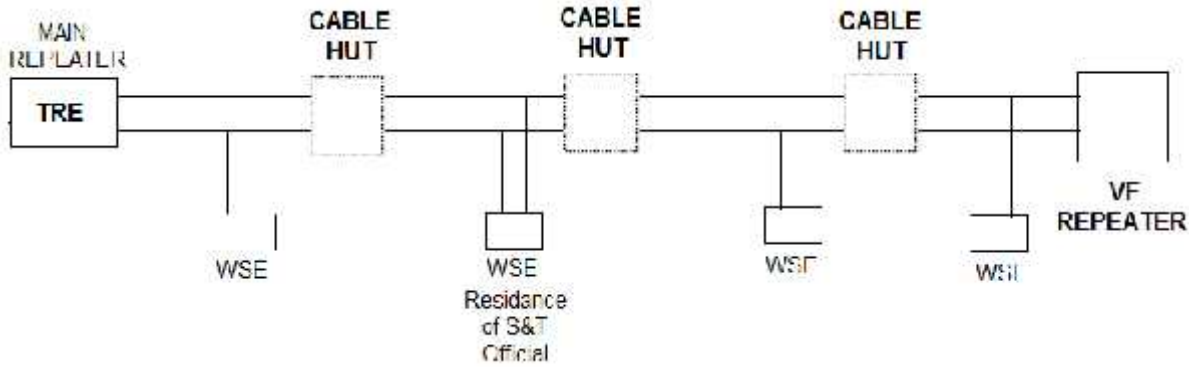
Traction loco Control: This is provided for communication between the Loco Power Controller in the control office and the various electric loco sheds, important stations and yards in a division for the optimum utilization of the locomotives. TLC



d) Traction Power Control: Provided between traction power controller and all way stations, TSS, SPs, SSPs and OHE maintenance staff for maintenance of OHE in RE areas.

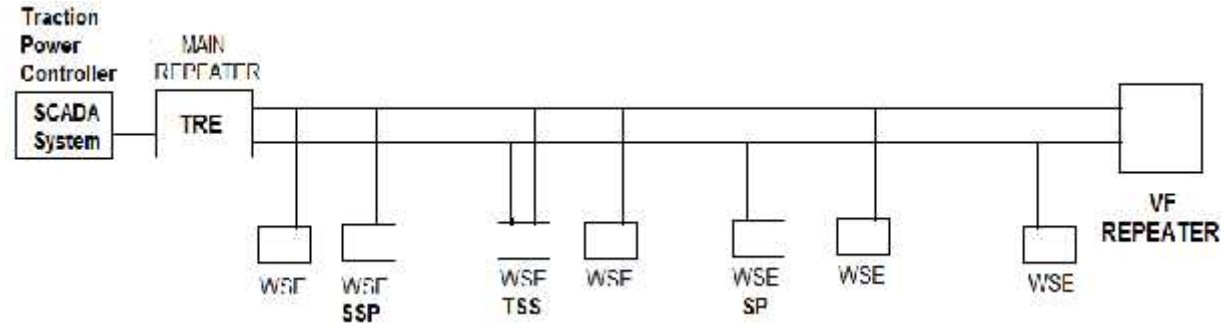


e) S&T Control: Provided between test room and way stations and residences of S&T officials for effective maintenance of S&T equipments.



f) Engineering control is mainly used for controlling maintenance activities of engineering department like track maintenance, ballast movement, line blocks etc. It is optional.

g) Remote control is meant for remote operation of 25 KV Traction equipments, which works on Supervisory Control and Data Acquisition Systems (SCADA) principle.



h) Emergency Control: Provided from midsection along the track route, for communication with TPC / SC at Control office. This is for the use of driver/guard, OHE staff and Permanent way staff in case of any emergency. For this purpose at every one Kilo meter, EC socket is provided on Quad cable. The emergency sockets are provided on rail posts at an interval of 1 Km (Max.) along the route. They are also provided at TS/SP/SSPs.

i) Emergency Wireless Control Communication: It is provided between control office/way stations and train crew for use in emergencies. Example:

a. **Mobile Train Radio Communication(MTRC)**

This type of communication is provided only in some railways and is meant for the communication between.

a. Driver and S/C
b. Guard and S/C
c. Driver and station master
d. Guard and station master

b. **VHF system:** 25 Watt VHF sets are provided at every station for communication between adjacent stations during block/control failure.

5 Watt walkie-talkie sets are provided to Driver/Guard to communicate with each other and with the nearest station master.

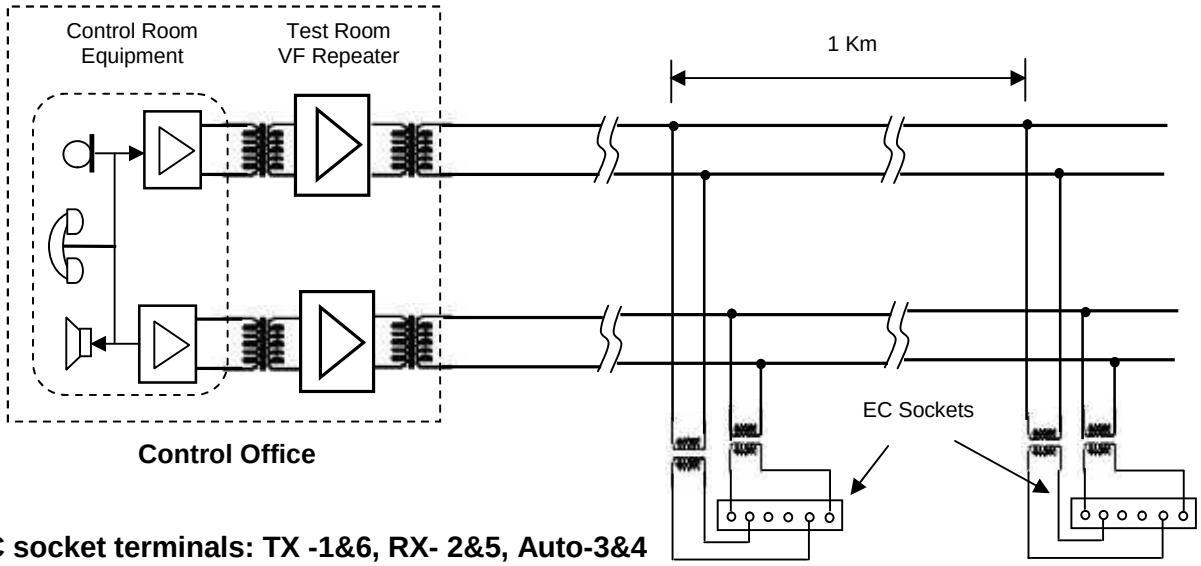
2.6 The Emergency Control Circuit

In non-electrified sections provided with over head line wires for control working, to contact the controller by the maintenance staff or Train Guard in emergencies, a 2-wire portable telephone and a telescopic tubular pole are provided to them. During emergencies they have to hook the portable telephone to the overhead line wires directly using the telescopic tubular pole to establish communication with the controller.

When circuits are through underground cables, it is not possible to connect a portable telephone to the control wires to establish communication between control office and any point on the railway line. To get over this difficulty tapings are provided from the underground quad cable at intervals of about 1 KM and these are terminated on 6-pin socket. The control office can be contacted by plugging a portable control telephone into any of the sockets.

As per Railway Board guide lines Quad no.3 is used in 6 Quad cable for emergency control circuit and EC sockets are tapped through isolation transformers to avoid main cable failure and any local fault on derivation cable.

The emergency control circuit is a 4-Wire circuit and works similar to any other 4-Wire control circuit. To respond to a call initiated from an emergency socket, generally a microphone and a loud speaker are provided with TPC. A separate quad is allotted for the working of the emergency control circuit. The line diagram showing the connectivity of emergency control circuit is given below. At Traction Power Controller's room, two sets of 4 wire HQ control office equipments are provided, one set for Traction Power Control working, and another for Emergency Control working which has provision for transfer of call from emergency control circuit to the Section Controller if needed.

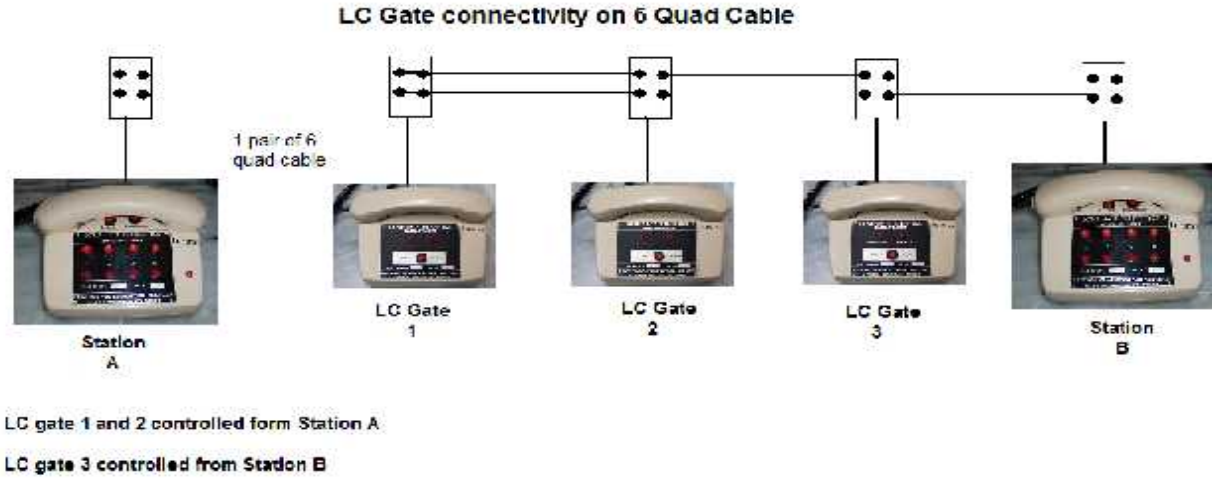


EC socket terminals: TX -1&6, RX- 2&5, Auto-3&4

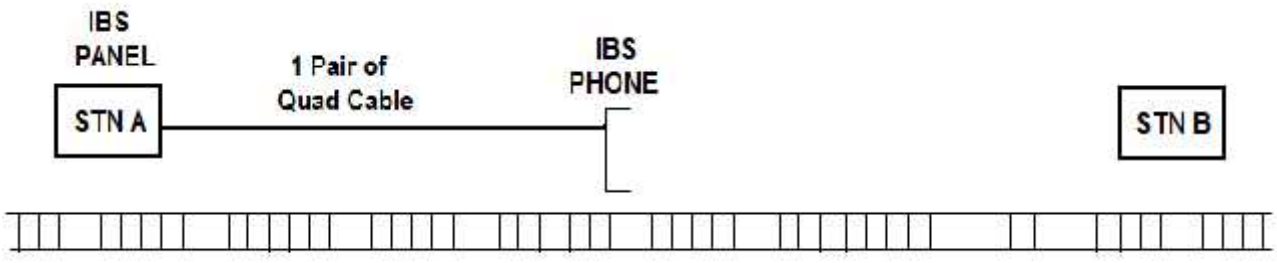
Fig. 2.1 Layout of Emergency Control Circuit

2.6.1 Emergency Wireless Control Communication: Communication is also provided in some sections of Indian Railways by wireless communication networks like MTRC or VHF link etc. for the purpose of communication between a moving train and the control office or nearest ASM office.

2.6.2 LC Gate Communication: It is meant for the communication between station master and the gateman at the Level Crossing Gate.



2.6.3 Intermediate Blcok Telephone: It is provided for the communication between driver of the train and the station master in the rear station.



2.7. Media used in Control Communication

Following media are used for control working on Indian Railways.

a) Overhead lines
b) Telecommunication RE cable used in Railway electrified areas
c) 4 quad PET cable
d) 6 quad PET cable
e) Optical Fibre cable

Among the above mentioned media, the Over head lines and RE cable have become almost obsolete.

In sections where fiber optic communication system is available, it will be used for providing control communication, and any one of the cables listed at (b) to (d) above, is used for extending Emergency control circuit, Block circuit, LC gate communication and some other circuits between adjacent way stations.

2.8. Implementation of Control Circuits

The control circuits can be implemented by any one of the following means:

a) 2-wire line on Overhead Alignment *or*
b) 4-wire line in Underground Cable *or*
c) VF Channel in a OFC communication System *or*
d) MTRC or VHF Communication System (only for Emergency Communication)

Among these, the 2-wire line on the overhead alignment cannot be used in RE-areas because it is prone to very high induced voltages due to the 25 KV AC traction supply. Its usage in new sections has been stopped as per railway board's policy. The second and third methods are suitable for both RE and Non-RE areas.

2.9. Why 4-wire line in Underground Cable Systems?

In underground cable communication circuits, due to the high attenuation offered by the thin conductor wires, there is a need for the use of speech amplifiers in both the directions. As an amplifier is a unidirectional device, two separate amplifiers are required for boosting both-way speech on control circuit. Because of this the 4-wire working is chosen whenever underground cable media is employed for control communication.

2.10 Requirements of the Control Circuit

A railway control circuit has to be designed to provide both speech communication and signaling facilities by satisfying the following requirements:

(a) Speech requirements:

I. Speech between the controller and the farthest station should be acceptable irrespective of the number of wayside stations listening.
II. The controller and the wayside stations should be able to have conference facilities.

(b) Signaling requirements:

I. The controller should be able to call any station along the route or a group of stations or all stations simultaneously.
II. The controller should get an audible indication when the bell at the called station rings.

2.11 Special Signaling Requirements of an Omnibus Circuit

As an omnibus circuit is shared by number of parallel subscribers, normal type of signaling which is employed on telephone circuits cannot be used because it leads to ringing of all the subscribers connected on the omnibus circuit, at a time. Because of this reason, we need a special type of signaling arrangement which enables selection of individual subscribers even on this common omnibus line. This special type of signaling is called **Selective Calling System.**

2.12 Selective Calling Systems implemented in Indian Railways:

Since our railway control circuits are omnibus in nature, we need to use, as mentioned above, the same selective calling method of signaling which is required for omnibus circuits. So far the following types of selective calling techniques have been implemented on Indian railways for control circuits. These are given in chronological order.

2.13 STC key sending system
2.14 Push button system
2.15 Dual Tone Multi frequency (DTMF) System

In the above mentioned systems, the first two have become obsolete and only DTMF signaling system is presently in use.

Dual Tone Multi Frequency (DTMF) System: In this system for every key pressed in a push button panel two frequencies are being transmitted simultaneously as per the standard DTMF frequency plan. 2 digit codes are used to call either one station at a time or a nominated group at a time or all at the same time.

2.13 Description of the DTMF Signaling system

DTMF is a system of signalling originally evolved for the transmission of dialling information to automatic telephone exchanges from subscriber's telephones. In this system two tones of frequency within the voice band are sent out on line corresponding to a given digit. Among these two frequencies one is below 1000Hz (row) frequency and the other is above 1000Hz (column) frequency, both within the VF band. The transmission of the tones is so fast (typically in millisecond) that the signalling does not interfere with the speech at all.

DTMF Tones → / Row Frequencies (Hz) ↓	Column Frequencies (Hz) 1209	1336	1477	1633
697	r1+c1 1	r1+c2 2	r1+c3 3	r1+c4 A
770	r2+c1 4	r2+c2 5	r2+c3 6	r2+c4 B
852	r3+c1 7	r3+c2 8	r3+c3 9	r3+c4 C
941	r4+c1 G	r4+c2 0	r4+c3 LR	r4+c4 D

Fig. 2.2

Why two tones? Since the signalling tone is in-band (within voice band), any voice simulation should not be recognised as a tone pulse, and that is why two tones, which are harmonically unrelated, are used. Another reason is O/H line noise or line whistles should not be recognised as a signal.

The tones are so chosen and recommended by **ITU (T)** that minimum inter modulation occurs between each of the 16 possible tone pairs. One tone from the low frequency group and one from the high frequency group are paired to mark the keyboard output. Since the tones are in VF range, the signaling can be transmitted on the same speech transmission medium such as the O/H lines and U/G cables.

The keypad is a 4x4 matrix type as shown in the figure 2.1. Each digit on the keypad is represented by two tones (or frequencies) i.e. one row frequency and one column frequency. There are **four** Row frequencies-r1, r2, r3, r4 and **four** Column frequencies-c1, c2, c3, and c4.

2.14 Advantages of DTMF selective calling system

The DTMF Selective calling system is adopted for Railway Control communication because of the following specific advantages.

(a) For Selective calling, group calling and general calling on O/H lines system (2W) or U/G cables (4W) system, the DTMF signalling is adaptable. Low level signalling, 500mV typically.
(b) Signalling is fast compared to the pulse mode signalling. Signalling period is same for all the digits keyed.
(c) A maximum of 99 Way Stations can be connected as against the 78 stations in 17-impulse system previously used.
(d) No moving parts, as the equipment is entirely solid state. A significant improvement in system reliability. Also reduction in hardware.
(e) No adjustments of voltage/current are involved at any of the Way stations irrespective of location, and hence absolutely maintenance-free.
(f) The system is immune to line noises and line distortion and hence poor line conditions do not degrade the performance.
(g) Ideal for establishing local control from the accident sites.
(h) A tone generator IC generates the DTMF tones. The system is readily adaptable for patching to any voice channel over UHF, VHF, microwave or OFC networks without any special arrangements for patching.

With the above advantages the DTMF Signaling has superseded all other types of selective calling systems. Because of this, the DTMF Signaling is chosen for fulfilling selective calling requirements of all Railway Control communication systems of present-day.

2.15 Systems of Control Communication: The type of control communication network to be provided is decided by the type of media deployed between the control office and the way stations. Based on the media used, presently the following types of control communication systems are being used in Indian Railways.

1) Under Ground Cable Based 4-Wire Control Communication System

a) Conventional System - Using RE Main cable with Loading.
b) Equalizer Amplifier System - Using 4/6 Quad PET cable without Loading.

2) OFC Based Control Communication System

2.16 General Requirements of The Control Communication System

Any system to be adopted for control communication system should fulfill the following requirements, as laid down in the telecom manual.

1) The headquarters equipment provided with the controller should have facility for selectively calling any one station or a group of stations at a time or all stations at a time.
2) A ring back tone shall be provided to automatically inform the controller whenever the bell/buzzer at a way station rings in response to the call initiated by him.
3) The signaling used for selective calling shall not hamper normal telephone conversation on the line.
4) Wherever traffic is light, and the circuit is not manned round the clock, facilities may be provided to call the attention of the controller by the way-stations, if required.
5) Adjustment and maintenance of the equipments in the control office and way-side stations should be easy and simple.
6) The equipment should be rugged and capable of intensive use.
7) The equipment should work satisfactorily within allowable margins of line characteristics without frequent critical adjustments.
8) The system should be capable of progressive expansion without any replacement.
9) The system should be compatible with open-wire lines and underground communication cables (both 4-wire and 2-wire working), and carrier circuits works on radio.
10) Feature of prolonged ringing of any way-station is desirable.

Objective Questions:

1) Railway control communication circuits are of _____ type circuits.
2) Type of signaling system suitable for control circuits is _____
3) Emergency control sockets are provided on rail posts at _____km intervals.
4) Name any one control circuit used only in RE sections. _____
5) No. of tones used in DTMF system. _____
6) Maximum no. of way station codes available in DTMF system. _____

Subjective Questions:

1) What is Control communication and control circuit? Name different control circuits used.
2) What are the requirements of control circuits?
3) List out the general requirements of control communication system.
4) Mention different types of speech (or telephone) circuits. Why only Omnibus circuit is adopted for railway control circuits?
5) Mention different control circuits used in RE and Non-RE areas and also briefly describe about important control circuits.
6) Mention different types of control circuits and their usage
7) Explain about the following controls
   a) Traction power control
   b) Remote control
   c) Section control
   d) Deputy control
8) Explain about Emergency control circuit with a simple sketch.
9) What is selective calling system and why it is used on railway control circuits?
10) List out different types of selective calling techniques
11) Explain about DTMF selective calling system
12) What are the advantages of DTMF signaling?

CHAPTER-3

DIFFERENT CONTROL COMMUNICATION SYSTEMS & EQUIPMENTS

3.1 Present day scenario of Control Communication Systems

1) The overhead 2-wire system is almost obsolete and is available in some branch lines or less important routes.
2) The underground cable based Conventional System is widely and extensively used throughout the Indian Railways and accounts for a large share.
3) The other type of underground cable based system, 4/6 Quad PET Cable Equalizer Amplifier System is a new system introduced in recent years which drastically reduces the number of joints to be made on the underground cable. The need of loading the cable is also eliminated.
4) The OFC based control communication system is the latest trend and it is gradually replacing all the other control communication systems.
5) Wireless Emergency Communication through MTRC/ VHF for Train to Control Office direct Communication.

3.2 Underground Cable Systems:

Presently there are following two underground cable systems:

a) Conventional System - Using RE Main Cable with Loading and 4/6 Quad Cable with Loading.
b) Equalizer Amplifier System - Using 4/6 Quad Cable without loading.

3.3 Conventional System & Its Equipments

Irrespective of the Control Communication system used, the following two equipments are compulsory and these equipment should comply with the RDSO specification No. **IRS TC: 60/2007.**

(a) Control Office Equipment and
(b) Way Station Equipment

In addition to these, in Conventional system using underground cable media, following equipments are required.

(c) VF Repeaters
(d) Isolation Transformers

These two equipments are provided at fixed intervals along the entire route.

3.4 DESCRIPTION OF THE EQUIPMENT:

3.4.1 Control Office Equipment: (RDSO Spec - IRS TC: 60-2007)

This is provided with the controller in the control office at the divisional head quarter. With the help of this equipment the controller can selectively call any required way station in the section and can talk to the SM in regard to the movements of trains in the section. The equipment comprises -

a) Controller's Console
b) Table Microphone
c) Loud Speaker
d) Power Supply Unit

The controller calls any way station by sending a 2 digit DTMF station code using the keypad. The called station code is displayed on the 2 digit 7-segment LED display panel. When the controller keys-in the 2 digit code of a station the DTMF encoder circuit converts these 2 digits into DTMF codes and transmits on the line to the way stations. When a way station responds to his call, the controller talks to him using either handset or mic & loudspeaker combination.

3.4. 2Way Station Equipment: (RDSO Spec - IRS TC: 60-2007)

This equipment is provided at every way side station along the track and also at yard master offices and loco sheds etc. This equipment consists of -

(a) DTMF Decoder & Buzzer
(b) Speech Amplifiers
(c) Control Telephone and
(d) Power supply unit

On receiving a DTMF station code from the controller the DTMF decoder circuit decodes and compares it with the pre-set station code. If the received code matches with station code the buzzer rings and catches the attention of station master. The station master then lifts his telephone hand set and talks with the controller.

3.4. 3 Conventional type VF Repeater: (RDSO Spec - IRS TC: 50-90)

This equipment is generally placed at every 50 Km intervals along the track. It accommodates a pair of amplifiers - one each for **Trans** and **Receive** direction, for every control circuit. These amplifiers compensate for the losses or attenuation introduced by the quad cable conductors, joints, equipment tapings etc. Each amplifier offers a maximum gain of 24 dB. There are three types of VF amplifier modules in this equipment

(a) VFR module - two VF amplifiers
(b) VFL module - two VF amplifiers plus a leak amplifier
(c) Buffer module - two VF amplifiers for branching purpose

3.4. 4Isolation Transformers: (RDSO Spec - IRS TC: 22-76)

These transformers are provided at every way station, in cable huts, on the underground cable circuits. One transformer is required for each pair of a quad. These transformers are used for isolate the induced AC voltage in RE-areas.

3.4. 5Cable Hut

Generally the isolation transformers are mounted on a rack and this rack is placed inside a small room, constructed along the track side, is called Cable Hut. Due to 25KV AC traction line, 8.75volts per kilometer is induced in every conductor of the screened cable. When the induced voltage increases above 150V it is dangerous for maintenance staff and for equipments. Therefore cable huts are located at every 17 KM along the track to isolate this induced voltage.

3.5 EQUALIZER AMPLIFIER SYSTEM (RDSO/SPN/TC/34/2002)

The control communication system so far discussed was used very extensively all over the Indian Railways and is known as conventional system. To overcome the difficulties faced in that system, a new control communication system is introduced with a new concept. This system is called as Equalizer Amplifier type VF repeater. In this system, instead of Repeater Amplifiers at fixed intervals, Equalizer-Amplifiers are provided at every way station.

3.5. 1What is Equalizer Amplifier?

This is an amplifier followed by an equalizer circuit which provides equalization as well as amplification of VF frequencies. This amplifier performs the role of a repeater amplifier of the conventional system.

3.5. 2What is Equalization?

Railway control circuits are working on very long distance cables spanning over a few hundreds of kilometers. The frequency response of these long distance cables is not flat over the entire VF (voice frequency) range. High frequencies are more attenuated than low frequencies, as a result of which the signal levels of higher end frequencies in VF band get reduced. To correct for or to boost the reduced levels of high frequencies Equalization is used.

3.6 Special Features of Equalizer Amplifier type Control Communication System

1) It eliminates the need of intermediate repeater stations and cable huts.
2) It also eliminates loading of the Quad Cable.
3) With the use of this new system, all the joints needed on RE Quad Cable except the normal joint are dispensed with.
4) Due to this the time required for jointing the entire length of cable is drastically reduced.
5) It also eliminates the need of leak amplifier in the terminal repeater in test room.
6) It offers 4-way connectivity at every way station.
7) This system also offers remote monitoring and management of way side stations from the test room.
8) At wayside station an 8 line local intercom facility is also provided.

3.7 Comparison Between Equalizer Amplifier and Conventional Systems

S.No	Equalizer Amplifier type System	Conventional Type System
1	Loading of the cable is not needed.	Loading of cable is very essential in this system
2	Balancing is done in the way station equipment itself, but not directly on the cable	Balancing of the cable is provided through balancing joints directly on the cable
3	Only **normal joint** is required on the cable. All other types of joints are dispensed with. (But for EC socket derivation is required at every 1km.)	All types of joints are required on the cable.

4	Reduction of joints drastically reduces the time needed for Cable jointing. Hence this system can be commissioned within very short duration	More time is consumed for jointing the cable itself. Hence, very long time is needed for commissioning this system
5	No separate VF repeaters stations & cable huts are required at any place along the cable route as these are combined with the way station equipment itself.	Provision of VF repeaters & cable huts at fixed intervals is required along the entire cable route
6	Remote monitoring and controlling of way stations is possible and hence can be managed unmanned.	No remote monitoring and controlling of way stations is possible
7	Auto-bypassing of way station is available, in case of power failure or any other fault in the control circuit.	No such facility is available
8	Local 8-line intercom facility can be provided, optionally, at way stations.	No such provision is available in this system
9	Required Equalization slope can be chosen, out of many possible slopes, simply by DIP switch settings	This is not possible in this system
10	Built-in provision for Radio patching is available through the 4-way amplifier	Separate arrangement is to be made for Radio patching
11	No need of any Leak amplifier	Leak amplifier is required for communication among way stations
12	Cost of each way station equipment is very high	Cost is very low for way station equipment
13	This system offers maximum FOUR control circuits only	This system can offer more number of control circuits.

Table-3.1

3.8 Equipments in Equalizer Amplifier System (RDSO/SPN/TC/34/2002)

The following equipments are used in Equalizer Amplifier system. All these have to comply with RDSO draft specification **RDSO/SPN/TC/34/2002.**

(a) Control Office Equipment
(b) Way Station Equipment and
(c) Test room Equipment

3.9 Control Office Equipment:

This equipment is the same as that used in conventional system with the following minor modifications.

I. It suits quad cable of 470 ohm characteristic impedance and
II. 3 digit / 2 digit dialing mode can be selected

3.10 Way Station Equipment:

The way station equipment used in the equalizer amplifier system is totally different from that of conventional type system. This equipment accommodates both the VF amplifiers and isolation transformers, in addition to the DTMF decoder. It consists of the following modules.

(a) Equalizer Amplifier
(b) Isolation Transformers
(c) DTMF Decoder
(d) Remote monitoring and Battery Management
(e) Local 8-line Intercom exchange
(f) Power Supply unit and
(g) Control Telephone

3.10. 1 Equalizer Amplifier

This module accommodates two equalizer amplifiers one for trans direction and another for receive direction. In addition to these two there are two buffer amplifiers also for providing 4-way connectivity. The following figure shows the 4-way connectivity of an equalizer amplifier. Each equalizer amplifier gives a max. gain of +20dB each. The gain can be varied through DIP switches providing an attenuation of 0 to 10dB.

In addition to these circuits the equalizer amplifier card also accommodates two Buffer circuits. With the help of these four circuits, ie., two amplifiers and two buffers, it provides a facility for **4-way connectivity** at every way side station as shown below.

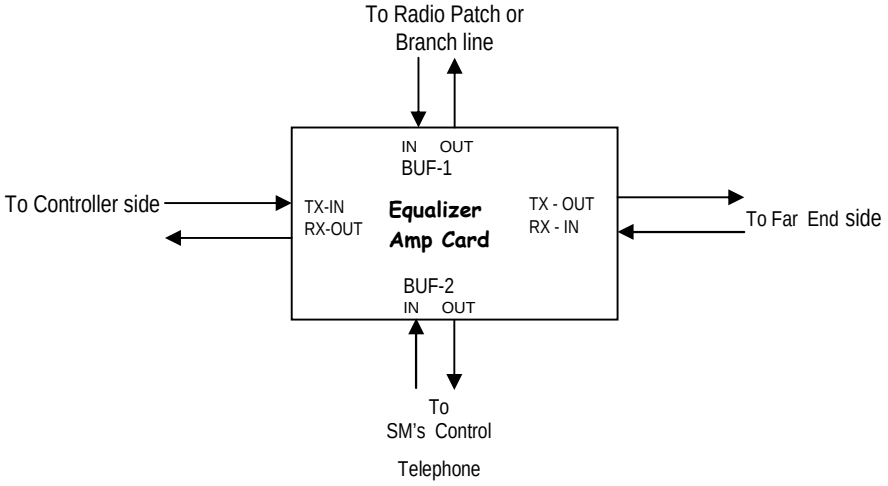


Fig.3.1 The 4-Way Connectivity of Equalizer Amplifier

The gain, attenuation and equalization of both trans and receive amplifiers are selected with DIP switches. For example the DIP settings in M/s Indisco make system are given in table 3.2 and table 3.3 below.

DIP S -7 TRANS Gain **DIP S - 8 TRANS Attenuation**
DIP S -3 REC Gain **DIP S- 4 REC Attenuation**

1	2	Amp Gain
OFF	ON	5dB
ON	ON	10 dB
OFF	OFF	15 dB
ON	OFF	20 dB

Table-3.2

1	2	3	4	Amp Attenuation
ON	ON	ON	ON	0 dB
OFF	ON	ON	ON	1 dB
OFF	OFF	ON	ON	2 dB
OFF	OFF	OFF	ON	3 dB
OFF	OFF	OFF	OFF	4 dB

Table-3.3

3.10. 2 Isolation Transformers

This card is housing 4 pairs of isolation transformers, one pair for each direction of the 4-way connectivity equalizer amplifier. These isolation transformers provide an impedance of 470Ω towards line side. There is also provision for adding balancing condensers on this card.

3.10. 3 DTMF Decoder

This card or module provides the same function as that of the way station decoder in the conventional type control system. Two DIP switches are provided for selecting the 2-digit station code.

3.10. 4 Remote Monitoring & Battery Management System

A Remote monitoring facility is provided in equalizer amplifier type control communication system. This facility offers disconnection, reconnection, battery voltage monitoring, power supply status monitoring and sending alarm to test room in case of power supply failure at way stations. In addition to this it also offers battery management function at way stations.

3.10. 5 Remote Monitoring & Battery Management Cards

The remote monitoring feature is provided through a set of two modules one of which is installed in the test room equipment and the other in every way station equipment. These two modules are

(a) Remote Monitoring - Master card (at Test Room)
(b) Remote Monitoring - Slave card (at every way station)

Every way station equipment is provided with the remote monitoring cum battery management slave card (RMT BTMN slave). Each slave card is identified by its own 2-digit Remote Station-code, set by two DIP switches provided on the card. This code is separate from the 2 digit way station code used by the controller for calling way stations. The slave card performs the following functions on receipt of remote commands from master.

a) **disconnects** the line and the equipment on any of the 4 sides
b) restores or **reconnects** the disconnected line
c) **changes over** the batteries that are on load and charge
d) reads the **power supply voltage** to the equipment and sends to master
e) sends the **status** information of the mains and the two battery supplies to master
f) sends to local loud speaker an audible tone
g) the remote control card gets **reset**

3.10. 6 Local 8-Line Intercom Exchange

Optionally, an intercom exchange facility is offered at way stations in the equalizer amplifier system with the help of two modules. The Intercom circuit can cater for a maximum of 8 subscribers or lines, which are sufficient for providing some communication facility to the supervisory staff of various departments headquartered at way side station. Normal auto telephone instruments can be used on these lines. Telephone connections to this intercom can be extended up to a loop resistance of 300 Ω.

All 8 telephones are assigned a single-digit or 2-digit number. It is possible to enable/disable control access facility (on any one control circuit), through an access code, to all the 8 telephones from the test room. Controller can talk to any of the subscribers by dialing a 3-digit DTMF code. The first 2-digits are station code and the third digit is local telephone number ignoring first digit if 2-digit numbering is used. Conferencing facility is also available among the intercom telephones.

3.10. 7 Power Supply System

The power system provided with equalizer amplifier system consists of the following multiple power sources.

1) **Dual Power Supply Unit:** It has two separate rectifiers-cum- chargers which derive 12V DC from the mains 230V AC supply. The outputs of both these chargers are combined and used (O Red through two diodes) for battery charging.
2) **NiCad Battery Set:** Two separate rechargeable batteries of 40 AH each are provided for fulfilling the load requirements of way station equipment. One of these batteries supplies the equipment load while the other battery gets charged. Auto-change over of batteries takes place once the load battery voltage drops to 11.5 volts. The two batteries can feed the equipment for 72 hours.
3) **Solar Supply:** Provision is also made for connecting solar supply to the equipment for charging the battery during mains failures.

3.10. 8 Control Telephone

A telephone instrument without dialing facility is provided at the way stations to enable ASMs to converse with the controller. This instrument is similar to the one used in conventional system.

3.11 TEST ROOM EQUIPMENT OF EQUALIZER SYSTEM:

Test room equipment plays vital role in the equalizer type control communication system. It is used to perform the general maintenance functions like sending way station codes for checking the ringing at way stations and also for fault localization and restoration purposes. In addition to this it is used to perform remote operations on the way station equipments. The Controller equipment is connected to the quad cable via the test room equipment. The test room equipment consists of the following units.

(a) DTMF Keypad & Display
(b) DTMF Tones Transceiver
(c) Handset & Loud speaker
(d) Remote Monitoring & Battery Management unit (master)
(e) Equalizer Amplifier
(f) Isolation Transformers
(g) Dual Power supply unit

3.11. 1 DTMF Keypad & Display

A keypad with 16 keys, which is same like the keypad provided on the Controller's Equipment and a 4-digit 7-segment LED display are provided on the test room equipment for testing and remote monitoring purposes. The display is 4-digit wide because the remote command codes are 4-digit long.

Fig.3.2 Remote Monitoring Panel

3.11. 2 DTMF Transceivers

A set of a DTMF tone generator and a DTMF tone decoder is provided in the equipment for the sake of sending and receiving DTMF codes respectively. The test room equipment receives DTMF reply signals during remote operations and SOS codes during power supply failures at way stations.

3.11. 3 Handset & Loud speaker

A Handset is provided with the equipment for the purpose of communication with way stations or controller. The loud speaker is for monitoring the speech between the controller and way stations.

3.11. 4 Remote Monitoring & Battery Management (Master)

The master card is provided in the test room equipment to send remote control commands to any way station slave unit to perform remote operations at the way station and also to receive test acknowledgements as well as SOS codes from way stations. It performs the following remote operations at way stations.

(a) cut or disconnect the line and the equipment
(b) restore or reconnect the disconnected line
(c) changeover of batteries
(d) read the power supply voltage to the equipment
(e) know the status of the mains supply and the two battery supplies
(f) send a tone
(g) reset all remote control cards

All these operations can be performed at a time on any three of the control circuits chosen. The remaining three modules are same like in way station equipment. These are

(a) Equalizer Amplifier
(b) Isolation Transformers
(c) Power supply unit

3.12 DESCRIPTION OF DTMF CONTROL COMMUNICATION EQUIPMENT

Now let us study about the DTMF Control equipment which includes the Control office equipment and the way station equipment.

3.12.1 CONTROL OFFICE EQUIPMENT (IRS TC - 60 /2007):

1) Operating Requirements:

(a) The technical requirements of the DTMF control office equipment should comply with the RDSO specification **No. IRS TC - 60 /2007**.
(b) The system shall permit working of voice communication and signaling on an omnibus circuit tapped at way stations and other places, on 4 Wire or 2 Wire basis as required.
(c) It shall be possible to call maximum of 99 stations with 2-digit codes either one at a time or a nominated group at a time or all at the same time.
(d) Audible indication to the controller when called station has been rung shall be provided.
(e) Every station shall be assigned a distinct calling code. In addition, a nominated
(f) group of stations may be assigned a group calling code. 4 such groups should be provided in the system. The push buttons should be designated as A, B, C & D. The push button for General call shall be designated G for calling all stations at the same time.
(g) The station code generation and transmission shall be accomplished by pressing two push buttons in a sequence. The group code/ general call code and transmission shall be accomplished by pressing relevant push button twice.
(h) The facility to repeat the last code transmitted by pressing one single push button designated RT shall be provided.
(i) The duration of the ringing at way station shall normally be 4 seconds (+/- 0.5 second). However, facility shall be provided to extend this period as long as desired by pressing a single push button designated LR by repeatedly sending the last transmitted code after every 4.5 seconds.
(j) It shall be possible to send the signaling code even when two or more parties are in conversation and also to a station engaged in conversation.
(k) The station code being transmitted shall be displayed on the console. The display shall continue till the next code is generated. The two push buttons for station code should be pressed in sequence within 5 seconds. The first digit remains displayed for 5 seconds, after which it gets erased automatically. It should be possible to cancel the first digit within 5 seconds by pressing a single push button designated DL.
(l) Facility to reset the system should be provided by pressing one single push button designated RS.
(m) Facility to check the row /column frequency shall be provided by pressing push button designated RC for test mode.

r1, r2, r3, r4 : **Row** frequency group (697 Hz to 941 Hz)
c1, c2, c3, c4 : **Column** frequency group (1209 Hz to 1633 Hz)

2) General Description of Control Office Equipment

The control office equipment with DTMF signaling consists of the following:

(a) DTMF Console
(b) DTMF code generator
(c) Communication PCB consisting of Microphone amplifier, Head/Hand set transmitter amplifier & loudspeaker amplifier.
(d) Hand set
(e) Head set
(f) Microphone
(g) Loudspeaker
(h) Hybrid attachment (required for 2-Wire operation)
(i) Power supply unit

DTMF Console

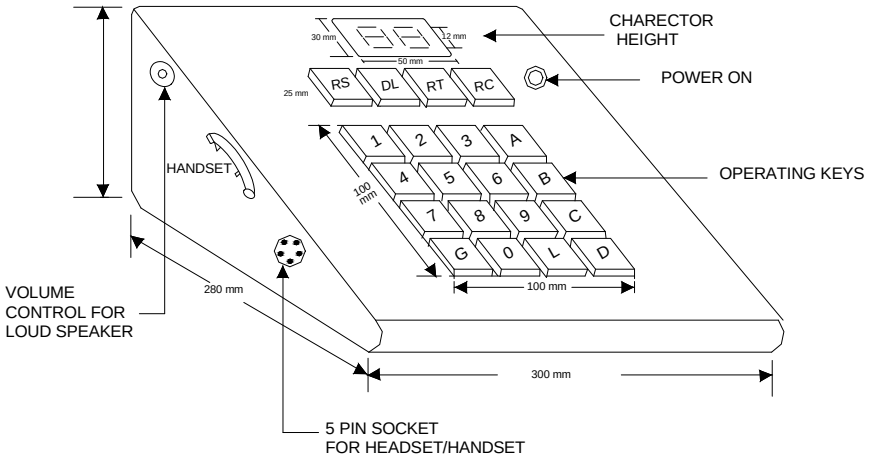
Front Panel: The Keyboard on the front consists of total 20 keys. Sixteen of these are DTMF keys arranged in 4 by 4 matrix. These are TEN decimal keys – **0 to 9** used for entering the 2-digit station codes. Then FOUR Group call keys – **A, B, C, D**, one general call key – **G** and long ring key – **LR**. For group call and general call the same key is to be pressed twice. For example; AA, BB, GG, etc. In addition to these 16 keys there are FOUR function keys – RS, DL, RT and RC.

RS – Reset key is used to reset the control office equipment, if it is required to do so at any time.

DL – Delete or Clear key used to cancel a wrong entry during the dialing process.
RT - Repeat key redials the last code transmitted.

RC – Row & Column Frequency Test key is used for generating individual row and column DTMF frequencies for testing purpose. On pressing this key the equipment goes into **frequency test mode** and outputs 1st row frequency (r1) on TX terminals on back panel. The display shows r1 indicating the output frequency. Now if RC key is pressed once again 2nd row frequency (r2) is outputted on Tx terminals. Similarly all row and column frequencies are sent sequentially one after other with every press of RC key. The equipment comes off the test mode by pressing reset key.

Fig. 3.3



DTMF CONTROL ROOM EQUIPMENT

Fig 3.4

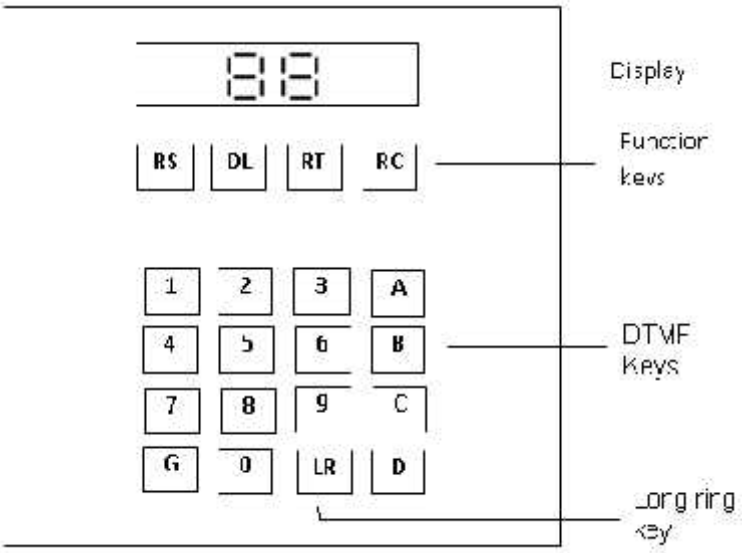


Fig. 3.5 Front Panel of DTMF Head Quarter's Equipment

Different row and column frequencies are as given below:

Display		Frequency
r1	:	697 Hz
r2	:	770 Hz
r3	:	852 Hz
r4	:	941 Hz
c1	:	1209 Hz
c2	:	1336 Hz
c3	:	1477 Hz
c4	:	1633 Hz

Long Ring key (marked LR) is used to extend the ringing duration at way stations.

Console Back Panel - The back panel consists of the following:

12 V DC Battery terminals, DC fuse holder, 6-way terminal strip having Trans (TX), Receive (Rx), LS (Loudspeaker) terminals in pairs.

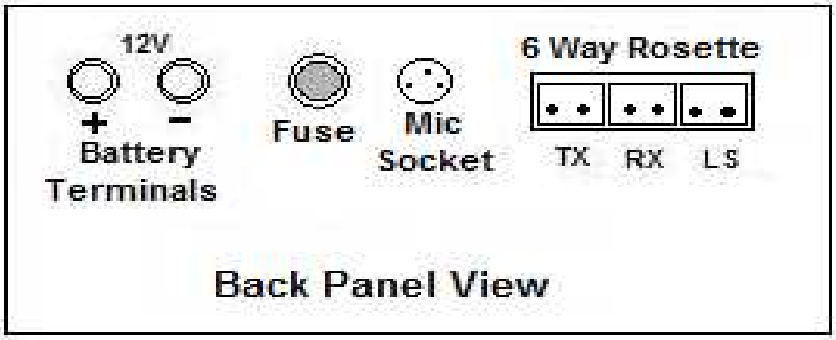


Fig.3.6 (a) Back Panel

Side Panel

Side panel consists of a volume control for loudspeaker marked as Volume and socket for the handset.

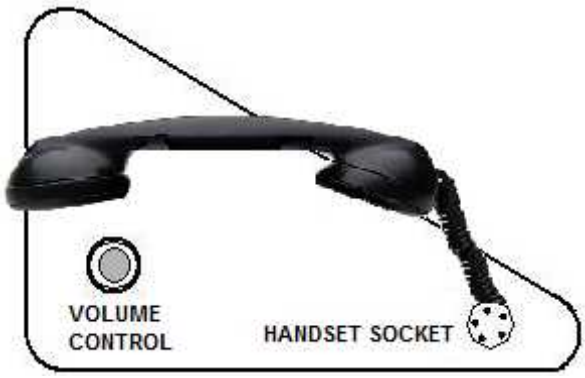


Fig.3.6 (b) Side Panel View

3) General Working Principle of DTMF Control office equipment:

For DTMF tones generation the control office equipment contains a Microprocessor or a Micro-controller. This Microprocessor/Micro-controller keeps scanning the keyboard (4 by 4 matrix) lines to check for any valid keyboard entry. As soon as a valid key closure (corresponding to the first digit of the station code) is detected, the processor/controller stores the information and display the digit pressed. The processor/controller waits for second key closure (corresponding to the second digit of the station code). If a second valid key is pressed within the specified period, the processor/controller updates the display and activates the tone generator to transmit DTMF tones for the keys pressed, in the order of key-press sequence. These tones are connected to the line through a combiner amplifier, where they combine with speech signals coming from the microphone/hand set.

In the receive direction the speech coming from the way stations is filtered and amplified before sending to the loud speaker. The block diagram of control office equipment is shown in fig. 3.7.

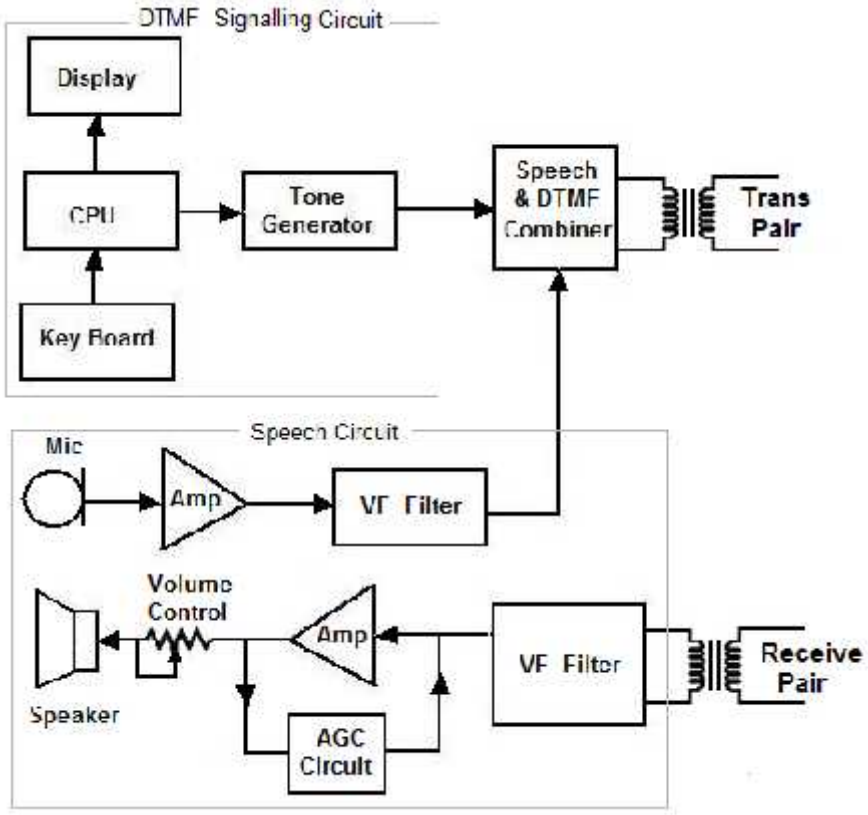


Fig. 3.7 Block Diagram of Control Office Equipment

3.12.2 DTMF WAY STATION EQUIPMENT (IRS: TC-60/2007):

1) Operating Requirements

(a) It shall be possible to assign any DTMF station code from 01 to 99 to a way station using DIP switches. And also any group code from A, B, C, D can be assigned to the way station.
(b) On receipt of the valid code, it shall be decoded and a piezo-electric buzzer shall be activated even if the hand set is off the cradle.
(c) After the buzzer in the telephone is actuated, a ring back tone shall be automatically and transmitted to the control office in acknowledgement of the receipt of ring. The level of the ring back tone when measured across trans terminals of way station equipment shall not be less than -12dBm.
(d) Along with the activation of the buzzer, a visual indication of LED shall be lit in the telephone. The LED indication shall continue to be lit until the handset is lifted off the cradle.
(e) The-output level of the buzzer shall be adjustable by means of fixed pad.
(f) The equipment shall not need manual resetting in case of power interruption. Protection from transients in power supply to be provided.

2) General Description of 4-Wire Way Station Equipment:

The DTMF way station equipment design has to comply with the RDSO specification **No. IRS: TC-60/2007**. This equipment consists of the following units.

(a) DTMF decoder & Speech circuits
(b) Control Telephone
(c) 12V DC Power supply & Battery unit

The equipment entire circuitry for DTMF decoder & speech amplifiers is assembled on a single PCB and then it is placed in a wall-mountable metal cabinet. The decoder part of the circuit performs the following functions -

(a) Receives DTMF 2-digit station code and decodes it into 2 digit decimal code,
(b) Compares it with the local code allotted to the station
(c) Switches on a piezo buzzer, if both codes are matched
(d) Sends a ring back tone to the controller, when buzzer rings and
(e) Amplifies speech signals in both directions

3) Working Principle:

In the way station decoder unit a 2-digit station code is set locally, using two DIP switch units (each of 10 switches) which are named as FD (First Digit) switch and SD (Second Digit) switch respectively. Controller transmitted DTMF code is received first at way station by a DTMF tone decoder IC which converts the DTMF tones representing the first digit into a 4-bit binary which is applied as input to a 4-to-16 line binary decoder. Depending on the 4-bit binary value only one of 16 outputs becomes high. The high signal representing the First Digit of the way station code passes through the FD DIP switch only if the setting on DIP switch matches with the received digit. This same signal after passing through the FD DIP switch triggers a ½ second Mono-shot whose output is given as input data for a Flip Flop. Similarly the second digit signal passes through SD DIP switch and applied as clock pulse to the Flip Flop. The Flip Flop output triggers another mono-shot of 3 to 5 seconds timing which drives a piezo buzzer and also activates a ring back tone (RBT) circuit. The block diagram of Way station DTMF Decoder & Buzzer Activation Circuit is given below.

4) Code Setting

Each way station is assigned a 2-digit code. It is possible to assign station codes from 01 to 99. Two DIP switch units FD and SD (containing 10 positions in each) are provided to set the station code. The appropriate switches marked 0 to 9 are to be turned ON. To receive a special group code (i.e. A or B or C or D) from controller a separate DIP switch (containing 4 positions) is provided inside the equipment. The desired special group code is selected by setting the corresponding position in the switch.

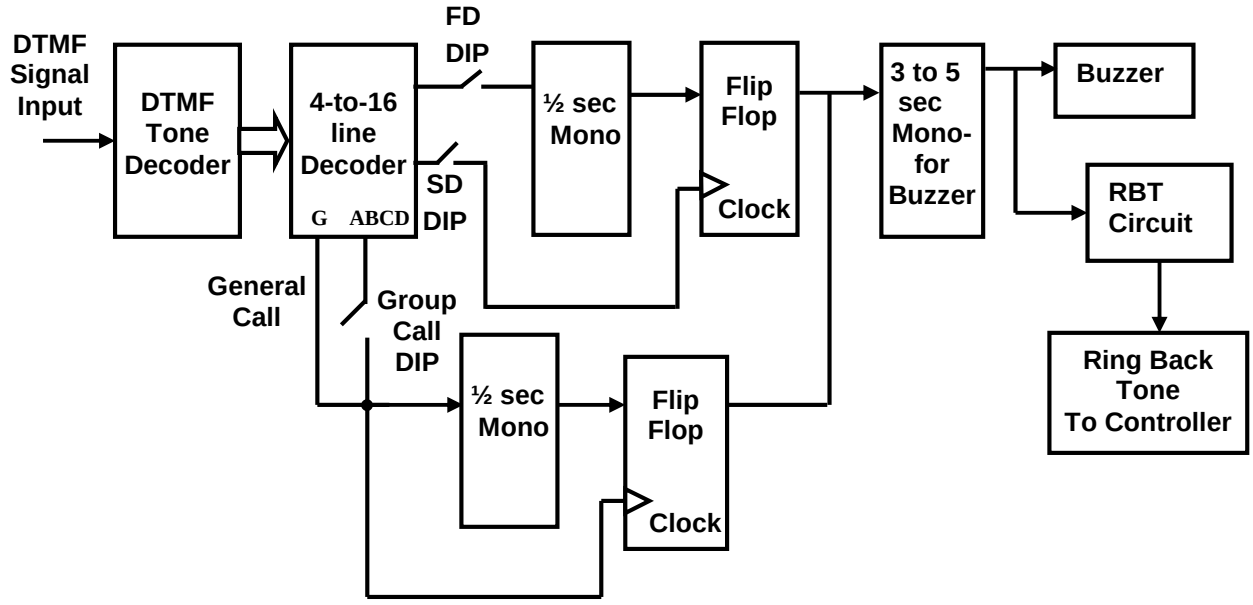


Fig.3.8 Block Diagram of Way station DTMF Decoder & Buzzer

5) Power Supply Arrangements

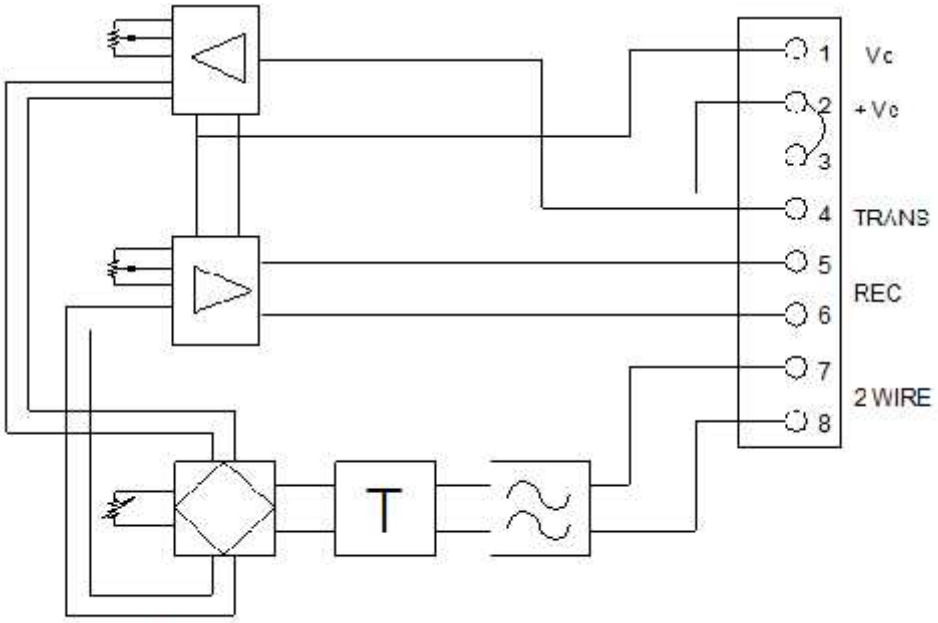
Way station equipment works on 12 V DC (+20%, - 10%). Reverse polarity protection is required to be provided.

6) 2-Wire Way Station Equipment

The 2-Wire Way Station Equipment is used in non-electrified sections where control communication is provided on overhead alignment. For satisfactory working of DTMF equipment in 2-wire overhead line territory, the overall loss on 2-wire line should not exceed 12dB. 4-wire equipment can be converted to have 2-wire interface by using **Speech Conversion Unit also** called as **Hybrid**. Brief description of a speech conversion unit which is used with control equipment is given below.

3.13 Speech Conversion Unit (Hybrid) (IRS: TC: 46-88)

The hybrid or speech conversion unit is required to interconnect a 4-wire control section with a 2-wire control section for speech conversion purpose. The following is the sketch of a hybrid unit used in control communication. This unit can also be used for providing a 2-wire interface to 4-wire control equipment; for example with a 4 wire controller to provide 2-wire connectivity. A typical Speech Conversion unit used with control equipment is shown below. It consists of a Trans amplifier, a Receiver amplifier, a Hybrid and a High pass filter. It is provided in a small M.S. wall mounting type cabinet. The design of this equipment should comply with the RDSO specification IRS: TC: 46/88.

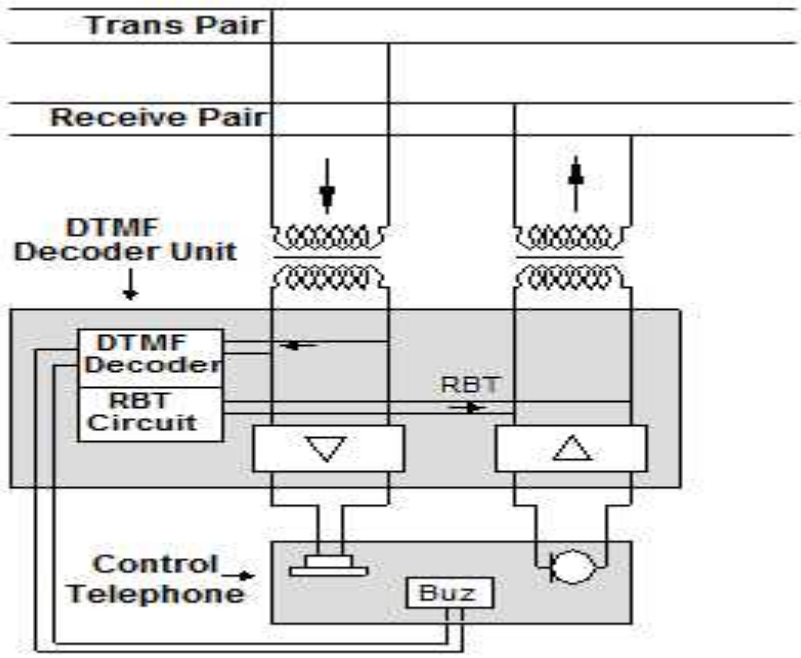


Block Diagram of Speech Conversion Equipment

Fig. 3.9

3.14 Connecting Way station Equipment to Quad Cable

On the omnibus control circuit the way station equipment is connected by means of a derivation joint on the Underground (U/G) cable. The connection between the cable quad and the way station equipment is shown by the following figure 3.10.



Connecting a Way Station Equipment to U/G Cable Pairs

Fig.3.10

3.15 CIRCUIT DESCRIPTION OF DIFFERENT MAKES OF CONTROL OFFICE EQUIPMENTS

3.15.1 M/s Epsilon Electronics Equipments Make:

a) Description

The control office equipment with DTMF selection system consists of the following circuits:

(a) DTMF Generator (Encoder)
(b) Speech Communication

Note: In 2 wire system of working a 4W to 2W conversion unit (Hybrid) is also required additionally.

The DTMF Generator is Microprocessor based with self-check facility and display of called station's assigned number. The DTMF Generator is designed for 4W operations. The block diagram of this equipment's encoder is shown in Fig.3.11.

The Encoder of this equipment uses IC 89C51 micro controller for its working. For interfacing the micro controller with display unit IC 74245 is used. Tone generator (IC 8888) generates the required DTMF tones.

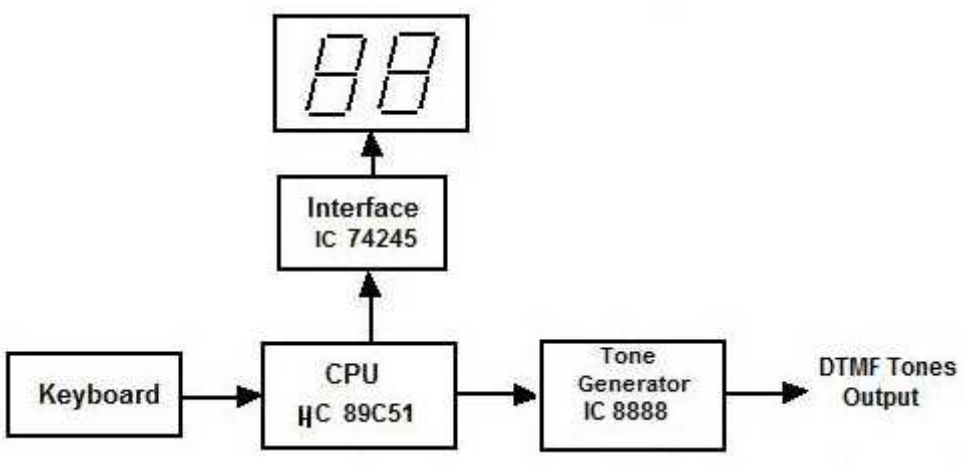


Fig.3.11 Block Diagram of DTMF Encoder (M/s Epsilon make)

3.15.2 M/s Tummala Electronics (P) Ltd Make:

This equipment consists of a micro controller based DTMF generator, display, line interface and speech circuit. A microcomputer handles all the functions of display, tone generation, timing and proper sequencing. The PCBs are functionally partitioned for modularity and are interconnected with minimal wiring for reliability and ease of maintenance.

A three digit, seven segments LED display is provided to display the code being transmitted. An AGC circuit is provided for the receive amplifier of the control room equipment.

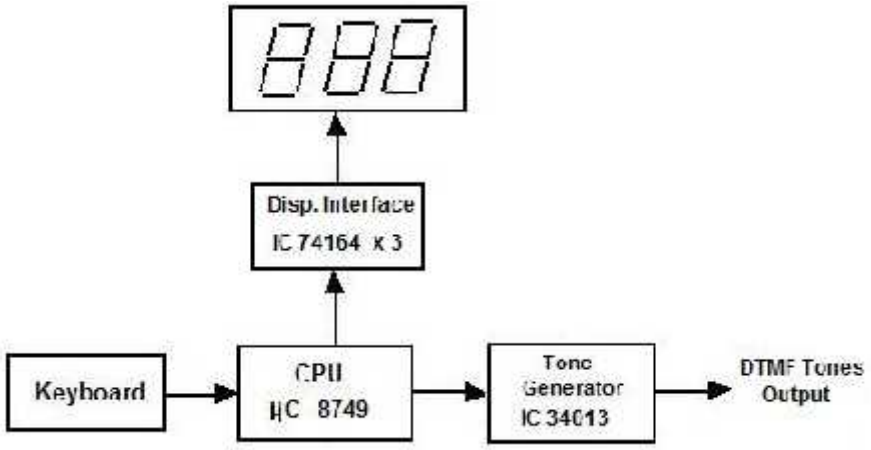


Fig.3. 12 Block Diagram of DTMF Encoder (Tummala make)

This equipment's encoder uses 8749 Micro-controller for its working. The keyboard, display and the tone generator units are directly connected to Micro-controller. IC 34013 is used as tone generator. 3 separate ICs i.e., 74164s are provided for driving each digit of the code as shown in Fig.3.12. The 3rd digit on extreme left displays **L** additionally, along with just called station code two digits when LR key is pressed. For example L36.

3.15.3 M/s Anu Vidyut Make:

The control office equipment consists of the following cards

(a) Key board & display card,
(b) Control card,
(c) Amplifiers card, and
(d) Power supply & filter

a) Circuit Description

Keyboard & Display card: It consists of 20 keys of which 16 are DTMF keys and remaining 4 keys are function keys. A 7-Segment display is provided to show the dialed codes.

Control card: It consists of microprocessor, the programmed EPROM, peripheral ICs and the DTMF generator. The microprocessor scans the keyboard if any key has been pressed, if a key press is detected a debounce routine is used to debounce the key. The number corresponding to the key pressed is indicated on the display, and the microprocessor then waits for the next key. When two digits of the dialed number is entered, the dialing sequence is started, the DTMF generator is instructed to output the DTMF code corresponding to the first digit for a fixed ON time, a pause corresponding to the OFF time is then generated, similarly the other digit is also transmitted.

The encoder of this equipment uses 8085 microprocessor for its working. This microprocessor interfaces the keyboard, display and tone generator through two I/O interfaces - IC 8155 and IC 8255. The selection of one of these two interfaces is done through a decoder IC 74156.

IC 8155 interfaces the microprocessor with the keyboard and display unit through port B and port A respectively. A driver IC 74138 is used for display the digits. IC 8255 interfaces the microprocessor with tone generator (IC 22859). This generates the DTMF tones as per the key pressed on the keyboard. This system uses IC 2764 as program memory (64 KB). Block diagram of control unit in Fig.3.13 shows these details.

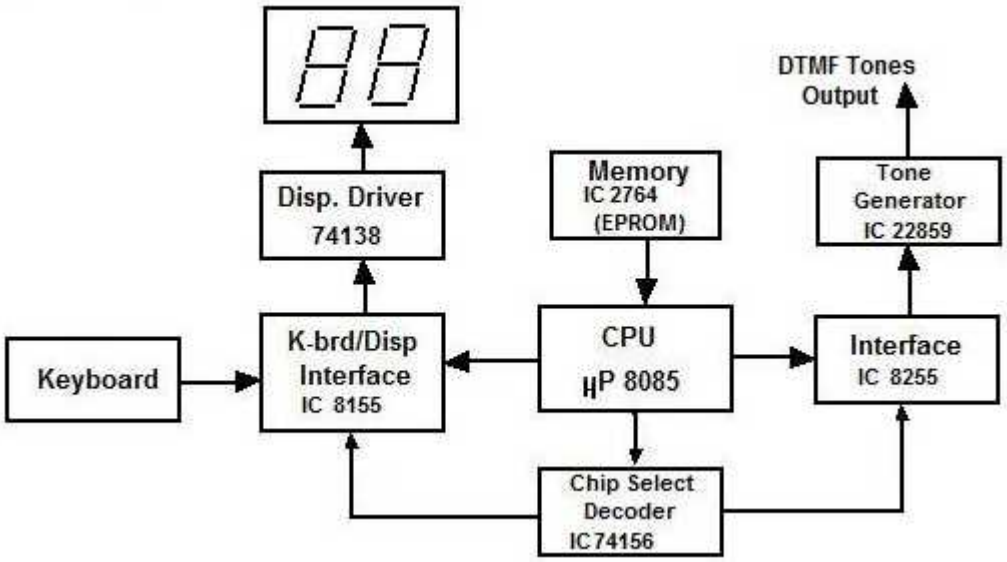


Fig.3.13 Block Diagram of DTMF Encoder (M/s Anu Vidyut make)

Amplifiers Card: This card consists of Trans Amplifier i.e., Microphone Amplifier and Receive i.e., Loudspeaker Amplifier. The Microphone Amplifier circuit is designed to amplify 5mV input signal or 250mV input signal for dynamic and carbon microphone respectively. Speech output can be controlled by preset marked 'TX GAIN'. This also amplifies the DTMF signal. The output of DTMF signal can be adjusted by preset marked as 'DTMF GAIN'.

Loudspeaker Amplifier: The loudspeaker amplifier is provided with an AGC circuit and a VF filter circuit. AGC circuit maintains a stable output in spite of the input variation between 0 to –20dBm. The output of AGC goes to filter circuit. The output of filter is given to loudspeaker amplifier, which amplifies it and gives a maximum output of 1 watt at 4 ohms. The output of loudspeaker amplifier can be adjusted by Volume Control, fitted on the side panel of console.

Power Supply & Filter Card: It consists of a reverse polarity protection and the RC filters to smooth the power supply for different cards. It provides power supply to control and Trans & Receive card. The Filter circuit works for loudspeaker amplifier and it rejects the frequencies, which are out of the speech band.

3.15.4 DESCRIPTION OF DIFFERENT MAKES OF WAY STATION EQUIPMENT

3.16.1 M/s Tummala Electronics (P) Ltd Make

The working of this decoder equipment is explained below with reference to Fig. 3.14.

Any valid DTMF signal on the Trans lines is recognized by the DTMF Receiver (IC 8870) and a four-bit output is passed on to a Decoder (IC4514). The Decoder converts this to a sixteen-line output for ease of code setting through DIP switches. The output of the Decoder is passed on to a MONO IC 4538 (500mS) through the first digits 10 DIP switch positions, provided the received first digit information and the first digit setting done in the DIP switch positions matches. The Q and Q^- outputs of this MONO are connected as J and K inputs to a J-K Flip-Flop (IC 4027), respectively. These J and K inputs will remain for a period of 500 milli seconds and before the end of this period the clock has to be provided to trigger this Flip-Flop.

The required clock will be coming from the Decoder as against the second digit information received from Trans lines, reaches the Flip- Flop through the 10 DIP switch positions meant for the second digit of the code. The clock input to the J-K Flip- Flop will appear only when the second digit information received and the second digit setting, matches. The Q output of this J-K Flip-Flop is used to drive the piezo-buzzer through another MONO IC 4538 (3 seconds) and the ring back tone generated by the operation of the buzzer is fed back to the controller on his receive lines.

Similar logic is employed to decode a **group code** and **general call code**.

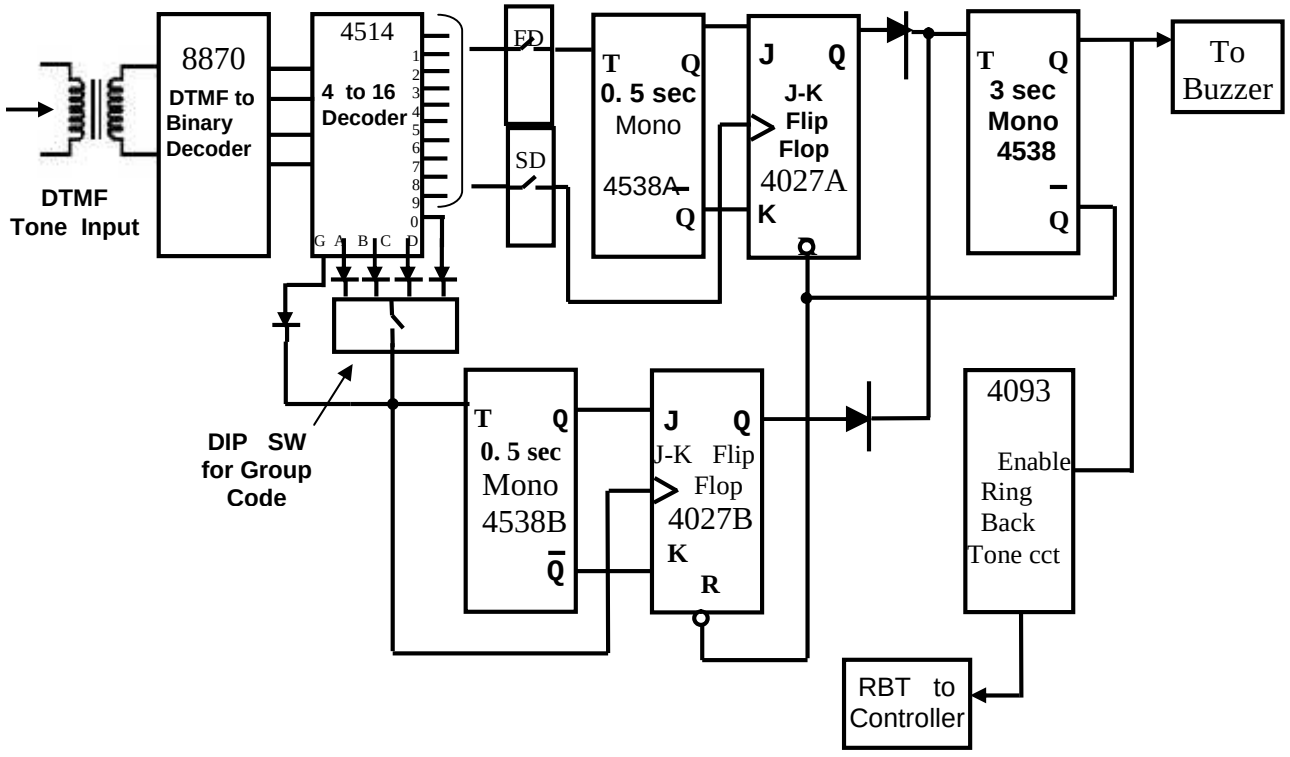


Fig. 3.14 Block Diagram of DTMF Decoder Unit of Tummala Make

3.16.2 M/s Epsilon Make Way Station Equipment

The earlier version of M/s Epsilon make way station decoder circuit was same as Tummala make except for a small change that the 4 to 16 line decoder IC 4514 outputs were fed to DIP switch contacts through series diodes. This arrangement eliminates the disadvantage of non-ringing condition which results when more than one contact is set to ON position in any of the two DIP switches meant for station code setting.

Presently, Epsilon is supplying microcontroller, 8751, based way station decoders. Its block diagram is given below in fig 3.15. The DTMF decoder IC 8870 supplies the received code digit information in 4-bit binary to the microcontroller 8751. The 8751 compares the **received-digit information** with the **DIP switch-set digit information** available on its I/O ports. It performs this comparison for both the digits of the DTMF code received from control office. If received code matches with the station code, set by the DIP switches, the buzzer and LED in the Control telephone on ASM's desk are activated.

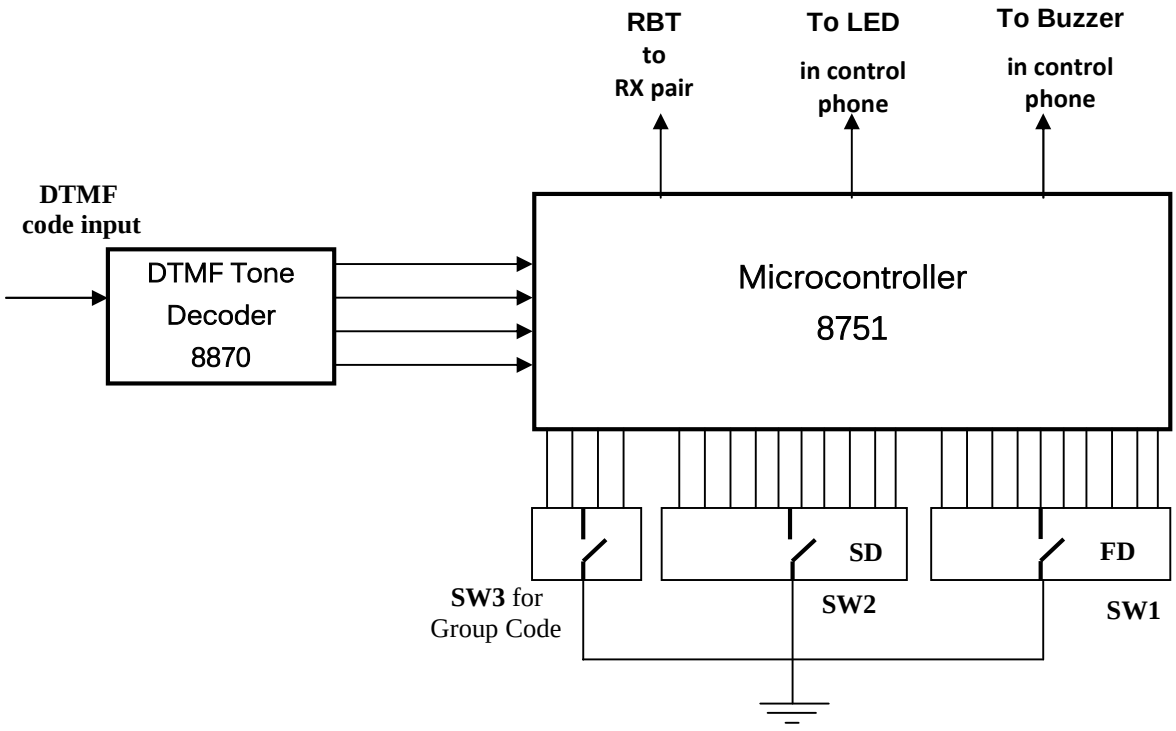


Fig. 3.15 Block Diagram of Epsilon Way Station DTMF Decoder

3.16.3 M/s Anu Vidyut Make Way Station Equipment

The block diagram of the above make equipment is as shown in the fig.3.16 below. The speech and DTMF signals coming from the controller on receive pair are amplified by the combiner amplifier before they get separated. The speech signals will be received by the control telephone receiver and the DTMF signals are fed to decoder unit in the decoder. The incoming DTMF signals are applied to 8870 decoder to produce 4-bit binary output. This binary output is applied to a 4 line to 16-line demultiplexer, where the output of it is appearing on one of the 16 output lines according to the pressed first digit of the code key at the controller's end. This output line is extended to 4013 first D flip-flop as clock input, provided the 10 DIP switches position for the first digit of the station code setting coincides with the digit pressed at the controller's end.

Along with the 4-bit binary output, the 8870 decoder also produces a triggering pulse to 74221 MONO. This MONO in turn provides the D-input to the first D flip-flop of 4013. This mono provides a time delay to cater for the delay between the first and second digit transmissions.

The output of this first D flip-flop is taken as data input to the second D flip-flop. The required clock to trigger this second Flip-flop is coming from 4514 demultiplexer through the second set of 10 DIP switches, set as per the second digit of the station code.

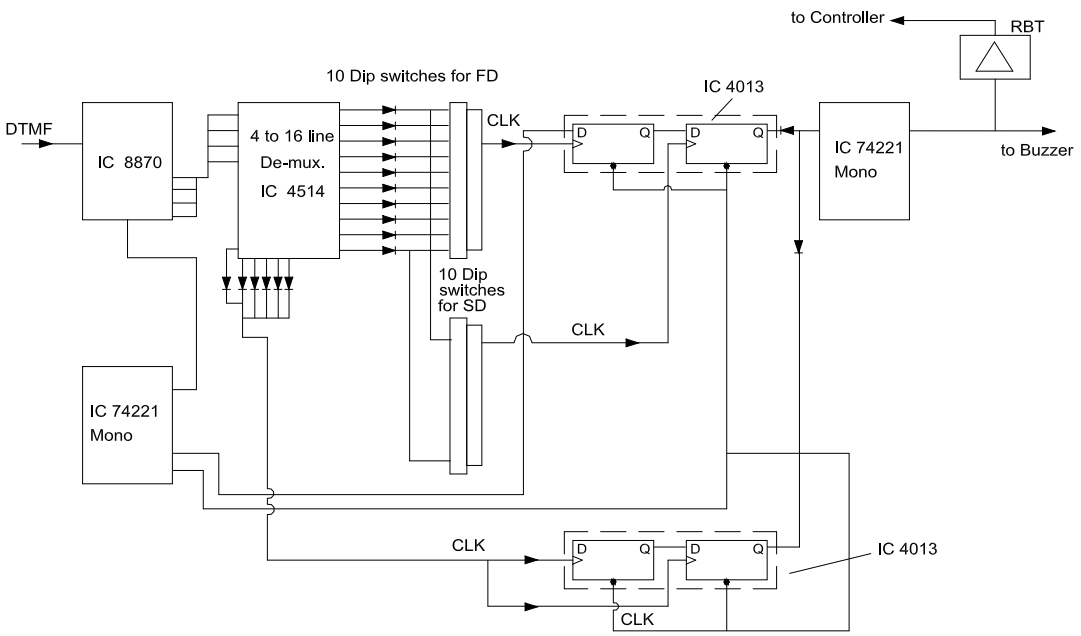


Fig.3. 16 Decoder Block Diagram of M/s Anu Vidyut

The output of the second D flip-flop provides the required driving current for the operation of buzzer through another 74221 MONO. This MONO determines the length of the ringing period. For group / general call, a similar arrangement is made with another set of 74221 MONO and 4013 D-flip-flop.

With operation of the buzzer, the ring back tone collected through the operated buzzer is fed back to controller on his receive pair along with speech signals coming from the control telephone microphone.

Technical Specifications: -

(a)	Signaling	:	Std. DTMF
(b)	DTMF Signal output level	:	0 to –7dB
(c)	Min. signal level	:	- 25dB
(d)	Trans output	:	0dB
(e)	Gain variation	:	12dB, nominal for both Trans and Rec.
(f)	Min. input signal	:	-20dB
(g)	Max. Input signal	:	+12dB
(h)	AGC dynamic range	:	-15dB to +10 d B
(i)	Frequency response	:	within 3dB from 0.3 to 3.4KHz
(j)	Insertion loss	:	2dB for Trans & 0.5dB for Rec.
(k)	Operating voltage	:	12VDC
(l)	Quiescent current	:	less than 150 mA
(m)	Max. Working current	:	less than 500 Ma

3.17 Control Communication System Layout on RE cable.

The layout showing the working of control with DTMF signaling consisting of control office equipment, way station equipments, VF Repeaters and cable huts is as shown in the figure-3.17.

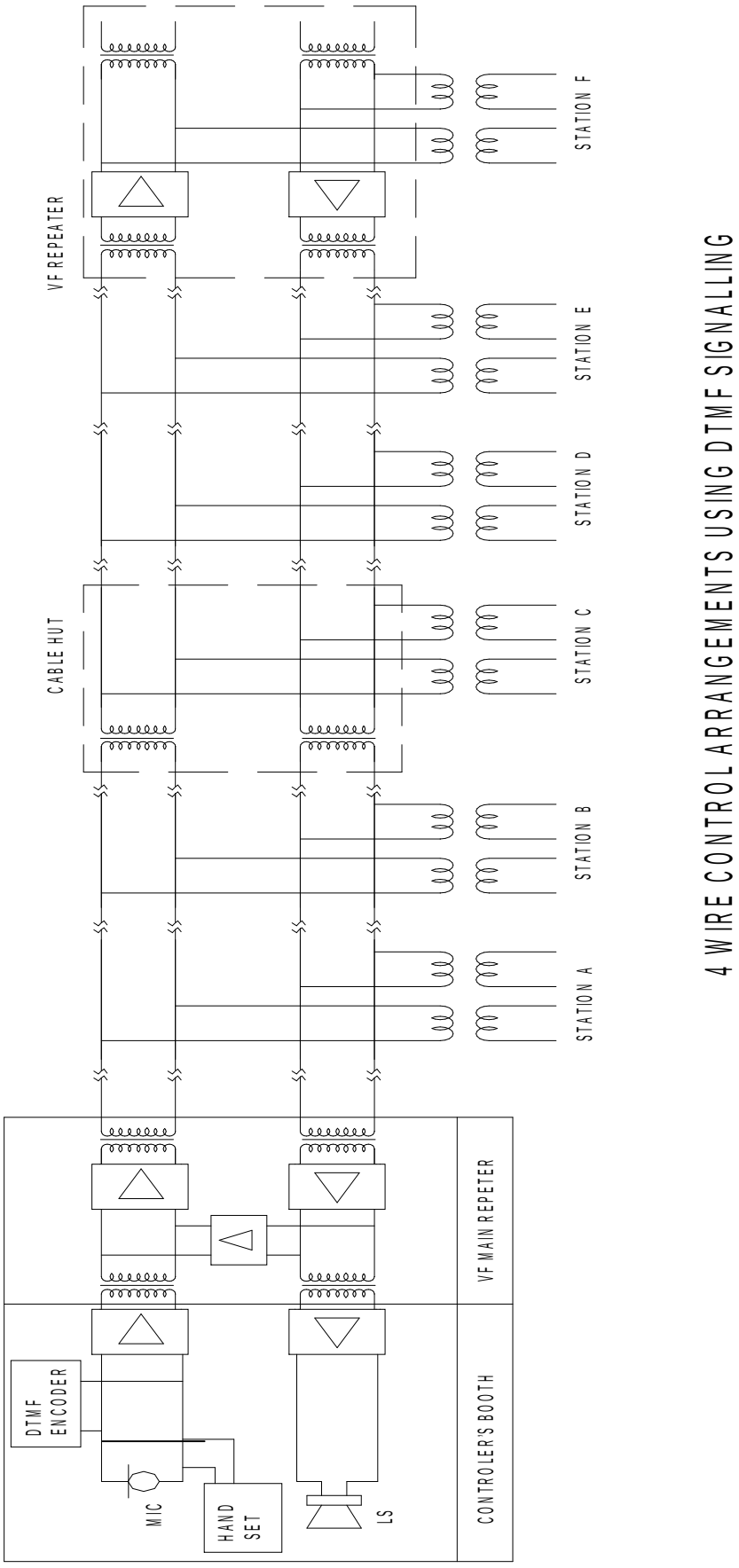

4 WIRE CONTROL ARRANGEMENTS USING DTMF SIGNALLING
VF REPEATER
CABLE HUT
STATION A
STATION B
STATION C
STATION D
STATION E
STATION F
VF MAIN REPETER
CONTROLER'S BOOTH
DTMF ENCODER
MIC
HAND SET
LS

Fig. 3.17

Objective Questions

1) Presently, there are _____control communication systems working on UG cable media.
2) _____ of VF amplifier modules are available in a VF repeater bay.
3) _____of quad cable is eliminated in Equalizer amplifier system.
4) _____is an additional facility in Equalizer amplifier system.
5) The dual power supply unit in Equa. Amp. system is used For _____
6) SOS code is sent by a _____ to test room equipment in case of fault.
7) In addition to speech unit a DTMF _____ is also needed at control office.
8) In addition to Control telephone a DTMF _____ is also needed at way stations.
9) A speech conversion unit is used for _____.
10) DTMF signal normal output level in Control office equipment is _____

Subjective Questions

1) Mention different types equipment required in Conventional system
2) Mention different types equipment required in Equalizer Amplifier system
3) List out the main differences between conventional and equalizer systems
4) Explain the principle of working of DTMF control office equipment with a neat block diagram.
5) Explain the working principle of DTMF way station equipment with a block diagram
6) What are the operating requirements of DTMF way station equipment
7) Draw the schematic diagram of a 4w to 2w converter(hybrid)
8) Show the control communication layout with a schematic.

CHAPTER-4

OFC BASED CONTROL COMMUNICATION SYSTEMS

4.1 Introduction

There are two types of Optical Fibre Cable based control communication systems in use. These are:

(a) Control Communication by RailTel OFC Network Using STM1 and PD Mux
(b) Control Communication Using CCEO System
(or Optical Fibre Based Control Equipment)

4.1.1 Control Communication By **RailTel OFC Network using STM1 & PD Mux:** RailTel Corporation of India Limited is a Government of India undertaking under the Ministry of Railways. The Corporation was formed in Sept 2000 with the objectives to create nationwide Broadband Telecom and Multimedia Network, to modernize Train Control Operation and Safety System of Indian Railways. The latest SDH and DWDM technologies are implemented into the RaiTel network.

In addition to offering services to Indian Railways, RailTel also offers the nationwide backbone support to many of the present-day's cellular, internet and internet-enable service providers. As its OFC network is available alongside the railway track it is very useful in fulfilling the train control communication needs of railways.

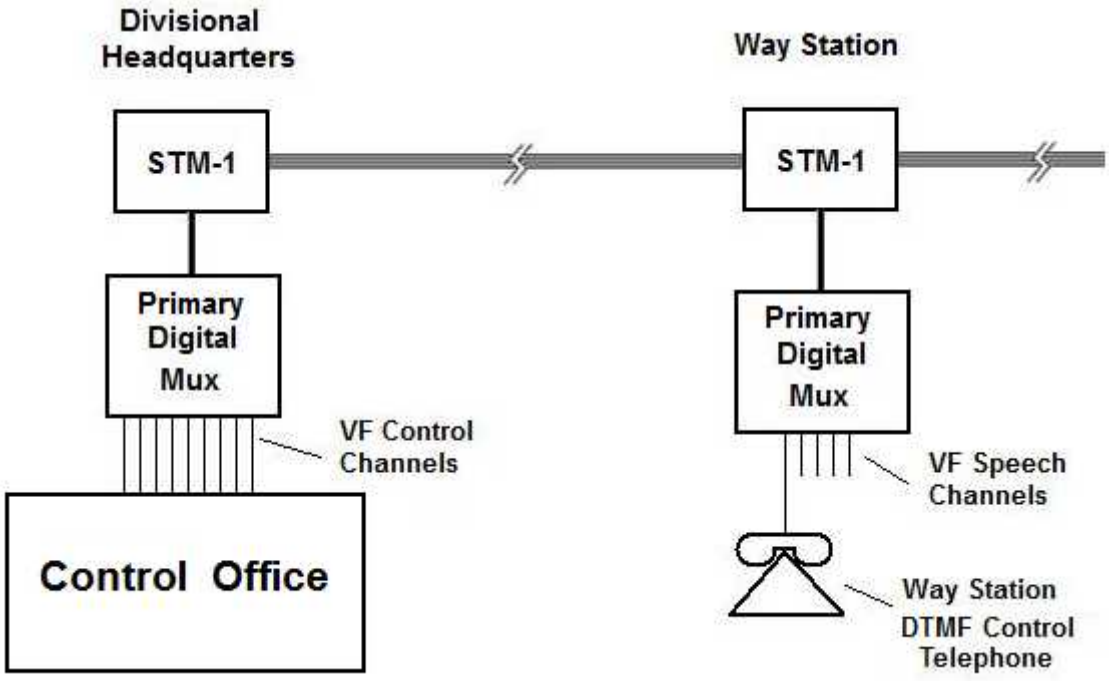


Fig. 4.1 Provision of Control Communication through RailTel OFC Network

For the purpose of providing control communication the following equipment are required at every way side station.

(a) STM1 Equipment
(b) Primary Digital Multiplexing Equipment

The railway control channels are fed to this system at the divisional headquarters (control office) and they are derived as speech channels from the PD Mux equipment at every way station. The diagram given in figure shows the system layout.

4.1.2 The Control Communication Equipments in CCEO System:

The CCEO (Control Communication Equipment for OFC) System also known as Optical **Fibre Interfaced Control Equipment** works on the OFC media. It should comply with the RDSO specification **RDSO/SPN/TC/66/2007** (Amd. 2). This System provides a 4-Wire Voice Frequency (VF) Channel at every way station, throughout the Control Section, with a line impedance of 600Ω. (Presently, a system known as Gf400 is being used in some zones of Indian Railways). The General block diagram of CCEO system is shown below.

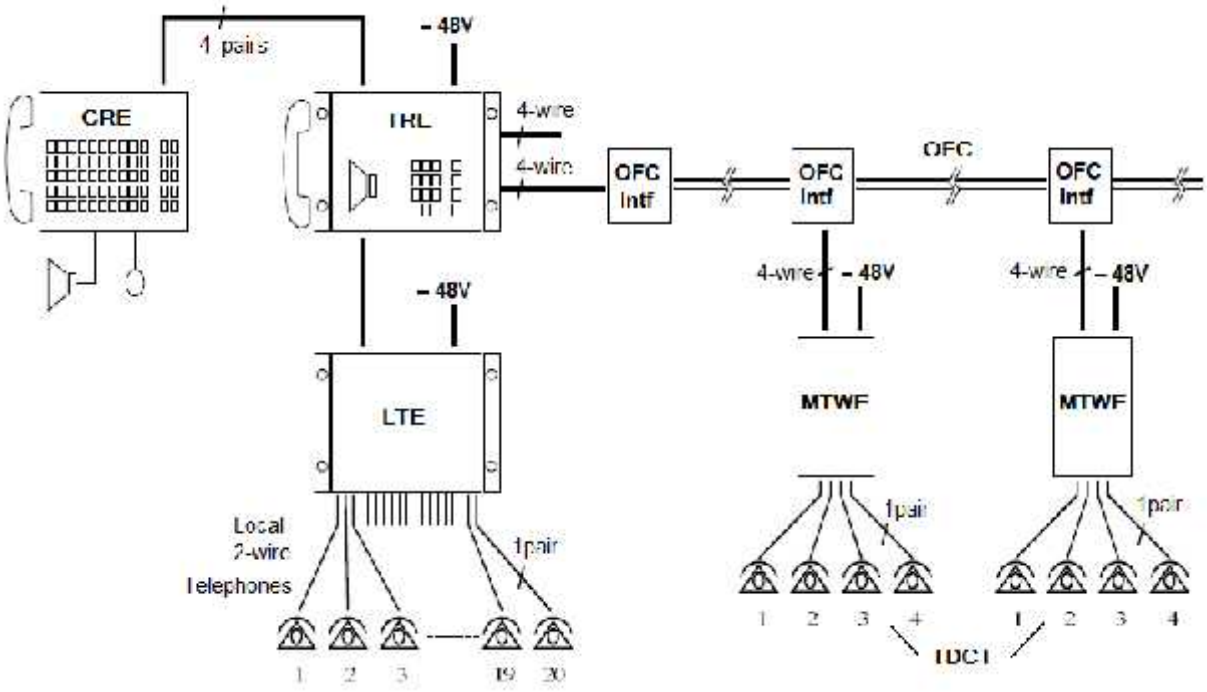


Fig. 4.2 General Block Diagram of CCEO

As per the RDSO specifications RDSO/SPN/TC/ 66 /2007 any control communication system working on OFC (CCEO) interface should consist of the following seven segments in all when both Headquarters Equipment and way Station Equipment are put together.

S.No	Name of the Unit or Segment	Part of
1	Control Room Equipment (CRE)	Headquarters Equipment
2	Test Room Equipment (TRE)	
3	Local Telephone Equipment (LTE)	
4	Multi Telephone Way station Equipment (MTWE)	Way station Equipment
5	Two-Wire Dialing Control Telephone (TDCT)	
6	Three Way Amplifier (TWA)	
7	Remote Patching Equipment (RPE)	

Table - 4.1

4.1.3 System Description of CCEO

The CCEO system consists of the following equipment

(1) Headquarters Equipment
(2) Way Station Equipment

1) Headquarters Equipment of CCEO:

The following units are provided at the headquarters in the control office

(a) Control Room Equipment (CRE)
(b) Test Room Equipment (TRE)
(c) Local Telephone Equipment (LTE)

(a) Control Room Equipment (CRE):

This equipment is provided on the controller's desk. Using this equipment the controller can selectively call any way station or any local telephone, TDCT (Two wire Dialing Control Telephone), of any way station and can speak to it. The CRE consists of the following units

1) Hand set
2) Table Microphone and loud speaker
3) 3-digit 7-segment LED display
4) LED Bar type Level Indicator for Trans and Rec levels
5) Key pad of 40 push buttons (numeric & special function keys) and a page shift button

The following are the main features and functions of Control Room Equipment (CRE):

1) It operates on -48VDC extended from the TRE
2) It has 40 Push Buttons and a Page-Shift Push Button, for calling TDCT (two wire control telephone) or Way Station Equipment selectively.
3) This gives a calling capacity of 80 stations.
4) Single push button calling facility is available
5) It has provision to configure Push Buttons or Page-Shift Push Button as Group Buttons for calling a group of TDCTs or Way Station Equipments.
6) There is a facility to call individual TDCT, or a group of TDCT, by single push button, directly or combined with the Page-Shift push button. This action will initiate a ring at the TDCT and provide an audio feedback to the controller.
7) A 3-digit 7-segment display for displaying system working mode and station code while calling
8) An LED bar level indicator is provided to show the outgoing speech level.
9) It can generate two different modes of DTMF known as CLASSIC and DASSFO. The classic mode is the conventional DTMF tones and Dassfo tones are for TDCTs.

(b) Test Room Equipment (TRE):

This unit is provided in the test room for carrying out maintenance and testing functions on way station equipment. It consists of the following units:

1) Line Interface unit

I. The TRE is connected to the control circuit on OFC system through a 4-wire line interface.
II. There is one more 4-wire line interface to connect to another Control Circuit on OFC System, if needed
III. The TRE is connected to the Controller equipment (CRE) using a 4-pair line.

2) **Control unit:** This unit consists of:

I. A hand set
II. LCD Display
III. Keypad
IV. Loud speaker with volume control
V. Bar indicators for Trans and Receive levels

3) Local Telephone Interface Unit (LTI)

The LTI unit is nothing but LTE segment mentioned earlier. Its details are given below under LTE sub-heading.

The Constructional and Functional Features of the TRE :

1) The VF channel provides interface as a '**digital branching in two direction**' configuration arrangement with a 600 ohms interfacing impedance with a unity input-output level arrangement.
2) The TRE has two 4-wire identical channels for connecting two paths of Control Circuits on OFC System.
3) The TRE is provided with a numeric push button pad and an alpha numeric LCD display.
4) The Test Room staff is able to call any TDCT or Local Telephone by using the numeric push buttons. It is also possible to initiate a call to a Way Station Equipment using the 2-digit code.
5) The Test Room staff is able to converse on line by using a handset.
6) A monitor speaker is provided along with volume control for monitoring the conversation on line.
7) A level indicator for monitoring the trans and receive channels is available on the panel.
8) It operates on -48VDC and it extends same to the CRE.
9) Gain settings of -12dB to 18dB are available for both DTMF and VF Signals on the trans and receive paths.

(c) Local Telephone Equipment (LTE)

The LTI mentioned above under TRE is nothing but LTE. The LTE is called as LTI (local telephone interface) in the Gf400 system. The features of LTE are:

1) 20 standard (2-wire) telephone can be connected to this unit
2) The loop resistance of the telephone line should be less than 600 Ω
3) As these telephones get -48VDC supply from the LTE no separate supply is required at the location
4) The ringing period of these telephones is generally fixed for 1minute
5) These telephones can be rung from both CRE and TRE
6) No dialing facility for these telephones
7) When its handset is lifted a local telephone is directly connected to the 4-wire VF control circuit on the OFC system
8) The CRE has facility to disconnect any particular Local Telephone if desires to do so.

2) Way Station Equipment of CCEO

The way station equipment consists of the following units

(a) Multi Telephone Way station Equipment (MTWE)
(b) Two-Wire Dialing Control Telephone (TDCT)
(c) Three Way Amplifier (TWA)
(d) Remote Patching Equipment (RPE)

(a) Multi Telephone Way station Equipment (MTWE): This unit is provided at every way station and it is connected to the VF channel from the PD Mux on OFC system by a 4-wire cable. It gives facility to connect maximum 4 control telephones at a way station. Its details are as following.

1) The Multi Telephone Way station Equipment (MTWE) works on -48 volt dc. This device is wall-mounting type and will be mounted next to the OFC equipment. Arrangement also exists to mount this equipment on a standard 19" rack.
2) The MTWE is directly interfaced to the OFC for the control circuit on 4-wire line configuration. Gain setting of -6, 0 and +6 dB is available for DTMF and VF signals on the trans and receive channel of the equipment.
3) The VF channel provides interface on a 'digital-branching-in-two-direction' configuration with 600 ohms line impedance and a unity input-output level arrangement.
4) A total **four** numbers of Two-wire Dialing Control Telephones (TDCT) can be connected to the equipment, each on a twisted pair of telecom switchboard cable.
5) A feedback tone is generated by the MTWE whenever a ring to one of its TDCT is received.
6) The RBT is initiated only if the telephone ringing current is detected. In situation where the wire pair connecting the TDCT is broken no RBT is generated.
7) The MTWE can provide four independent calling numbers for the four TDCT connected to it. Each can also be set for a group number.
8) The MTWE has facility to program each of the TDCT for dialing or non-dialing mode.
9) If more than four TDCTs are required at a way station it is possible to connect one more MTWE to increase capacity to another four TDCTs by using a TWA unit which is discussed next to this.
10) It can be programmed that the dialing capacity of local telephones is restricted to only four other station telephones for limited use.

(b) Three Way Amplifier (TWA): The TWA unit is used when the number of telephones required at a way station is more than four which is the maximum capacity of a MTWE unit. By using TWA one more MTWE can be provided at a way station. The details of TWA are as given below.

1) The Three Way Amplifier (TWA) also works on -48 volt dc and is wall-mounting type. It can be mounted next to the OFC equipment, within 10 meters. It can also be mounted on a standard 19" rack.
2) The TWA provides a three way branch amplifier configuration with unity gain. Wherever more than one MTWE is to be deployed, the TWA can be used. See the figure given below.
3) The TWA is directly interfaced to the OFC for the control circuit on 4-wire configuration with 600 ohms line impedance.
4) The TWA is also used where Remote Patching Equipment is provided to connect microwave/BSNL channel, etc.

(c) Two-Wire Dialing Control Telephone (TDCT)

1) The Two-wire Dialing Control Telephone (TDCT) is the standard telephone instrument with a handset and a numeric dial.
2) Each TDCT is connected to MTWE with a twisted pair having a loop resistance of less than 1200 Ohm.

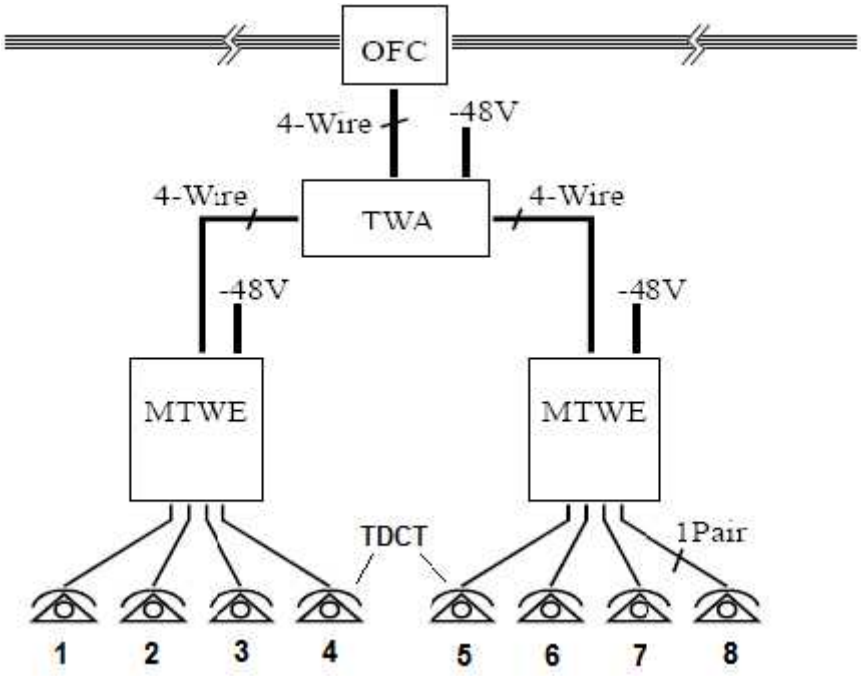


Fig. 4.3 Provision of an Additional MTWE using TWA at a Way Station

3) The TDCT has the following features and functions.
   (a) As soon as the handset is lifted, the telephone should get connected to the control circuit with Rx path being made through, but keeping the TX path disconnected. The TX of the handset will be enabled either by tapping the cradle switch or by pressing any one of the key switches on the telephone, except # and * switch.
   (b) The telephone rings whenever it is called by CRE, TRE or any other TDCT irrespective of its on-hook or off-hook condition.
   (c) The ring lasts for a period of ONE minute (adjustable from 30 Seconds to 3 Minutes) whenever called, and gets terminated as soon as the handset is taken off-hook. In case the handset is already off-hook, then a momentary on-hook action shall terminate the ring.
   (d) A visual indication is displayed whenever a ring is received and remains till the handset is lifted.
4) The TDCT functions on pulse dialing system.

(d) Remote Patching Equipment (RPE): The function of RPE is to provide patching between the two 4-wire VF control circuits available on the OFC system. The patching can be effected locally from the way station where the RPE is provided, or remotely from the test room. Its constructional and functional details are given below.

1) This device can be mounted on a wall or in rack and to be mounted next to the OFC equipment.
2) The RPE interconnects (patches) the two VF 4-wire channels (of 600Ω impedance) to each other. It is possible to interconnect the two channels by a local command (from the RPE panel) or from a remote command (from TRE).
3) Nine numbers of RPEs can be connected over one control circuit. One will be at Test room and other eight at various locations in the section.
4) The RPE provides a unity gain path for the patching channels.
5) The channel patching status should be seen on the RPE panel. The action of patching and unpatching (releasing) the channel shall be carried out by pressing a push button on the RPE panel, when operated locally.

6) For remote operations RPE offers the following features and functions.
   (a) The TRE will be able to perform the 'patching' and 'un-patching' action on any particular RPE by a command addressing its number (ID).
   (b) It is also being possible for the TRE to get the status report (patched or un-patched condition) of any particular RPE by addressing it.
   (c) The addressing number for RPE is between1 to 9. The remote commands make use of calling protocol similar to that used for MTWE.
   (d) The installed location of RPE may be anywhere on the control section, from test room to the far end station point.

4.2 GF400 System

4.2.1 Introduction to Gf 400 System

Gf 400 is an OFC based Control Communication System designed and supplied by M/s Marvel Electronics as per the RDSO specifications RDSO/SPN/TC/66/2007 for CCEO system.

4.2.2 Components of Gf 400 System

Gf400 System comprises all the equipment required for providing control communication. The two main parts or equipment of this system are –

1. The Headquarter Equipment and
2. The Way Station Equipment.

Each of this equipment is constructed in modular form and accommodates the following modules.

The Headquarter Equipment

It comprises of –

a) **Gf464** - Line Interfacing and Control Unit(TRE)
b) **Gf466** - Desk Equipment for the Controller(CRE)
c) **Gf468** - Local Telephone Interfacing Unit(LTE)

Way Station Equipment

The way station equipment comprises of-

a) **Gf444 -** Way Station Unit & Desk Telephones
b) **Gf430 -** Three Way Amplifier Unit
c) **Gf462 -** Remote Patch Unit

Specific Features of Gf400 System

a) The maximum cable length for 2 wire Local Telephones connected to Test Room Equipment is 1km on a 0.6 mm diameter twisted pair cable.
b) Length of the 4 wire line used for connecting the Way station Unit to the OFC system should not be more than 10 meters.
c) A Way Station Telephone can call other Station Telephones on the same control circuit by dialing a two digit number.
d) The Way Station Telephone can also call the **Test Room** or **Control Room** equipment by dialing **98** and **99** respectively.
e) Way station telephones are connected using a 0.6 mm diameter telecom cable up to a distance of 2 km.

Objective Questions

1. _____types of OFC based control communication systems are used in Indian Railways at present.
2. Equipment used Railtel's OFC control communication system are _____ In CCEO system TRE can use _____ no. of 2-wire telephones.
3. Maximum no. of control telephones a MTWE can have _____
4. Supply voltage required for CCEO system is _____
5. Dialling facility is not available in telephones connected to _____ equipment of CCEO.
6. Telephones having dialling facility are known as _____
7. Maximum length of 2-wire telephone line usable in TRE is _____.
8. Maximum length of 2-wire telephone line usable with MTWE is _____.
9. TWA is used for _____.
10. Radio patching in CCEO system can be affected remotely _____.
11. In Gf400 system the equipment equivalent to TRE _____
12. Equivalent of TWA in Gf400 system _____
13. Radio patching equipment in Gf400 system _____

Subjective Questions

1. Mention the OFC based control communication systems you know and explain about any one with a diagram.
2. Explain about control communication through Railtel OFC network.
3. Draw the schematic diagram of Control communication system on Railtel network.
4. What is CCEO system? And explain with a block diagram.
5. What are units in the Headquarters equipment of CCEO system? Briefly explain about each one.
6. What are units in the Waystation equipment of CCEO system? Briefly explain about each one.
7. Mention the function of CRE
8. Write about TRE
9. Explain about MTWE
10. What is TDCT and its features?
11. Explain about the use of TWA.
12. What is RPE and when is it used?
13. Briefly explain about Gf400 system.
14. Explain about headquarters equipment in Gf400 system.
15. Explain about way station equipment in Gf400 system.

CHAPTER-5

VF REPEATERS

5.1. General Description

VF Repeater stations are provided along the transmission line of underground telecommunication quad cables to boost the signal by way of compensation of loss in signal strength incurred during the transmission of speech and signaling through various parts of communication circuits.

The VF Repeaters used in Railways are of the two types as given below:

(a) **Conventional VF Repeaters** (Using with under Ground RE /Quad Cable with loading)

It consists of VF amplifiers and Leak amplifier, and buffer amplifiers as per specification **IRS: TC-50-90.**

(b) **Equalizer Amplifier System** (Using with under Ground Quad Cable without loading)

It consists of Equalizer amplifiers and Buffer amplifiers as per the specification **RDSO/SPN/34/2002.**

5.2. VF Repeater Equipment (IRS: TC-50-90)

This equipment is placed in VF repeater stations located at approximately 50km intervals along the track. The VF Repeaters are classified as **Terminal** or **Intermediate** Repeaters as per their location. The Repeater installed in Test Room is named as main Repeater and repeaters situated at regular intervals along the track are named as Intermediate Repeaters.

5.2.1. 4-Wire VF Repeater Amplifier

This is provided in both main and intermediate repeater stations for all circuits to compensate for the loss incurred due to

i) Attenuation of the cable,
ii) Insertion loss of the sectionalizing transformers at cable huts and repeaters and
iii) Bridging loss due to tapping transformers at way stations.

It provides the required amplification in both the directions of a control channel to compensate for the attenuation in the transmission path. One pair of amplifiers is required for every control circuit. One **Trans amplifier** and one **Receive amplifier** is provided for each quad. The repeater equipment should consist of as many no. of amplifier pairs as the no. of control circuits.

Generally, **4 VFL** cards or modules and 4 **VFR** cards and one buffer card are provided with every repeater bay. Each of these cards contains one Trans Amplifier and one Receive Amplifier. The VFL additionally contains one Leak amplifier which is to be connected between Rx-out and Tx-in. This cross connection facilitates the way stations to speak with one another.

VFL Card: It houses two VF amplifiers; one for trans direction and another for receive direction. The maximum gain of each amplifier is +24dB. In addition to Trans and Receive amplifiers there is also one more amplifier called Leak Amplifier on the VFL card.

The Purpose of Leak Amplifier: It is provided for intercommunication among the way stations. Each control circuit uses two pairs of a quad on telecom cable. One pair is for trans of controller and another pair is for the receive of controller. Suppose, two way stations need to talk with each other, the voice output (or trans) of both these stations travels on the same receive pair of controller. The way station control telephone receiver is connected to trans pair of the controller. This means that any way station can hear the voice of other way station only if that speech signal is available on the trans pair. For this reason leak amplifier is used to leak (or couple) the way stations' speech signals from controller's receive pair to his trans pair and thus enabling intercommunication among way stations. The leak amplifier will give a minimum attenuation of 20dB.

Circuits Requiring Leak Amplifiers: All omnibus control circuits like Section control, Dy. Control, Traction Loco Control, Traction Power Control, Engineering Control, Maintenance Order Wire (MOW) and Emergency Control require Leak Amplifiers along the cable route. However this leak is not provided in all repeaters. If leak amplifier is connected to a control circuit at every repeater station instead of at alternate ones, the gain on the control circuit increases and subsequently, singing or whistling takes place rendering noisy conversation and also crosstalk is induced into other control circuits in the cable. Leak amplifier is not required for Remote Control.

Note: When Leak amplifier is disconnected VFL is equivalent to VFR.

VFR Card: The circuitry on the VFR card is the same like that on VFL card except that it consist one leak amplifier.

BUFFER Card: In a control section comprising a main line and branch line cable, for branching from an intermediate location, a buffer amplifier is provided at the junction for avoiding heavy shunting loss occurring due to direct connection of branch line cable. The buffer amplifier works as interface between the main cable and branch line cable shunted with high impedance.

5.2.2. Structural Layout of the Repeater Equipment

The equipment consists of the following:

(a) 4-Wire VF Repeater & Miscellaneous Bay of suitable size to accommodate other sub-assemblies. The frame of this bay is made of sheet metal of minimum thickness 2.5 mm.
(b) The power distribution, termination & monitoring panel is provided in the top most position of the bay. It includes the power distribution units for 24 volts DC working. For termination of cables, separate Krone connectors are there for each incoming and outgoing cable, for each direction. For monitoring the circuits, separate U-link panels at the input and output of the amplifiers are provided.
(c) The rest of the place in the bay below the distribution, termination and monitoring panel is used for providing VF Repeater amplifier, leak amplifier and buffer amplifier panels according to the requirement.

5.3. M/s Indisco Make VF Repeater Equipment (As per Spec. IRS: TC-50/90)

This equipment is pre-wired repeater bay consisting of the following:

(a) Distribution Panel
(b) Link Panel
(c) Amplifier Panel
(d) Loud speaker Amplifier

5.3.1. Distribution Panel

It consists of Krone connectors (most widely used connectors in telecommunication) on to which connections from UG cables are terminated.

5.3.2. Link Panel

The equipment consists of 4 nos. of link panels with U-Links. All cable connections from distribution panel for inputs and outputs such as Trans-IN, Trans-OUT, Receive-IN and Receive-OUT for all the Quads are terminated on upper links of link panels and from bottom links of link panels connected to the Amplifier panel. U-Links permit connection and disconnection between cable wires and VF amplifier circuits.

5.3.3. Amplifier Panel

In this panel two or more amplifier-shelves are provided. Each shelf can accommodate 4 numbers of VF amplifier modules (VFL / VFR) and a power supply module for these four modules. All together the following three types VF amplifiers modules can be accommodated in this panel.

1) **VFL Card** - Houses Two VF Repeater Amplifiers and a Leak amplifier
2) **VFR Card** - Houses Two VF Repeater Amplifiers only
3) **Buffer Card** - Houses Two VF Buffer Amplifiers used for branching purpose.

Block Diagrams of VF Amplifier Modules

(a) VFL Card

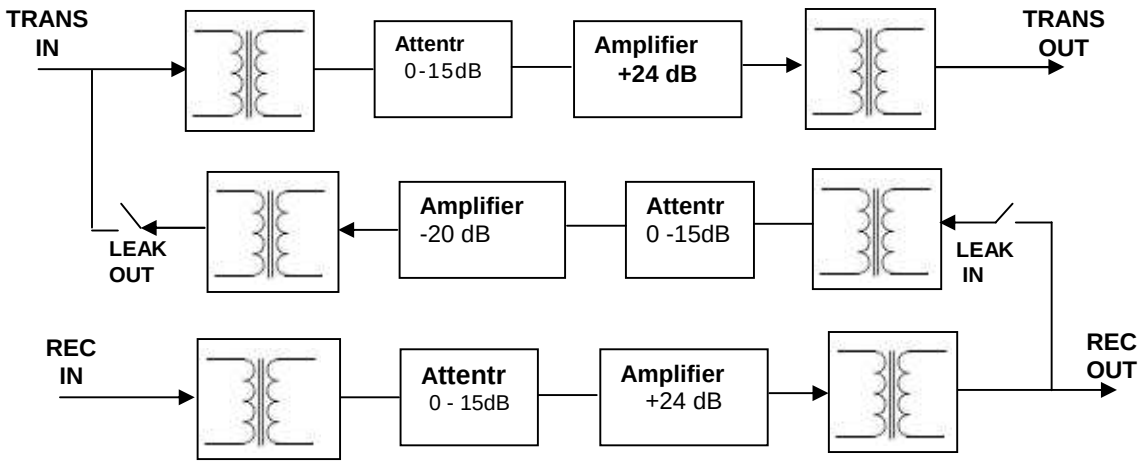


Fig. 5.1 Block diagram of VFL

(b) VFR Card

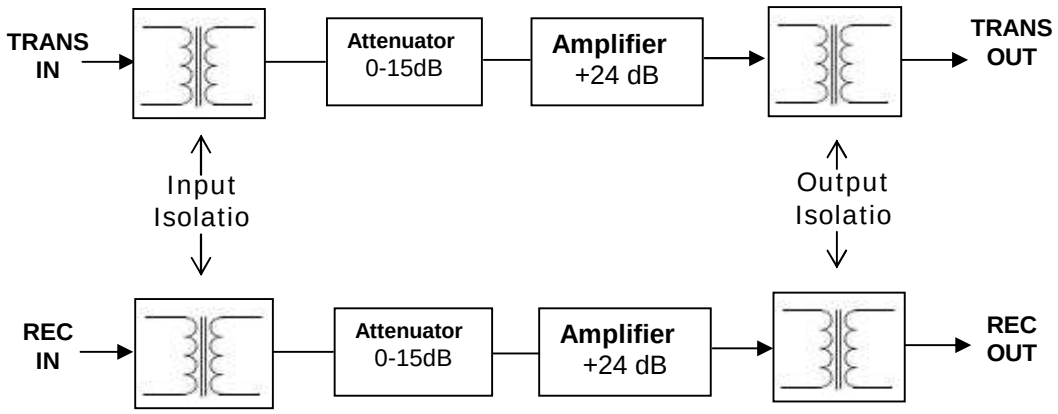


Fig. 5.2 Block Diagram of VFR

A variable attenuator is also provided with each VF amplifier in both **VFL** and **VFR** cards. The purpose of this attenuator is to adjust the gain of a VF amplifier to a required level, below +24dB. The attenuation range offered is between 0 dB to –15 dB which is selected by DIP switches. The switch settings for different attenuation values can be seen below. For Trans and Receive gain settings DIP-**SW3** and DIP-**SW-1** are used respectively.

The following DIP switches are provided on VFL and VFR cards

Gain adjustment:

DIP Switch – 1 for adjusting Receive gain

DIP Switch – 3 for adjusting Trans gain

Equalizer setting:

DIP Switch - 2 for adjusting Receive slope

DIP Switch - 4 for adjusting Trans slope

Leak Amplifier setting: (only on VFL card)

DIP Switch - 5 for adjusting attenuation of Leak Amplifier

DIP Switch - 6 for connecting / disconnecting Leak Amplifier

DIP Switch Settings for VFL & VFR Cards:

Trans Gain						Receive Gain					
DIP Switch SW – 3						DIP Switch SW – 1					
1	2	3	4	ATTN	GAIN	1	2	3	4	ATTN	GAIN
OFF	ON	ON	OFF	**0 dB**	**24 dB**	OFF	ON	ON	OFF	**0dB**	**24dB**
ON	ON	ON	OFF	**1 dB**	**23 dB**	ON	ON	ON	OFF	**1dB**	**23dB**
OFF	OFF	ON	OFF	**2 dB**	**22 dB**	OFF	OFF	ON	OFF	**2dB**	**22dB**
ON	OFF	ON	OFF	**3 dB**	**21 dB**	ON	OFF	ON	OFF	**3 dB**	**21dB**
OFF	ON	OFF	OFF	**4 dB**	**20 dB**	OFF	ON	OFF	OFF	**4 dB**	**20dB**
ON	ON	OFF	OFF	**5 dB**	**19 dB**	ON	ON	OFF	OFF	**5 dB**	**19dB**
OFF	OFF	OFF	OFF	**6 dB**	**18 dB**	OFF	OFF	OFF	OFF	**6 dB**	**18dB**
ON	OFF	OFF	OFF	**7 dB**	**17 dB**	ON	OFF	OFF	OFF	**7 dB**	**17dB**
OFF	ON	ON	ON	**8 dB**	**16 dB**	OFF	ON	ON	ON	**8 dB**	**16dB**
OFF	OFF	ON	ON	**10 dB**	**14 dB**	OFF	OFF	ON	ON	**10dB**	**14dB**
OFF	ON	OFF	ON	**12 dB**	**12 dB**	OFF	ON	OFF	ON	**12dB**	**12dB**
ON	OFF	OFF	ON	**15 dB**	**9 dB**	ON	OFF	OFF	ON	**15dB**	**9dB**

Table - 5.1

(c) BUFFER Card

Like VFL and VFR the Buffer amplifier module also has two VF amplifiers of +24dB gain each. But its attenuator is different which can be adjusted between 0-24dB. These amplifiers are mainly used for branching of control circuits. When branching is not required the buffer amplifier is utilized for monitoring of speech on control circuits.

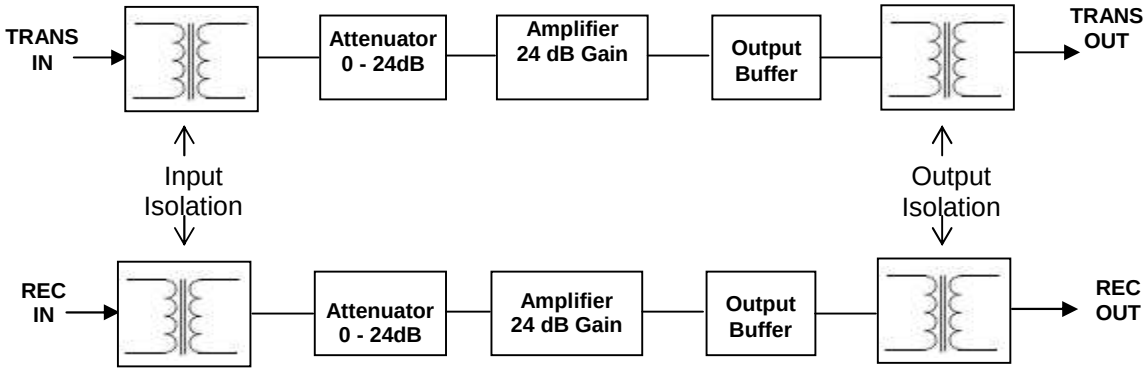


Fig. 5.3 Block diagram of BUFFER Card

The following DIP switches are provided on Buffer card

Gain adjustment:

DIP Switch – 1 for adjusting Receive gain

DIP Switch – 2 for adjusting Trans gain

DIP Switch Settings for BUFFER Card

Trans SW -2 & Receive SW-1						
1	**2**	**3**	**4**	**5**	**ATTN**	**GAIN**
ON	OFF	ON	ON	OFF	**0 dB**	**24 dB**
OFF	OFF	ON	ON	OFF	**1 dB**	**23 dB**
ON	ON	ON	ON	OFF	**2 dB**	**22 dB**
OFF	ON	ON	ON	OFF	**3 dB**	**21 dB**
ON	OFF	OFF	ON	OFF	**4 dB**	**20 dB**
OFF	OFF	OFF	ON	OFF	**5 dB**	**19 dB**
ON	ON	OFF	ON	OFF	**6 dB**	**18 dB**
OFF	ON	OFF	ON	OFF	**7 dB**	**17 dB**
ON	OFF	ON	OFF	OFF	**8 dB**	**16 dB**
ON	ON	ON	OFF	OFF	**10 dB**	**14 dB**
ON	OFF	OFF	OFF	OFF	**12 dB**	**12 dB**
ON	OFF	ON	ON	ON	**16 dB**	**8 dB**
ON	OFF	ON	OFF	ON	**24 dB**	**0 dB**

Table - 5.2

5.3.4 Loudspeaker Amplifier

Loudspeaker Amplifier consists of a speaker and the amplifier circuit housed in a wooden cabinet. It is supplied in a separate wooden box. Connection strip are provided on the back of the speaker box inside the repeater panel.

5.3.5 Power Supply System

Power supply system is to be connected separately. The power supply system should consist of a battery bank of 24 Volt. The capacity of the batteries can be chosen as per the backup required. A battery charger will be used to charge these batteries.

5.4. Technical Specification

VF Amplifiers (VFL &VFR)

1. Operating voltage : 24 VDC nominal (21 to 30 VDC)
2. Input current : Less than 30 mA per PCB

Trans & Receive Amplifiers: -

a) Gain : 24dB +/-0.5dB
b) Input impedance : 1120Ω +/-5%
c) Output impedance : 1120Ω +/-5%
d) Frequency response : Flat within +/-0.1dB for 0.3 to 3.4 KHz.
e) Attenuator Range : 0dB to -15dB

Attenuators: -

Four attenuators of value 1dB, 2dB, 4dB & 8dB are provided.

Equalizers: Active circuit equalizer slopes for 0.3 to 3.4 KHz.

(a) 0.5 dB +/-0.2 dB
(b) 1.0 dB +/-0.2 dB
(c) 2.0 dB +/-0.2 dB
(d) 2.5 dB +/-0.2 dB

Leak Amplifier: Available only on VFL cards.

(a) Gain : -20 dB (loss)
(b) Input impedance : High ≥10KΩ
(c) Output impedance : High ≥10KΩ
(d) Input insertion loss : ≤ 1.0 dB
(e) Output insertion loss : ≤ 1.0 dB
(f) Attenuators : 4 attenuators of value 1dB, 2dB, 4dB & 8dB are provided.
(e) Total attenuation level : 15 dB (Selection by dip switches)
(f) **Leak Amplifier** is connected in the circuit by **SW – 6**
i) **To connect** all the **four** switches in **SW-6** should be **ON**
ii) **To disconnect** all the **four** switches in **SW-6** should be OFF.

Buffer Amplifier:

(a) Gain : 24 dB ï0.5dB
(b) Input Impedance Trans : High
(c) Output Impedance Trans : 1120ohm ï 5%
(d) Input Impedance Receive : 1120 ohm ï 5%
(e) Output Impedance Receive : High
(f) Shunting loss : Better than 1. 5dB
(g) Frequency Response : Flat within ï 0.2 dB
(h) Attenuator Range : 0dB to -24dB

Attenuators: (5 attenuators)- of 1dB**, 2dB, 4dB, 8dB, 16dB** are provided with tolerance of ï 0.2dB.

Mechanical Dimensions of VF Repeater Bay:

Height : Depending upon no. of panels
Width : 625 mm
Depth : 330 mm
Legs for floor mounting : 110 mm

5.5 Equalizer-Amplifier Type Control Communication System used with 4/6 Quad PET cable (as per specification RDSO/SPN/34/2002)

5.5.1 General Details

The control circuit works on PET quad cable of 0.9mm diameter with characteristic impedance of 470 ohms.

(a) The PET quads are not loaded. To compensate uneven attenuation over VF band, every station is provided with this system to provide communication at that station and also to equalize the loss in the VF range.
(b) Balancing of various quads is carried out at every station by providing suitable condensers if required on control side.
(c) It is possible to provide end patching or mid patching from underground quad cable media to radio communication system for normal working or working in case of failure without reversing the direction of amplifiers.
(d) The circuit gets isolated from the system, if any card of that circuit is taken out, and in case of power supply failure at a station, the station is bypassed.

5.5.2 System Configuration

The system comprises following assemblies:

(a) Cable termination, distribution & monitoring panel
(b) U link panel
(c) Equalizer Amplifier and V F transformer panel
(d) DTMF Decoder
(e) 8 Way Intercom System
(f) Remote Monitor/sensor
(g) Power supply unit.

In addition to the above, the system is provided with one Emergency socket, for connecting the emergency circuit through one buffer amplifier for communication between stations to control office during emergency.

A phantom circuit derived from the emergency socket is also provided to plug-in a magneto-telephone to communicate with maintenance staff at emergency socket or from one station to another station.

The complete system is housed in a standard 19 inches rack. Cabinet will be made of metal sheet of steel having minimum thickness of 1.2 mm. The cabinet is wall mounting type or floor mounting type. All non-current carrying metal parts are bonded together and earthed.

5.5.3 Cable Termination, Distribution & Monitoring Panel

For terminating the incoming and outgoing cables, radio patching and way station equipment, separate Krone connectors are provided. On the distribution panel, two terminals are provided for extending the power supply to monitor card. For monitoring VF circuits, a loud speaker with a loudspeaker amplifier (200-milli watts output) is provided. A test tone generator of 1 KHz +/- 100Hz at 0dBm +/-1 dB output at 470 ohms is also provided in the monitoring panel.

On the incoming and outgoing cables, the Krone connectors are provided with IPM (Integrated Protection Module) consisting of poly- switches, LDs and fuses.

5.5.4 U Link Panels

2 rows of U links of adequate number and size are provided for interconnecting incoming /outgoing cables to the V F Repeater circuits.

5.5.5 Equalizer Amplifier and VF Transformer Panel

Two types of cards/modules, one 4-way equalizer amplifier card and one isolation transformers card, are provided in this panel. These two cards cater for one control circuit. Cards needed for 4-control circuits can be accommodated on this panel. In the Test Room repeater one additional card consisting of 4 buffer circuits is provided.

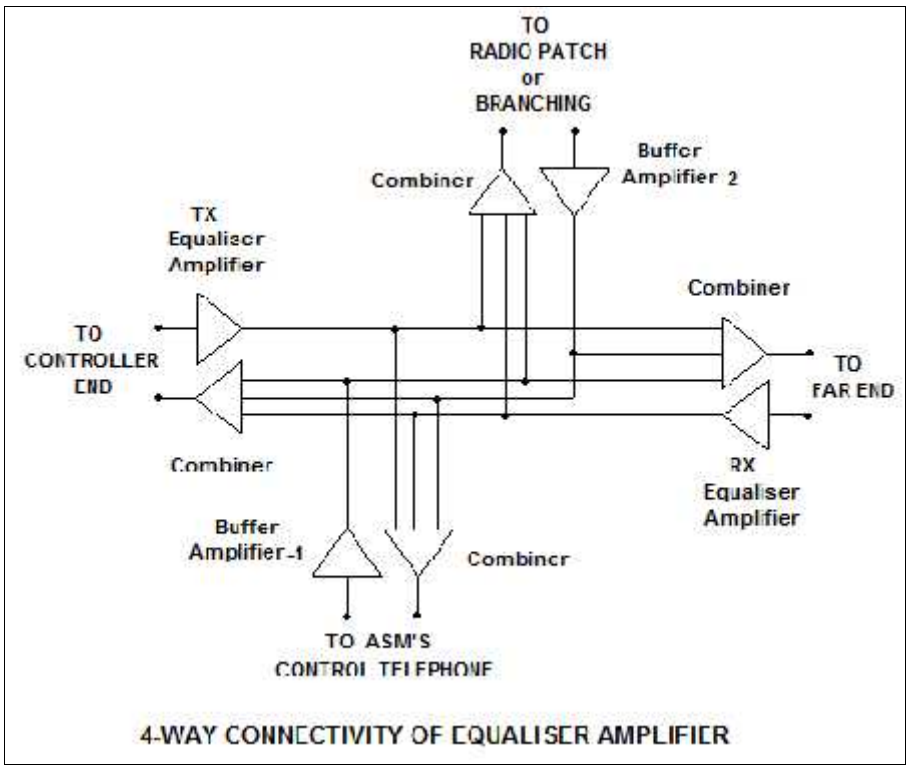


Fig. 5. 4

5.5.6 Technical Details of Equalizer Amplifier

The 4–way VF equalizer amplifier is provided to compensate for the loss of the speech level due to cable attenuation, insertion loss of the transformers and bridging loss of the tapping transformers at way station.

The 4 ways of equalizer amplifier are –

I. **Control end,**
II. **Far end,**
III. **Radio Patch or Branching end and**
IV. **ASM's Control Telephone end.**

(a) Trans. and receive amplifiers are identical
(b) Input and output of the amplifier is provided with isolation transformers. Surge protection is also provided at input and output of each amplifier.
(c) Each amplifier is provided with variable equalizer to compensate the slope of cable attenuation in the frequency range of 300Hz to 3400Hz.

(d) The equalizer circuit consists of single or multiple profile filters to compensate attenuation characteristics. In case of manual equalization, it is possible to select particular characteristics by choosing a DIP switch position depending upon the sectional length for compensation.
(e) Multi-way Branch: Each way station equipment is provided with 4 way full conference circuits as per block diagram given in figure-3.4 below.

(a) DTMF Decoder

The function of this unit is to decode selective calling DTMF station codes (or other codes also) and then to activate the buzzer.

(b) Local 8- Way Intercom Exchange

(a) This Intercom facility provides communication to the supervisory staff of various departments headquartered at stations, which neither have telephone exchange nor connected to the Divisional office by any other means other than the control communication.
(b) The controller can call any of the subscribers using DTMF codes, irrespective of the position of the subscriber's telephone i.e., whether it is free or engaged.
(c) The telephone connections to this Intercom can be extended up to loop resistance of 300 ohms.
(d) It is possible that all the subscribers can talk to each other without disturbing the controller (conferencing).
(e) It is possible to call any subscriber within the group using suitable access codes.
(f) By dialing suitable access code any subscriber can communicate with the controller.
(g) There is a facility to bar any subscriber for communicating with the controller.
(h) Normal auto dialing telephone can be used.
(i) This Intercom facility need not be provided in Main Repeater situated in headquarters station.

(c) Remote Monitoring Facility

Remote monitoring facility provides for remote monitoring and fault localization from Test Room. This facility can be provided to section control, deputy control and S&T control circuits separately.

For providing this facility a Remote monitor is provided in the Test Room and Remote sensor is provided in Intermediate Repeater.

It is possible to execute the following remote functions on control circuits using remote monitoring facility (except Emergency control).

(a) Disconnect one side of card of that circuit at a particular station.
(b) Disconnect another side of the card of that circuit at a particular station.
(c) Buffer 1 cut for card of that circuit at a particular station.
(d) Buffer 2 cut for card of that circuit at a particular station.
(e) Battery change over.
(f) Connect cards of that circuit at a particular station.
(g) Connect power supply voltage.
(h) Send AC fuse, charger and battery status.

These commands with relevant access codes are displayed on the equipment in addition to being displayed at control desk in Test Room. On failure of AC fuse, Remote sensor automatically sends fuse fail signal to Test Room equipment along with its ID.

(d) Power Supply Unit

(a) The power supply unit is operated normally with 230 VAC (160–270V). Provision for Solar power operation is also available with automatic change over from 230 VAC to solar supply and vice-versa.
(b) Power-supply system is fully duplicated. This includes two 40AH batteries and dual power supply unit. Over voltage (above 270V) protection is available.
(c) Power supply is provided with self-resetting type short circuit protection.
(d) The way station equipment is automatically bypassed in case of fault or when the battery voltage drops to threshold voltage of the amplifier.
(e) Power Supply Management Module: Out of two power supply units, one shall remain as standby and this unit automatically connected to battery charging system whenever main unit fails. One battery bank shall be connected to load while the other shall be connected to the power supply unit for charging. If the voltage across the battery on-load drops down to 11.5 volt, change over between the two batteries takes place automatically. Changeover of battery is also possible through remote operation as well as manually.
(f) The change over stop if due to any reason, both the batteries go below 11.5 volts. An indication/alarm to this effect is provided in the Test Room with station code. However, the change over process again begins once command for battery change over is given locally or from Remote monitoring unit. Reverse polarity protection is also provided in the module.
(g) The power supply unit shall be suitable to charge the batteries at 1/10th of rated current. It should be a constant current/constant voltage device.
(h) A set of two low maintenance batteries of 12 volts each, capable of operating the equipment for 72 hours at least are kept in a separate housing made of unbreakable material (to avoid damage to the equipment), and are sourced from reputed manufacturers against performance guarantee of 24 months minimum. The capacity of each battery shall be minimum 40 AH.

5.5. EQUIPMENT DESCRIPTION OF EQUALIZER AMPLIFIER SYSTEMS

Presently there are two types of Equalizer Equipments uses in Indian Railways. The details of these two are as given below

5.6.1 Equalizer Amplifier System (M/s EPSILON make as per Spec. RDSO/SPN/TC-34/2002)

Each amplifier has a graphic equalizer with 4 nos. of multi turn potentiometers for adjustment of gain for 4 different frequency bands.

Pot -1	300 - 800Hz,	Pot -2	0.6 - 1.4 kHz,
Pot -3	1.2 - 2.0 KHz,	Pot -4	1.8 - 3.5 KHz.

(a) **4-Way Branching system:** Each way station equipment is provided with 4-Way branching system.

The 4 ways are: -

(a) Control end, (b) Far end,
(c) Radio patch or Branching end and (d) Control telephone end.

Fig. 5.5 M/s Epsilon make Way Station Equipment Rack (Equalizer Amplifier System)

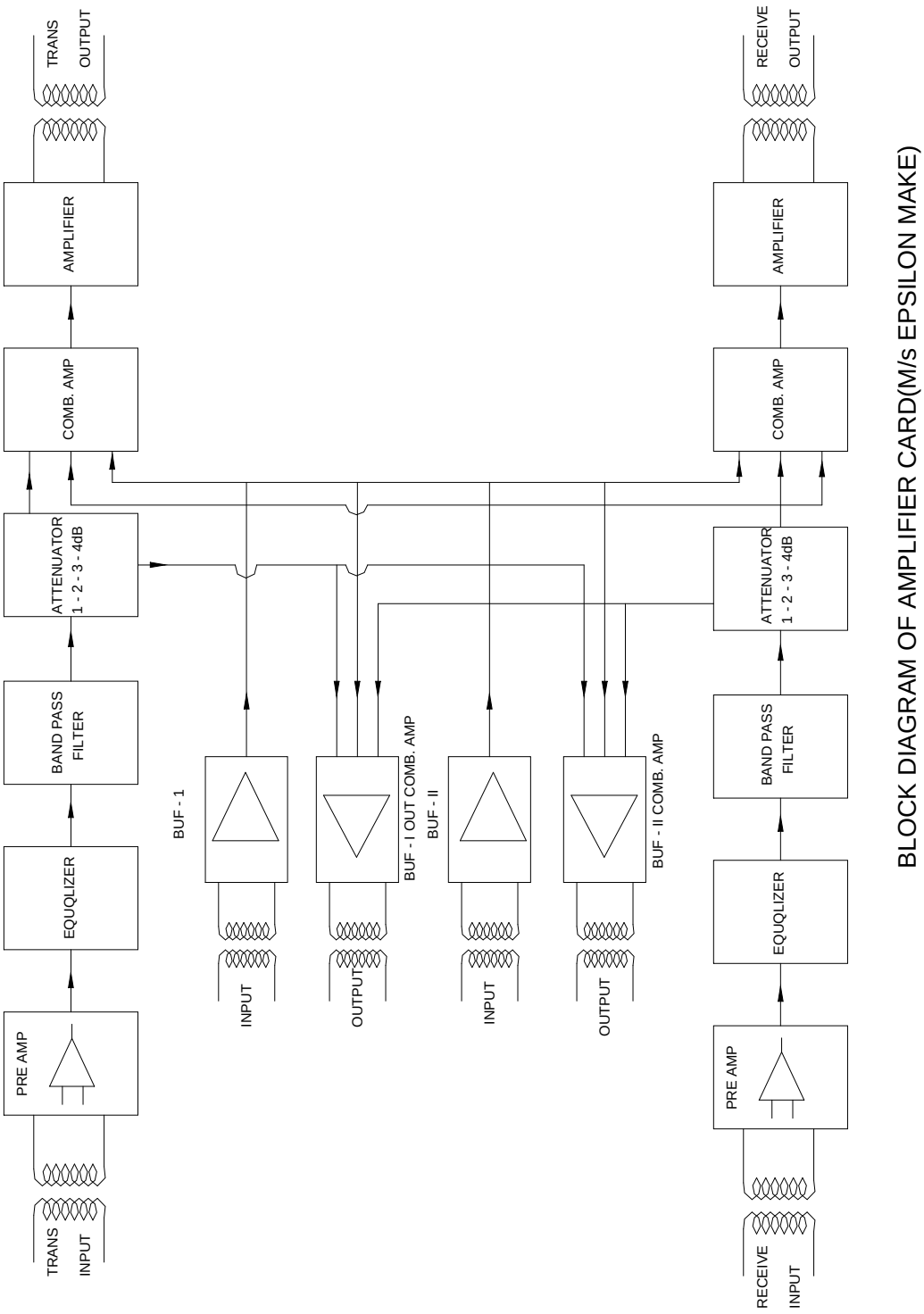
In the 4-way equalizer amplifier provided in this system the Buffer-1 is used for radio patching and Buffer-2 is used for connecting to SM's DTMF decoder and control telephone. This enables wayside-to-wayside conferencing without insertion loss, uniform speech levels, dispersal of leak amplifiers, easy radio patching.

The VF isolation transformers used are 470Ω : 470Ω in main Trans/Receive circuits and higher impedance for buffer circuits. The frequency response of the transformers in the range 0.3 to 3.4 KHz is within +/-0.5 dB.

(b) Specifications:

Trans & Receive Amplifiers: -

(a) Input impedance : 470Ω
(b) Nominal gain : 20dB +/-1dB
(c) Frequency response : +/-3dB
(d) Output (adjustable) : -2dB to 0dB
(e) Harmonic distortion @1kHz : ≤3%
(f) Cross talk level @1kHz : Better than –60dB between any two channels
(g) Variation slope : +/-10d B (0.3 to 3.4kHz)



BLOCK DIAGRAM OF AMPLIFIER CARD(M/s EPSILON MAKE)

Fig. 5.6

5.6.2 M/s Indisco Make Equalizer Amplifier System:

Fig. 5.7 M/s Indisco make Way Station Equipment Rack (Equalizer Amplifier System)

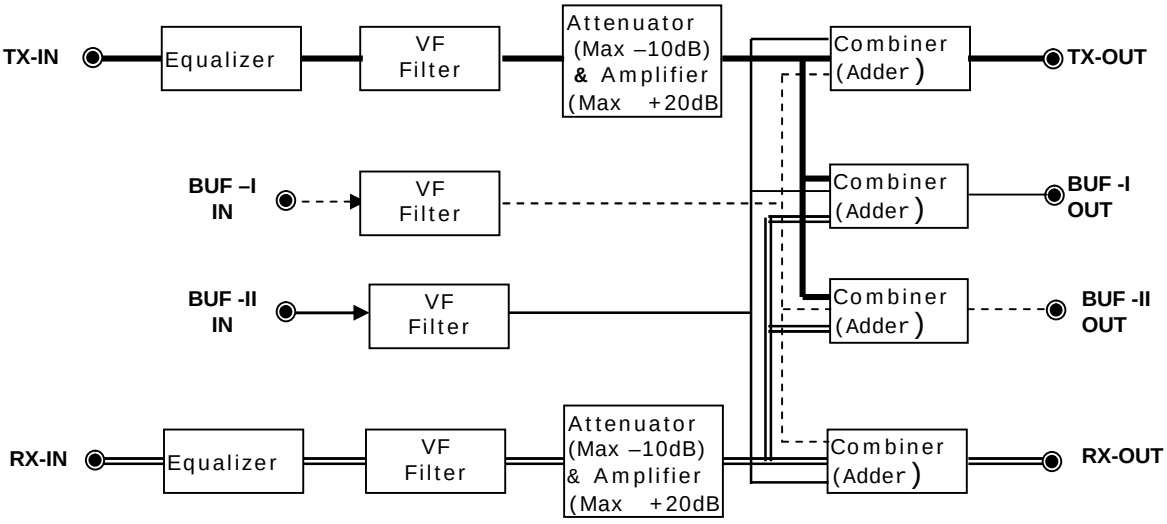


Fig. 5.8 Circuit Block Diagram of Equalizer Amplifier in Indisco System

There are four relays on the equalizer amplifier PCB, which are provided for effecting disconnection between U/G cable line and the circuits. The following table 5.3 gives the details of these.

Relay Name	Bypasses/Isolates	Name of Remote function performed
Relay-1	**Far end cable** from **TX-OUT & RX-IN**	West cut
Relay-2	Buffer-1	Buffer-1 cut
Relay-3	Buffer-2	Buffer-2 cut
Relay-4	**Controller end cable** from **TX-IN & RX-OUT**	East cut

Table - 5.3

Selection of Equalizer Slope:

Equalization slope in M/s Epsilon system is selected by 4 potentiometers whereas in M/s Indisco system by two DIP switch assemblies of 4 contacts each. Some sample slope settings with these DIP switches are shown below in table-5.4.

Some Samples of Slope Settings for Equalizer Amplifier								
Slope	DIP SW2				DIP SW1			
	1	2	3	4	1	2	3	4
12.65 dB	OFF	OFF	OFF	ON	ON	ON	ON	ON
8.09 dB	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF
5.09 dB	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF

Table - 5.4 - DIP Switch Settings for Equalizer Slope Selection

(a) Technical Specifications:

Trans & Receive Amplifiers: -

(h) Input impedance : 470Ω
(i) Nominal gain : 20dB +/-1dB
(j) Frequency response : +/-3dB
(k) Output (adjustable) : -2dB to 0dB
(l) Harmonic distortion @1kHz : ≤3%
(m) Cross talk level @1kHz : Better than –60dB between any two channels
(n) Variation slope : +/-10d B (0.3 to 3.4kHz)

Objective Questions

1. In repeater equipment the VF amplifier module containing leak amplifier is _____
2. Purpose of leak amplifier is to facilitate _____
3. Control Circuit not requiring leak amplifier is _____
4. Difference between VFR and VFL modules. _____
5. Gain of VF amplifier is _____
6. Maximum attenuation that can be set in Indisco VF amplifiers is _____
7. Operating voltage of VF repeater amplifiers. _____
8. Input and output impedance of VF amplifiers is _____
9. Main advantage in Equaliser Amplifier system. _____
10. 4-way amplifier is available in _____system.
11. Mention an extra facility available in Equalizer amplifier system. _____
12. Maximum gain of Equalizer amplifier. _____
13. Minimum gain selectable for Equalizer amplifier is _____

Subjective Questions

1. Explain about the 4-way amplifier with a sketch.
2. What remote functions are offered by the equalizer system?
3. Draw the block diagram of Equalizer Amplifier system of any make.
4. Briefly explain about the Remote Monitoring feature of Equalizer Amplifier system.
5. Explain about Local Intercom Facility of Equalizer Amplifier system.

CHAPTER-6

PATCHING OF CONTROLS

6.1 General Description

We have seen that the control communication is vital for smooth and efficient train operations. If this communication gets interrupted, not only the operations are hit but also the way stations are de-linked from the Headquarters which masterminds the train operations. As such whenever the control communication is interrupted either totally or partially, alternate arrangements are made.

6.1.1 Patching of Control Circuits

The Control circuits which are connected mainly with the train traffic are generally two, one is the Section control and other is the Deputy control. Both these circuits will have the same alignment on overhead line or through same underground quad cable. The section control is the more vital circuit concerned with the movement of trains, than the other control. This section control circuit is used always, intensively, for train control communication between controller and way stations.

In case there is any interruption due to a line fault in any portion of the section control, the following patching arrangements are used to replace the interrupted portion of the section control to achieve an interruption-free train control communication.

(a) Patching with the Deputy control wires,
(b) Radio patching, and
(c) Patching with Co-axial/OFC channels hired from BSNL.

Before affecting any one of the above patchings, the switching arrangements available at each way station are to be known thoroughly.

6.2 Switching Arrangement at Way Stations with Over Head Alignment

The simplest switching arrangement used at the SM's office of a way station, provided with control communication through over head line wires, is of two types:

(a) Utilizing two double pole double throw switches (DPDTs)
(b) Utilizing three double pole single throw switches. (DPSTs)

The circuit diagram of the arrangement with two switches is given in the figure-6.1. When both the switches are in top position, the line is made through with the way station equipment disconnected. When both the switches are put in bottom positions, the way station equipment also is in the circuit. This is the normal position.

If one switch only is kept in the middle or top position, the particular end gets disconnected at the station with office equipment out of circuit. The main advantage of this arrangement is the saving in the number of switches i.e. two switches for three operations -normal, test both ways and isolate office with line through. The disadvantage is the likely confusion in the manipulation of switches by the station staff during tests.

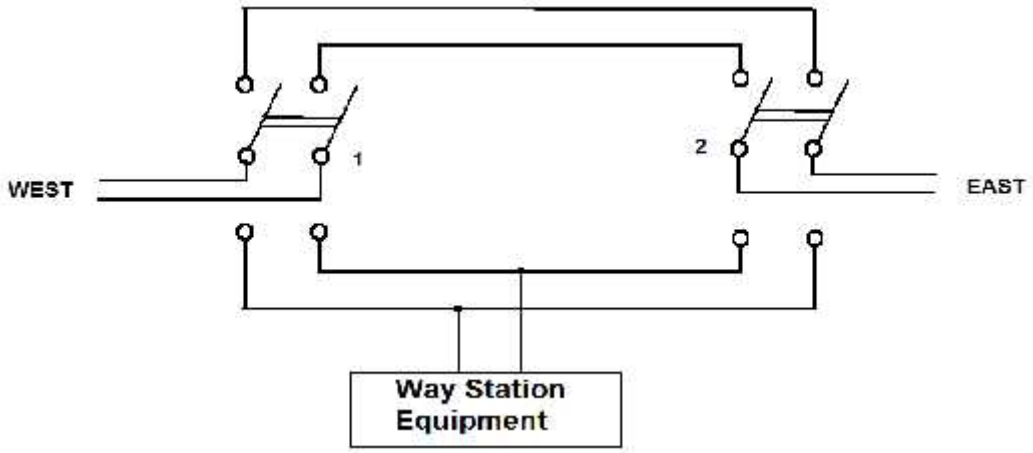


Fig.6.1 Switching Arrangements with 2 DPDT Switches

S.No	Switch-1	Switch-2	Result	Remarks
1	Down	Down	Way Station Equipment in circuit	Normal condition
2	Down	Up	East side disconnected	Isolating east side
3	Up	Up	Bypass Way station	Way station disconnected
4	Up	Down	West side disconnected	Isolating west side

The arrangement with **3 DPST switches** is given in the Fig 6.2. This consists of one switch each for the incoming and outgoing lines and a third switch for the way station equipment, the connections to which are tapped from the inter-connecting wire between the two switches. Normally the way station switch is kept at the center of the line switches. The operation involved is only disconnect or connect the required switch so the manipulation is fool proof.

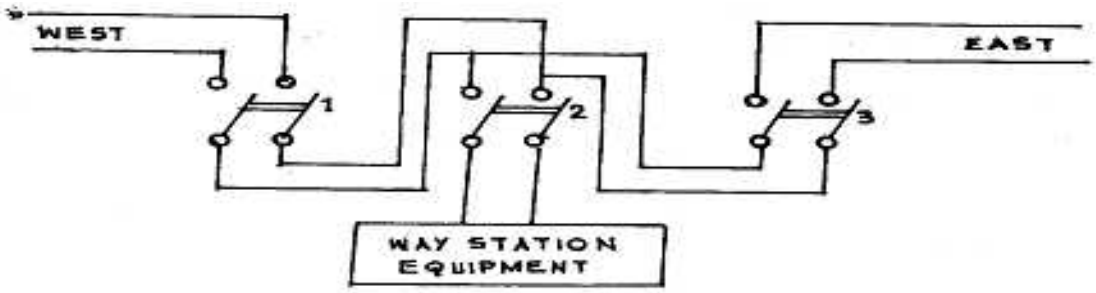


Fig. 6.2 Switching Arrangement with 3 DPST switches

S.No	Switch 1	Switch 2	Switch 3	Result	Remarks
1	ON	ON	ON	Way Station Equipment in circuit	Normal condition
2	**OFF**	ON	ON	West side disconnected	Isolating **West** side
3	ON	ON	**OFF**	East side disconnected	Isolating **East** side
4	ON	**OFF**	ON	Bypass Way station	Way station disconnected

Table - 6.1

6.3 Switching Arrangements at Way Stations with Under Ground Cable

In case of way stations provided with control communication through under ground cable, the switching/isolating arrangement is done only at the cable huts and VF Repeaters available enroute. At each cable hut/ VF Repeater the cables coming from different directions are

terminated using individual Krone tag blocks. Then these terminated wires are extended to isolating transformers and VF Amplifiers through U-links. For isolating the two portions of a circuit the U-links provided in between them are to be removed. For patching a portion of a circuit with other circuit, patch cords in conjunction with the U-link locations are used. The arrangements at a cable hut and at a VF Repeater are as shown in the figures 6.3 & 6.4 below.

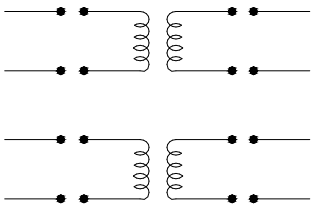


Fig. 3 Isolation arrangements at Cable Hut using U - Links

Fig.6.3

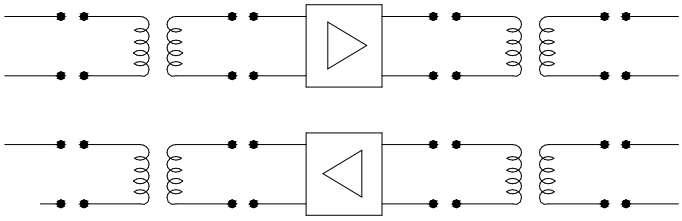


Fig.4 Isolation arrangements at V F Repeater using U - Links

Fig.6.4

6.4 Patching with Deputy Control Circuit:

6.4.1 Patching with 2-Wire Deputy Control Circuit (Over Head Alignment):

For patching purpose, deputy control circuit is looped in at every third/fourth station, and at such stations suitable arrangements are made on the test panels. Two sample switching arrangements adopted by Railways are shown in Fig.6.5 & 6.6

It will be noted that the code for both section control and deputy control section should be the same. Seven double poles, double throw (DPDT) switches are required.

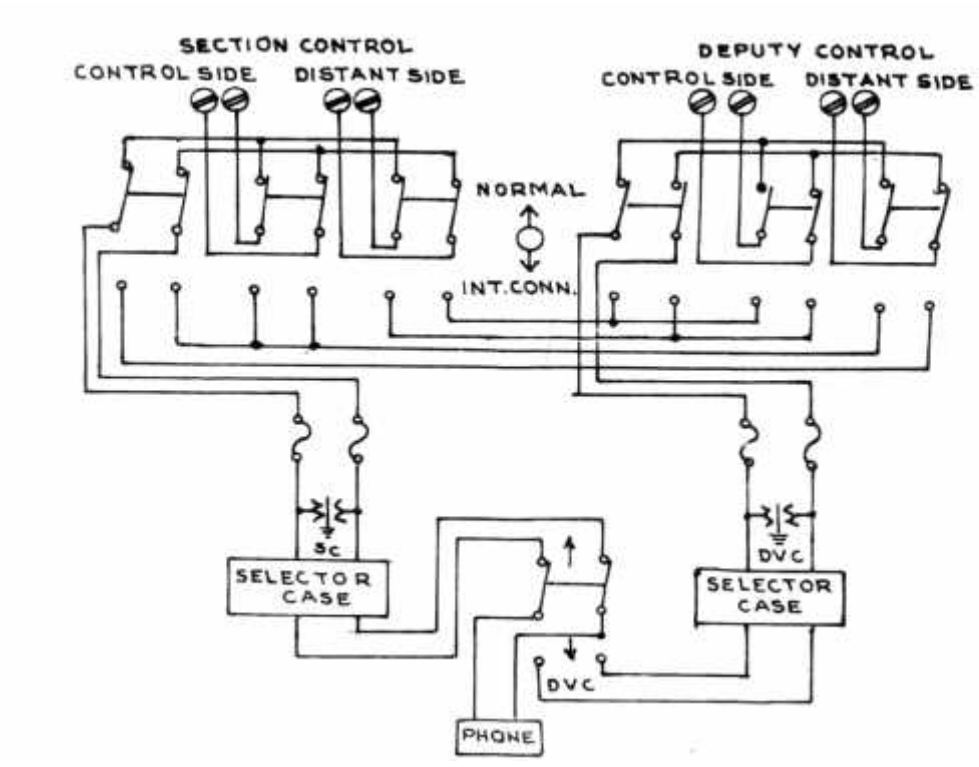
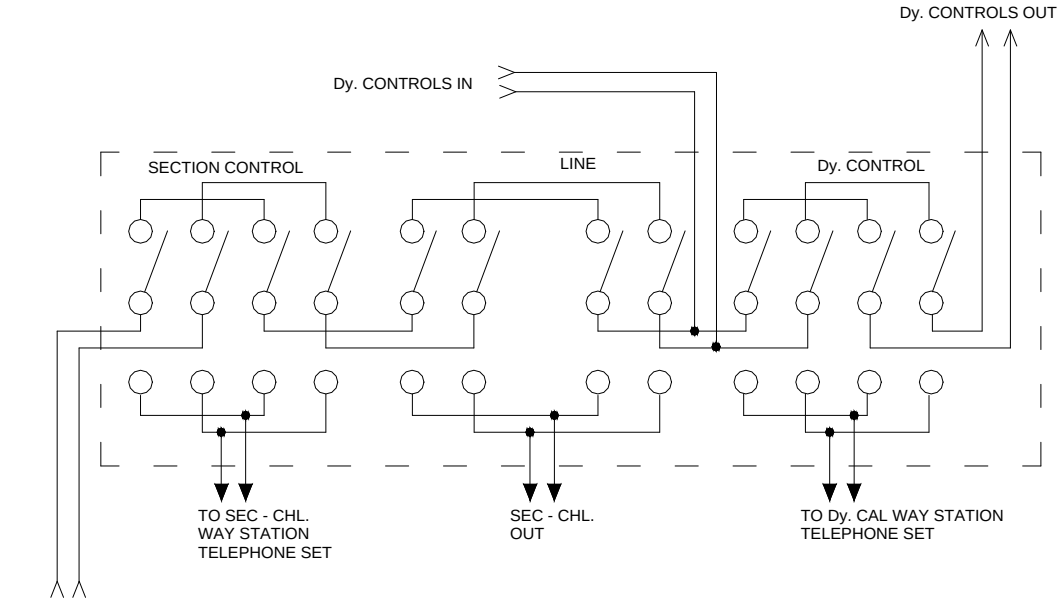


Fig.6.5 Control Switching Arrangements at Way-Stations for Patching Between Section Control & Deputy Control

Another switching arrangement is shown in Fig.6.6. In this arrangement 6 DPDT switches are used.



PATCHING ARRANGEMENT BETWEEN Dy. - CHL & SEC - CHL
AT WAY STATION (EASTERN RLY)

Fig.6.6

6.5 Patching with Deputy Control on U/G cable wires

The patching of section control wires with the Deputy Control wires; to substitute the faulty portion of the section control is as shown in the fig.6.7. In underground quad cables, the substitution of the section control faulty portion with the Deputy Control wires will be done from one VF Repeater or Cable hut to adjoining VF Repeater or Cable hut, covering the faulty portion. The VF Repeater/ Cable hut is chosen for substitution because the termination arrangements are only available at these places. No termination arrangements are available in Station Master's Room for underground cables as done in the case of overhead lines.

i) To isolate the faulty section of the section control, remove the U-links provided on section control wires on far end at station A and on control end at station B.
ii) To prepare the Deputy Control wires ready for patching, remove the U-links provided on Deputy Control wires on control end at station A and on far end at station B.
iii) Patching will be effected as shown in the fig.6.7 using patch cords.

6.6 Radio Patching

It will be noted that in the above Deputy Control patching arrangements where one physical circuit is patched to another physical circuit, the basic disadvantage is that both the circuits patched are prone to the same type of faults, generally. Also, to maintain the control communication link in abnormal weather conditions like storm, floods and heavy wind, the physical patching with Deputy Control wires will not be much useful. Therefore, a suitable alternative would be to patch the circuit with a more reliable circuit, which is immune to the faults that interrupt the physical circuit.

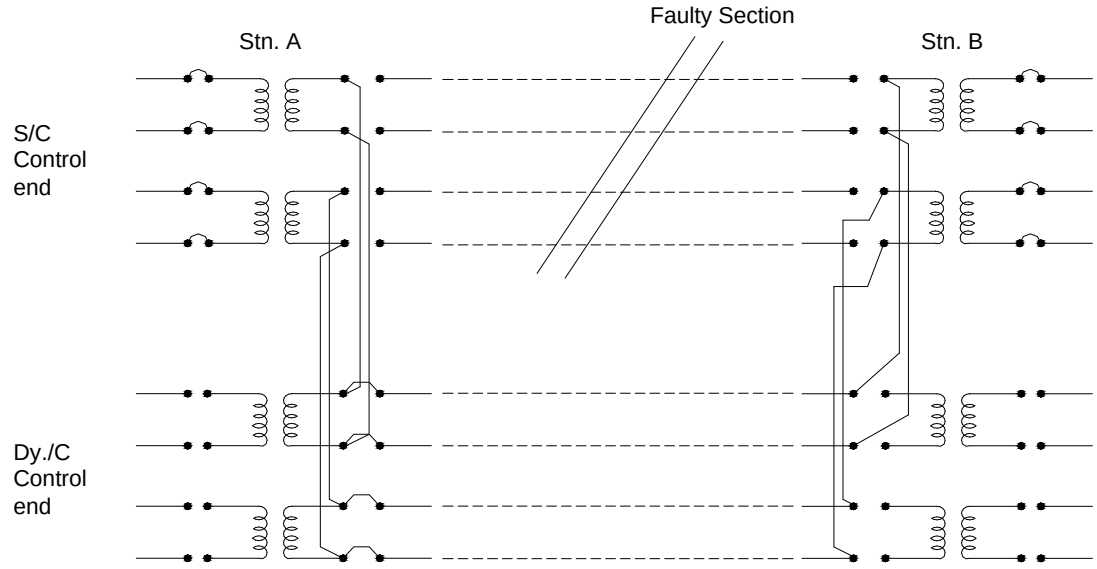


Fig. 6.7 Patching Arrangement with Dy. Control Wires

As we have seen, the control communication is vital for smooth and efficient train operations. If this communication gets interrupted, not only the operations are hit but also the way stations are de-linked from the Headquarters which master-minds the train operations. As such whenever the control communication is interrupted either totally or partially, alternate arrangements are made through Microwave Radio Relay System wherever such a system exists on the same route. This is called Radio Patch of Control Circuits.

The Radio patch can be effected either from the remote end of the control circuit or from anywhere 'in the middle, provided there exists such a facility. For the radio patch to work effectively, the speech level and signalling voltage levels should be adjusted properly. The speech level should give better both way communication for all way stations. The signalling level should be sufficient to ring all way station equipments satisfactorily.

As the DTMF Signalling lends itself suitable for both 2 wire and 4 wire circuits and also the signalling is in voice frequency range no separate arrangements are required while patching on Microwave System.

6.7 Radio Patch on Overhead Alignment:

In Non-RE areas, where control works on overhead alignment on 2-wire basis if the circuit is interrupted due to line problem the speech and signalling are transferred on to the Microwave System at the head quarters end. At the distant end, they are transferred back on to the overhead line wires after isolating the interrupted section. Since Microwave system works on 4-wire basis, the speech is converted from 2-wire to 4-wire at the Head quarters end and 4W to 2W at the distant end. This conversion is accomplished in the MUX equipment at the microwave station. See figure - 6.8

6.8 Radio Patch on Underground Cable:

Where control communication works on underground cable the reliability of communication is quite high. Radio patch is felt necessary as an emergency measure in the event of cable failure or theft.

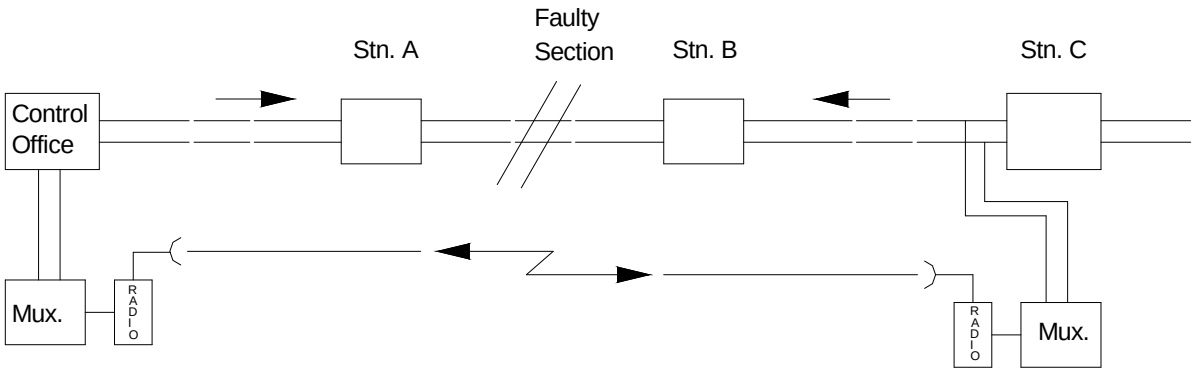


Fig. 6.8

In underground cables the circuits work on 4 wire basis, the signalling will be on the Controller's Trans pair extended from control test-room to microwave station. The ring back from the way stations will be connected on to the controller's receiving pair. The patching arrangement is as shown in the figure 6.9.

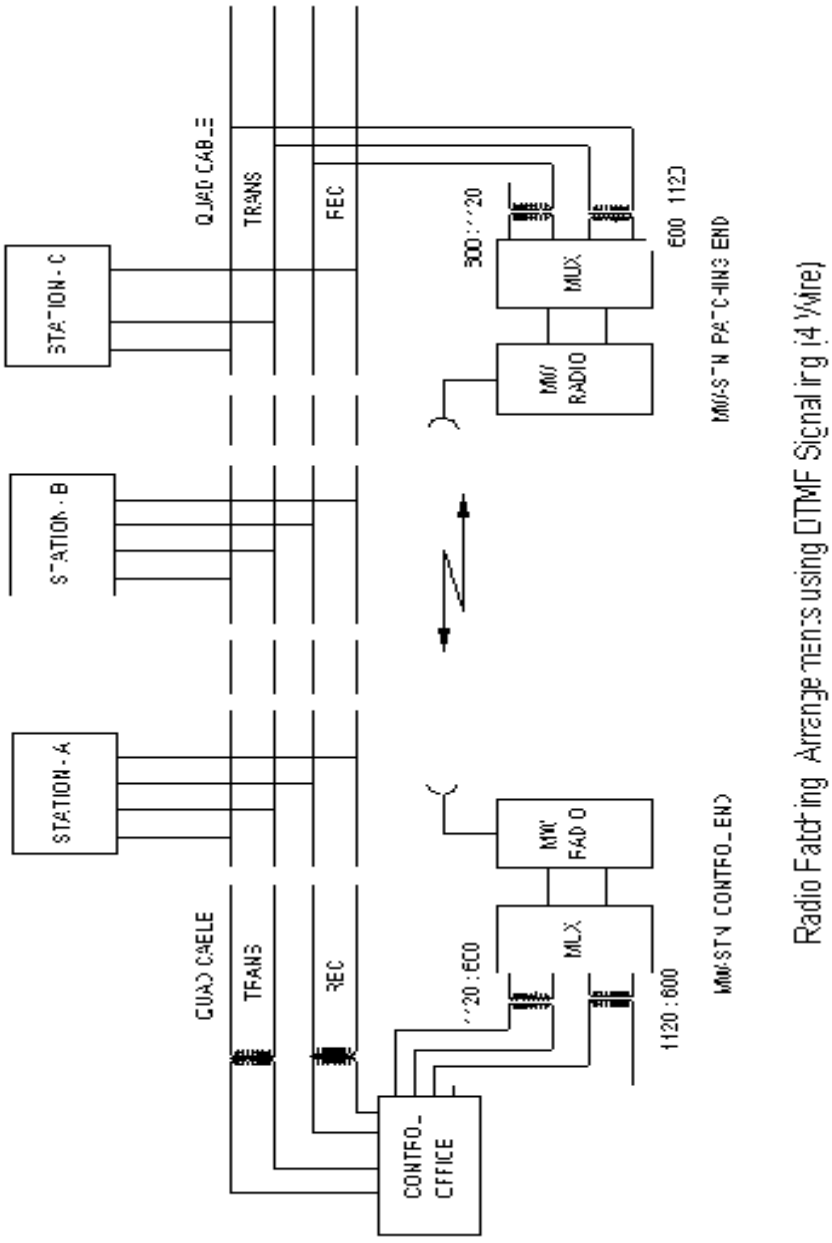


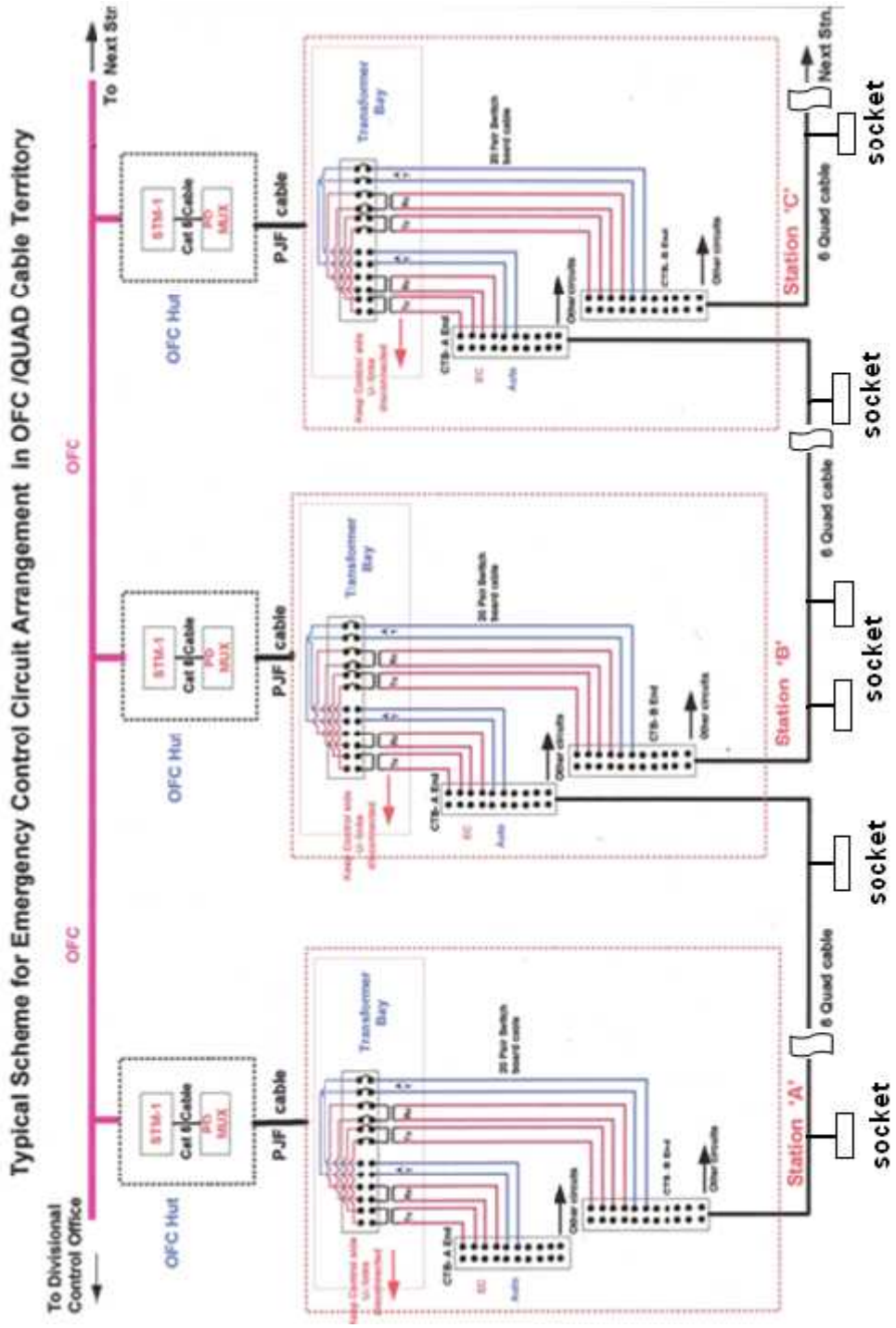
Fig. 6.9

6.9 Patching with OFC Channels Hired from BSNL:

In controlled sections where a Railway Microwave System doesn't exist, long distance OFC channels are hired from BSNL for patching. These hired channels are provided between the control office and some of the important Railway stations on the control section.

6.10 Patching of OFC Channels to 4/6-Quad U/G Cable for Emergency Control:

In sections where optical fibre cable is laid, all the controls will be working through the OFC channels. But for connecting the wayside EC sockets, the OFC channel meant for EC working has to be patched to the EC quad of the 4 quad or 6 quad PIJF cable at the stations. EC sockets are connected by tapping the Emergency circuit on quad cable. The below shown arrangement may be adopted for patching. See figure-6.10.



Objective Questions

1. Interconnection between section control and Dy. Control is called _____
2. Radio patching means _____
3. Separate equipment for radio patching is not needed in _____system.
4. No. of OFC patching practices followed for EC circuit _____
5. The Radio patch connection is taken from Buffer _____ in Indisco equipment.

Subjective Questions

1. What is patching and why is it required?
2. Show the patching arrangement between section control and Dy.Control circuits.
3. What is Radio patching? When is it implemented?
4. Show OFC channel patching with quad cable for emergency control circuit.

CHAPTER-7

CONTROL TELEPHONES & OTHER CONTROL EQUIPMENTS

7.1 Way Station Control Telephones

7.1.1 4-Wire Way Station Control Telephone

The 4 wire way station control telephones are provided at way stations for providing communication from 4-wire omnibus control network. They are desk type and work in conjunction with control way station equipment on 4-Wire basis. The control way station equipment provides battery for the microphone. Trans and receive amplifiers provided in the control way station equipment take care of matching of the impedance of microphone and receiver with that of the line.

On receipt of a valid code, the way station equipment extends an audio output and positive of battery to the loudspeaker and LED display device, respectively.

The details of 4-Wire way station telephone as per Specification IRS: TC: 38-97 are as given below:

7.1.2 Salient Features

1. The telephone consists of ABS (Acrylonitrile Butadiene Styrene) body, HMT with press to talk switch, cradle switch, coil cord of length 1.5 meters, 6 way rosette box, buzzer and LED.
2. Both transmitter and receiver are electro dynamic transducer type.
3. It has a pre-amplifier circuit in the Trans side to give an output voltage of 250mV across the line with 1120Ω load impedance for an input of 5mv across the dynamic type transmitter (220Ω load resistance).

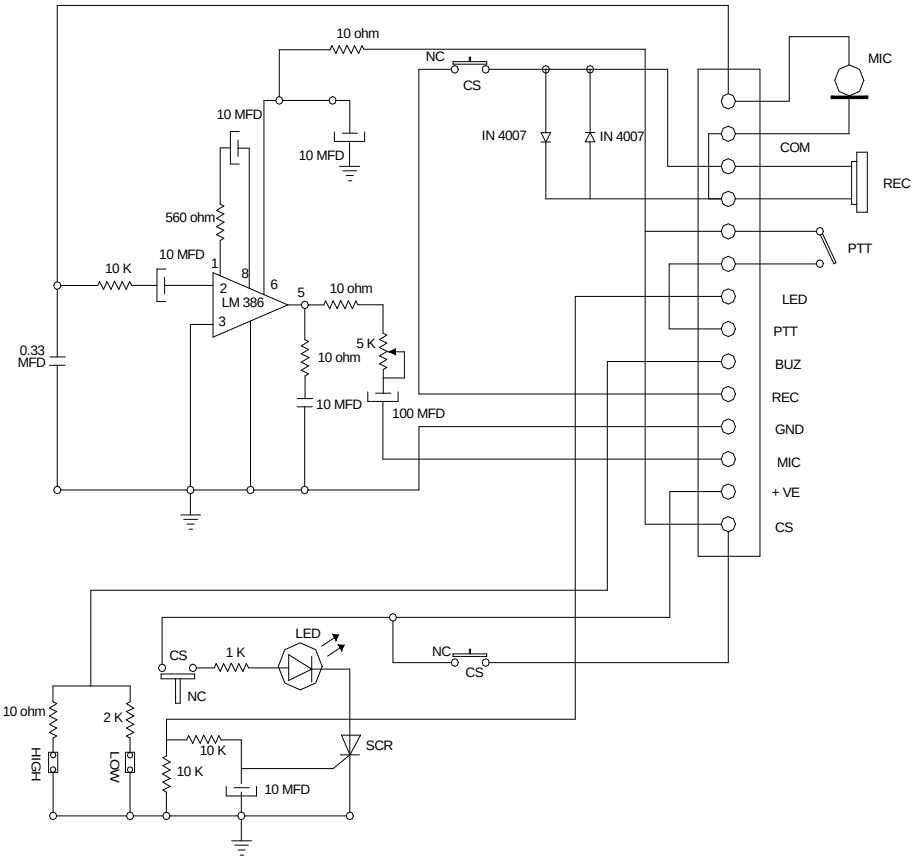
The circuit diagrams of two different makes of 4-wire way station control telephone are as given below in fig. 7.1 & 7.2

7.2 2-Wire Way Station Control Telephone (As per IRS: TC: 37-97)

2-Wire way station control telephones are provided at way stations for providing communication from 2-Wire omnibus control network. It works along with 2-Wire DTMF way station equipment. Whenever the way station is called the piezo-buzzer comes ON in addition to a latched LED indication until the handset is lifted. When the telephone is lifted, this LED gets off and the communication is made.

7.2.1 Salient Features

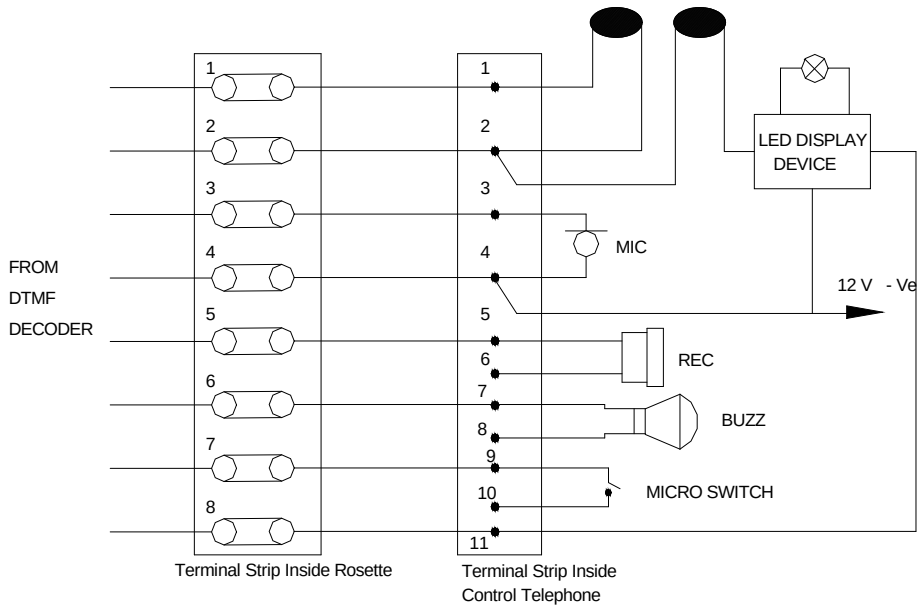
1. The telephone body, HMT, and rosette are made of ABS (Acrylonitrile Butadiene Styrene).
2. Both transmitter and receiver are electro-dynamic transducer type.
3. Hand set is provided with approved micro-switch.
4. Working voltage is 3 VDC (+ 20% or - 10%).
5. Insulation resistance should not be less than 10 MΩ (tested with 500 VDC Megger).
6. Insertion loss should not be greater than 0.2 dB while listening & 0.8dB while speaking.
7. Both input and output terminal strips for amplifier PCB are provided inside the telephone body.
8. When idle, current should be less than 20mA.



4 WIRE CONTROL TELEPHONE (M/s EPSILON make)

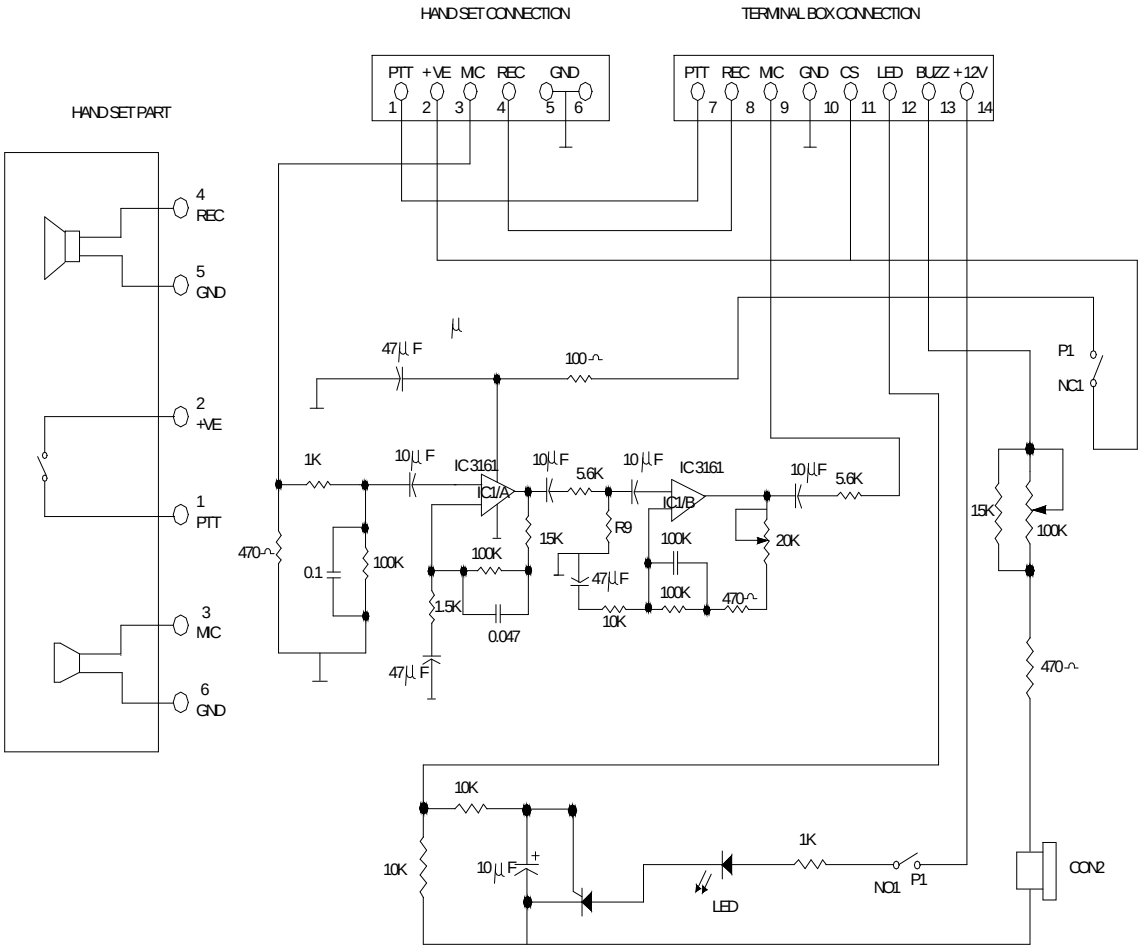
Fig.7.1

The 4-wire control telephone termination details:



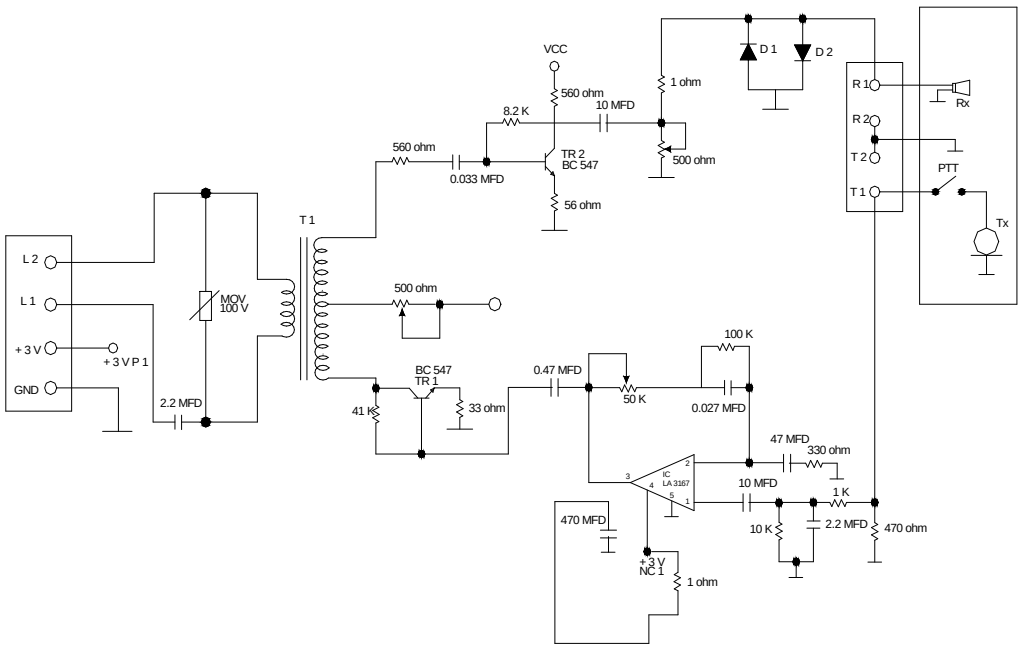
TERMINATION DETAILS OF 4 WIRE CONTROL TELEPHONE

Fig.7.2



CIRCUIT DIAGRAM OF 4-WIRE WAY STATION CONTROL TELEPHONE
(M/S ANU VIDYUT MAKE)

Fig.7.3



CIRCUIT DIAGRAM

2 WIRE WAY STATION CONTROL TELEPHONE (M/s ANU VIDYUT make)

Fig.7.4

The circuit diagram of 2-Wire way station control telephone manufactured by **M/S Anu Vidyut** is shown in the figure-7.4.

7.3 Universal DTMF Wayside Control Telephone (IRS: TC 82-2005)

Universal DTMF Way Side Control Telephone is suitable for both 4 Wire and 2 Wire working. The telephone includes the circuitry of conventional control telephone as well as DTMF decoder equipment. There is a flap on front side of the telephone. When this flap is opened two DIP switch assemblies are visible which are used for setting the way station code. The telephone works on 12V DC with ±20% supply voltage.

The current consumption:

30mA	in idle condition
75mA	during conversation
125mA	during ringing period

7.4 Portable Control Telephone

Portable control telephones are used to communicate with the controller from the section provided with either over head alignment or underground cable. These are available in 2 wire, or in 4 wire, or in 2 wire/ 4-wire forms. These telephones are provided with Drivers & Guards to communicate with the controller in case of accidents and other unusual occurrences. These telephone sets are also provided with some important maintenance staff of Engineering, S&T and Electrical (OHE & TRD) departments to have communication for maintenance of their respective gears. In Railway Electrified areas and some of the Non Electrified areas where underground cables are provided for control working, Emergency sockets are provided along the cable route (at every 1 KM, approximately) to which the portable control telephones are to be plugged to communicate.

7.4.1 2- Wire Portable Control Telephone

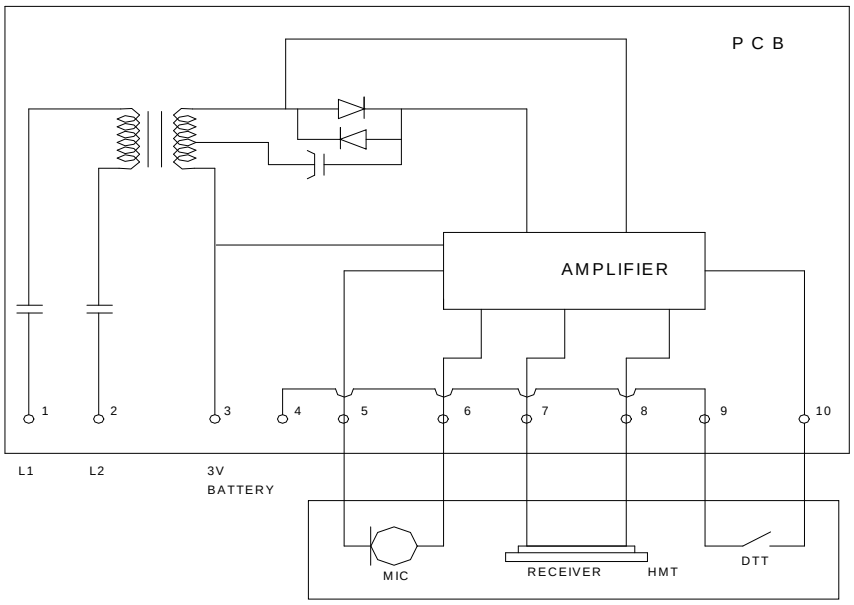
This telephone is used for communicating from an emergency site with the controller, by hooking to the overhead alignment provided along the track.

This telephone is in the form of rectangular box made of mild steel consisting of main body and cover. The main body is divided into 2 parts. The upper part accommodates HMT and cords. The lower part accommodates one matching transformer PCB and screw terminals. A separate compartment is provided with a lid and sealing facilities to house two flash light cells of 1.5 volts each.

7.4.2 Features

1. Both transmitter and receiver are of electro dynamic transducer type.
2. Transmitter works on 3 volts

The internal wiring of the components of the telephone is as shown in the fig.7.5



NOTE

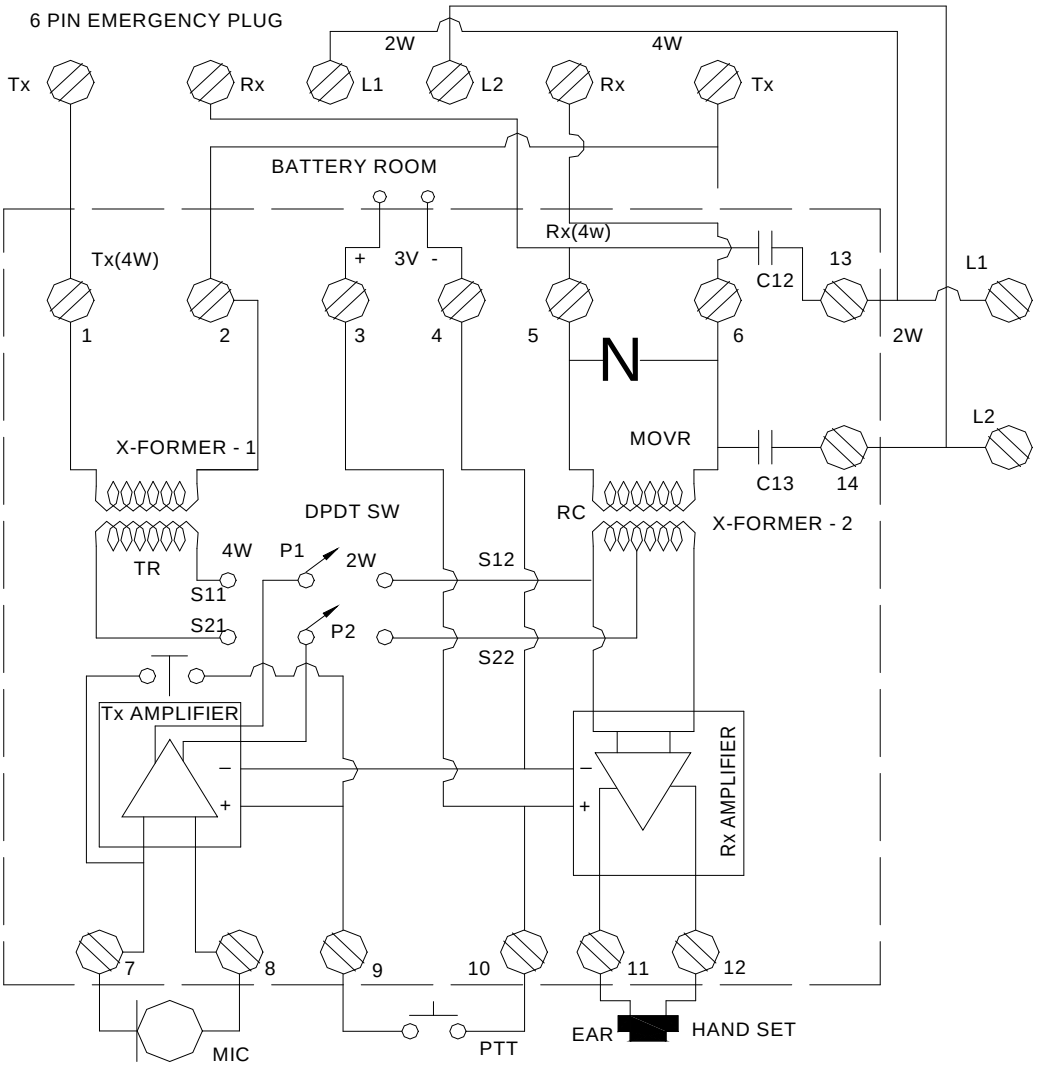
1) TREMINALS 1 TO 10 DIRECTLY MOUNTED ON PCB
2) Rx AMPLIFIER GETS SUPPLY THROUGH CRADLE SWITCH

2-WIRE PORTABLE CONTROL TELEPHONE

Fig-7.5

7.4.3 4 wire/ 2 wire Portable Control Telephone (IRS: TC: 75-99)

Portable control telephones are provided with train crew for talking with controller in emergencies. These are also used by engineering and S&T staff. A 4w/2w portable telephone is very useful as it can be used both in 4 wire and 2 wire territories. The internal wiring diagram showing the internal components and the connections between them is given in the figure-7.6.



OPERATION INSTRUCTIONS

2W OPERATION

1) PRESS 2W/4W SWITCH TO 2W POSITION
2) CONNECT L1&L2 TO 2W LINE
3) PRESS PTT SWITCH IN HANDSET AND START CONVERSATION

4W OPERATION

1) PRESS 2W/4W SWITCH TO 4W POSITION
2) CONNECT 6 PIN EMERGENCY PLUG TO 4 WIRE EMERGENCY SOCKET
3) PRESS PTT SWITCH IN HANDSET AND START CONVERSATION

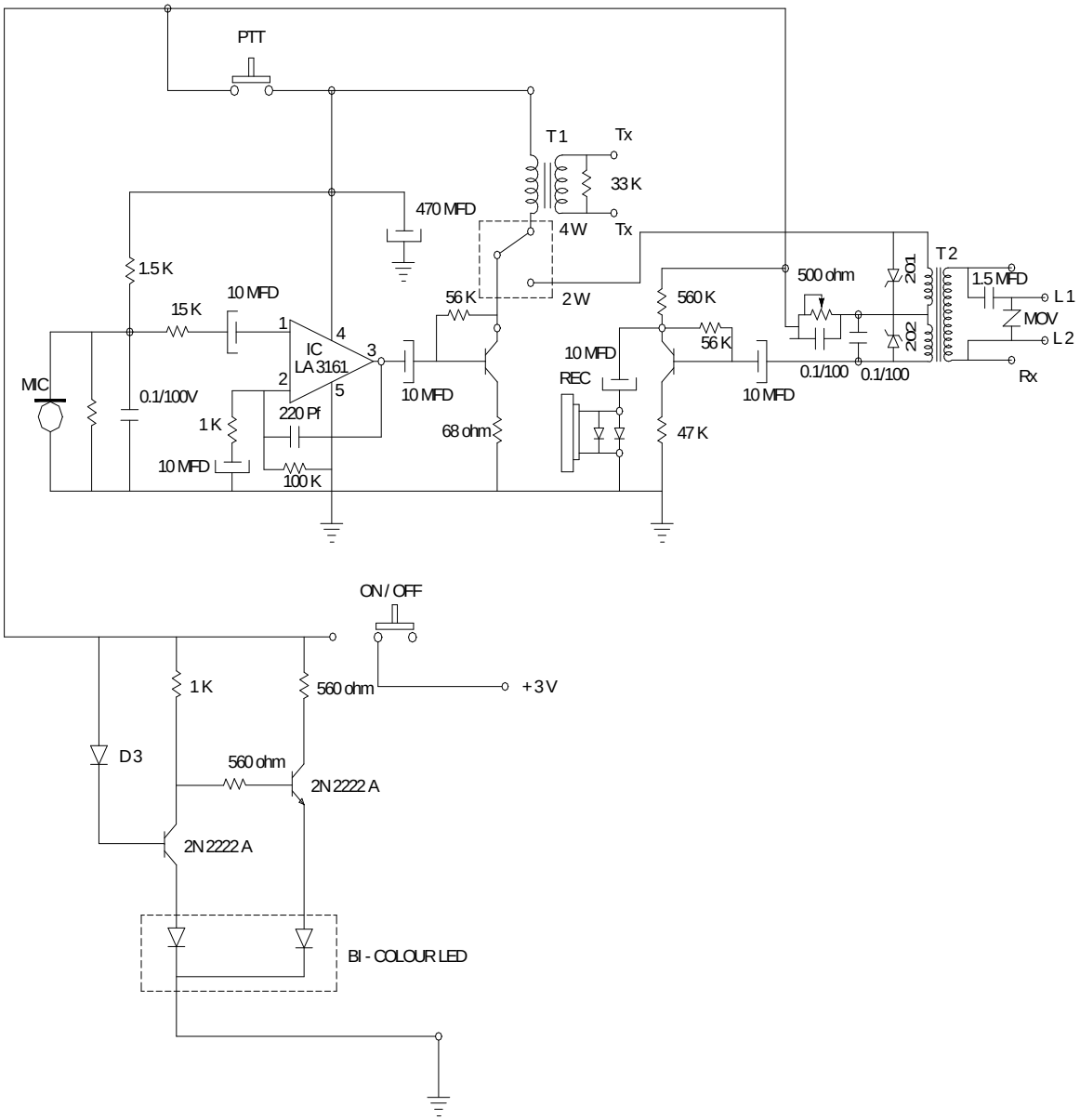
4W/2W PORTABLE EMERGENCY CONTROL TELEPHONE(M/s BENTRON MAKE)

Fig.7.6

Separate amplifiers are provided for the microphone and the receiver. By pressing the press to talk (PTT) switch provided in the HMT, the 3 volts speaking battery gets extended to the microphone. A 4W/2W switch provided is to be operated to 2W side for using in 2 Wire sections. By this operation, the receive pair will become common pair and serve for both trans and receive directions. For using in 4 Wire sections, the same switch is to be operated to 4W sides.

7.4.4 4-Wire/2-Wire Light Weight Portable Control Telephone (IRS: TC 78-2000)

The diagram shown next is a 4-Wire/2-Wire Light Weight Portable Control Telephone manufactured by **M/S EPSILON** as per RDSO Specification IRS: TC: 78-2000: Its use is the same like the above mentioned 4w/2w portable telephone with an extra advantage of light weight.



4 WIRE / 2 WIRE LIGHT WEIGHT PORTABLE CONTROL TELEPHONE (M/s EPSILON make)

Fig.7.7

This lightweight portable control telephone is enclosed in ABS plastic moulded box. The telephone works on 3 VDC (2 Nos. of 1.5 dry cells). With the help of a switch, the battery is connected to the circuit. The telephone can be selected for 2-Wire/4-Wire operation with help of 2W/4W switch.

7.5 2-Wire 12-Way DTMF Telephone (IRS: TC: 80-2000):

This telephone is an electronic version of Magneto telephone used for providing communication at LC gates, Cabins etc. at a wayside station. This has an additional feature of push button (4x3 matrix) for calling the other locations. It works on 2-Wire omnibus circuit tapped at different places for point to point and multi point communication.

As a system, the telephones are provided in Master-Slave configuration. There is 1 Master + 10 Slave telephones. Standard DTMF tones are used for selective calling. It is possible to assign any code to a slave telephone in the decimal system. The numbering scheme used in the system is as given below:

(a) 2 to 10 and * (11) are used as 10 slave telephone numbers.
(b) 1 Is used as Master telephone number.
(c) # Is used for General call from the Master telephone.

This telephone works on 12 VDC. The specifications of this telephone are as per **IRS: TC: 80-2000.** The circuit diagram of this telephone (Epsilon make) is as given in fig.7.8

Originating a call: The calling subscriber will lift his telephone hand set and press the number on the key pad with whom he desires to contact. By this, the Micro-controller (IC 89C2051), which is scanning the keypad lines, if finds a valid entry, generates a command according to the key pressed and delivers it to the Tone Generator (IC1214B). This Tone Generator generates the required DTMF tones and feeds on to 2-Wire line.

Receiving a call: The DTMF tones are first received and decoded by a Decoder (IC 8870). These decoded signals actuates the buzzer through the Micro-controller where strapping is available as per the number allotted to the telephone. The ring back tone generated by the actuation of the buzzer is fed back to the calling subscriber.

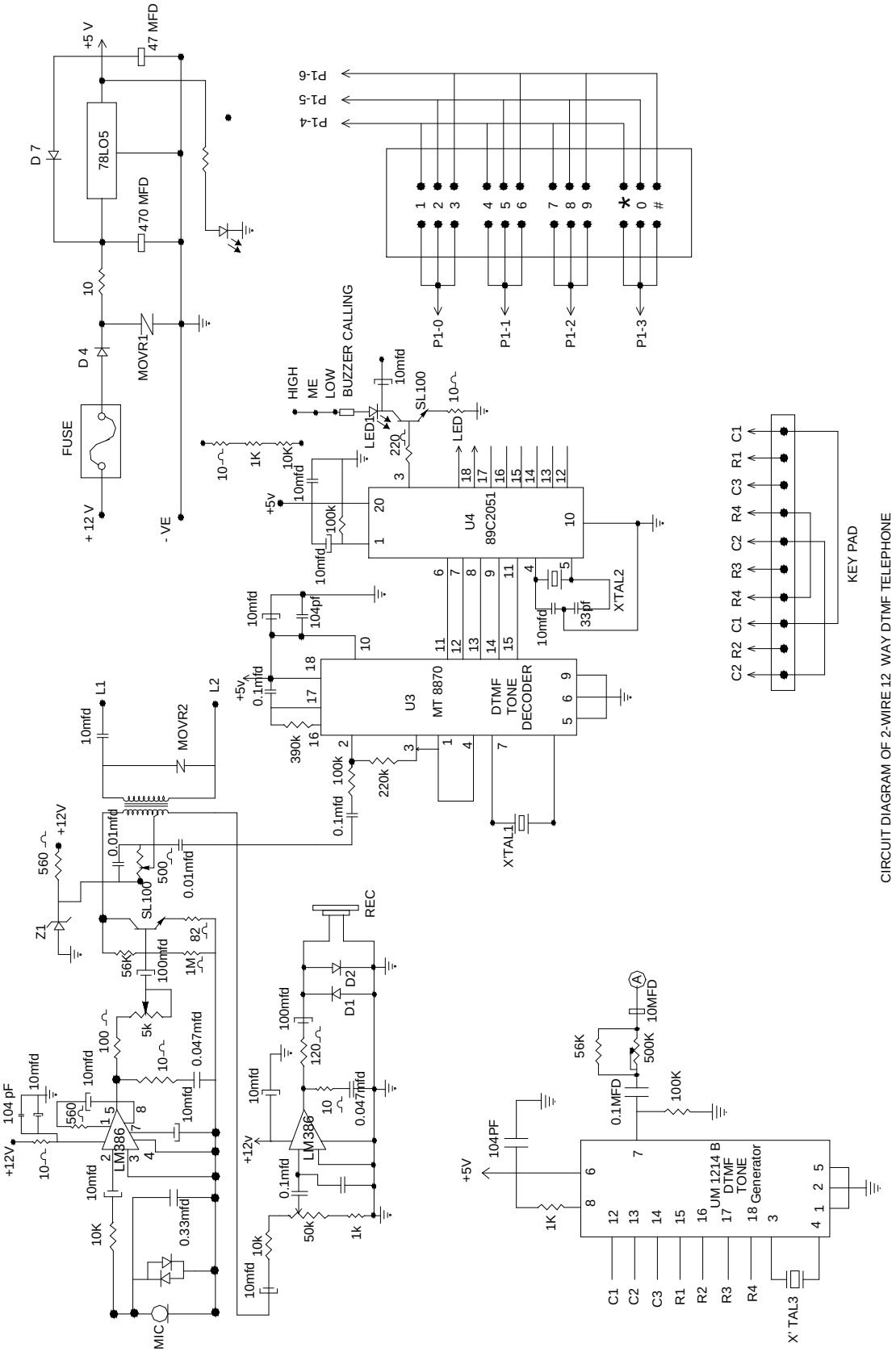

+5 V
47 MFD
78LO5
470 MFD
D 7
10
D 4
MOVR1
FUSE
+ 12 V
- VE
P1-6
P1-5
P1-4
P1-0
P1-1
P1-2
P1-3
HIGH
ME
LOW
BUZZER CALLING
LED1
SL100
LED
U4
89C2051
XTAL2
33pf
U3
MT 8870
DTMF
TONE
DECODER
XTAL1
L1
L2
MOVR2
Z1
SL100
REC
LM386
MIC
KEY PAD
C2 R2 C1 R4 C2 R3 C3 R4 C4 R1
UM 1214 B
DTMF
TONE
Generator
X' TAL3
CIRCUIT DIAGRAM OF 2-WIRE 12 WAY DTMF TELEPHONE
(M/S EPSILON MAKE)

Fig.7.8

7.6 Electronic LC Gate Telephone (RDSO/SPN/TC-51-2004)

This system is meant for communication between ASM office and LC gates. It works on Master and slave principle. One master at ASM office can be connected to 4 LC gate telephones using an omnibus 2wire line. A 24V power supply to LC gate phones is extended through the same omnibus speech line from the master. The master phone operates on 12V supply derived from a 24V 7AH maintenance free battery. Its main features are as given below

- Each LC gate phone is connected with ASM's master telephone only when it is called by the master.
- The connectivity is through a 2 wire line
- Even though all telephones are interconnected using an omnibus line there is confidentiality in the speech between ASM and an LC gateman.
- The max. distance between the master and an LC can be up to 6km using a pair of 0.9mm copper cable
- Each LC gate telephone works as an **electronic magneto** telephone without the need of any battery or power supply source at the LC gate
- Master operates with 12V DC and slave LC gate phones with 24V DC.
- For calling master from the slave telephone a push button is provided
- The master is provided with separate push buttons for calling each slave

7.7 Integrated Way Station Control Communication Equipment (IWCCE):

(RDSO/SPN/TC/70/2007)

This will replace all the 4-W Way Station Equipments used separately with Section Control, Deputy Control, Traction Power Control, Engineering control circuits at a way station and will additionally facilitate **Intercom Facility** amongst Control Telephone Subscribers.

The equipment is designed to work with the Control Office Equipment designed of as per IRS: TC 60-2007.

- IWCCE can cater for **eight** 4-wire Omnibus Control Circuits or Channels at way stations
- IWCCE can be connect up to 30 Way Station Control Telephone (Subscribers).
  * 6 (six) Subscribers each to first two Control Channels and
  * 3 (three) Subscribers each to remaining six Control Channels.
- Provision also exists to increase the number of subscribers in a particular Control Channel by utilizing the resources of other unused Control Channels.
- The system decodes both two digit and three digit DTMF code coming from head quarter equipment and generates ring to the desired subscriber.
- The IWCCE has facility to generate ring back tone whenever a ring comes from the Control office.
- For selective calling from Control Office Equipment a ring back tone is sent back to the controller if the desired way station phone handset is in on-hook. If the desired subscriber is already off- hook, an acknowledgement tone is sent. For group or general call from control equipment, there is no ring back tone to controller.
- Way Station Control Telephones connected to the IWCCE has dialing facility to call other control telephones and they can use either Pulse dialing or Tone dialing.
- These Way Station Control Telephones have volume control facility.

- The ring at the control telephone lasts for the period of 15 seconds whenever called and gets terminated as soon as handset is OFF-hook.
- As soon as the handset is lifted, the control telephone gets connected to the control circuit with the Rx path through but keeping the Tx path disconnected. The Tx of the handset is enabled either by tapping the cradle switch or by pressing anyone of the keys on the telephone handset, except # and * keys.
- If programmed, the call from Controller can be diverted to any other telephone under same or different control channels in case of unattended call or telephone instrument faulty.
- The system has provision for gain adjustment of 4-Wire Control circuit in both Tx & Rx directions.
- The IWCCE supports the intercom as well as exchange access facility. The same way station telephone can be used for this purpose when it is free. However, if a control call comes during a local conversation, then the local call is disconnected and the control call is extended to the selected subscriber. Local conversation can not disturb the call on omnibus control circuit.
- The equipment has facility to extend standard communication tones like ringing tone, dial tones, ring back tone, number busy tone etc.
- The equipment also has the facility to interface at least two analog tie lines like Railway Telephone, BSNL Telephone etc. Subscriber/User connected with this equipment has facility to access any of the tie lines as per requirement in addition to communicate with the controller of the connected 4-W control circuit.
- In case of Railway or BSNL exchange tie lines (telephone line) to be interfaced by the equipment, the exchange should have tone detection facility.
- If any exchange subscriber wants to dial IWCCE subscriber, it has to first dial exchange number of the particular line connected to the IWCCE to get IWCCS dial tone and then dial subscriber code XY as long as dial tone persists (15 sec.). After this interval, the incoming exchange call gets landed to a particular subscriber if programmed as operator.
- Provision is there to bar the Intercom & Tie line access facility on a particular telephone through software.
- **Call Overriding Facility for Controller:** Controller has overriding priority to call a particular way station telephone even if the subscriber is busy in conversation on intercom or Tie lines.
- Tie line terminating facility:
  (i) It is possible to terminate one Railway and one BSNL telephone circuit at all the Way Station equipment having intercom facility for communication of Way Station subscribers with Divisional/other subscribers on Railway/BSNL Network and vice-versa.
  (ii) Provision for tie line bypass directly on the telephone instrument, provided on the SM's table, is also available, in case of equipment shutdown.
- Way station subscriber has programmable exchange priority feature. A priority subscriber can get access to exchange tie line, if the line is engaged by some other low priority subscriber.
- Voice calling from way station telephone to the controller is available in the system.
- The system is compatible to work on any communication media like OFC or Microwave.
- The IWCCE works with -48V± 20% DC Power Supply.
- All the Way Station Control Telephones work in tandem with IWCCE and do not require separate power supply.
- The way station telephone works on twisted pair cable having a loop resistance of less than 1200 Ohms.

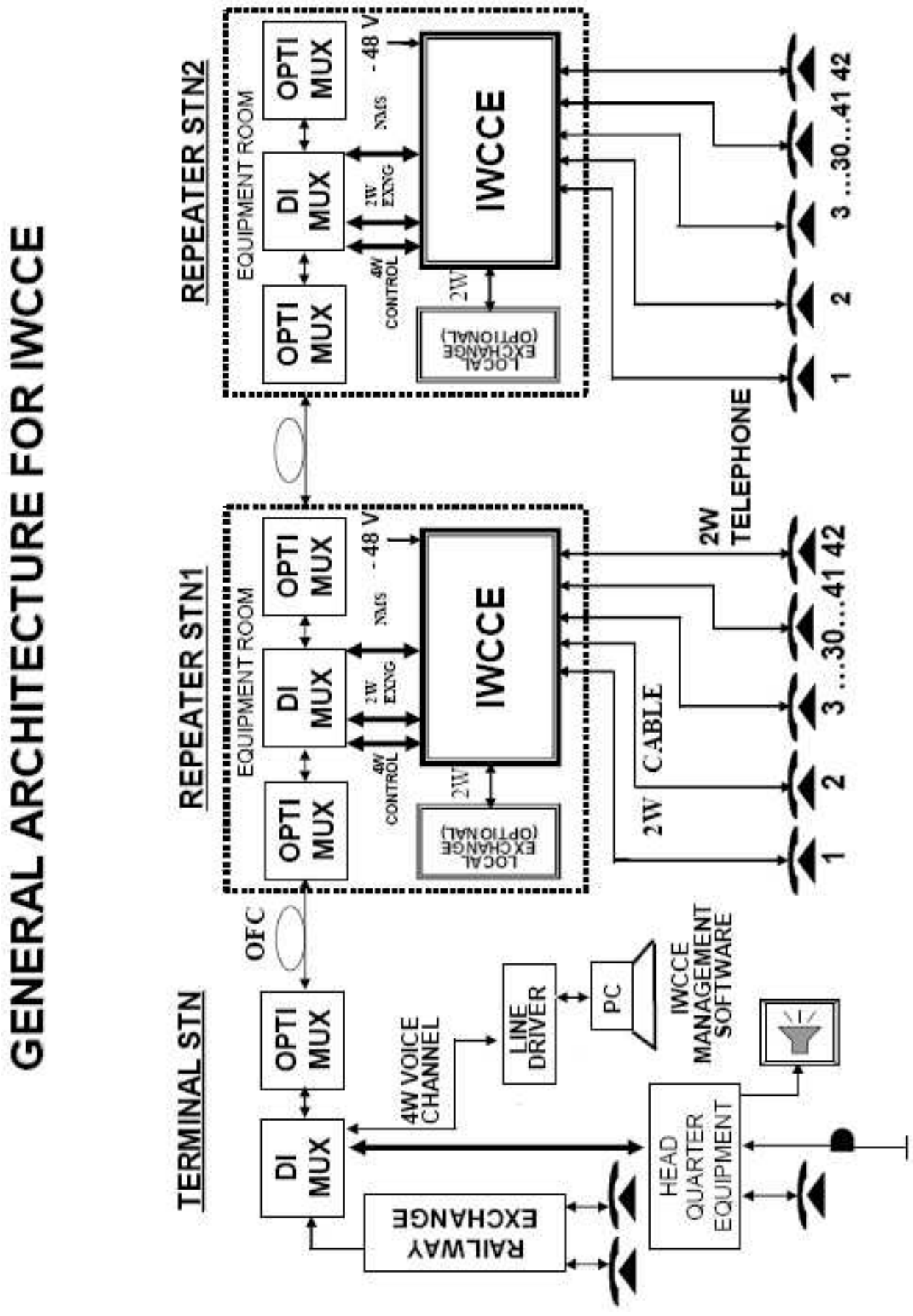

GENERAL ARCHITECTURE FOR IWCCE
REPEATER STN2
EQUIPMENT ROOM
OPTI MUX
DI MUX
OPTI MUX
- 48 V
NMS
2W EXNG
4W CONTROL
2W
IWCCE
LOCAL EXCHANGE (OPTIONAL)
REPEATER STN1
EQUIPMENT ROOM
OPTI MUX
DI MUX
OPTI MUX
- 48 V
NMS
2W EXNG
4W CONTROL
2W
IWCCE
LOCAL EXCHANGE (OPTIONAL)
2W TELEPHONE
2W CABLE
1
2
3 ...30...41 42
OFC
TERMINAL STN
OPTI MUX
DI MUX
4W VOICE CHANNEL
LINE DRIVER
PC
IWCCE MANAGEMENT SOFTWARE
RAILWAY EXCHANGE
HEAD QUARTER EQUIPMENT

Fig. 7.9

7.8 Remote Control & SCADA

In Electrified sections of Railways there is a need to provide a control circuit called **Remote Control** which is used by the Electric Traction Power wing. The Remote Control circuit is used for implementing the SCADA system. The SCADA (**Supervisory Control and Data Acquisition)** performs remote controlling and monitoring functions upon the sectioning/sub-sectioning/feeding points and overhead equipment (OHE). The SCADA system consists of:

- a **Supervisory Computer System** running MMI (Man-Machine-Interface) software at headquarters station and
- **Control Units**, located at remote stations along the track for performing data acquisition and control functions. The control units are RTUs (Remote Terminal Units).

The Supervisory Computer system consists of a Host computer used as server and a FEP (front end processor) computer connected to the RC quad in the communication cable through a modem. Both Host and FEP are duplicated for 100% standby support. Supervisory (Operator) terminals, working as clients to the server are used to send the control and measurement commands to RTUs and also to acquire data from RTUs. The remote control (MMI) software used for Remote Control in Secunderabad RC centre of SCRly is **SETSS** which is an abbreviation for *'Standard Electrical Traction SCADA Software'.*

The RTUs (control units) make measurements as well as report back to and execute commands from the supervisory computer. Each RTUs consists of:

- a **modem** - receives command from headquarters PC and passes on to control circuit
- a microprocessor based **control unit** and
- an **interrupter**

The modem receives remote command from the headquarters PC and passes it on to the control circuit. The control unit drives the interrupter either to OPEN or CLOSE the HT supply circuit. The control units also collect status of all the remote interrupters and sends to the supervisory PC at the headquarters. And also data regarding the remote equipments health is collected and sent by it. The control units have provision for connecting a keyboard and a monitor and can be programmed for different options or functions.

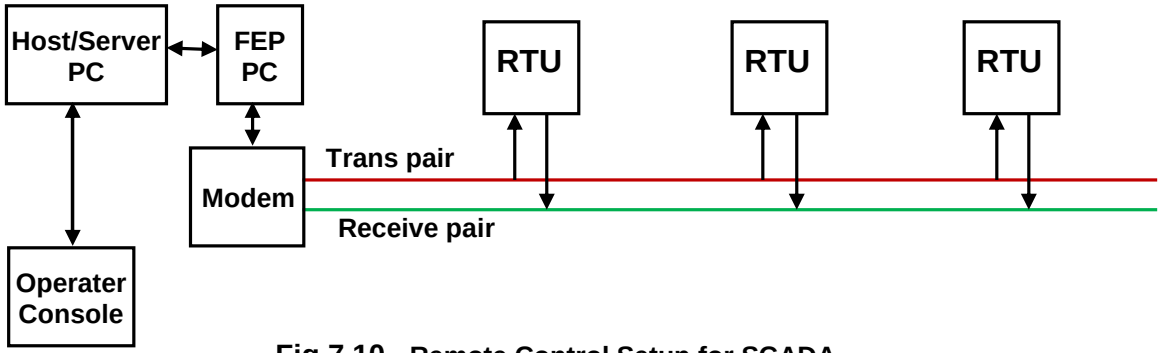


Fig.7.10 Remote Control Setup for SCADA

7.9 Auto Dialing System (IRS: S-83/2007):

With the inclusion of Auto dialing system to the existing Emergency control circuit, facility is extended to the Emergency socket available alongside the Railway track to connect any subscriber either of a Railway Telephone Exchange or of a BSNL Telephone Exchange in case of emergency.

The system mainly consists of the following units:

(a) Way side telephone unit and
(b) Base station unit

The wayside telephone unit work s from emergency socket and base station unit is provided at the Test Room, and works as part of the overall system.

This Auto dialing system connects Railway Exchange or BSNL Exchange by pressing the designated button from the wayside telephone unit, through Test Room. Wayside telephone unit will work similar to Auto telephone and it becomes a subscriber of a Railway Telephone Exchange by pressing Star button (*) on its key pad or becomes a subscriber of a BSNL Telephone Exchange by pressing Hash button (#). Connectivity is achieved automatically through Base station unit provided in the Test Room. The block diagrams of the auto dialing system are shown in the figures 7.13 and 7.14.

7.9.1 Base unit:

Base unit is to be placed at the control test room where Exchange telephone connections and 4-Wire Emergency circuit is available. A loud speaker is provided to monitor the speech from wayside telephone. 12 digits LED display shows the Telephone number dialed from the wayside telephone. LED indications are provided on the front panel of this unit to indicate whether wayside telephone is connected to BSNL or RLY Exchange.

Specifications

(a) Power supply : 12VDC +/- 20%
(b) Current consumption : 300mA max.
(c) Dialed number display : 12 digit 7 segment display to indicate the Telephone number dialed from the way side telephone
(d) Loud speaker output : 1 watt max.
(e) Frequency response : within +/-3dB

Indications available on Base unit are as given below

(a) LED indication for power ON,
(b) LED indication for RLY Exchange Connection and
(c) LED indication for BSNL Exchange Connection.

Fig.7.11

7.9.2 Wayside Telephone (or Field Unit):

4-Wire Way side Telephone is kept in a wooden box along with a 12 V/ 7AH battery which is to be carried to the way side from where communication is to be made through the emergency control line. It has the following facilities. A 3x4 key matrix with key numbers 1,2,3,4,5,6,7,8,9,0, *, and # is provided to establish connection with the Exchange telephones.

(*) Key is used to establish connection with the RLY. Exchange. and
(#) Key is used to establish connection with the BSNL Exchange.

When the (*) key is pressed once, dial tone from the RLY Exchange will be available. Connection to the desired auto telephone can be established by dialing the desired number. Ring back tone will be heard and conversation can be made through this wayside 4-Wire telephone. When the conversation is over the 4-Wire telephone can be disconnected from the Exchange by pressing (*) key once more. If the connection is to be established with a BSNL Exchange telephone, (#) key is pressed once, dial tone from the BSNL Exchange will be available. Connection to the desired auto telephone can be heard and conversation can be made through this wayside 4-Wire telephone. (#) Key is to be pressed once more to disconnect the line.

From RLY Exchange one number has to be allotted to the Emergency wayside telephone and similarly another number is to be allotted from BSNL Exchange. RLY and BSNL Exchange lines are to be connected to the Base unit. The wayside telephone can be dialed from those telephones by dialing this allotted number. The wayside telephone has the facility to ring when its telephone number is dialed from an Exchange telephone.

1. Signalling mode : By DTMF
2. Transmitting media : Any VF transmission media
3. Current consumption : 20mA(max) in idle & 100mA(max) in talking mode
4. Signalling level : 0 dBm maximum
5. Speech level : -5 dBm, typical
6. Line attenuation : 20dB maximum
7. Keys : 1,2,3,4,5,6,7,8,9,0.*, and #
8. Power supply : 12 VDC
9. Frequency response : within +/-3dB

Indications available on Field Telephone are as given below

1. LED indication for power ON,
2. LED indication for RLY Exchange Connection and
3. LED indication for BSNL Exchange Connection.
4. A buzzer for audio indication that the telephone is being called.

Fig.7.12

7.9.3 Operation in Brief:

- Insert the 6-pin plug into the Emergency socket.
- Make the switch on. Power-ON LED glows.

To Connect to Railway /BSNL Exchange

- Lift the handset of the telephone.
- Press (*) key to connect RLY Exchange. Or (#) key connects BSNL Exchange.
- Dial tone is received.
- Dial the desired telephone number of Exchange.
- This gives ring to the called Telephone and ring back tone is received.
- When the called party lifts the handset connection is established.
- After conversation to disconnect the wayside telephone press (*) key once more for RLY Exchange., (#) key once more for BSNL Exchange.

To receive a call from RLY/BSNL Exchange:

- When wayside telephone gets a call from Exchange Telephone, the buzzer rings and LED corresponding to calling Exchange glows.
- Lift the handset and Press (*) key to connect RLY Exchange. or (#) key to connect BSNL Exchange.
- At the end of conversation to disconnect the wayside telephone press (*) key once more for RLY Exchange, (#) key once more for BSNL Exchange.

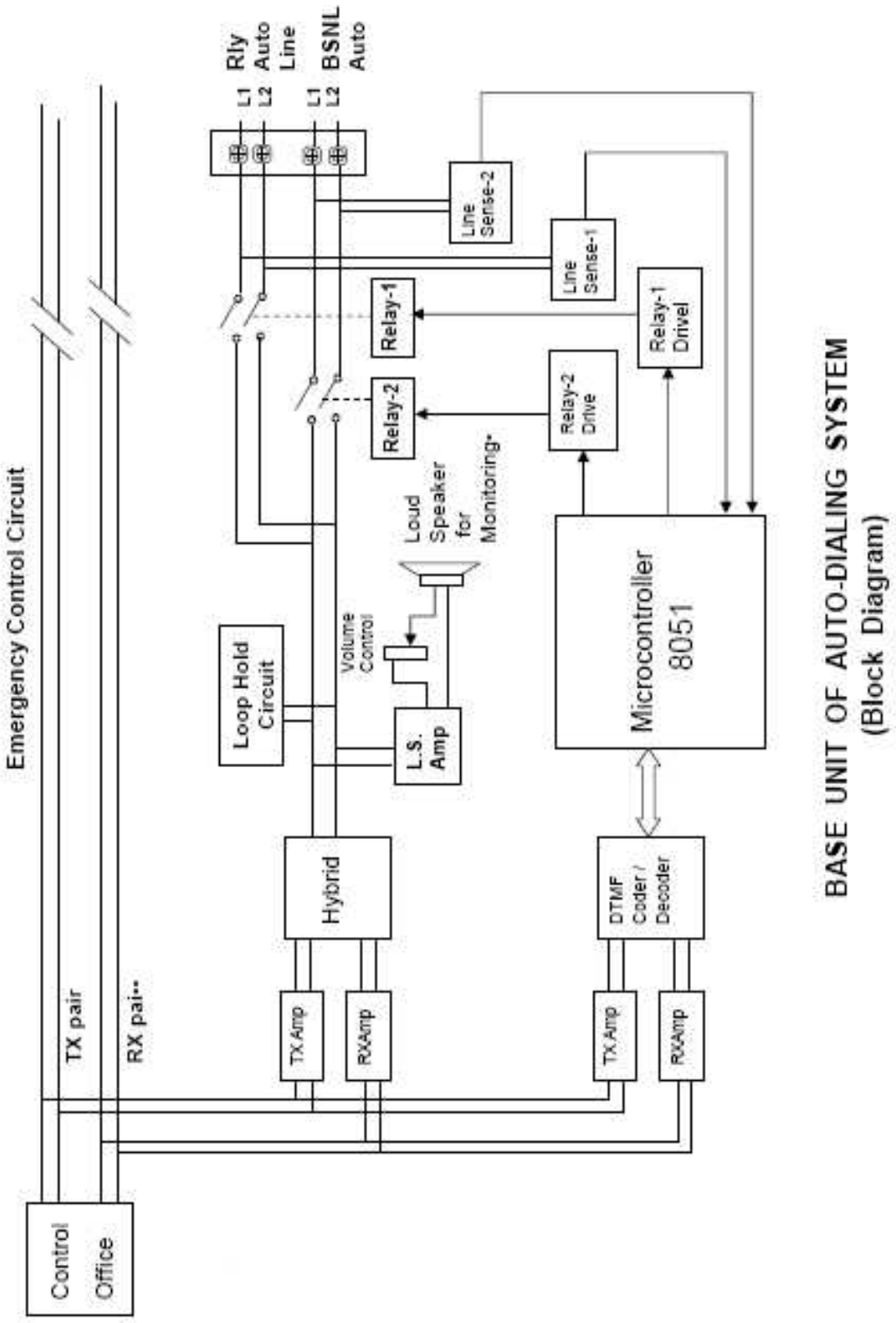

BASE UNIT OF AUTO-DIALING SYSTEM
(Block Diagram)
Emergency Control Circuit
Rly Auto Line
BSNL Auto
L1
L2
L1
L2
Line Sense-2
Line Sense-1
Relay-1
Relay-1 Drivel
Relay-2
Relay-2 Drive
Loud Speaker for Monitoring
Microcontroller 8051
Loop Hold Circuit
Volume Control
L.S. Amp
Hybrid
DTMF Coder / Decoder
TX Amp
RX Amp
TX Amp
RX Amp
TX pair
RX pair
Control Office

Fig.7.13

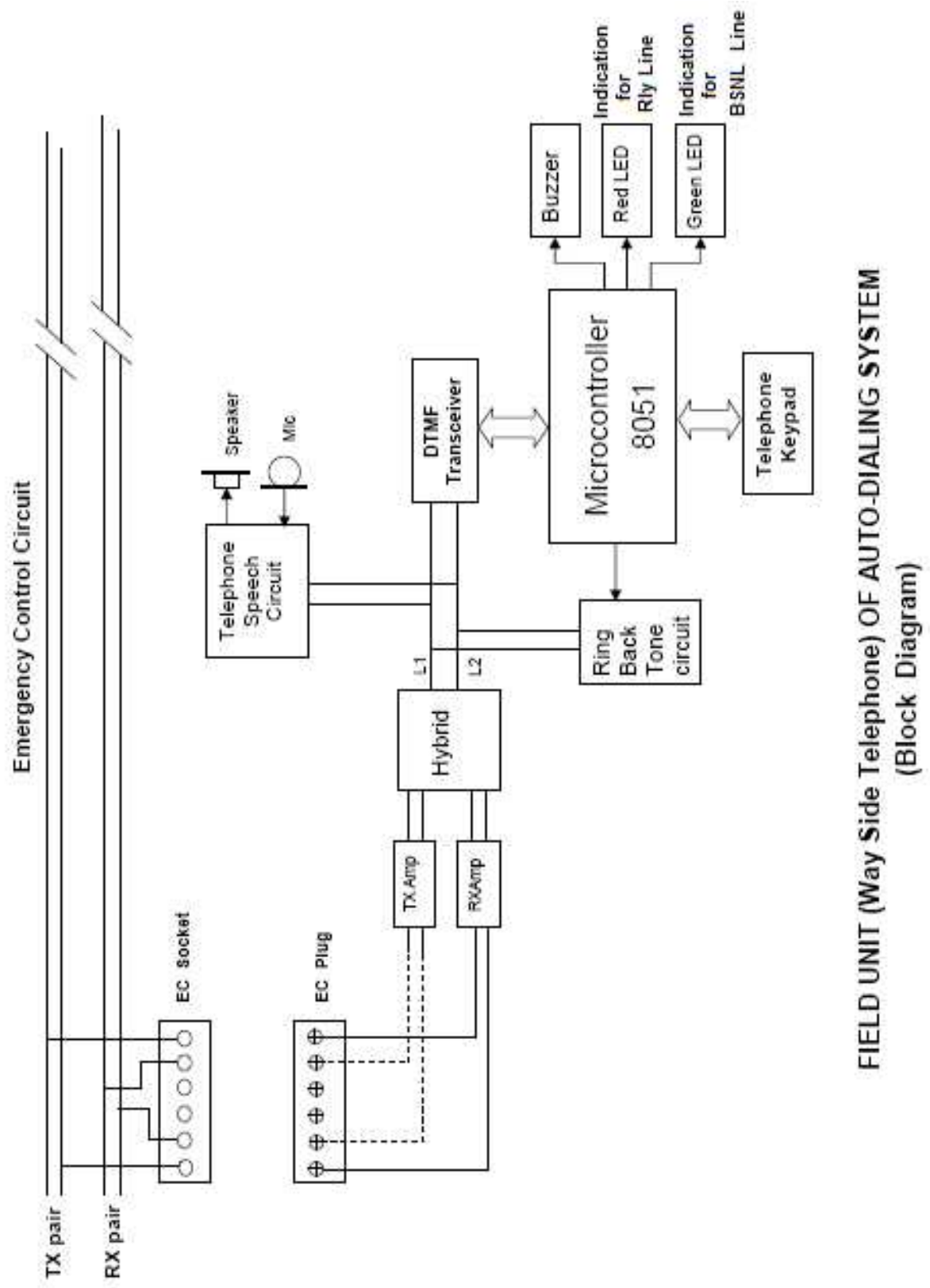

FIELD UNIT (Way Side Telephone) OF AUTO-DIALING SYSTEM
(Block Diagram)
Emergency Control Circuit
TX pair
RX pair
EC Socket
EC Plug
TX Amp
RXAmp
Hybrid
L1
L2
Telephone Speech Circuit
Speaker
Mic
DTMF Transceiver
Microcontroller 8051
Ring Back Tone circuit
Telephone Keypad
Buzzer
Red LED
Green LED
Indication for Rly Line
Indication for BSNL Line

Fig.7.14

Objective Questions

1. There is no _____ facility in a Control Telephones provided at way stations.
2. A universal control telephone has a _____in addition to control phone.
3. A portable EC telephone is used by _____.
4. A 2-wire 12-way telephone consists of one master and _____slave phones
5. Electronic LC gate phone has one master and _____slaves phones
6. Electronic LC gate master phone operates on _____ DC supply.
7. IWCCE can replace all _____ used at a way station.
8. It can be connected to _____ no. of control circuits
9. _____ number of telephones IWCCE can cater for.
10. Voice data logger is used in _____offices in railways
11. Minimum no. of speech channels recorded by one voice logger unit._____
12. SCADA system is operating through _____control circuit.
13. Auto dialing system is used in emergencies for providing _____ facility at a track side place.

Subjective Questions

1. Explain about any control telephone you know.
2. Explain about universal control telephone.
3. Describe about different types of portable EC telephones
4. Briefly explain about the following:
   a. 2 wire control telephone
   b. 2-wire 12-way DTMF telephone
   c. Electronic LC gate phone
5. Explain about IWCCE and its main uses.
6. Briefly explain about the following:
   a. Voice data logger
   b. SCADA
7. Explain about Auto dialing system

CHAPTER-8

INTERRUPTIONS & ROUTINE TESTS ON CONTROL CIRCUITS

8.1 Introduction

The causes for interruption to control communication can be many. But, an S&T personnel should be aware of some of the common faults, the various test procedures or practices to be adopted for detecting the cause of these faults and also to localise the exact place where the fault occurred. Different test procedures are to be adopted for different types of media used for providing the control communication.

8.2 Faults on Overhead Lines

The following is the general procedure to be adopted in localizing the faults on **Overhead Lines**.

(a) First, localize the defective section to the minimum possible block section.
(b) Then, verify the office and confirm whether the fault is in the office or line.

8.3 The faults occurring in the Overhead line may be classified under 4 categories:

(a) Disconnection
(b) Earth
(c) Contact
(d) Twist

8.3.1 Disconnection:

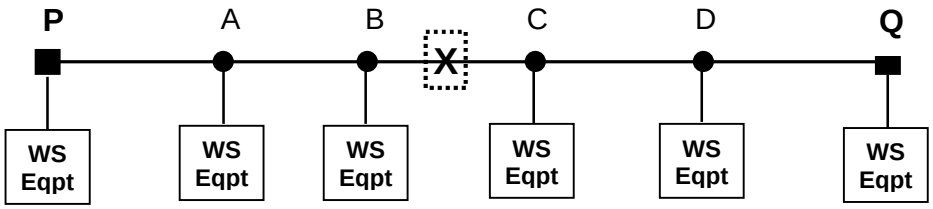


Fig. 8.1 – Disconnection between B and C stations

Consider a section P-Q with intermediate station A, B, C and D as shown. In the event of disconnection between section B and C, ringing and speech would fail for all stations between C and Q. The circuit between P and B will function normally. Assume that the control office is located at P in which case the section is located by ringing the last station of the correct section i.e., B and then ensuring that ringing is not possible at the adjacent station C. Station B should be instructed to call C via block telephone and ask the Station Master at C to confirm that controller is not heard with his office switch connected as well as the line made through at C. Controller at P ensures the faulty section is then localised as B - C.

8.3.2 Earth Fault

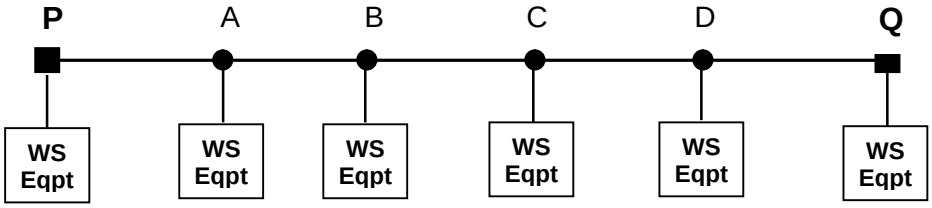


Fig. 8.2

Assume an earth fault in the section B&C which will cause heavy hum or induction if one limb is earthed and also in the case of earthing of two limbs if the earth connection is not good. If the earth is made by slight rubbing contact with stay wire, pole or bracket, there will be a crackling sound besides the hum. Localization is done as before, but in this case the switch on C Station side at B station should be disconnected to render working possible in section P and B**.**

8.3.3 Contact Fault

The symptom in this case is induction with AC, block bell beats and magneto ringing as the case may be according to the circuit to which the contact is made. With reference to fig. 8.2 localization procedure is same as before. Defective section has to be isolated for enabling working in the remaining good section which is free of fault.

8.3.4 Twist Fault

In this case the line will be silent. There will be breakdown for stations adjacent to and beyond the fault. Localization of faulty section is done as before and defective section is isolated.

8.4 Intermittent Faults:

All the above cases dealt are to describe regular faults in persisting fault condition. Cases occur like intermittent disconnection due to loose joints at transposition points, earth faults due to loose joints at transposition points, earth faults due to bad leveling and sagging wires. Localisation is difficult in these cases and ladder inspection by maintenance staff should be ordered after localising the faulty sections regularly.

8.4.1 Interruptions

Registers shall be maintained to record the interruptions in the control sections under the charge of SE/SSEs. A 100-page foolscap ruled book shall be allotted for the purpose and the pages divided equally for each section control. The details shall be entered in the following proforma:

Date	Sub-section	Nature of Fault	Interruption		Total Period in Hours.	Remarks
			From	To		

Table 8.1

Under 'remarks' column, enter details of the faults removed by concerned LM at the specified mileage or details of office fault if fault is in the office.

8.5 Routine Tests on Control Circuits on Over Head Lines

8.5.1 Weekly Ringing Test:

At least six stations are rung at random choosing two stations each from tail end, mid-section and near section of the control circuit. It is ensured that all stations ring properly. The details are entered in a register maintained for this purpose in the proforma shown below:

Date	Station Rung	Remarks	Signature of the Testing official

Table 8.2

8.5.2 Quarterly or Half yearly Tests:

A joint Test is arranged with the P&T department for conducting Conduction, Transmission loss and Insulation tests.

Conduction Test gives the loop resistance of the conductors of the circuit and indicates the condition of joints of way station loop terminations of the line. This test should be taken during the hottest period of the day (i.e.) between 12 and 13 hours.

The Transmission Test gives the overall transmission loss of the system and also indicates the magnitude of the insertion losses of the way station equipments. This should be taken along with the insulation test at the coldest period of the night (4 A.M to 5 A.M.).

Insulation Test gives the leakage of the line and also indicates the insulation resistance of the insulators, way station fittings, etc. This test should be taken at the coldest period of the night (i.e.) between 4 AM and 5 A.M.

Tests are taken for sections of 15 to 20 miles and since control working has to be suspended during tests, these tests should be conducted as quickly as possible. A recommended method for the testing is the testing official has to remain at the tail end of the section under test, with an assistant at the control office to give the required tests.

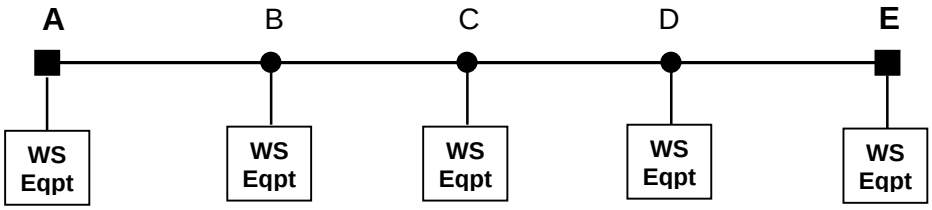


Fig. 8.3

Insulation Test: For conducting **Insulation Test** in a section shown above in fig.8.3, the procedure to be followed is as given below. If the testing point is at E the staff will be posted at A and E, A being the control end. D first disconnects the switch to isolate E end and an insulation test is taken from E for section D-E. It will be ensured that at E, the test is taken from the terminating point of the line from D. Three readings are taken.

(a) L1, L2 (Cross insulation)
(b) L1, E (Line 1 to Earth)
(c) L2, E (Line 2 to Earth)

D then puts the line through, disconnecting his office and the test is repeated for sections C-E. Similarly, sections B-E, A-E are tested:

Line-to-Earth Insulation: Same as above and also indicate whether balanced or unbalanced. If cross insulation equal to P mega ohm per mile, limb to earth insulation is equal to Q mega ohm, and R mega ohm per mile for L1 and L2 respectively, then P = Q + R and Q = R. When the value of Q & R is not equal, then the line is called unbalanced.

Conduction Test: The **Conduction Test** for the same section is taken during noon with all way station equipment disconnected. In this case also, three readings are taken:

(a) L1, L2 (loop)
(b) L1, E (Line I to Earth)
(c) L2, E (Line 2 to Earth)

Reading for a conduction test is taken with Wheat-Stone Bridge type Ohmmeter. Standard insulation testers known as "Bridge meter" are available in which facilities are provided for measuring resistance also.

Transmission Loss Test: For conducting transmission loss test, a transmission measuring kit is required. This consists generally of three units, the tone oscillator, an attenuator and a level meter.

The tone generator should be an audio frequency oscillator generating frequencies ranging from 100 HZ to 10,000 HZ. The range may be continuous or may be in certain preset spot frequencies as 400, 800, or 1000 c/s. The output is terminated on a standard value of impedance say 600 ohms. and a meter is provided with a red mark on the scale so that if the output control is adjusted for the pointer to coincide with the red mark, the output is correctly calibrated as per the dB scale provided on the attenuator.

The attenuator setting may vary from -20 to +20 dB and the level for zero dB may vary according to the manufacturer, but the general standard is 1 mw across 600 ohms.

The level meter is similarly calibrated in decibel scale with corresponding ranges from -10 to +20 dB. The oscillator and attenuator have to be kept at the sending end of section being tested and the level meter at the receiving

The Tests should be taken as follows:

(a) All the offices are disconnected and the overall loss of the line above is measured. Let this be "X dB". This value should be checked with the specified dB loss for the conductor used.
(b) All the way station equipments are joined to the line. The bridging impedances now are the selector relay circuits alone, the loss of which is negligible at speech frequencies. The reading should be the same as above (i.e., "X" dB). If it is different, say "Y" dB, then Y-X dB gives the dB loss of the entire circuit with equipment and the defective equipment should further be localized.
(c) Each station is directed to keep the telephone in speaking position and remain on the line and the reading taken. Let this be "Z". The loss which is "Z" - "X" dB should correspond with the specified loss given for the particular type of telephone by the manufacturers. Repeat test for all telephones in the circuit under test.

Record your observations as under:

(i). dB loss for line only (indicate total mileage)
(ii). dB loss with all selectors connected (indicate No. of selectors)
(iii). dB loss with one telephone at a time switched in (indicate type -of telephone)

The Recommended Standards are as follows:

Insulation:

I. During cold weather : 1 MΩ per mile.
II. During hot weather : 2 MΩ per mile.

Conduction: This depends on the type of the conductor.

Transmission loss: This depends upon the type of conductor and its loop resistance.

8.6 Routine Tests on 4-wire Control Circuits of Underground Cable:

Apart from the testing to be performed during laying and after laying the cables, routine tests shall also be conducted on the cables to ensure that the cable is in good condition and efficiency of the control circuits are maintained. This will provide data to decide as to when a cable has served its life and to replace the same in time to avoid complete breakdown.

All spare pairs in a cable shall be tested periodically once a year to ensure that they are in good condition. This will help in using the same pairs whenever a working pair has been faulty and the control circuit carried by it has to be transferred to one of the spare pairs.

Periodical testing is conducted as per CSTE's circular of zonal Railways. Generally the following tests are conducted as per the schedules followed in zonal railways. This may differ from railway to railway.

I. Insulation
II. Transmission loss
III. Through tone test (Level test)
IV. Conduction (Continuity)
V. Cross Talk
VI. Psophometric noise Level
VII. Repeater amplifier gain
VIII. Earth

S.No	Name of Test	Equipment
1	Insulation Test	Megger 100V/100MΩ
2	Transmission Loss Test	TMS/ Oscillator & Level meter
3	Through Tone Test (Level Test)	TMS/ Oscillator & Level meter
4	Conduction Test	Wheat-stone bridge Ohmeter or Multimeter
5	Cross Talk	Cross Talk Measuring Set or Oscillator & Level meter (measuring upto -80dBm)
6	Psophometric Noise Test	Psophometer
7	Amplifier Gain Measurement	TMS
8	Earth Test	Earth Tester
9	Location of a Short/Break/low insulation on UG cable	Cable Fault Locator

Table 8.3

8.4.1 Insulation Test :

This test is conducted to know the condition of insulation of the quad cable between two VF Repeaters. The insulation of the trunk cable is tested with the help of a Megger of 100V (Balanced cable). For testing facility one pair of quads of main cable is put through bypassing the transformer at cable huts. This will help to know the condition of the insulation of the cable from repeater to repeater.

Two types of insulation measurements are to be carried out.

I. Between each conductor and earth. This can be done on all conductors.
II. Between pairs of a quad only where the quad is untapped between the measuring points.

The test will be conducted with Insulation Megger at 100 VDC (Balanced cable). The Measured values shall be verified with standard values whether there is any deterioration of insulation or not.

Test Setup

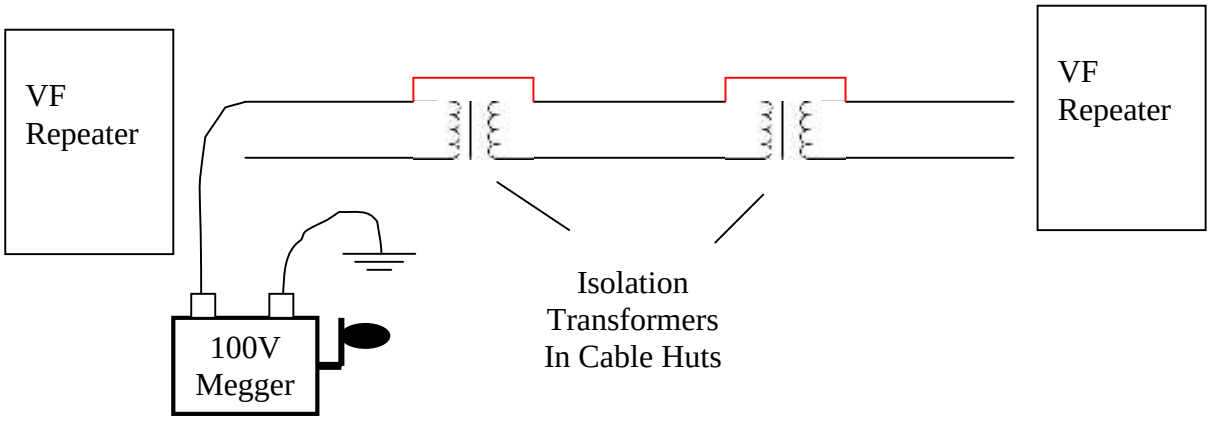


Fig. 8.4

Procedure for Insulation Test

1. Disconnect U links of one control circuit at both adjacent VF repeaters
2. Bypass isolation transformers in cables huts as shown in the figure
3. Connect one lead of 100V Megger to one conductor of quad and another to ground
4. then rotate handle of megger fast and record the reading on it
5. Compare this with standard value to know the condition of insulation.
6. Repeat the same for all conductors of the cable.
7. Insulation between two pairs of a quad can also be measured.

8.4.2 Transmission Loss Test: -

Tone test on each pair of the quads of the cable is conducted from repeater to repeater. For this a tone of 800Hz at 0dBm is used to feed the tone at cable point with appropriate impedance matching. The standard section loss is given in level diagram of the cable.

The typical cable loss in the telecom cable in RE area is 0.25 dB/KM (loaded cable) and characteristic impedance is 1120Ω. The measured cable loss should not exceed 20dB (includes cable loss of 0.25 dB/km, isolation loss of less than 0.6 dB/ isolation due to provision of isolating transformers at cable hut and bridging loss of 0.016 dB / tap due to tapping transformers).

S. No	Loss Introduced by	Loss
1	Quad Cable (Un-Loaded)	0.63 dB/km
2	Quad Cable (Loaded)	0.25 dB/km
3	Isolation Transformers	Less than 0.6 dB/isolation
4	Bridging loss due to Tapping	0.016 dB /tap

Table- 8.4 The typical Losses On The Cable

Test Setup

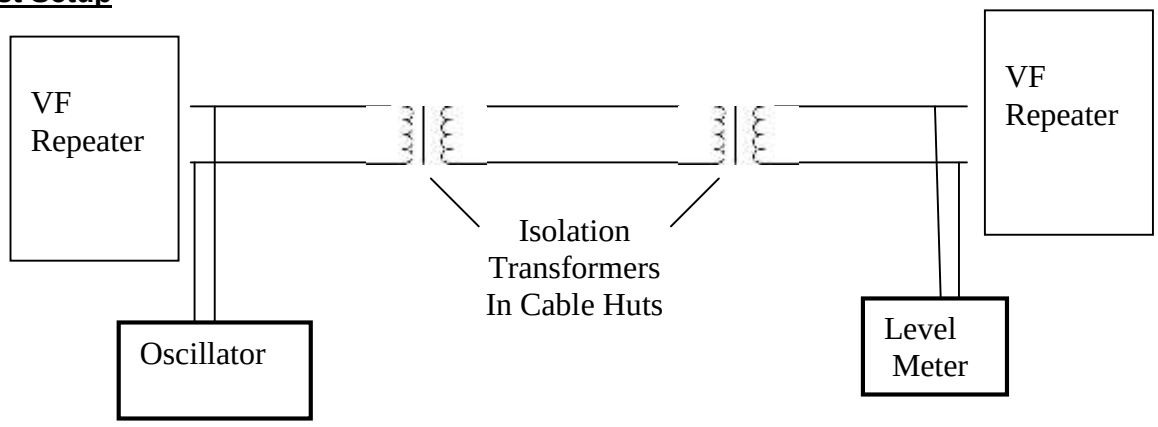


Fig. 8.5

Procedure for Transmission Loss Test

1. Disconnect the VF repeater from the cable by removing U links
2. Select proper output impedance
3. Feed a tone of 800Hz at 0dBm to the cable points on one pair of a quad at one end VF repeater using an Oscillator or TMS kit.
4. Measure its level at the other end repeater on the cable side with a level meter or TMS kit
5. Compute the transmission loss on the cable from these two values
6. This loss should not be more than -20dBm.

8.4.3 Through Tone Test (Level test):

Through tone test is conducted for each working circuit by the **Test room.** The test room gives the tone of 800Hz at fixed level in the cable point by disconnecting the control side and the level is maintained at every repeater by giving the same output to the next section. The level of tone depends on the sectional loss of the cable. Generally it is fixed to –5dBm tone level and every repeater has the output tone level of –5dBm. Each repeater verifies the tone level at the input of the repeater at cable point and compares the reading with the standard section loss of the cable. The output tone level of the repeater is checked to know the standard output level of repeater amplifier. If it is required to adjust the gain of the amplifier, it is adjusted as per the loss of the preceding section of the cable. The maximum gain of an equalizer amplifier is 24 dB. The last way station should have a tone level of –20dBm.

This is also called as Level test and it is conducted by test room for each circuit. The instruments required are Oscillator and Level meters or TMS kits.

Test Setup

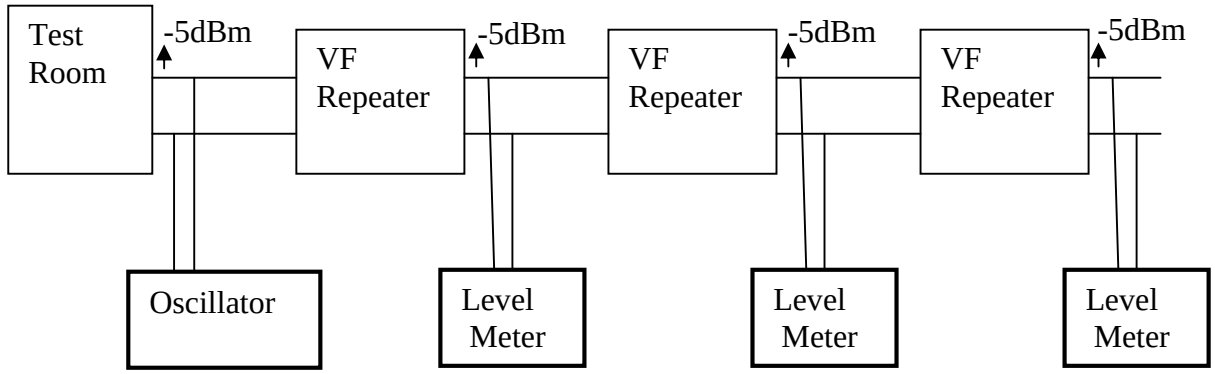


Fig. 8.6

Procedure for Through Tone Test:

1. Disconnect cable points from control office equipment in the Test Room by removing U links.
2. At Test Room feed 800Hz tone at a fixed level, say -5dBm, (which depends on the sectional loss given by the level diagram) on Trans pair of a control circuit towards UG cable side
3. Tone level is measured at every VF repeater and its output is adjusted, if required, to maintain it at the fixed level, which depends on the sectional loss of cable, so that the last way station in the section ahead can receive an input level of -20dBm.

8.4.4 Conduction (Loop) Test:

The conduction/loop test is conducted between

i. Cable hut to cable hut and
ii. Repeater to cable hut in each pair of the cable.

A bridge Megger or a digital multimeter can be used. The standard value as per IRS-TC 30-1997 for 0.9mm dia. of copper cable is 56 Ohms/Km.

8.4.5 Cross Talk Measurement:

Cross talk means induction due to speech signals in adjacent circuits or channels. In 4wire TTC systems all control channels or circuits are accommodated on the same quad cable. Sometimes speech in one quad gets into adjacent quads through induction and causes disturbance to speech on those quads. Main cause for cross talk is high levels in the channel introducing cross talk.

The cross talk is classified into two types - near-end crosstalk (NEXT) and far-end cross talk (FEXT). Cross talk measurement is carried out between repeaters.

The cross talk is measured using Cross talk Measuring Set or with a VF oscillator and a level meter (preferably a selective type) capable of measuring very low levels of about -90dBm.

1) Measurement of Near-End Crosstalk (NEXT): For measuring NEXT make connections as shown below.

Setup

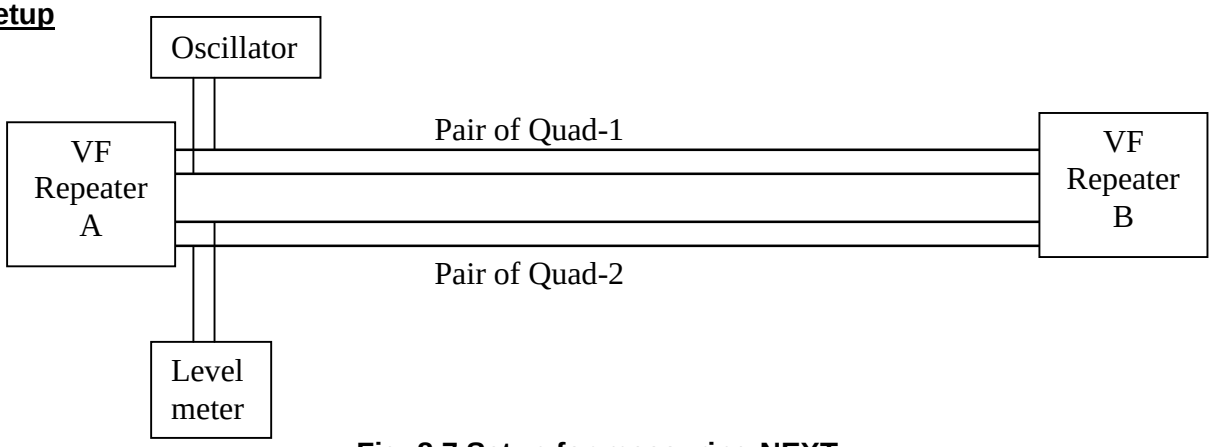


Fig. 8.7 Setup for measuring NEXT

Procedure for NEXT

i. Feed a tone of 800Hz at 0dBm on one pair of quad-1 at Repeater A
ii. Measure for the induced signal on a pair of quad-2 at the same repeater.
iii. Measured signal level should be better than -61dB

2) Measurement of Far-End Cross Talk (FEXT): For measuring FEXT make connections as shown below.

Setup:

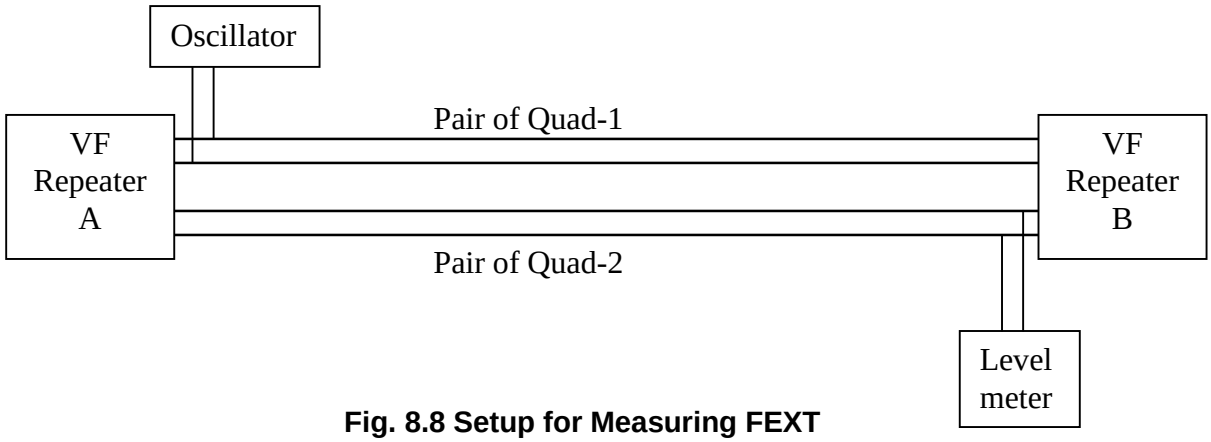


Fig. 8.8 Setup for Measuring FEXT

Procedure for FEXT

i. Feed a tone of 800Hz at 0dBm on one pair of quad-1.
ii. Measure for the induced signal on a pair of quad-2 at far end repeater.
iii. Measured signal level should be better than -65dB

Points to Remember

i. Cross talk is to be measured once in a quarter with cross talk meter.
ii. Both types of cross talk measurements are required to be performed i.e. near end (NEXT) and far end (FEXT).
iii. Cross talk measurements are to be carried out between repeater to repeater.
iv. Cross talk measurement is done by feeding a 800 Hz tone on one pair of a given quad and measuring the cross talk on one pair of adjacent quad.
v. Near end cross talk (NEXT) should be better than –61dB.
vi. Far end cross talk (FEXT) should be better than –65dB.

8.4.6 Psophometric Noise Voltage Measurement:

1) Measurement of psophometric noise voltage on telecom cable should be done once in a year.
2) Psophometric test should be done from repeater to repeater.
3) Measurements are taken between conductor of a pair and also between conductor and ground.
4) As per the standards of communication circuits the psophometric noise voltage should not exceed 2 mV.

8.4.7 Tests on VF Amplifiers in RE Repeaters:

At a repeater station both Trans and Receive Amplifiers gain and frequency response measurements are made periodically. These measurements are made with the help of TMS kit or an Oscillator and a Level meter. The following tests are performed on VF amplifiers in Repeater stations

1) The Gain of trans and receive amplifiers should be measured once in a month.
2) The gain with different setting of pads should also be measured.
3) The full amplifier gain is 24 dB ± 0.5 dB with pad set to 0dB attenuation.
4) Frequency Response is also to be found by feeding all the frequencies in VF range.

Setup:

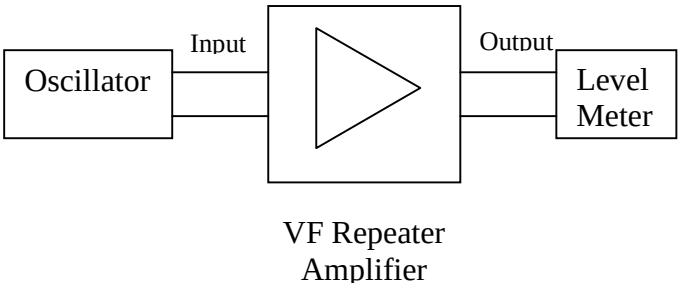


Fig. 8.9 Repeater Amplifiers Gain & Frequency Response Measurement Setup

Procedure

1) Make connections as shown above
2) Feed 800Hz tone at -20 dBm level from oscillator to the input terminals of TX Repeater amplifier.
3) Measure the output with level meter
4) Compute the gain

8.4.8 Repeat the same steps for RX amplifier Earth test:

The test is conducted twice in a year; one test is conducted before the monsoon and another test is conducted after the monsoon. The equipment is disconnected from earth electrode by providing alternative earth connection to the equipment. If there are multiple electrodes for parallel earthing, the measurement of earth resistance with each electrode is taken and recorded. The value should be less than 5 ohms.

Limits of Earth Resistance Values: The following table gives the required values of earth resistance for different telecom installations.

S.No	Equipment	Earth Resistance Value Required
1	Equipment earth in VF repeaters, Cable Huts and Way stations	Not more than 5 Ω
2	Screen/Armour Earth for Aluminum-Sheathed Telecom Cable	Not more than 1 Ω
3	Surge arrestors / lighting dischargers of Telecom Equipment	Not more than 10 Ω

Table- 8.5

8.4.9 Periodicity of Tests on UG Cable Circuits:

The following table-6 gives the schedule for periodical tests performed on UG cable control circuits. These tests are carried out from Repeater to Repeater.

S.No	Name of Test	Periodicity			
		Monthly	Quarterly	Half Yearly	Yearly
1	Attenuation/Transmission Loss Test	✓			
2	Cross Talk Test		✓		
3	Noise Level Test		✓		
4	Loop Resistance/ Conduction Test	✓			
5	Insulation Test			✓	
6	Level Test		✓		
7	Earth Test			✓	
8	VF Amplifier Gain Measurement	✓			
9	Frequency Response of VF Amplifiers		✓		
10	Psophometric Noise Measurement				✓

Table-8.6

Objective Questions

1. Twist fault can occur only on _____lines
2. _____ sound is the result of an earth fault on overhead circuits.
3. The symptom for contact fault on overhead lines is _____
4. Interval for measuring attenuation/transmission loss on overhead lines._____
5. On UG cable circuits transmission loss test periodicity is _____
6. Time for taking insulation test on overhead lines. _____
7. Time for taking conduction test on overhead lines. _____
8. Value of psophometric noise level should be below _____

Subjective Questions

1. Mention the faults occurring on overhead lines.
2. What is the procedure followed for locating the disconnection on overhead lines?
3. List out different test carried out on quad cable circuits periodically.
4. How do you conduct transmission loss measurement on UG cable circuits?
5. Explain with a sketch the procedure involved in conducting Insulation test on UG cable lines.
6. Show with table the periodicity of various tests on UG cable circuits.
7. What is the procedure for frequency response test of VF Repeater amplifiers?

CHAPTER-9

TROUBLESHOOTING OF DTMF EQUIPMENT

9.1 TroubleShooting

In case of any faults on control circuits the Control Communication between control office and way stations is interrupted and subsequently the movement of trains is affected badly. To avoid this, immediate localization and restoration of faults is needed. Fault localization and restoration is generally called as **trouble shooting.**

9.2 LIKELY FAULTS ON CONTROL SYSTEMS:

9.2.1 One Way Speech to Controller:

a) No Trans From Controller :

This means way stations do not receive controller speech.

Causes: The likely causes for this problem can be

i. Microphone or mouth piece may be defective or got disconnected
ii. Trans amplifier gain may be very low or amplifier IC may be defective
iii. Disconnection between amplifier output and the terminal strip on the back of the equipment
iv. Disconnection in trans cable-pair
v. U-links may not be put through or may be open in the test room panel

One by one these aspects are to be checked to localize the fault.

b) No Receive to Controller from any Way Station:

This means that controller does not receive speech of any way stations.

Causes: This problem may be due to

i. Disconnected or defective earphone or loud speaker
ii. Receive amplifier gain may be very low or amplifier IC may be defective
iii. Disconnection between amplifier output to the terminal strip on the back of the equipment
iv. Disconnection in receive cable-pair
v. U-links are not put through or defective U-links in test room panel

One by one these aspects are to be checked to localize the fault.

9.2.2 Both Way Speech Loss at Controller:

There is no speech in either direction

Causes:

i. Problem may be in Controller equipment or
ii. Disconnection in quad between controller and test room

9.2.3 No Ringing :

a) At one or two way stations
b) At all way stations beyond a point
c) At all way stations in the entire section.

a) No Ringing at a Way Station

Causes:

i. Disconnection in the receive pair
ii. Wrong setting of station code at that particular way station or stations. This means more than one contact may be made ON in either **First Digit DIP** switch or Second **Digit DIP** switch.
iii. Power supply may not be extended
iv. Problem may be in the piezo buzzer itself
v. Or any IC or component in the decoder circuit may be faulty

Check for the correctness of the above mentioned things one by one till the fault is located and problem is solved.

b) No Ringing at All Way Stations beyond a Point

Causes:

i. The main cause of this problem can be a break **or short** in the **Trans pair** beyond the way station at this point.
ii. Or if all these stations are located immediately after a repeater, that particular repeater output may not be present.

c) No Ringing at All Way Stations in the Entire Section

Causes:

i. The problem may be in the controller equipment such as
   - No DTMF signal output from it or
   - Its DTMF signal level may be very low or
   - Tone sending relay may not be operating
ii. The problem may be in the test room. This may occur due to
   - Break in the test room panel board
   - Or no output from terminal repeater in the test room.

d) Continuous Ringing:

Causes:

i. Due to faulty output IC in the DTMF decoder unit
ii. DTMF decoder circuit doesn't get reset after ringing period due to break in the circuit
iii. Due to faulty Flip Flop/ Mono-shot IC

9.2.4 No Speech or Low Speech Beyond a VF Repeater

Cause:

i. No output or low output from the repeater equipment

Procedure for Locating the Fault:

i. This fault is clearly in the Repeater.
ii. This can be confirmed by taking tone test with the help of TMS kit.
iii. Feed any tone in VF range at –10 dB level to the input of repeater trans amplifier and measure its output.
iv. Compare this with the level shown in Level chart.
v. If there is no output check the amplifier circuit and fix the fault. Generally, the out of a repeater falls between –1dB to + 14 dB. (Because amplifier gain is +24dB and selectable attenuation is between 0dB to –15dB.)

9.2.5 No Communication Between Way Stations

Cause:

i. The main cause of this problem is Leak Amplifier may not be connected between the trans and receive pairs.

Procedure For Locating The Fault:

i. Check the working of leak amplifier by tone test
ii. Its gain should be –20dB max.
iii. If no output from the LA checks first the DIP switch connecting it to the control circuit.

9.2.6 Singing On Control Circuits

Cause:

The main cause for singing is high levels on the line.

Remedy:

Locate the VF repeater having high gain. Then adjust it to normal level for restoration of the system.

9.2.7 Cross Talk On Control Circuits

Cause:

i) It is already known that the main cause of cross talk in cable circuits is the capacitive unbalances in the cable. This problem is solved by balancing the cable. In spite of this if cross talk is there on control circuits it can be due to the following reason.
ii) High levels on any control circuits in the cable can also induce cross talk into adjacent circuits in the cable.

Remedy:

i) First find out the control circuit having high level on its line by taking level test.
ii) Reduce gain on the circuit inducing cross talk to normal level
iii) Then take cross talk tests on the disturbed circuit to confirm it is free from cross talk.

9.2.8 Noise Hum on Control Circuits

Cause:

i) Due to low insulation of cable
ii) Due to entry of water into paper quads of cable
iii) Due to earth contacts
iv) Due to contacts between conductors caused in a damaged cable
v) Due to a defective joint on cable

Remedy:

i) Take insulation test and find out the

9.2.9 Hum On Control Circuits

Cause:

Hum is generally caused by the chargers used at repeater stations/at test room and also due to earth faults on the line.

Remedy:

Locate the source of hum by sequentially switching of chargers in the route one by one and attend to the fault to eliminate the hum

9.2.10 Recurring Interruption on a Circuit

Recurring interruption on control circuits is generally caused due to low insulation resulted by water entry into the cable joints. Localize the spot and replace it with a new piece of cable at that area.

9.3 Circuit Trouble Shooting Procedure As Given By A Manufacturer

The following is the circuit trouble shooting procedure for Way station Equipment as given by M/s Tummala Electronics.

9.3.1 Trouble Shooting of Tummala make 4-wire DTMF Way station Equipment

(Refer figure 9.1)

The following TEST Equipment is required for trouble suiting Way Station Equipment:

(a) 3½ digit multi-meter
(b) Test Jig
(c) 12 V @ 100 mA DC power Supply with current limit.

a) DTMF Decoder

The following step-by-step test plan is to be adopted whenever a DTMF receiver is to be serviced.

(i). Apply 12V± 3VDC to the battery terminals of the equipment, marked +12V & –12V with proper polarity.

(ii). Connect the ground lead of the multi-meter (set to 20 VDC range) to the ground (-12V point) of the equipment.

(iii). Check the DC voltage at the test points mentioned below:

(iv). Measure the voltage At TP1. It should be greater than or equal to 9V, else check the power supply lead wires etc. Also check whether equipment is drawing more than 25mA of current. If so switch off DC power to the equipment and remove ICs marked, IC1, IC2, and IC4 to IC 10 before carrying out any further testing. If the standing current is less than 25mA then continue testing as shown below.

(v). TP2 voltage should be 5V +/-0.25V, else replace IC3 or D7. Connect test jig output to TRANS terminals of the equipment and check whether the test point marked3 on the equipment is going high, when a key is depressed.

(vi). NOTE: TP3 will remain high until the key on the test jig is released.

(vii). Press keys 1,2 …9,0 successively and check whether the corresponding point on the code setting terminal block goes to 5V, else replace IC2.

(viii). Press G on the test jig. TP4 should go high momentarily and return to 0 after about 1 second, else replace IC4. Press first digit of the code then TP5 should go high momentarily, else replace IC4

(ix). Press general call twice while monitoring TP6. TP6 goes high when the general call button is pressed the second time, else replace IC5. Press first digit and second digit keys in sequence, again TP6 should go high, else replace IC5.

(x). Press general call twice. TP7 goes high, else replace IC6.

(xi). Buzzer should be ON if TP 10 momentarily touched to ground, else replace Buzzer after checking Q4.

(xii). Press general call twice and monitor TP8 and collector of Q2. They should be at about 3 V AC (change the multi-meter setting to read the AC voltage), else replace IC7 or Q2 after checking Q4, and Q5.

(xiii). When a Group code button is pressed, TP 11 goes high if the corresponding Dipswitch is ON, else change Dipswitch.

(xiv). In case the equipment is drawing more than 25m A of standing current while conducting test 4 above, remove all ICs except IC3 as suggested and monitor the current. Now the current should be less than 20m A, else replace IC3. Switch OFF the power supply and insert one IC at a time and monitor the current each time. If the current exceeds 20m A by inserting a particular IC, replace it and continue testing.

b) Speech Circuit

(i). Check whether 12 V supply is available on the terminals marked + 12V& -12 V on the rosette. If the supply cannot be realized then check any fuse, if provided. After ensuring fuses connection check reception in telephone and Transformer TR2 as well as IC8 in the equipment.

(ii). Short terminal marked PTT to –12 V, check for the action of the relay RL1. If the relay does not operate when PTT is shorted then change the relay after ensuring continuity of telephone cord.

(iii). If no speech is going to controller check Microphone connections, IC9, Relay RL1 and Transformer TR1

(iv). Short the terminal marked Bz to-12 V. Check for the flashing of LED and buzzer sound. If the LED is not flashing check the telephone and the connecting wires.

(v). Check and replace buzzer if not coming ON.

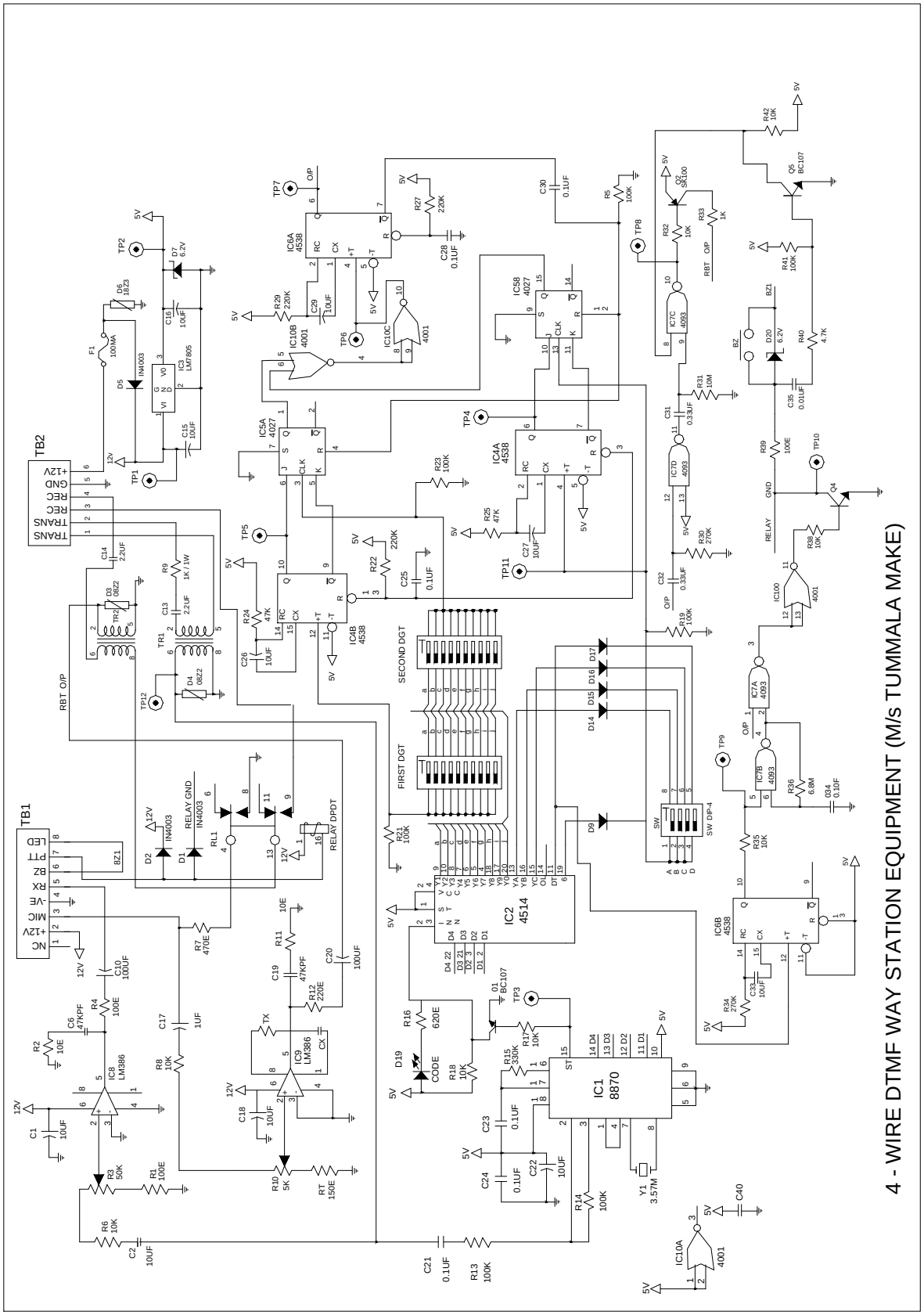

4 - WIRE DTMF WAY STATION EQUIPMENT (M/s TUMMALA MAKE)
TB1
TB2
IC1 8870
IC2 4514
IC3 LM7805
IC4A 4538
IC4B 4538
IC5A 4027
IC6A 4538
IC6B 4538
IC7A 4093
IC7B 4093
IC7C 4093
IC7D 4093
IC8 LM386
IC9 LM386
IC10A 4001
IC10B 4001
IC10C 4001
IC58 4027
IC100 4001
SECOND DGT
FIRST DGT
SW DIP-4
RELAY DPDT
RELAY GND
IN4003
RBT O/P
CODE
TRANS
RELAY
GND
+12V
5V
12V

Fig.9.1

Objective Questions

1. If there is no trans from controller one of the likely cause can be _____
2. If there no ringing at a way station one of the likely cause can be _____
3. _____can result in both way communication loss with the controller.
4. There is no communication beyond an intermediate VF repeater. The cause may be

   _____ _____

Subjective Questions

1. What are the likely causes if there is no speech to controller from any way station?
2. What are the likely causes for no ringing at a way station?
3. Mention causes and remedial procedure for no/low speech beyond a point on control circuit.
4. What is the cause of crosstalk and the procedure to find?

CHAPTER-10

VOICE LOGGER FOR CONTROL COMMUNICATION

10.1 Introduction to voice logger

A voice logger is a device used to record audio information from telephone, radios, microphones and other sources for storage on a computer hard disc or removable media. There are two basic modes of recording. They are VOX mode and non VOX mode. VOX mode is voice activated and in non VOX mode, recording is continuous. The recording systems are used by Airlines, Railways, Security organizations and private individuals. Some time the legality of the practice may come into question.

In Indian Railways, we are using Voice Data Logger/Monitor for control circuits as per specification: RDSO/SPN/TC/38/2002 Rev1.1 with amendment No.1. This facilitates to record the conversation over various control circuits for transparency in operational activities. There is 4-channel module for recording / logging from four telephone lines/inputs. This has built in hard disc of 40 GB for enabling recording operation without switching on computer. Computer connectivity is through Ethernet port. Number of lines can be increased through networking hub /switch. Storage media of computer can be used for parallel recording as well as transfer of voice data files built in hard disk of the Voice logger.

10.2 System Features

1. Number of channels is scalable up to 64. However, each module is of four channels. (indicate no. of channels required while ordering).
2. Modular construction.
3. Easy installation and user-friendly software interfaces. Each channel Bank is of four channels. Compression rate required is 64 Kbps to retain original voice. Higher compression rates can be provided.
4. Separate indications are there for every channel recording in progress. Records voice with date and time.
5. Plays any channel without interrupting recording of any other channel, including channel being played. It has Ethernet port to get connected in computer network. Play control is by any computer in the network optional portability of record from logger by flash memory.
6. Computer programmable selection of VOX, Pseudo calls or off hook calls. GSM / CDMA interface for recording. Recording remains uninterrupted even in case of defect in computer and software.

Fig. 10.1. Smart Logger

10.3 SYSTEM TECHNICAL SPECIFICATIONS

Channels	: Analog (multiples of 4)
Voice recording methods	: 64Kbps G.711 A/u law PCM.
Record Trigger modes	: Parallel off hook / VOX / Ring detection / Forced.
Storage capacity / media	: a) Direct to hard disk recording: in 40 GB hard Disk provided to every 4 ch. module b) Parallel recording in hard drive of computer c) Storage in flash memory for 17 hrs in 1 GB
Frequency response	: 300-3400Hz +/-3Db
Analog input	: 1. Impedance 600 ohms or >10kohm 2. Balanced or unbalanced.
Signal to Noise ratio	: Better than 40 Db.
Distortion	: Less than 5 percent.
Cross talk	: Better than -40Db
Recording sensitivity	: Better than -20Db
Power supply	: 12V / 2 A DC.
Telephone port	: RJ11
Unbalance inputs port	: RJ11
PC Recording port	: 10-BASE-T, RJ45, UTP.
Display (in standard configuration only)	: Four line 20 characters, alphanumeric LCD.
Keyboard (in standard configuration only)	: PS2 keyboard.
Temperature	: Operating -10°c to +55°c.

In order to use smart logger, mandatory requirements are computer with 100/10Mbps LAN card running on Microsoft windows 2000/XP with Net Framework 2.0 installed. It is recommended that to have at least 512MB RAM installed in computer. The system will be ready after installing smart logger server software and connecting at least one smart logger to the PC.

After connecting smart loggers, one has to assign suitable IP addresses for each modules and the server PC. Smart loggers and PC are connected in LAN through Ethernet switch.

Now connect 2W/4W input voice channels in the RJ 11 connectors provided at backside of smart logger. The system is password protected. ADMIN and user IDs and passwords can be created. User can be assigned different privileges and can have multilevel restrictions on call records, loggers and other feature sets. Channel can be configured by selecting channel setting window. Here we have to enter channel name, call type, codec type etc. Call type can be selected as VOX for voice actuated recording, POH for parallel off-hook recording, etc. Normally for control circuits, it should be VOX and for recording conversation over telephone it should be POH. Real time window will show the recording progress or idle accordingly.

The real time monitoring window will show the smart logger number, Channel number, call type, phone number, call duration of current recording, etc. When recording is in progress, the particular row of the channel will show green color and no color while idle. Back up window allows to take manual back up of desired time period and to save it at desired location. Health status window will display connected time, up time duration, DSP status, LAN status, line status, etc.

All the recordings will be saved automatically to individual logger HDDs of 40 GB capacity and simultaneously into the HDD of PC also. Play back feature allows the recorded files to be played on connected multimedia speakers. Real time monitoring of speech is also possible with an inbuilt speaker in the smart logger.

For this, we have to connect a key board to the jack provided in front of the logger and select the required channel to be monitored.

For playing the records:

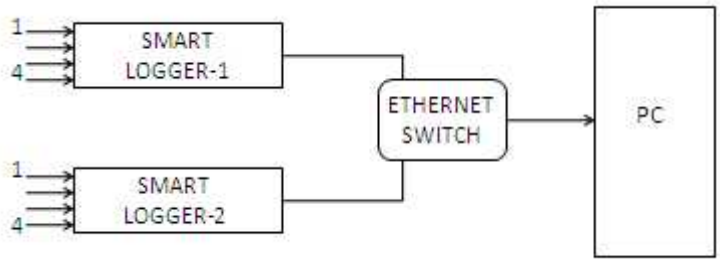
- Select a file from the searched results.
- Right click on the selected file and choose play record.
- If audio is available, then playing would begin in the embedded media player.

For downloading the files:

- Select files to be downloaded.
- Select location where it has to be saved.
- Right click on the files and select download.

10.4 Trouble shooting

1. **Logger not connected:** Make sure the logger is turned ON and its power LED is not blinking. Also make sure that LAN cable is connected properly.
2. **Access denied or serial connection failed:** Make sure that some other application is not using the specified COM port.
3. **Serial configuration failed:** Confirm that the serial port is working properly by checking it with some other applications.
4. **Unable to connect with server:** Check the LAN cable connectivity and configuration of Smart logger.
5. **Time out messages:** Please try restarting logger and server.
6. **Taking long time to search, delete and backup records:** Delete records from database regularly and don't let more than 10,000 records to get stored in database.
7. **VOX calls are recording even when there is silence:** Try increasing calibration gain and volume gain.



Connectivity diagram for Voice Logger

Objective:

State true or false and fill in the blanks.

1. Computer connectivity to the Voice logger is through Ethernet port. ( )
2. The operating voltage and current of the Voice logger are _____and_____.
3. POH (Phone off hook) mode is used for recording voice over telephone and VOX mode is used for recording voice over control circuits. ( )
4. The Voice logger used in control communication has a built in hard disc of Capacity _____.
5. Recordings are saved automatically in HDD of logger as well as in the HDD of PC simultaneously. ( )
6. RJ 11 connectors are used to connect control voice channels to the Voice logger. ( )

Subjective:

1. What is Voice Logger? Explain the system features of the Voice Logger used in control communication.
2. Write down the trouble shooting procedures used in Voice Logger

CHAPTER-11

TRAIN MANAGEMENT SYSTEM (TMS)

11.1 Introduction:

The Train management system (TMS) is a safe, reliable and effective system for regulating trains by monitoring their movements, automatic recording and retrieval of train timings and generation of control charts. This is an integration of many systems working in perfect coordination, thereby making it a complex system offering complete solution to train traffic control especially in high traffic density sections. This system enables to effectively manage the train movements in sections where trains are spaced at three minutes interval, thus working very close to available headway of three minutes.

11.2 Limitations of the previous conventional systems:

- Controller in such high traffic density sections were essentially a recorder than a controller.
- Real-time fetching of information on special occurrences was not possible.
- Taking decisions/actions were delayed.
- Even the decisions taken were ad-hoc.
- Information displayed by train indication boards were not matching with the actuality.
- Announcements were delayed.

As a result of the above limitations, restoration to normalcy took a long time leading to commuter dissatisfaction and sometimes followed by agitation and violence.

Hence, the earlier system did not provide much assistance to the controller to take timely action for train controlling in case of unusual event that may put operations out of gear.

Similarly, timely information to ASMs was also not available for ensuring correct displays and announcements. Due to above limitations, the conventional type train control communication system was not able to cope up in the high traffic density sections. Therefore, the need arose to provide **"on line"** information of train movements to the various railway agencies e.g. controller, ASMs, etc, who can take timely and effective steps both in case of normal routine operation and during disruption of the operation.

11.3 Primary functions of TMS:

- On line display of movements of all trains with Train Numbers/Rake Nos. on video monitors as well as over view indication panel, located in control room.
- Interfacing with the train indicator boards at various stations for minute to minute train arrival information to commuters.
- Provision of video display units for train running information to commuter with countdown in minutes.
- Interfacing with the announcement system for facilitating auto announcements.
- To provide remote control operation of signaling interlocking system.
- Generation of MIS reports and statistical data.
- Off line planning tools like log replay, Timetabling, Simulation, etc.
- As a part of it, Mobile Train Radio communication between Motormen/Guards of suburban trains and controllers has also been catered for.

11.4 Assistance provided to the section controller:

1) On line display provides complete picture to the section controller about train running in the entire section. By this, controller can take timely and proper decisions for cancellation, diversion and termination including induction/withdrawal of rakes in case of any disruption to the train services due to any unusual occurrences.
2) This provides the current status of all interlocking information pertaining to various stations i.e. signals, points, track circuiting etc. Thus failure of the same and consequential hold up the trains are suitably taken care of.

Fig.1 Typical live train movements on TMS

3) Optimum decision can be taken regarding retrieval/induction of rakes from/into the system by viewing the position of availability of various rakes on the sidings, car sheds etc. This information is available to EMU controller also.
4) Train control charts are stamped automatically.

11.5 Display of real-time movement of suburban trains on projection screens in control room:

- Rear video projection screens have been installed in the TMS control room by which viewing of live train movements, track layout, status of points, signal aspects, level crossing gates are possible. The real time train movements on the 13mx2m rear view projection panel are assisting our traffic controllers in efficient management of intense suburban train operations. Any yard layout changes occurring can be carried out with ease through software requiring no expensive and time consuming hardware modifications.
- TMS providing real-time train running information of suburban trains to commuters by automatic operation of train indicator boards and automatic announcement at station platforms.

Fig.2. Projection screen panel

VDU screens and Train indication boards for providing train information to commuters:

Fig.3. Train Indication Board at stations

- VDU screens and Train indication boards are installed at the entrance of the station for providing scheduled arrival as per time table and expected arrival in minutes, train indication boards are directly operated from the system, on ON LINE basis Thus possibility of wrong displays due to manual operation is avoided.
- Audio announcements also work on ON LINE basis. Train information are automatically available to ASM/indicator operator / Announcer, well in advance. Announcements are triggered from TMS control centre

11.6 ON LINE VDUs FOR STATION MASTERS

On line displays on the VDU screen gives expected arrival time of next 2 trains on each platform. This enables the master in optimum planning of train movements in his jurisdiction.

Cases of diversion (from slow to fast corridor or vice-versa)/cancellation of trains, are automatically flashed on his screen, well in advance enabling him to ensure correct operation of train indication boards and making timely announcements about cancellation or diversion/change of platform.

Fig.4. OVERVIEW OF SM PC

The application has many software modules, they are:

- Train describer
- CTC (Certified Traffic Control modules)
- MIS report generator
- Replay facility
- Time table editor
- Passenger information system
- Decision support system
- Site data builder (for data base changes)

Management information system (MIS):

- Daily suburban punctuality support
- Auto sending of punctuality report to CRB
- GMs position
- Daily lost/ delayed
- Train control charts
- Train describer report

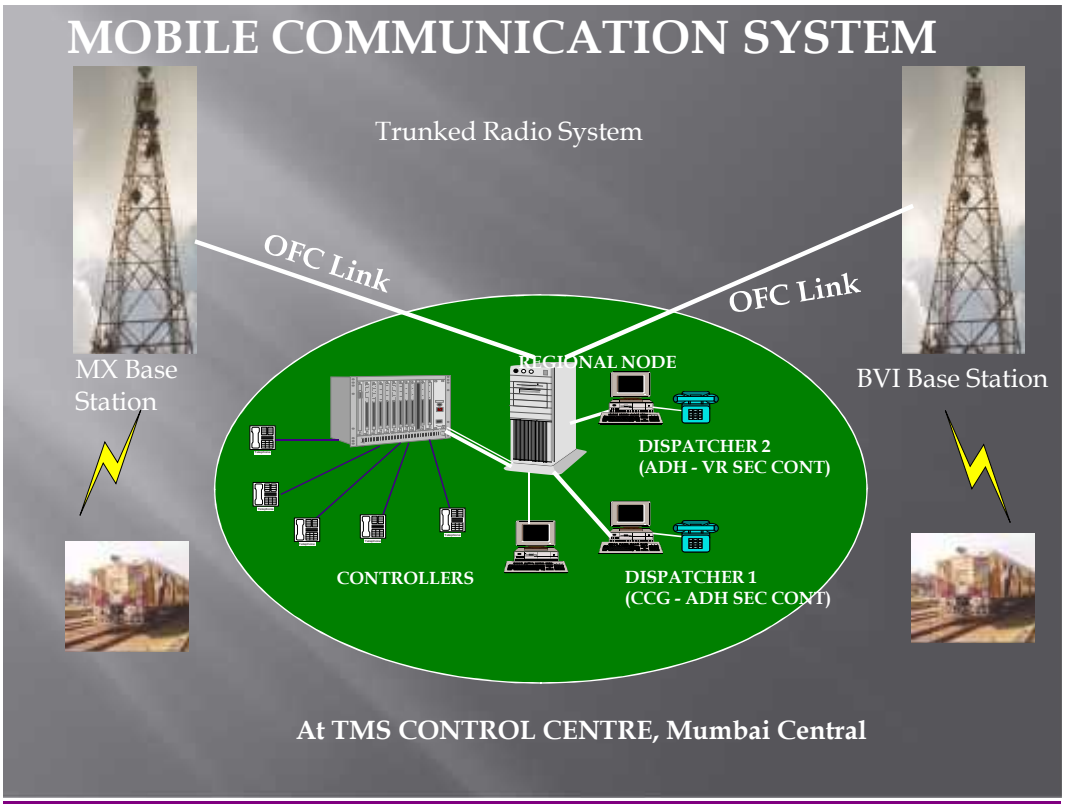
Log and replay

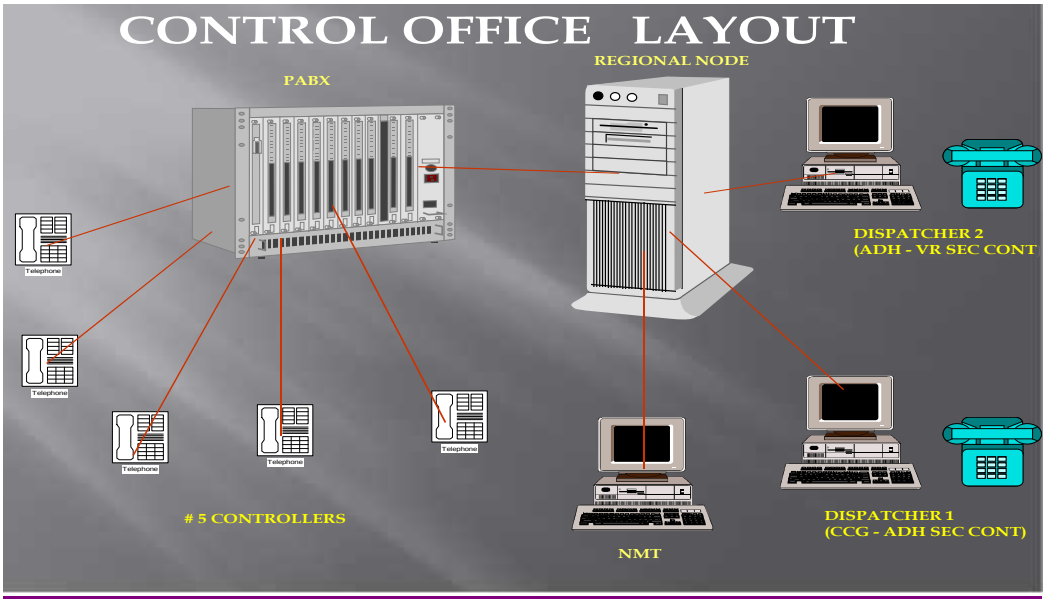
Logged event can be replayed for analyzing the unusual occurrences

Mobile train communication between trains and control centre

11.7 The salient features are:

- Working on MPT 1327 trunking system
- Frequency band
- TX / RX frequency: 338 to 355 MHz
- Base stations: Two
- Each base stations having one control and five traffic (voice) channels
- Dispatcher PC can make individual call
- Call can be broadcasted by lifting the handset of dispatcher phone and by typing in dialing area by entering 3 digit CAB RADIO Number.
- DESP can send short data Message and broadcast messages.
- DESP PC shows train information in address book and it gets updated on real-time from TMS server.
- Voice loggers are integrated with DESP 1 & 2 base stations for monitoring.
- Tetra based new MTRC has been proposed for replacement of existing system.





11.8 Conclusion:

Following are the advantages obtained by the introduction of TMS:

a) TMS has enabled the controllers to focus much more on management of train operation rather than working as a train recorder.
b) The communication gap between the section controller and cabin ASMs has been eliminated, thus train movement information is available in time both to the controller and ASMs.
c) The damage control is prompt to act in case of traffic disruption due to equipment failure or any other operational reasons.
d) Availability of indications at control centre as well as in ASMs cabin about the closing and opening of LC gates at major stations. This is very useful in planning traffic movements.
e) Availability of rake no along with train no on station pictures is very useful in planning train movement to car sheds.
f) During major blocks, availability of live train movements is especially useful for planning train movement and diversions.
g) Mobile communication has enabled conveying of EMU rake defects expeditiously to the EMU controller. EMU controller in turn directs the electrical maintenance staff at the examining depots to attend to the defects reported on line which expedites rectification of EMU defects.
h) Mobile communication is used to make broadcast calls from the control centre to suburban trains during traffic dislocations to guide the driving crew as well as to inform the travelling public.

Objective:

State true or false and fill in the blanks.

1. The Train management system provides 'On Line' information of train movements to the various railway agencies. ( )

2. _____ have been installed In TMS control room for viewing of live train movements, track lay out, status of points, signal aspects and status of level crossing gates.

3. On line Video display unit enables the master in optimum planning of train movements in his jurisdiction. ( )

4. Train indication boards, Video display units and Audio announcement systems work on_____ basis to avoid wrong display and announcements.

5. The Tx and Rx frequency used for Mobile train communication between trains and Control centre is _____.

6. Mobile communication in TMS guides the driving crew as well as to inform the travelling public during traffic dislocations. ( )

Subjective:

1. What were the limitations of the conventional Train control communication system in high traffic density sections and how the limitations have been overcome in the Train management system?

2. Explain the primary functions of Train management system.

3. Explain the devices used in Train management system as mentioned below
   a. Rear video projection screen installed in the control room.
   b. Video display unit screen (VDU) and Train indication boards installed in railway stations.

4. What are the salient features of the mobile train communication used between trains and control centre in Train management system?

CHAPTER-12

VOIP BASED TRAIN CONTROL COMMUNICATION SYSTEM

12.1 The RDSO specification for VIOP based train control communication system is RDSO/ SPN/99/2010 Revision 0.

The intention of providing voice over internet protocol based train control communication is to make use of the standard, modern and widely proven Internet Protocol technology as a platform. This enables use of common infrastructure for voice and data services. By this the control communication system becomes rich with many features which are not available in the existing system. Thus making the system more reliable and efficient.

The existing system is analog based by using transmission on copper cable or by using digital transmission on OFC.

12.2 The limitations of the existing system:

- The system being analog has no additional features. Even to provide a small additional feature, changes in the hard ware is required.
- The control communication system is used only in Railways. Other than railways no where it is used. This limits the market driven improvement.
- Way station equipment cannot be interfaced with the railway exchange without manual intervention for routing an administrative call from HQ to the way station equipment.
- Station master's table has many phones. As a human being managing all phones of different type is quite difficult.
- Significant impedance mismatch degrades voice quality when way station equipments are connected to the same point.

12.3 Advantages of VOIP based train control communication system:

- The VOIP based TCCS shall be based on open international standards.
- Provides many features which are common in modern telephony, such as caller ID, call logs, etc.
- Being IP based network, it shall use common network infrastructure for voice, video and data.
- Since the system has internationally accepted technology, future improvement in the system shall benefit the train control communication system also.

12.4 The components of the VOIP based TCCS:

a) Server and end points

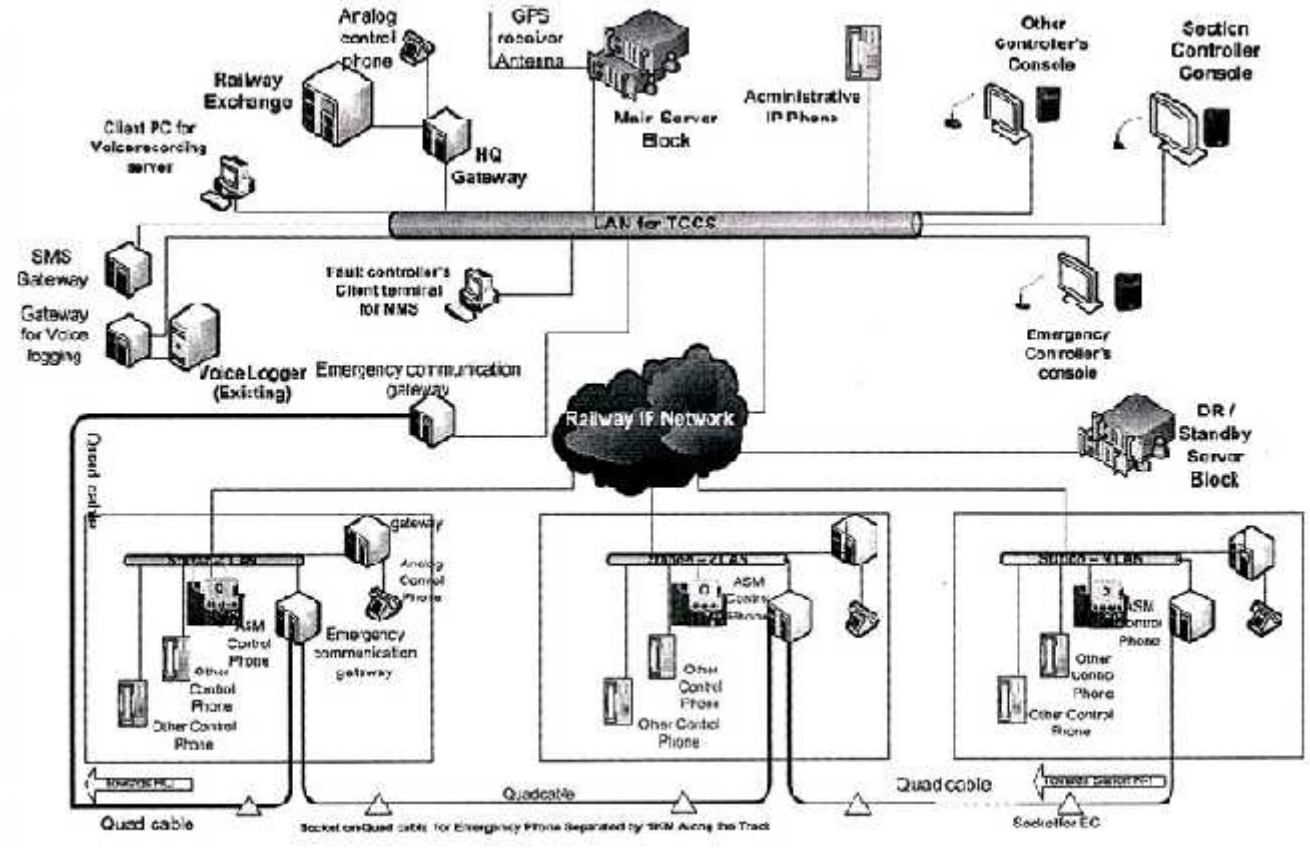
I. Server/servers cluster for Call control and conferencing, network management, voice recording.
II. Section controller's console and other Controller's control telephones/consoles.
III. Gateways for providing connectivity with Railways Telephone Exchange, Emergency communication circuit and Analog control telephones and SMS gateway.
IV. Way side IP control telephones for Station masters and other users of control circuit.

12.5 General and Functional requirement:

The schematic arrangement for "VoIP based train control communication system (TCCS)" is given in figure 1.

Train Control Communication System (TCCS) shall fulfill the following requirements:

- It shall be possible for controller to selectively call any permitted (as per the call rule matrix given in this spec.) way side station control telephone.
- It shall be possible for controller to selectively call to one or a group of stations or all stations under his jurisdiction.
- The controller shall get suitable audio and visual indications on his console whenever the bell/buzzer at the way station control phone rings in response to the call initiated by him. The controller shall get visual indications regarding status of the call initiated by him till the time the called party responds by lifting the handset. It shall be possible to disable the audio indication. The called party is added to the conference when it answers the incoming call.
- While the selective calling is done, it shall not hamper or put on hold, ongoing communication, if any, between controller and way side station/stations.
- The section Controller shall be able to call other controllers from his console and add them to ongoing conference call. When the section controller is in conference with one or more subscribers or other controllers, it shall be possible to make selective call from section controller to any other subscriber including way side station, without disconnecting the existing connections and without putting them on hold.



Connectivity diagram for IP based control communication system

- From way station control telephone, it shall be possible to call the controller by a touch of button or by dialing a code. The way station control telephone shall get connected to the ongoing conference of controller without generating any ring at controller's end. The controller shall get a visual indication and a beep (it shall be possible to disable the beep) regarding newly added way station telephone to its conference. When way station Phone calls the controller, it will generate ring if the controller's telephone is "On Hook". If controller's phone is on a call, way Station Phone joins the conference call automatically.
  ASM's control telephone at a way station shall have programmable keys or soft keys to call any of the controllers pertaining to that section. Individual key shall be programmed to call a particular controller. The top key shall be programmed to call the section traffic controller.
- The section traffic controller shall be able to give ring to the way station control telephone for ASM (Assistant Station master) even if this phone is busy in conversation or not properly restored to "On Hook" condition. The ASM's phone shall show the caller ID of the second caller. On getting this audio visual indication, ASM would be able to take section controller's call.
- The control phone at a way station for ASM shall be able to receive call from any of the controller pertaining to that section. However, the incoming call from section traffic controller to ASM's telephone shall generate distinct ring tone.
- The system shall provide, at control office, both internal dedicated recording devices and an interface (through a gateway) to connect an external analog multi-channel voice logger as per RDSO specification RDSO/SPN/TC/38-02 with latest revision/ amendments.

12.6 Emergency Control Circuit:

An arrangement (gateway) shall be required at every way station for interfacing IP network and the emergency control circuit. It shall be possible to reach the control office by plugging a 4 wire portable control telephone into any of the sockets. The voice shall be carried over the IP network to the Emergency controller's conference which is always ON and shall be heard on a speaker. A two way communication shall be setup between the emergency controller and the site. If any other person plugs his telephone in some other socket on the same emergency control section, he will also join the conference.

Facility is also provided to connect emergency conference call received on this emergency control circuit, to the Section Controller's conference in control office by Traction power controller/Power controller who normally also works as emergency controller.

12.7 Technical specifications:

The various components of the VoIP based train control communication system shall comply all the functional and general requirements as per the specification, even if it requires additional hardware and software other than those mentioned in the specification.

- Servers (Communication, Application, NMS, Voice recording and other servers)
- Gateways (for interconnecting with Railway exchange and existing voice loggers, for providing analog telephones, SMS gateway, for emergency communication purpose)
- Consoles for section controllers and other controllers.
- IP telephones for Station masters and others at wayside stations.

12.8 Communication Protocol: The communication server shall support SIP 2.0 as per RFC 3261 and its extensions as per latest relevant RFCs or it shall support both SIP 2.0 and H.323.

The end points shall support either SIP or H.323 as detailed against these individual items in the specification.

12.9 The IP phones in this specification shall include both SIP based and H.323 based IP telephones unless specifically mentioned otherwise.

12.10 Any reference to ASM's way station control telephone shall include both IP telephone and console. Reference to button shall include soft button also in case of touch screen panel based solutions.

12.11 The equipment hardware and software shall take care of changes in system time caused by events such as leap year etc. and shall not affect system working.

12.12 There shall be uniform distribution of time for all elements (servers and end points) from a single source through NTP v 4.1.2 (RFC 1305). All the elements shall have NTP protocol support. The timing and date information shall be retained even if the power supply to the element is cutoff. For this NTP server, with GPS receiver along with external antenna and connecting RF cable shall be used along with the TCCS.

12.13 The TCCS is expected to work continuously round the clock with high availability. Therefore all the components shall be capable of intensive 24x7 operations.

12.14 The TCCS shall have a centralized Network management system (NMS). The system shall provide remote configuration and real-time performance monitoring.

12.15 Other Important Features

- Easy replacement of IP phones wherein the configuration details are stored at centralized location and uploaded when these devices are replaced.
- The end point shall provide QoS markings at layer 2 and layer 3 to minimize delays in LAN and WAN.
- Voice logger shall notify events like records storage capacity, recording activated or not, switch over to back-up server etc. in the form of SMS or email.
- Support for wideband codec is provided on controller's console and ASM's IP phone to provide good quality voice if sufficient WAN bandwidth is available.
- Features like Voice activity detection, comfort-noise generation, Echo cancellation, error concealment, adaptive Jitter Compensation are provided for acceptable voice quality and efficient utilization of bandwidth.

12.16 Security:

a) There shall be separate VLAN for TCCS system (subject to VLAN capable switches).
b) End to end signaling encryption shall be provided using TLS as per RFC 5246 or as per IP Sec/ESP Transport mode using AES 128 bit. However, this is not applicable for emergency Gateway. All IP telephones shall be authenticated by TCCS server with username and password to register/ communicate within the system. These username and password shall be provisioned centrally.
c) Any PC connected to second Ethernet port of the IP telephones shall not be able to send data traffic to the voice VLAN for TCCS.
d) The configuration shall be possible only from centralized location or through maintenance portable terminal running EMS/NMS software. Any change in configuration shall be logged with date and time stamp.

e) Call server shall have following protocol support for secure configuration:
   1. SSHv2 for secure sessions, and
   2. SSLv2/v3 for secure HTTP session

f) The communication Server should deny any intruders to access the system using false identity. It shall have Syslog file for intrusion management and it shall keep records or logs regarding the following:
   1. Connection (who is connected and at what time)
   2. Unauthorized attempts to enter the system
   3. History of system commands

g) The communication server shall allow communication only with trusted hosts like IP phones, gateways, NMS stations etc. based on ACL permitting only required applications on these hosts.

h) The entire user specific configuration on the phone set shall be stored centrally and restored if there is reset power down or set replacement.

i) The vendor road map for upgrading TCCS from IPv4 to IPv6 shall be available.

Objective:

State true or false and fill in the blanks.

1. Significant impedance mismatch degrades voice quality due to the connecting of way station equipments to the same point. ( )
2. Gateways shall be used for connecting TCCS with Railway Telephone exchanges, emergency communication circuit and Analog control telephones. ( )
3. In VOIP based TCCS, IP phones shall be provided to way side station masters and other users of control circuits. ( )
4. Remote configuration and real time performance monitoring of TCCS shall be done by centralized _____.
5. The communication server shall deny any intruder to access TCCS using _____.
6. Since VOIP is internationally accepted technology, future improvement in the system shall also benefit the TCCS. ( )

Subjective:

1. What are the advantages of VOIP based train control communication system when compared to the existing system?
2. Write down the names of the components of VOIP based Train control communication system and briefly explain its functional requirements.
3. Explain the security arrangement provided to VOIP based Train control communication system.

CHAPTER-13

WORKING UNDER TOTAL COMMUNICATION FAILURE CONDITION

13.1 Total communication failure is said to have occurred between two block stations on a single line or a double line section, when line clear cannot be obtained for running the train by any one of the following means stated in the order of preference.

a) Block instruments, Track circuits or Axle counters.
b) Telephone attached to the Block instruments.
c) Station to station fixed telephones, where ever available.
d) Fixed telephones such as railway auto telephones and BSNL telephones.
c) Railway control telephones, and
d) VHF sets.

13.2 Rules and regulations for temporary single line working on double line section during total interruption of communications:

The following rules must be observed by the staff:

1. Whenever an accident to a train or track or other obstruction prevents the use of one line on a double line section during total interruption of communications, Engineering official shall give the certificate to the Station Master of the station at the end of the affected section. On receipt of this certificate, the Station Master will follow the rules prescribed for opening of communications.
2. Loco Pilots of trains, including light engines, shall be given authority for opening communication during total interruption of communication on Single Line Section (T/B602).
3. The endorsement shall also be made in the T/B 602 given to the Loco Pilot of the first train to stop and inform all Gatemen, Gang men, patrolmen, OHE staff, Telecom staff and any other staff on the way about the introduction of temporary single line working and specifying the road on which the trains will run.
4. On reaching the next station, the Loco Pilot shall bring his train to a stop opposite the FSS pertaining to the right line or at the LSS pertaining to the wrong line.
5. The Station Master of the station in advance shall depute a railway servant in uniform at the foot of the signal (whichever the train would encounter first) who shall stop the train on stop hand signal and thereafter ‘pilot in’ into the station on a written authority issued by the Station Master.
6. The telecom staff who has reached the station in advance by the engine will restore the communication over any one of the means mentioned in a to d of 12.1. He will inform the station master at both the ends and testroom immediately after getting the consent of SMs.

13.3 Rules and regulations for working of trains during total interruption of Communications on double line sections:

1. In the event of total interruption of communications occurring between two block stations on a double line section.

The following procedure shall be adopted for train passing**.**

2. Before any train is allowed to enter a block section in advance, it shall be brought to a stop and the Loco Pilot and the Guard of the train shall be advised of the circumstances by the Station Master on duty.

3. The Station Master shall give T/C 602 **(Authority for working of trains during total interruption of communication on double line section)** to the Loco Pilot of each train which includes:
   3.1. An authority to proceed without line clear,
   3.2. A caution order restricting the speed to 25 KMPH over the straight and 10 KMPH when approaching or passing any portion of the line where the view ahead is not clear due to curve, obstruction, rain, fog or any other cause,
   3.3. An authority to pass LSS in the 'ON' position.
4. In the event of a Loco Pilot approaching or passing any portion of the line where the view ahead is not clear, a railway employee with hand signals must be sent in advance to guide the further movement of train. A sharp look out ahead should be kept and the engine whistle freely used.
5. No train shall be allowed to enter the block section until there is a clear interval of 30 minutes between the train about to leave and the train which has immediately preceded.
6. The Guard shall keep a sharp look out in the rear and be prepared to exhibit a stop hand signal to prevent the approach of a train from the rear and to protect it if necessary.
7. When a train is stopped in the block section, the Guard shall immediately exhibit a stop hand signal towards the rear and check up that the tail board or the tail lamp is correctly exhibited. If the stoppage is on account of accident, failure, obstruction or other exceptional cause and the train cannot proceed, the Loco Pilot shall sound the prescribed code of whistle to apprise the Guard of the fact, whereupon the Guard shall protect the train by placing one detonator at 250 metres from the train on the way out and 2 detonators, 10 metres apart, at 500 metres from the train, irrespective of the gauge. In the absence of the Guard, the duty of protecting the train shall devolve on the Loco Pilot.
8. No train shall be backed. In exceptional circumstances when it may be unavoidable to back a train, the train shall be backed only after providing protection by placing one detonator at 250 metres and two detonators, 10 metres apart, at 500 metres in rear of the point upto which the train is to be backed.
9. When approaching the station ahead, the Loco Pilot must bring his train to a stop outside the FSS and sound continuous whistle (or any other code prescribed by special instruction).
10. The Loco Pilots of all trains shall make over the T/C 602 **(Authority for working of trains during total interruption of communication on double line section)** to the Station Master of the station at the other end of the affected section.
11. A record of all trains passed over the block section on T/C 602 **(Authority for working of trains during total interruption of communication on double line section)** during the course of total interruption of communications, shall be maintained in the TSR at both the stations concerned.
12. Trains must continue to work on this system until one of the means of communications, mentioned in para 12.1 above, is restored by the competent authority.
13. As soon as any one of the means of communications has been restored, the Station Master must send a message to the Station Master at the other end of the section on the prescribed form T/I 602 **(Message on restoration by any one of the communication)**.
14. Thereafter intimation about this shall be given to Section controller also, on controlled sections, if communications with the Section Controller has also got restored and normal working resumed.

13.4 Rules and regulations for working of trains during total interruption of communications on single line section:

1. The Station Master who has a train to dispatch through the affected block section shall open communication by establishing contact with the Station Master of the block station at the other end of the affected block section by sending an engine or self propelled vehicle or any other vehicle enumerated below, in the order of preference laid down.
   1.1. Light engine.
   1.2. Train engine, after it is detached from the train by the Loco Pilot on instructions from the Station Master on duty.
   1.3. Motor trolley/Tower wagon duly accompanied by a Guard or by a Station Master other than the Station Master on duty.
   1.4. Trolley/Cycle trolley /Moped trolley duly accompanied by a Guard or by a Station Master other than the Station Master on duty.
   1.5. Diesel Car/Rail Motor Car/EMU Rake etc., after ensuring that all passengers have detrained.
2. T/B 602 (**Authority for opening communication during total interruption of communication on Single Line Section**) for only one train, if to be dispatched; or T/E 602 (Line clear enquiry message asking Line Clear for dispatch trains during total failure of communication on single line section) - for more than one train, if to be dispatched, along with T/B 602 (Authority for opening communication during total interruption of communication on Single Line Section) shall be sent through the Loco pilot/ Motorman/Guard/Station Master going to open communications.
3. After an engine is dispatched to the next station to open communications with LC enquiry message and CLC messages for the return journey of the engine shall be allowed to leave the station and proceed in the same direction until the engine returns.
4. The engine proceeding on T/B 602 shall switch on the flasher light and dim the head light and shall proceed at a speed not exceeding 15 KMPH by day when the view is clear and 10 KMPH during night or when the view is obstructed.
5. On the return journey, the engine either light or attached to a train may run at booked speed observing speed limits in the Working Time Table and other relevant rules.
6. On arrival at the station, T/F 602 shall be handed over to the Station Master who shall prepare T/G 602 or T/H 602 **(Conditional Line Clear Ticket)** for the waiting train.
7. Trains must continue to work on this system until any one of the means of communications mentioned in para 12.1 is restored by the competent authority.
8. As soon as any one of the means of communications has been restored, the Station Master must send a message to the Station Master at the other end of the section on the prescribed form T/I 602.
9. Thereafter intimation about this shall be given to section controller on controlled sections.

Subjective:

1. When it is said that Total communication failure have occurred and on basis of which line clear cannot be issued for running the train in the block section.
2. Write down the Rules and Regulations to be followed on single line and double line sections during total interruption of communications.

ANNEXURE-I

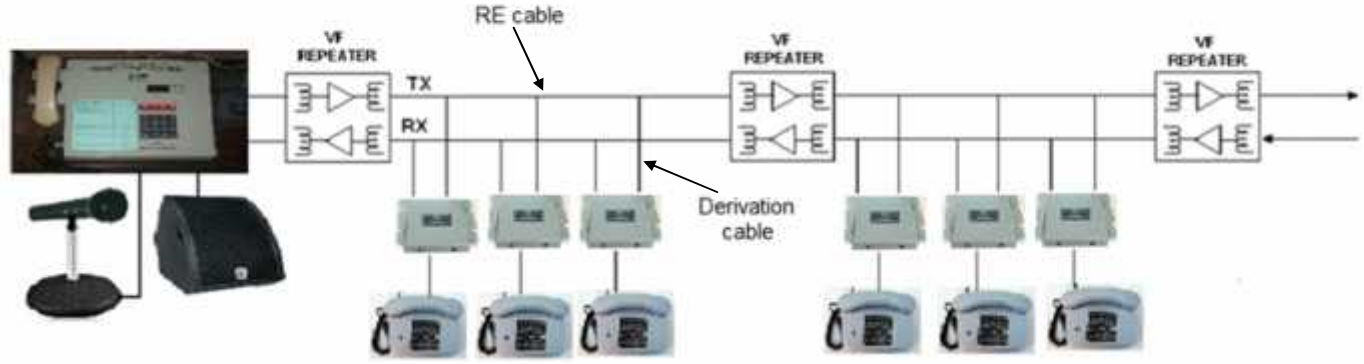
RDSO Specifications for Different Telecommunication Items

S. No.	Name of Telecommunication Item	Specification/Drawing No.
1	4 Wire/2 Wire Train Traffic Control Equipment with Dual Tone Multi Frequency (DTMF) Signalling	IRS TC: 60/2007
2	Repeater Station Equipment	IRS TC 50/90
3	Desk Type 2 Wire, 12 Way DTMF Telephone	IRS TC 80/2000 (Amd. 1)
4	Universal Wayside DTMF Control Telephone	IRS TC 82/ 2005 (Amd.1)
5	Emergency Control Room Equipment	IRS TC:61/93 (Amd.1)
6	Light Weight Portable Control Telephone	IRS TC: 78/2000 (Amd.1)
7	4-Wire Way Station Control Telephone	IRS TC: 38/97 (Amd.1)
8	2 –Wire Way Station Control Telephone	IRS TC 37/97 (Amd.1)
9	4-Wire/2 Wire Combined Portable Control Telephone	IRS TC: 75/99 (Amd-2)
10	Magneto Telephone Desk Type	IRS TC: 36/97 (Amd.1)
11	Desk Type Electronic Magneto Telephone	IRS TC: 79/2000(Amd.2)
12	Power Supply Unit For Telecom Installations At Way Side Stations In 25 KV Electrified Area	IRS TC: 72/97 (Amd.1)
13	V.F. Tapping Transformer ; 1120: 1120 , 1120: 600 & 470 : 1120	IRS TC: 22/76
14	V.F. Transformers (2T/3T) Suitable for underground telecom. Cable circuits.	IRS TC: 76/2000 with Amd-1
15	Balancing Condensers.	IRS TC 11/73
16	Polystyrene Condenser for Balancing and Building out Network.	IRS TC 49/93
17	Loading Coil joints.	IRS TC 29/81
18	Digital Capacitance Unbalance Measuring set.	IRS TC 48/90
19	Transmission Measuring Sets.	IRS TC 43/87
20	Cross Talk Measuring Sets.	IRS TC 45-88
21	Cable Termination boxes (Indoor) for Railway Electrified Area.	IRS TC 18/75
22	Auto Dialing System From Emergency Socket in RE Area	IRS: S-83/2007 Amd-1
23	Six Pin Emergency Plug And Socket	IRS TC : 42/87 (Amd .1)
24	Emergency Socket Box of FRP Material	RDSO/SPN/TC/44/2002 Ver.2, Amd-2
25	48V SMPS Power Plant For Indian Railways Telecom Equipments With FR/FC Module	RDSO/SPN/TL/23/99 (Ver-3) Amd-1
26	Integrated Way Station Control Communication Equipment	RDSO/SPN/TC/70/2007 With Amendment- 1
27	Multi Channel Voice Recorder	RDSO/SPN/TC/38/2002 (Rev.1.1) Amd-1
28	Voice Frequency Communication System For Underground Quad cable	RDSO/SPN/TC/34/2002 (Ver. 4)
Control Equipment for OFC		
29	Primary Digital Multiplexer (Drop Insert)	IRS TC 68-2004 Amd-1
30	Automatic Radio Patching System for Control Circuit using DTMF Signalling in Optic Fiber Communication	IRS TC 59-93
31	Control Communication Equipment for OFC (CCEO) Using 2-Wire Telephone.	RDSO/SPN/TC/66/2007 (Amd. 2)

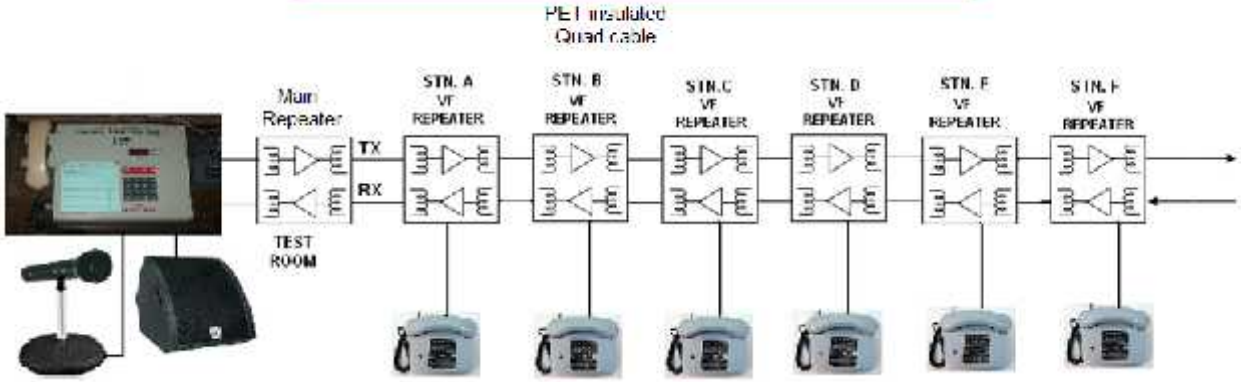
OFC Cable		
S. No.	**Name of Telecom Item**	**Specn./ Drg.No.**
32	24 Fiber Armoured Optic Fiber Cable	IRS TC: 55/2006 Rev-1 Amd. 1.1
33	Fibre Distribution Management System	RDSO/SPN/TC/037/2000 (Ver. 3) Amdt.-1
34	Fibre Distribution Management System for Composite (Optical and Quad) Underground Armoured Cable	RDSO/SPN/TC/071/2008 (Rev. 1.0) Amdt.-1
VHF, UHF & Microwave		
35	2MB Digital UHF Equipment.	IRS TC 64-94
36	(34+2)MB 7 GHz Digital Microwave Antennas.	IRS TC 66-94
37	3M dia., 7GHz Microwave Antenna.	IRS TC 67-94
38	Dehydrator System for Microwave Link.	IRS TC 13-2000
39	Code of practice for protection of Radio relay station against lighting.	IRS TC 39-86
40	Minimum performance requirements for long system for 120 Channels on Indian Railways.	IRS TC 10-73
Overhead Item		
41	Insulator Light Weight Unbreakable Polycarbonate	IRS TC: 32/2007 Amd-1
Telecom Cable & Accessories		
42	PIJF Telephone Cable	IRS TC 41/97(Amd.2)
43	Underground Railway Jelly Filled Quad Cables For Signaling And Telecom Installations	IRS TC 30/2005 (Ver.-1) Amd. 4
44	Thermo Shrink Jointing Kit For Jointing Underground Quad Cable	IRS TC 77/2006(Rev.1) Amd.1
45	Thermo Shrink Jointing Kit For Jointing Underground PIJF Cable	RDSO/SPN/TC/57/2006 (Rev.0) Amd-1
46	Composite Underground Armoured Cable Consisting of 6 Copper Quads And 8/24 Fibers	RDSO/SPN/TC/50/2007 (Rev 5.0)
47	1.4 mm dia Copper Conductor 4/6 Quad Cable	RDSO/SPN/TC/72/2007(Amdt.1)
48	Joint Closure for Composite (Optical & Quad) Underground Armoured Cable.	RDSO/SPN/TC/56/2007(Rev.-2.0) (Amdt-1)
Miscellaneous Telecommunication Items		
49	Junction Equipment and speech Conversion Equipment used in AC Electrified Area.	IRS TC 46-88
50	Electro-dynamic Transducer.	IRS TC 74-97
51	LC Gate Control Equipment Using Wired & Wireless Data Communication.	RDSO/SPN/TC/49/2003 Version 3
52	Electronic L.C Gate Telephone System	RDSO/SPN/TC/51/2004 (Ver.-0) Amdt-2
53	Integrated Passenger Information System Consisting of train Indication coach guidance and P.C. based announcement System.	RDSO/SPN/TC/61/2007, (Rev.-2.0) With Amdt. No.1
54	True Colour Video cum Train Information Display System.	RDSO/SPN/TC/67/ 2008 (Rev-1)
55	Digital Clock with GPS Synchronization	RDSO/SPN/TC/62/2008, Rev-3

ANNEXURE-II

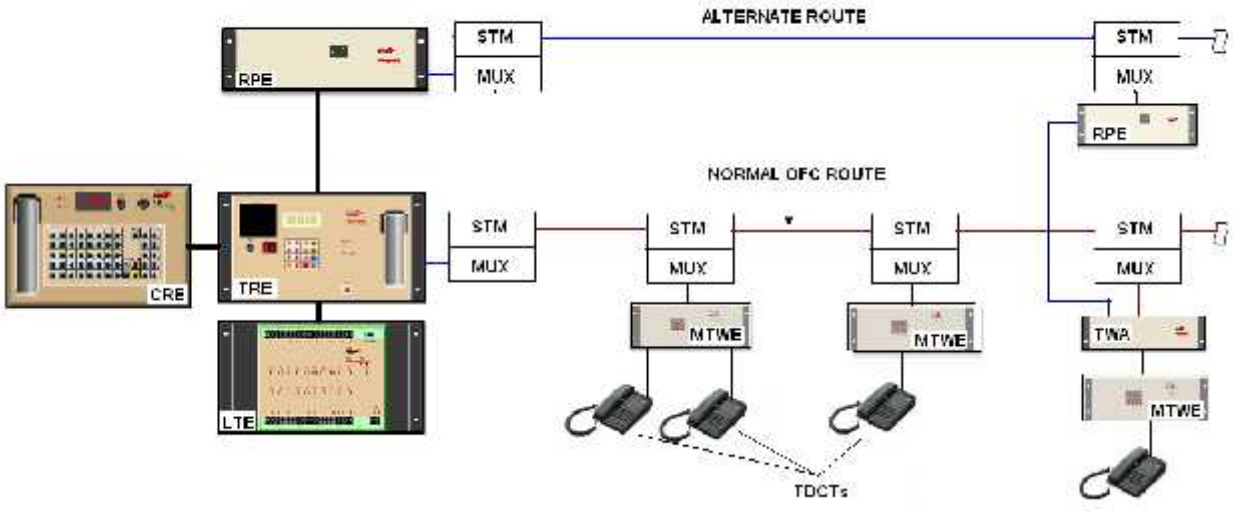
CONTROL WORKING ON 6 QUAD CABLE WITH CONVENTIONAL TYPE VF REPEATER

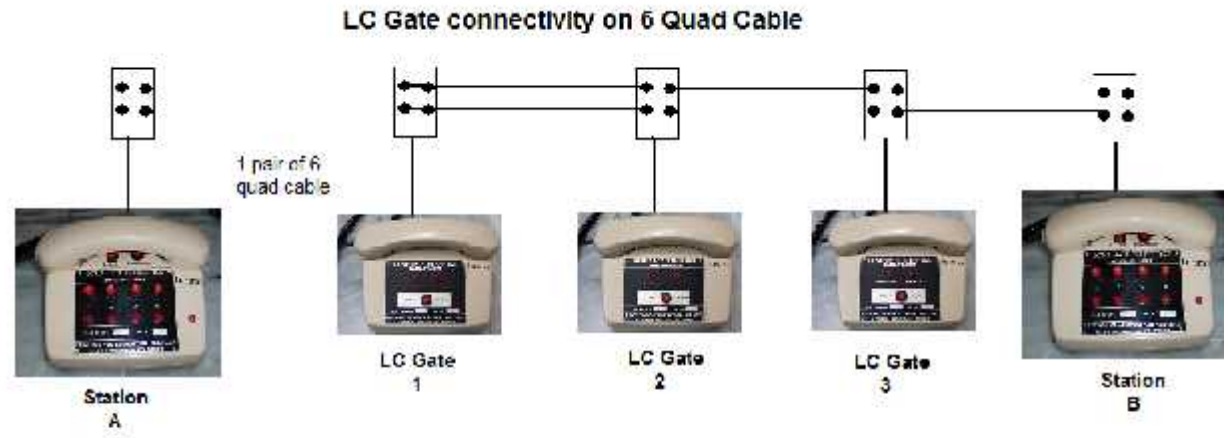


CONTROL WORKING ON 6 QUAD CABLE WITH EQUALIZER TYPE VF REPEATER

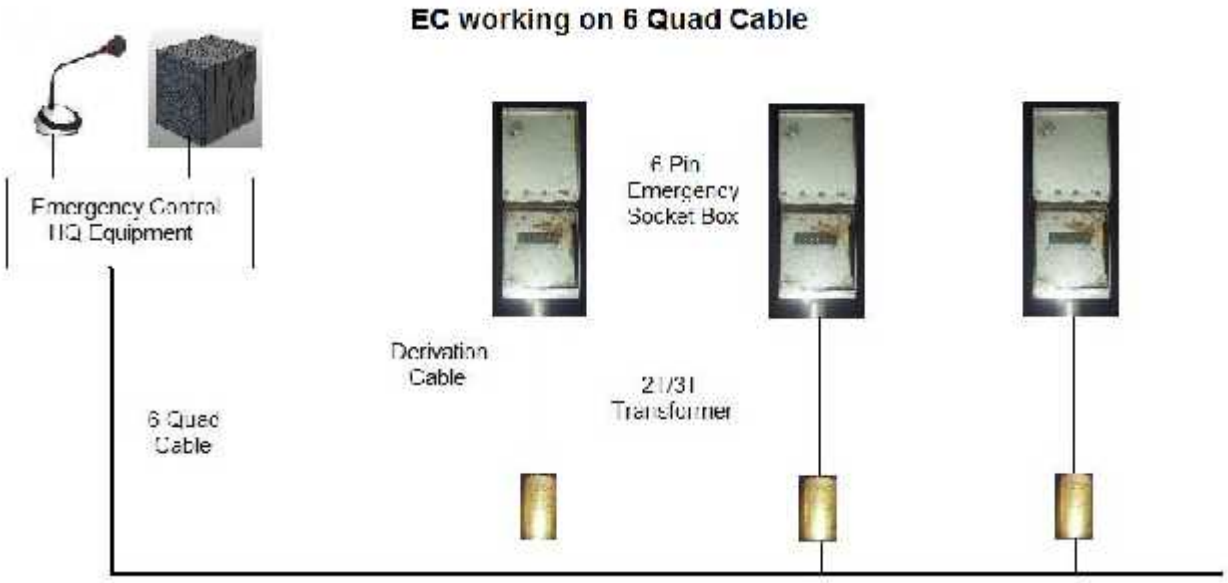


CONTROL WORKING ON OFC WITH CCEO SYSTEM

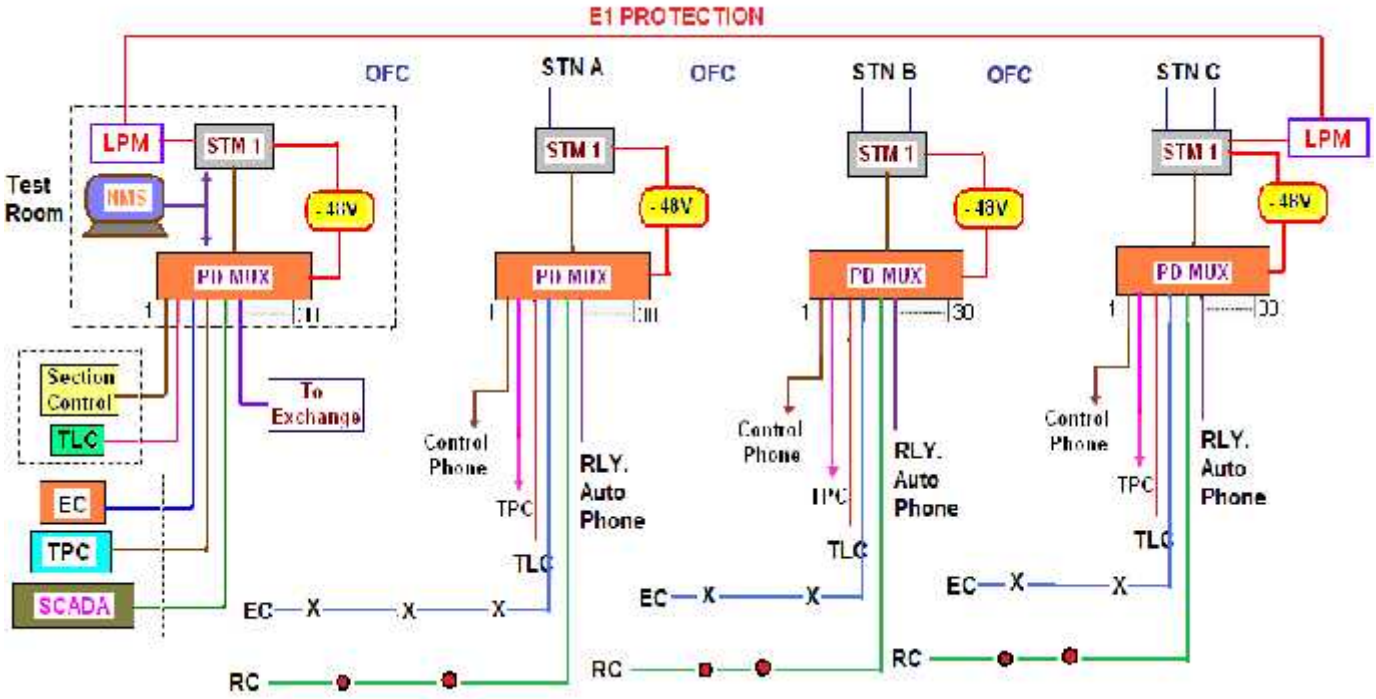




RDSO SPECIFICATION No. RDSO/SPN/TC/51/2009
Master Telephone works on 12V DC
Slave telephone works on 24V DC
Power supply for slave telephones are fed from stations.
Totally DTMF selective calling system.



FULL LAYOUT OF CONTROL COMMUNICATION ON OPTICAL FIBER CABLE SYSTEM



CONTROL OFFICE LAYOUT