



GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS  
(For Official Use)

A Pocket book on  
**EARTH LEAKAGE DETECTOR**



CAMTECH/S/PROJ/2013-14/PB- ELD/ 2.0  
JULY 2013



**Contact person:** Director (S & T)  
Indian Railways Centre for Advanced Maintenance Technology  
Maharajpur, GWALIOR (M.P.) 474 005  
☎ : 0751-2470185, FAX: 0751-2470841 e-mail: [dirtsntcamtech@gmail.com](mailto:dirtsntcamtech@gmail.com)

A Pocket book on

# EARTH LEAKAGE DETECTOR



**CAMTECH/S/PROJ/2013-14/PB- ELD/ 2.0**  
**JULY 2013**

## FOREWORD

The reliability of Signalling cables is important for working of the railway signalling. Earth Leakage Detector being an aid for monitoring the earth faults in signalling cables increases the efficiency and reliability of Signalling system.

This pocket book covers the installation and operating instructions of Earth Leakage Detector to help the signal maintenance personnel in taking the preventive action before any major failure occurs due to earth fault.

I hope that this handbook will definitely help to improve the skill of maintenance staff.

*CAMTECH*

*Gwalior*

*Date: 31.07.2013*

*A.R.TUPE*

*Executive Director*

# PREFACE

This pocketbook has been prepared to help the signal maintenance personnel in monitoring of earth faults in signalling circuits thereby enhancing the performance of the system. The pocket book covers brief overview, principle of operation, operating instructions and interpretation of indications and controls for fault detection.

We are sincerely thankful to Shri Satendra Kumar, Sr.D.S.T.E. Mughalsarai E.C.Rly., M/s Anu Vidyut, Roorkee and field personnel who helped us in preparation of this pocketbook.

Since technological up-gradation and learning is a continuous process, you may feel the need for some addition/modification in this pocketbook. If so, please feel free to write us at Indian Railways, Centre for Advanced Maintenance Technology, Maharajpur, Gwalior 474005 or mail us at [dirtsntcamtech@gmail.com](mailto:dirtsntcamtech@gmail.com). We shall be highly appreciating your contribution.

*CAMTECH  
GWALIOR  
DATE: 31.07.2012*

*D.K.M.YADAV  
JT.DIRECTOR (S&T)*



# CONTENTS

<b>Section</b>	<b>Description</b>	<b>Page No.</b>
	<i>Foreword</i>	<i>IV</i>
	<i>Preface</i>	<i>VI</i>
	<i>Contents</i>	<i>VIII</i>
	<i>Correction slip</i>	<i>X</i>
1	Introduction	1
2	Design	2
3	Insulation resistance	4
4	Leakage resistance	4
5	Principle of operation	5
6	Fault indications	6
7	Controls and indications of Main module	7
8	Controls and indications of Channel module	7
9	Main Terminal strip details (Rear side)	10
10	Channel Terminal strip details (Rear side)	11
11	Installation	12
12	Operating instructions	13
13	Testing of insulation with Cable Insulation Tester	16
14	Some common fault indications	18

	of ELD for diagnostics	
Annex-	Pre-commissioning check list for	19
ure	ELD as per RDSO SPN/256/2002	
	Disclaimer	23

## 1. Introduction

The Earth Leakage Detector (ELD) is used to detect earth faults in the signalling cables and circuits. The ELD conforms to RDSO specification no. RDSO/SPN/256 /2002.

This pocket book covers ELD of RDSO approved firm M/s Anu Vidyut, Roorkee.

### **Earth Leakage Detector Multi-Channel type 905-B2 (M/s Anu Vidyut)**

This ELD has been designed for preventive maintenance of system insulation by monitoring its 'On-line' condition. It monitors and reads the insulation of all the cables and loads connected with power supply AC or DC (bus bar) in the form of leakage resistance.

It measures 'On line insulation' (Leakage Resistance) directly on meter. It can also measure actual value of the insulation resistance of the signalling circuit during un-energised (OFF Line) condition through a built-in Cable Insulation Tester (CIT).





**Channel Module**

**Main Module  
(Cable Insulation Tester)**

***Fig. 1: ELD equipment front view***

## **2. Design**

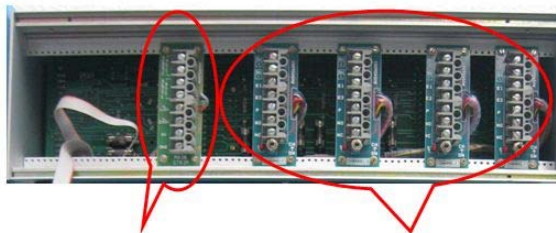
Basic unit comprises of two instruments in 19 inch sub rack:

- 4-Channel ELD for use on signaling circuits of 110V/60V/24V/12V in AC or DC –Online
- Cable Insulation Tester (CIT) - Off line

All channels of ELD and Cable Insulation Tester have a common Meter. If all the 4 channels are not in use then extra channels are covered with dummy plates.

For More than 4-channels, say 8, 12 or 16-channels, add-on units of 4-channels are attached to the Basic unit. Various controls and indications

are provided on the front plates of the 'Channel module' and 'Main module' (Cable Insulation Tester), the details of which are under 'Controls and Indications'.



**Main Strip**

**Channel Strip**

***Fig.2: ELD equipment rear view***

On opening the rear panel of ELD, two types of terminal strips are seen as shown above. The first is MAIN STRIP which is common for all channels. It has tappings for connecting 110 V or 230 V AC supply. The second terminal strip or the CHANNEL STRIP is separate for each channel. It has various connections which are shown in fig.

### 3. Insulation resistance

Insulation is the property of insulated material and can be measured in off line condition.

### 4. Leakage resistance

Leakage is also property of insulated material and can be measured on line condition.

On line System Insulation of Signaling system with respect to Earth

= Insulation of Power Supply + Insulation of Control circuits + Insulation of Cables+ Insulation of loads (all in parallel) = Leakage Resistance

For example if

Insulation of power supply( w.r.t Earth) = $R_p$

Insulation of one cable pair (w.r.t Earth) = $R_c$

Insulation of one load (any) (w.r.t Earth) = $R_s$

Then total insulation of (pair + load)

$$R_1 = 1/R_c + 1/R_s$$

If we have n such circuits in our system and when all such circuits are working on common power supply (called bus bar), they all are in parallel. and

equivalent parallel Insulation Resistance, will be given by the formula.

$$1/R=1/R_p+1/R_1+1/R_2+\dots+1/R_n.$$

Where R is equivalent parallel Insulation Resistance.

This value of Insulation Resistance in parallel is called as On line System Insulation or Leakage Resistance.

## 5. Principle of operation

Earth Leakage Detector measures on line insulation (Leakage Resistance) directly on meter.

Measurement Principle is based on superimposition of a DC measuring voltage.

ELD constantly monitors and measures Leakage Resistance of Bus Bar with respect to Earth in on-line condition.

Leakage Resistance can be read on meter.

When Leakage Resistance value drops below reference value, fault is detected; which is either announced as audio and/or visual alarm.

Fault can be recorded by counter / Data logger.

Reference value can be set anywhere between 1M to 2K (Factory setting on 2K).

## **6. Fault Indications**

Earth Leakage Detector has twin indicating arrangements:

- (i) Through direct display of leakage current on a D.C. analogue meter of Cable Insulation Tester, equivalent to the resistance in the meter circuit from infinity to nearly dead short (about  $500\Omega$  or zero) resistance. The meter is common for all channels and Cable Insulation Tester. For multi-channel equipment it can be selected through a Rotary Switch labeled SELECTOR.
- (ii) By way of lighting a RED LED on Channel Module front plate, labeled FAULT and initiation of an audible alarm which operates as per pre adjusted leakage limit. This arrangement is provided for alerting the maintenance staff to take suitable measures well in advance.

## 7. Controls and indications of Main Module



**Fig.3: Controls & indications of Main module**



**BLACK Scale**  
Reads leakage  
resistance

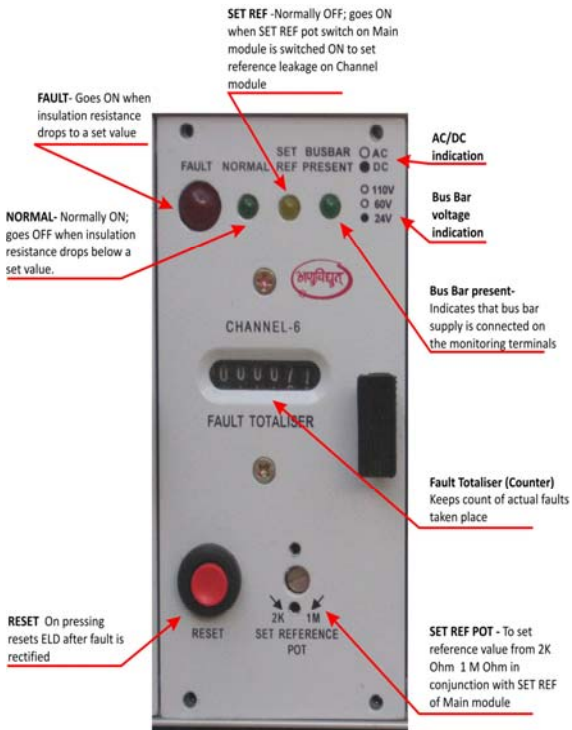
**RED Scale**  
Reads insulation  
resistance

**Fig 4: Meter for display of leakage and insulation resistance**

## Details of Indications

Label	Description	Function
A	MAINS (RED neon lamp)	Glows when the mains is connected to the instrument
B	SET REFERENCE	Normally OFF, Switched ON to set reference leakage at which ELD will announce fault of the selected channel (selected through SELECTOR switch)
C	CHANNEL SELECTOR	Selects (i) Any one channel from 1 to 4 (ii) Insulation resistance meter (iii) Next channel from additional unit if provided.
D	MUTE BUZZER	To stop the buzzer sound
E	TEST	To connect the cable pair under measurement
F	EARTH	To connect cable sheath or earth
G	METER	Reads bus bar to earth leakage or insulation resistance as per the position of switch
H	PAIR ENERGISED (GREEN LED)	ON when cable pair connected to circuit (Measurement not possible)
I	LOW INSULATION (RED LED)	ON when insulation resistance is lower than or equal to the set value, otherwise OFF.

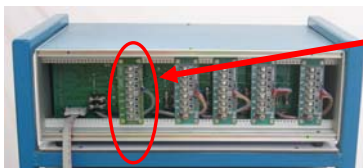
## 8. Controls and indications of Channel Module



**Fig.5: Controls & indications of Channel module**



## 9. Main terminal strip details (Rear side)



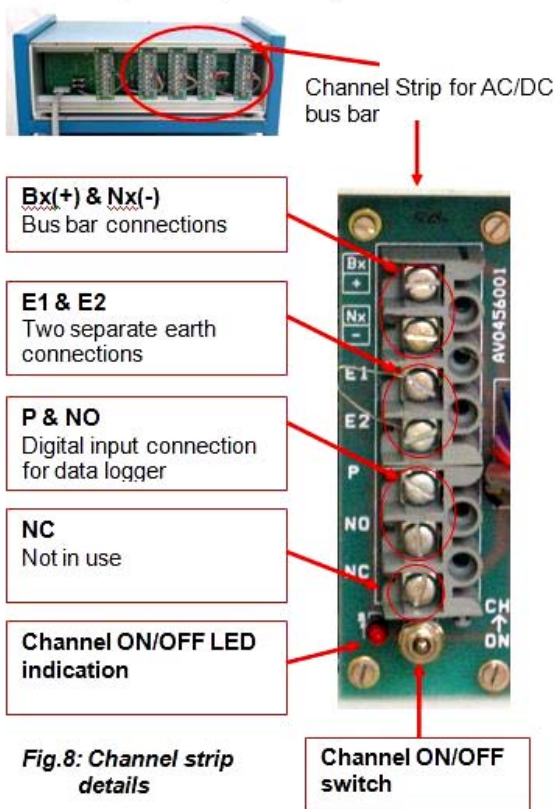
Parallel to mute switch of front panel. Simple bell type switch can be connected here to mute the buzzer from remote location

To connect the buzzer at a distance away from the installed equipment

Tappings for connecting 0-110 V or 0-230 V mains AC supply



## 10. Channel terminal strip details (Rear Side)



## 11. Installation

- Open the rear panel.
- Loop together all the terminals marked E1 on channel strips with a suitable wire.
- Loop together all terminals marked E2 of channel strips.
- Mount the ELD on the provided stand in the Relay Room near CT Rack.
- Connect AC/DC bus bar to Bx/+ and Nx/- terminals of relevant channel strip.
- Connect E1 & E2 to separate earths. In case of ring earth connect E1 & E2, with two separate wires. DO NOT SHORT CIRCUIT E1 & E2 on terminals side.
- Connect one conductor from instrument ground on main terminal strip to relay rack.
- Connect buzzer to REMOTE BUZZER terminals of Main terminal strip with extended buzzer wires.
- Connect a simple push switch (door bell type) to REMOTE MUTE terminals on extended wires.
- Connect P of each channel to the Data Logger digital common.
- Connect N O of each channel to the empty points at Tag Block. (In normal condition of

ELD P & N O remain short and in Fault condition P & N O remain open).

- Finally connect the instrument with available power of 230V AC or 110V AC to the terminals marked '230V~' and '110V~' on main terminal strip. '0' is marked for neutral.

## 12. Operating instructions

- After the instrument is given Power, switch ON the connected channels from the rear terminal strip.
- The buzzer will sound and red light will glow on each channel. Mute the buzzer from the mute switch.
- Check the Leakage resistance on the Meter panel, one by one for each channel after selecting through the Channel selector.
- In case the meter reading of a channel is  $> 2K$  (say for example 10K or 100K Ohms) push the reset switch of the respective channel (for about 3 secs). Channel will reset with Red light (Fault) getting off and Green light (Normal) appearing.

If leakage shown by meter is below 2K continuously then take action as follows:

### **12.1 For non-IPS type power supply**

- Check earth connections. The resistance between two Earths should be  $< 10$  Ohms.
- If this is an AC Channel it should be connected to the Bus-bar.
- The above two conditions also cause FAULT indication even if the Leakage conditions are alright.
- If it is observed that on the panel meter the reading comes down to less than 2K, improves for some time and again falls down to 2K after sometime.
- In such cases investigate during operation, for which particular circuit (bus-bar) the Leakage resistance reading becomes  $< 2K$ .

By ascertaining this we can locate low insulation pair/pairs with the help of Insulation Tester (part of ELD).

In case the reading remains continuously  $< 2K$  or 2K, investigate as follows –

- For AC Bus bar remove transformer Earth connection and check ELD meter reading for improvement in Leakage resistance.

- For DC BUS BAR remove charger's Earth connection and check ELD meter reading for improvement in Leakage resistance.
- If reading remains  $<2K$  then remove Battery Bank (Both connections) and check ELD meter reading for improvement in Leakage resistance.
- If meter reading remains  $<2K$ , (AC or DC bus bar) perform all the operations of the associated BUS BAR.
- During any operation if leakage reading becomes  $>2K$ , note that operation.
- Now with the help of insulation tester find out low insulation pair/pairs.

## **12.2 For IPS type power supply**

In case the bus-bar supplies are taken directly from the IPS and the leakage is below 2K continuously then change that module of the IPS and check leakage reading on ELD.

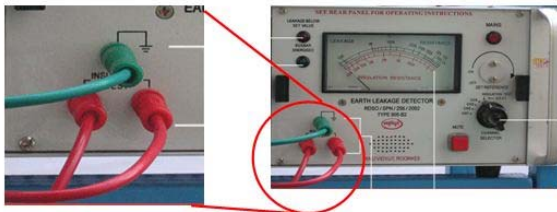
If it is not possible to change the module, check the current to the load (On IPS Amp meter) and compare it with similar load condition in another or same station. If there is a large difference

(about 2 times), then be sure that the leakage condition is caused by the IPS system. To ensure this, check all conductor pairs associated with this IPS module with the help of Insulation Tester.

### **13. Testing of insulation with Cable Insulation Tester**

- Connect earth lead (GREEN) on EARTH terminal.
- Connect measuring leads (RED) to TEST.
- Keep Channel Selector switch in INSULATION TEST position.
- Touch RED leads to GREEN lead, meter needle will move fully towards right side and Green LED (BUS BAR ENERGISED) glow momentarily and red LED (Leakage below set value) start glowing. It shows that instrument is working properly.
- Now connect earth lead probe (GREEN) to cable sheath or earth.
- Touch measuring lead probes (RED) to outgoing cable pair on CT rack whose insulation is to be tested.
- If the pair is energized, Green LED (PAIR ENERGISED) will start glowing and meter will not show any reading. Connect to another

pair, if Green LED does not glow and meter shows a reading (RED SCALE), then this is the insulation resistance of the pair.



**Fig.9: Connections for testing of insulation**

- By repeating this procedure we can find insulation of all pairs.
- In case any energized pair is to be measured, follow proper procedure for disconnection.
- Remove both links and measure the insulation.
- After detecting low insulation pair/pairs, Meggering\* of that pair can be done.

(\*For instructions on meggering refer pamphlet on “Testing & Meggering of Signalling Cable” prepared by CAMTECH)



**Some common fault indications of ELD for diagnostics**

<b>Indication</b>	<b>Fault</b>
Bus Bar LED on and meter showing actual reading FAULT & NORMAL LED off	The switch on the rear terminal strip in off position
FAULT & NORMAL both LED on	Channel faulty
Meter showing above 10M ohm Fault light and Buzzer ON, ELD not being reset	E1 & E2 are not properly connected or high resistance between them

**Annexure**

Pre-commissioning check list for  
EARTH LEAKAGE DETECTOR AS PER  
RDSO SPN/256/2002

Station.....

Division.....

Date of commissioning.....Serial No.....

ELD procured through Manufacturer...../  
Contractor...../Railway (COS)

ELD wired by : Manufacturer ...../  
Contractor...../Railway.....

Note: These are the technical guidelines only. The hardware, wiring material, earth etc. required to implement these guidelines shall be covered in the commercial agreement with the executing agency.

Sr. No.	Description	Requirement	Result
1.	Availability of space	½ m from side 1 m from back 1 m from front	
2.	ELD mounting stand size (Provided with equipment)	½ m X ½ m	
3.	Input power supply	220 V AC/110 V AC	

Sr. No.	Description	Requirement	Result
4.	Type of wire to be used for various connections	1.0 mm diameter indoor cable	
5.	No. of wires required		
	(i) Operating supply	2 wires	
	(ii) Bus bar connection for 4 Ch 8 Ch 12 Ch	8 wires 16 wires 24 wires	
	(iii) Measurement Earth (E1,E2)	2 wires	
	(iv) Data logger connection for 4 Ch 8 Ch 12 Ch	5 wires 9 wires 13 wires	
	(v) Remote buzzer optional for 4 Ch 8 Ch 12 Ch	2 wires 4 wires 6 wires	
	(vi) Remote buzzer optional for 4 Ch 8 Ch 12 Ch	2 wires 4 wires 6 wires	
6.	Provision of different earths (i) Supply 220 AC  (ii) measurement earths (E1,E2) long life type	1. Electric earth  2. Two separate earth one should	

Sr. No.	Description	Requirement	Result
		be cable/ armerd shieth and second should be another ub use earth, NO SEPARATE EARTH PIT REQUIRED FOR ELD. Or 2. Wires from ring earth (having more than 3 earths)	
6.1	Resistance between two earth	Less than 10 ohms.	
7.	Wiring board with fuses	Yes	
7.1	Wiring board fuse rating i) Bus bar ii) Measurement earth iii) Power supply	100 mA 200 mA 2 A	
8.	Insulation resistance of various items (as per RDSO requirements) i) Cables ii) Signals iii) Charges iv) Bus bar transformer v) IPS output vi) Insulation of battery bank in between earth and battery body only	More 10M ohms More 50M ohms More 50M ohms More 50M ohms More 50M ohms More 50M ohms	

Sr. No.	Description	Requirement	Result
9.	Measure earth to bus bar (DC detecting) voltage: After installation of ELD	Measured DC voltage should be: In AC channel	
	When leakage resistance is:		
	1M ohm to 10M ohms or above	About 100 V to 150 V	
	100K ohm to 1 M ohm	About 25 V to 100 V	
	2K ohm to 100K ohm	About 0.5 V to 25 V	
	When leakage resistance is:		
	1M ohm to 10M ohm or above		
	-ve Bus bar	About 100 V to 150 V	
	+ve Bus bar	About 100 V to 150 V $\pm$ bus bar voltage	
	When leakage resistance is:		
	100K ohm to 1M ohm or above		
	-ve Bus bar	About 25 V to 100 V	
	+ve Bus bar	About 25 V to 100 V $\pm$ bus bar voltage	

Sr. No.	Description	Requirement	Result
	When leakage resistance is:		
	2K ohm to 10K ohm		
	-ve Bus bar	About 0.5 V to 25 V	
	+ve Bus bar	About 0.5 V to 25 V $\pm$ bus bar voltage	
10.	Ensure before putting wiring fuses that AC bus bar connected to AC channel and DC bus bar connected to DC channel as per channel voltages	Yes	
11.	Ensure bus bar name sticker on ELD channel for identification	Yes	
12.	Ensure earth connection soldered on earth side for corrosion free connection.		

### **DISCLAIMER**

***The information given in this pocket book does not supersede any existing provisions laid down in S.E.M., Rly. Board and RDSO publications. This document is not statutory and instructions given in it are for the purpose of guidance only. If at any point contradiction is observed, then S.E.M., Rly. Board/RDSO guidelines or Zonal Rly. instructions may be followed.***