Report on Conductivity Measurement of Soil around Jaliardwip at Teknaf



BUREAU OF RESEARCH, TESTING & CONSULTATION DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING CHITTAGONG UNIVERSITY OF ENGINEERING & TECHNOLOGY CHATTOGRAM-4349, BANGLADESH



1.0. Introduction

Prof. Mahmood Omar Imam, Team Leader, Naf project, Consultancy Services for Construction of Cable Car in Naf Tourism Park, issued Work Order (Ref. No.: CUET/BRTC-Naf/21/21/89(1) Date: 22.03.2021) for **'Conductivity Measurement of Soil around Jaliardwip at Teknaf'** in 32 locations to BRTC, Department of EEE, CUET.

In response, BRTC, EEE, CUET carried out Conductivity Tests of Soil at **29 locations** around the Jaliardwip at Teknaf. The tests report is enclosed here.

Test Apparatus:

Instrument Name Earth Resistance & Resistivity Tester Model/Asset number KEW 4106 Serial Number E0107639

Environmental Conditions:

Weather Conditions		Soil Conditions	Soil Type
Sunny		Wet	Loam
Partly Overcast		Moist	Clay
Overcast		Dry	Sand
Raining		Very Dry/Arid	Stone/Granite
Temperature: (Oct"21)	34°C	Humidity: (Oct"21)	89%
Temperature: (Dec'21)	28°C	Humidity: (Dec'21)	55%

Test Points/Locations:

SL	Test Points	SL	Test Points	SL	Test Points
1	Station-A	11	Station-B, Additional Point	21	T-2B7C (Ex-3)
2	Station-A	12	Station-B	22	T-2B7C (Ex-4)
3	T-1B7A	13	2B	23	Station-A, Additional Point-1
4	T-1B6A	14	T-2B1C	24	Station-A, Additional Point-2
5	T-1B5A	25	T-2B2C	25	Station-A, Additional Point-3
6	T-1B4A	16	T-2B5C	26	Station-A, Additional Point-4
7	T-1B3A	17	T-2B6C	27	Station-A, Additional Point-5
8	T-1B2A	18	T-2B7C	28	Station-A, Additional 1 (Right side)
9	T-1B1A	19	T-2B7C (Ex-1)	29	Station-A, Additional -2 (Left side)
10	1B	20	T-2B7C (Ex-2)		

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Figure: Google Earth View of the site





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Figure: Some snapshots during testing

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1.1 Objectives of a grounding system

1.1.1 To Ensure Personal Safety to personnel during normal and fault conditions by limiting step and touch potential.

1.1.1.1 Grounding of Electrical Systems. Electrical systems that are required to be grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher voltage lines and that will stabilize the voltage to earth during normal operation.

1.1.1.2 Grounding of Electrical Equipment. Conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected to earth so as to limit the voltage to ground on these materials. Where the electrical system is required to be grounded, these materials shall be connected together. Where the electrical system is not solidly grounded, these materials shall be connected together in a manner that establishes an effective path for fault current.





Figure: Eart current flowing



1.1.2 Prevent damage to electrical/electronic apparatus.



1.2 Types of Grounding Systems



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Ground plate

Ground mesh

Figure: Schematic drawings of typical earthing systems

1.3 Soil Resistivity

Soil resistivity is another name for the specific resistance of the soil. It is measured in ohm-meters or ohmcentimeters. An ohm-meter is that resistivity of the soil when it has a resistance of 1 ohm between opposite faces of a cube with one meter sides.

Resistance is directly proportional to soil resistivity. This relationship is not as easy to compute in real life as it may sound, because soil resistivity will inevitably vary with depth. The second difficulty in dealing with different locations is that the resistivity varies greatly with sites. Factors that will affect the resistivity of the soil are the soil type, compactness, chemical composition, temperature and water content.

The tables below give an idea of the resistivity of several mediums that are of interest for the design of grounding system.

Material	Typical Resistivity
Copper	1.72 x 10-8 ohm.m
GEM, Material	0.12 ohm.m
Bentonite	2.5 ohm.m
Concrete	30 to 90 ohm.m

1.4 Grounding System Design & Planning

- ✓ Establish the need: Resistance-to-ground < 25 ohm/3 or 5 ohm/1 ohm
- ✓ Site analysis and collection of geological data
- \checkmark Soil resistivity testing.
- ✓ Data Analysis: sophisticated computer programs can begin to provide a soil model showing the soil resistivity in ohm-meters and at various layer depths.
- ✓ Grounding Design



1.5 Ground Testing Methods

1.4.1 Resistivity Measurement (Wenner method)

Resistivity measurements are performed by using a four-wire method. Used to determine which kind of earthing should be used shown in the following figure.



Figure: Ground resistivity measurement by using Wenner method.

Using the Wenner Array method, four small electrodes (auxiliary probes) are placed in a straight line at intervals of a and the depth of b. A current is passed through the outer two probes, and the potential voltage is then measured between the two inner probes. A simple Ohm's Law equation determines the resistance. From this information, it is now possible to calculate the resistivity of the local soil. For most practical circumstances, "a" is 20 times larger than "b", where we can then make the assumption that b=0.

Then the Resistivity, ρ , is determined by:

$$\rho = 2 \pi S R$$

where,

- ρ = Resistivity of the local soil (Ω -m)
- S = distance between probes (m)
- b =depth of probes into the ground (m)
- R = resistance value measured by the testing device (Ω)



1.4.2 Test Procedure:

The Wenner method, for soil resistivity testing shall be used. All four electrodes are moved for each test with the spacing between each adjacent pair remaining exactly the same. In each method the depth penetration of the electrodes is less than five percent of the separation to ensure that the approximation of point sources, required by the simplified formulae, remains valid.



Test No 1: Station A

Test Point:	1. Station A, Marine drive side				
	(X=421908.00 m, Y=2310316.00 m, Z = 3.605 m), Soil type: sandy clay (paddy				
	field)				
Date:	6-Oct-21				
** This soil wa	s tested aga	ain on 01-Dec-21 c	luring dry season to check the	results	
(please see the	result in T	est No.: 02)			
		1	Test Results:		
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m)	R (Ω)	
		• • •	Calculated (2*Pi*S*R)		
1	1	125.600	6.283	1.000	
2	2	24.000	16.035	1.276	
3	3	35.400	70.874	3.760	
4	4	31.000	27.571	1.097	
5	5	16.300	13.635	0.434	
6	7	19.800	18.561	0.422	
7	10	22.700	25.321	0.403	
8	15	13.400	13.477	0.143	
9	20	24.100	24.127	0.192	





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Test No 2: Station A

Test Point:	Station-A clay (pad	Station-A, Again (X=421908.00 m, Y=2310316.00 m, Z = 3.605 m), Soil type: sandy clay (paddy field)				
Date:	1-Dec-21	•				
		r	Test Results:			
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)		
1	1	50.700	50.705	8.070		
2	2	64.500	64.591	5.140		
3	3	79.900	79.922	4.240		
4	4	17.000	17.090	0.680		
5	5	15.300	15.394	0.490		
6	7	40.400	40.464	0.920		
7	10	26.600	26.641	0.424		
8	15	75.400	75.493	0.801		
9	20	81.800	81.807	0.651		





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Test No. 3:

Test Point:	3. T-1B7A (X=421911	3. T-1B7A (X=421911.00 m, Y=2310380.00 m, Z = 4.541 m), Soil type: Slit soil (Mixed soil)					
Date:	7-Oct-21	7-Oct-21					
	Test Results						
Sl.No	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)			
1	1	190.300	190.381	30.300			
2	2	173.700	173.793	13.830			
3	3	63.500	63.523	3.370			
4	4	50.200	50.266	2.000			
5	5	37.000	37.071	1.180			
6	7	26.800	26.829	0.610			
7	10	25.100	25.133	0.400			
8	15	32.980	3.299	0.035			
9	20	37.600	37.699	0.300			



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Test No. 4:

Test Point:	4. T-1B6A (X=421929.00 m, Y=2310748.00 m, Z = 7.236 m), Soil type: clay-sand mixture (down side of hill)			
Date:	7-Oct-21	l		
Test Results				
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)
1	1	14.800	14.828	2.360
2	2	15.700	15.708	1.250
3	3	25.600	25.635	1.360
4	4	26.100	26.138	1.040
5	5	23.200	23.248	0.740
6	7	14.500	14.514	0.330
7	10	12.500	12.566	0.200
8	15	9.400	9.425	0.100
9	20	12.500	12.566	0.100





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Test Point 5:

Test Point:	5. T-1B5A (X=421954.00 m, Y=2311310.00 m, Z = 21.673 m), Soil type: clay-sand mixture (down side of hill)			
Date:	8-Oct-2	1		
			Test Results	
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)
1	1	164.600	164.620	26.200
2	2	135.500	135.591	10.790
3	3	114.700	114.794	6.090
4	4	71.100	71.126	2.830
5	5	68.400	68.487	2.180
6	7	48.300	48.381	1.100
7	10	28.200	28.274	0.450
8	15	24.600	24.693	0.262
9	20	21.300	21.363	0.170





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Test No.: 06

Test Point:	6. T-1B4A (X=421969.00 m, Y=231608.00 m, Z = 85.930 m), Soil type: clay-sand mixture (down side of hill)					
Date:	7-Oct-2	7-Oct-21				
Test Results						
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)		
1	1	14.800	14.828	2.360		
2	2	15.700	15.708	1.250		
3	3	25.600	25.635	1.360		
4	4	26.100	26.138	1.040		
5	5	23.200	23.248	0.740		
6	7	14.500	16.713	0.380		
7	10	12.500	12.566	0.200		
8	15	9.400	9.425	0.100		
9	20	12.500	12.566	0.100		





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Spacing, S (m) vs. Earth Resistance, $R(\Omega)$ 2.500 2.000 1.500 1.000 0.500 0.000 0 2 4 6 8 10 12 14 16 18 20



Test No.: 07

Test Point:	7. T-1B3A (X=421978.00 m, Y=2311816.00 m, Z = 98.305 m), Soil type: clay- sand mixture (middle of hill)				
Date:	8-Oct-21	l			
]	Fest Results		
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)	
1	1	35.700	35.751	5.690	
2	2	21.200	21.137	1.682	
3	3	14.400	14.476	0.768	
4	4	12.400	12.416	0.494	
5	5	9.600	9.613	0.306	
6	7	11.300	11.391	0.259	
7	10	10.400	10.493	0.167	
8	15	13.400	13.477	0.143	
9	20	21.200	21.237	0.169	





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Test No. 8:

Test Point:	8. T-1B2A				
	(X=422005.00 m, Y=2312388.00 m, Z = 152.621 m), Soil type: sand-rock mixture (Hill)				
Date:	9-Oct-21	l			
			Test Results		
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)	
1	1	84.100	84.132	13.390	
2	2	43.700	43.731	3.480	
3	3	60.800	60.884	3.230	
4	4	62.500	62.581	2.490	
5	5	85.100	85.137	2.710	
6	7	77.400	77.409	1.760	
7	10	62.200	62.204	0.990	
8	15	55.600	55.606	0.590	
9	20	149.500	149.540	1.190	





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Test No. 9

Test Point:	9. T-1B1A				
	(X=422017.00 m, Y=2312644.00 m, Z = 204.777 m), Soil type: sand-rock mixture				
	(Hill top				
Date:	12-Oct-2	21			
			Test Results		
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m)	R (Ω)	
			Calculated (2*Pi*S*R)		
1	1	488.800	488.833	77.800	
2	2	546.600	546.638	43.500	
3	3	183.400	183.407	9.730	
4	4	239.200	239.264	9.520	
5	5	122.500	122.522	3.900	
6	7	21.900	21.991	0.500	
7	10	31.400	31.416	0.500	
8	15	44.200	44.297	0.470	
9	20	49.000	49.009	0.390	





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Test No 10.:

Test Point:	10.1B				
	(X=422017.00 m, Y=2312660.00 m, Z = 205.061 m), Soil type: sand-rock mixture (Hill top)				
Date:	12-Oct-21				
			Test Results		
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m)	R (Ω)	
			Calculated (2*Pi*S*R)		
1	1	291.500	291.540	46.400	
2	2	348.000	348.089	27.700	
3	3	91.900	91.986	4.880	
4	4	58.800	58.811	2.340	
5	5	38.000	38.013	1.210	
6	7	55.800	55.858	1.270	
7	10	32.600	32.673	0.520	
8	15	158.300	158.337	1.680	
9	20	138.200	138.230	1.100	



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Test No. 11

Test Point: Date: Test Results	11. Statior (X=422017 mixture (F 12-Oct-21	n-B Additional Poin 7.00 m, Y=2312655 Hill top)	nt 1 5.00 m, Z = 204.707 m), Soil type: clay-sa	nd-rock
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)
1	1	179.000	179.071	28.500
2	2	115.100	115.108	9.160
3	3	115.300	115.360	6.120
4	4	109.800	109.830	4.370
5	5	85.700	85.766	2.730
6	7	55.400	55.418	1.260
7	10	140.100	140.115	2.230
8	15	53.700	53.721	0.570
9	20	69.900	69.995	0.557





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Test No 12:

Test Point:	11. Station-B (X=422019.00 m, Y=2312680.00 m, Z = 203.325 m), Soil type: clay-sand-rock mixture (Hill top)			
Date:	12-Oct-21			
Test Results				
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)
1	1	141.300	141.372	22.500
2	2	84.400	84.446	6.720
3	3	45.000	45.051	2.390
4	4	34.000	34.005	1.353
5	5	24.800	24.881	0.792
6	7	38.700	38.705	0.880
7	10	35.700	35.751	0.569
8	15	39.700	39.773	0.422
9	20	56.400	56.423	0.449





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Test No. 13:

Test Point:	13. 2B (X=422039.00 m, Y=2312681.00 m, Z = 201.695 m), Soil type: clay-sand-rock mixture (Hill top)				
Date:	12-Oct-21				
Test Results					
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)	
1	1	243.700	243.788	38.800	
2	2	77.700	77.786	6.190	
3	3	52.500	52.590	2.790	
4	4	50.000	50.014	1.990	
5	5	69.700	69.744	2.220	
6	7	28.100	28.149	0.640	
7	10	28.200	28.274	0.450	
8	15	22.600	22.620	0.240	
9	20	40.200	40.212	0.320	





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Test No. 14:

Test Point:	14. T-2B1C (X=422068.00 m, Y=2312683.00 m, Z = 199.020 m), Soil type: clay-sand-rock mixture (Hill top)			
Date:	12-Oct-21			
Test Results				
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m)	R (Ω)
		-	Calculated (2*Pi*S*R)	
1	1	309.700	309.762	49.300
2	2	767.800	767.807	61.100
3	3	209.200	209.231	11.100
4	4	118.100	118.124	4.700
5	5	65.900	65.974	2.100
6	7	39.500	39.584	0.900
7	10	50.200	50.266	0.800
8	15	47.100	47.124	0.500
9	20	37.600	37.699	0.300



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Test No. 15:

Test Point:	15. T-2B2C (X=422221.00 m, Y=2312694.00 m, Z = 185.127 m), Soil type: sand-rock mixture (Hill top)				
Date:	10-Oct-21				
Test Results					
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)	
1	1	346.200	346.204	55.100	
2	2	181.300	181.333	14.430	
3	3	91.600	91.609	4.860	
4	4	75.900	75.901	3.020	
5	5	91.400	91.421	2.910	
6	7	87.900	87.965	2.000	
7	10	69.100	69.115	1.100	
8	15	273.300	273.319	2.900	
9	20	315.400	314.160	2.500	





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Test No. 16:

Test Point: Date: Test Results	16. T-2B (X=4234 mixture 14-Oct-2	5C 46.00 m, Y=2312 (Hill top) 21	2781.00 m, Z = 31.638 m), Soil type: 6	clay-sand-rock
SI No	$\mathbf{S}(\mathbf{m})$	$\alpha(0,\mathbf{m})$	at(0,m)	P (O)
51.190.	5 (III)	p (32-111)	Calculated (2*Pi*S*R)	K (22)
1	1	61.900	61.952	9.860
2	2	163.200	163.238	12.990
3	3	36.400	36.417	1.932
4	4	40.800	40.816	1.624
5	5	31.900	31.981	1.018
6	7	35.900	35.934	0.817
7	10	41.400	41.406	0.659
8	15	32.300	32.327	0.343
9	20	21.900	21.991	0.175





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Test No. 17:

Test Point:	17. T-2B6C (X=423859.00 m, Y=2312809.00 m, Z = 22.783 m), Soil type: clay-sand mixture (Hill top)			
Date:	14-Oct-2	21		
Test Results				
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)
1	1	579.900	579.939	92.300
2	2	239.500	1597.189	127.100
3	3	942.400	942.480	50.000
4	4	318.400	318.433	12.670
5	5	604.100	604.130	19.230
6	7	497.800	497.881	11.320
7	10	397.000	397.098	6.320
8	15	289.300	289.341	3.070
9	20	462.400	462.444	3.680





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Test No. 18:

Test Point: Date:	18. T-2B7C (X=424357.00 m, Y=2312844.00 m, Z = -1.578 m), Soil type: clay-sand-water mixture (coastal area) 2-Dec-21				
Test Results					
SI.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)	
1	1	2.900	2.909	0.463	
2	2	2.400	2.488	0.198	
3	3	2.300	2.394	0.127	
4	4	2.300	2.312	0.092	
5	5	2.200	2.231	0.071	
6	7	2.100	2.243	0.051	
7	10	2.700	2.765	0.044	
8	15	0.000	0.000	0.000	
9	20	0.000	0.000	0.000	



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Spacing, S (m) vs. Earth Resistance, $R(\Omega)$ 0.500 0.450 0.400 0.350 0.300 0.250 0.200 0.150 0.100 0.050 0.000 0 2 4 6 8 10 12 14 16 18 20



Test No. 19:

Test Point:	19. T-2B7C (Additional Point)				
	(X=4243	65.00 m, Y=23128	348.00 m, Z = 1.043 m), Soil type: Sand	ly (coastal area)	
Date:	2-Dec-21				
Test Results					
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m)	R (Ω)	
	~ ~ ~		Calculated (2*Pi*S*R)		
1	1	2.500	2.582	0.411	
2	2	1.800	1.835	0.146	
3	3	2.400	2.413	0.128	
4	4	2.400	2.413	0.096	
5	5	2.300	2.388	0.076	
6	7	2.200	2.243	0.051	
7	10	2.300	2.325	0.037	
8	15	0.000	0.000	0.000	
9	20	0.000	0.000	0.000	



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Test No. 20:

Test Point:	20. T-2B7C (Additional Point) (X=424365.00 m, Y=2312848.00 m, Z = 1.043 m), Soil type: Sandy (coastal area)				
Date:	2-Dec-21				
Test Results					
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)	
1	1	11.600	11.655	1.855	
2	2	5.700	5.755	0.458	
3	3	4.800	4.863	0.258	
4	4	3.600	3.619	0.144	
5	5	3.100	3.173	0.101	
6	7	2.800	2.859	0.065	
7	10	2.800	2.890	0.046	
8	15	0.000	0.000	0.000	
9	20	5.500	5.529	0.044	



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Test No. 21:

Test Point:	21. T-2B7C (Additional 3) (X=424367.00 m, Y=2312835.00 m, Z = 1.032 m), Soil type: Sandy (coastal area)					
Date:	2-Dec-21	2-Dec-21				
Test Results						
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)		
1	1	10.000	10.047	1.599		
2	2	6.500	6.547	0.521		
3	3	5.100	5.146	0.273		
4	4	3.700	3.770	0.150		
5	5	2.500	2.545	0.081		
6	7	2.800	2.859	0.065		
7	10	3.000	3.079	0.049		
8	15	3.400	3.487	0.037		
9	20	0.000	0.000	0.000		





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Test No 22:

Test Point:	22. T-2B7C (Additional 4) (X=424369.00 m, Y=2312824.00 m, Z = 1.124 m), Soil type: Sandy (coastal area)				
Date:	2-Dec-21				
Test Results	.1				
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)	
1	1	3.700	3.707	0.590	
2	2	2.200	2.262	0.180	
3	3	2.000	2.073	0.110	
4	4	2.200	2.262	0.090	
5	5	3.700	3.770	0.120	
6	7	5.200	5.278	0.120	
7	10	3.700	3.770	0.060	
8	15	10.900	10.933	0.116	
9	20	0.000	0.000	0.000	





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Test No. 23:

Test Point:	23. Stat	23. Station-A, Point-1 (Z = 3.605 m), Soil type: sandy clay (paddy field)				
Date:	1-Dec-2	1-Dec-21				
Test Results						
Sl.No.	S (m)	ρ (Ω-m)	$\rho t (\Omega-m)$	R (Ω)		
1	1	4.600	4.650	0.740		
2	2	6.900	6.912	0.550		
3	3	9.000	9.048	0.480		
4	4	10.800	10.807	0.430		
5	5	11.900	11.938	0.380		
6	7	14.000	14.074	0.320		
7	10	17.200	14.703	0.234		
8	15	16.900	16.965	0.180		
9	20	16.200	16.211	0.129		





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Test No. 24:

Test Point:	24. Stat	24. Station-A, Point-2 (Z = 3.605 m), Soil type: sandy clay (paddy field)				
Date:	1-Dec-2	1-Dec-21				
Test Results	I					
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m)	R (Ω)		
			Calculated (2*Pi*S*R)			
1	1	3.600	3.644	0.580		
2	2	2.700	2.790	0.222		
3	3	2.500	2.507	0.133		
4	4	2.300	2.337	0.093		
5	5	2.200	2.231	0.071		
6	7	2.300	2.331	0.053		
7	10	3.000	3.016	0.048		
8	15	0.000	0.000	0.000		
9	20	0.000	0.000	0.000		





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Test No. 25:

Test Point:	25. Statiion-A, Point-3 (Z = 3.605 m), Soil type: sandy clay (paddy field)						
Date:	1-Dec-21						
	Test Results						
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)			
1	1	88.700	88.782	14.130			
2	2	44.100	44.108	3.510			
3	3	23.000	23.053	1.223			
4	4	11.000	11.033	0.439			
5	5	14.700	14.766	0.470			
6	7	9.300	9.324	0.212			
7	10	20.100	20.106	0.320			
8	15	43.700	43.731	0.464			
9	20	75.300	75.398	0.600			





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Test No. 26:

Test Point:	26. Statiion-A, Point-4 (Z = 3.605 m), Soil type: sandy clay (paddy field)						
Date:	1-Dec-21						
	Test Results						
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)			
1	1	83.700	83.755	13.330			
2	2	49.600	49.637	3.950			
3	3	49.700	49.763	2.640			
4	4	52.600	52.678	2.096			
5	5	46.000	46.056	1.466			
6	7	46.800	46.885	1.066			
7	10	32.200	32.296	0.514			
8	15	32.500	32.516	0.345			
9	20	52.200	52.276	0.416			





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Test No. 27:

Test Point:	27. Statiion-A, Point-5 (Z = 3.605 m), Soil type: sandy clay (paddy field)					
Date:	1-Dec-21					
Test Results						
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)		
1	1	50.300	50.391	8.020		
2	2	42.200	42.223	3.360		
3	3	31.100	31.158	1.653		
4	4	26.500	26.591	1.058		
5	5	32.900	32.987	1.050		
6	7	18.200	18.253	0.415		
7	10	19.900	19.981	0.318		
8	15	15.000	15.080	0.160		
9	20	17.700	17.719	0.141		





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Test No. 28:

Test Point:	28. Station-A, Additional Pont-1(Right side) (Z = 3.605 m), Soil type: sandy clay (paddy field)					
Date:	1-Dec-21					
Test Results						
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)		
1	1	191.600	191.638	30.500		
2	2	86.400	86.457	6.880		
3	3	56.700	56.737	3.010		
4	4	31.200	31.290	1.245		
5	5	19.800	19.823	0.631		
6	7	19.300	19.396	0.441		
7	10	30.000	30.034	0.478		
8	15	53.200	53.250	0.565		
9	20	64.500	64.591	0.514		





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Test No. 29:

Test Point:	29. Stati (paddy f	29. Station-A (Additional Point -7, Left side) (Z = 3.605 m), Soil type: sandy clay (paddy field)					
Date:	1-Dec-21	1-Dec-21					
Test Results							
Sl.No.	S (m)	ρ (Ω-m)	ρt (Ω-m) Calculated (2*Pi*S*R)	R (Ω)			
1	1	27.900	27.960	4.450			
2	2	23.200	23.248	1.850			
3	3	14.300	14.326	0.760			
4	4	11.000	11.058	0.440			
5	5	13.500	13.509	0.430			
6	7	12.700	12.711	0.289			
7	10	23.800	23.813	0.379			
8	15	43.400	43.448	0.461			
9	20	119.200	119.255	0.949			





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2. Recommendations:

Earth electrodes and their installation: The earth electrode shall, as far as practicable, penetrate into moist soil (which will remain moist even during the dry season) preferably below ground water table. The resistance of an earthing system after measured after the installation of earth electrodes (individually or combined as a single group) **shall be around one ohm**.

The types of earth electrodes are to be used for earthing of electrical installations of a building and their sizes shall be as under:

(a) Copper rod earth electrode: shall have a minimum diameter of 12.5 mm of minimum length of 3.33 m. Multiple copper rod earth electrodes may have to be installed to achieve an acceptable value of earthing resistance of around 1 ohm.

(b) Copper plate earth electrodes: shall be 600 mm x 600 mm x 6 mm minimum in size. The copper plate shall be buried at least 2 m below the ground level. Multiple Copper plate earth electrodes may have to be installed to achieve an acceptable value of earthing resistance of around 1 ohm.

(c) Galvanized Iron (GI) pipes: GI pipe earthing shall have a minimum diameter of 38 mm and of minimum length of 6.5m. Multiple GI pipes Earth Electrode may have to be installed to achieve an acceptable value of earthing resistance of around 1 ohm.



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Picture Evidence of the Testing Work

1. T-1B7A								
	Geo Location							
100			Earth Re	sistivity	Testing		a 1 a 4	
Tes	Spacing (a)	Direct Earth Resistivity p1	ion-1 Earth Resistance (Rg) in Ω1	Dire Earth Resistivity p2	ction-2 Earth Resistance (Rg) in Ω2	Date : 06- Average Earth Resistivity ρ (Ω-m)	CU + 24 Average Earth Resistance Rg (Ω)	
1	251	125.60	1.00					
2	オン	24.00	1.270					
3	4/33	35.40	3.760	110				
4	\$4	31.00	1.097					
5	0/5	16.30	0.4'59					
6	ther	19.80	0.922					
7	1000	12. 70	0,403		+			
9	202	24.10	0.192					
10	00	21.10	0.15/2		L			
				1				
Reading-2 (2 Meter)			Readir	ng-8 (1	5 Meter)		Reading-9 (20 Meter)
PRESS TO TEST 2000 Q 200 Q 200 Q 200 F 2000 Q 200 C 200 Q 200 C 200 C 20		ROOM P- R9- L- L- L- EXTER PRESS	S001 (13.4 cm F 0.143 cm F 15.0m (14.14) 15.0m (14.14) 15.	10/06 17 th= 459 15= 89 2-0/AU Fat 20k 2000 9		4 TESTER 4 WIRES W 4106		Image: State of the s



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2. Station –A (Again)						
	Geo Location					
Condition						
Reading-1 (1 Meter)	Reading-2 (2 Meter)	Reading-3 (3 Meter)				
X885/387 S040 12/01 15:42 P= 50.7 Ωm Rh=7.65 kΩ R9= 8.07 Ω Rs=5.62 kΩ L= 1.0m P-w/RUTO	NRRD/387 S040 12/01 15:42 ρ= 64.5 Ωm Rh=8.34 kΩ Rg= 5.14 Ω Rs=6.88 kΩ L= 2.0m ρ-w/AUTO	X827/387 S040 12/01 15:37 ρ= 79.9 Ωm Rh=6.36 kΩ Rg= 4.24 Ω Rs=3.87 kΩ L= 3.0m ρ-w/AUTO				
Reading-4 (4 Meter)	Reading-5 (5 Meter)	Reading-6 (7 Meter)				
N822/387 S040 12/01 15:39 ρ= 17.0 Ωm Rh=3.84 kΩ R9= 0.68 Ω Rs=2.37 kΩ L= 4.0m	13325/387 S040 12/01 15:34 ρ= 15.3 Ωm Rh=2.00 kΩ R9= 0.49 Ω Rs=1.56 kΩ L= 5.0m	1322//387 S040 12/01 15:32 P= 40.4 Ωm Rh=3.60 kΩ R9= 0.92 Ω Rs=1.20 kΩ L= 7.0m P-w/AUTO				
Reading-7 (10 Meter)	Reading-8 (15 Meter)	Reading-9 (20 Meter)				
NB28/387 S040 12/01 15:28 P= 26.6 Ωm Rh=1.89 kΩ P= 0.424 Ω Rs=1.39 kΩ L= 10.0m P-w/AUTO	N322/387 S040 12/01 15:27 ρ= 75.4 Ωm Rh=3.74 kΩ R9=0.801 Ω Rs=1.31 kΩ L= 15.0m	321/387 S040 12/01 15:24 β= 81.8 Ωm Rh=3.40 kΩ Rg=0.651 Ω Rs=1.16 kΩ L= 20.0m ρ-w/AUTO				



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5. T-1B5A Geo Location 0 ¢ Reading-1 (1 Meter) Reading-2 (2 Meter) Reading-3 (3 Meter) 1042/387 S004 10/08 09:2 045/387 S004 10/08 09:1 2=164.6 ΩmRh=5.61 kΩ 2=135.5 ΩmRh=5.76 ks ρ=114.7 ΩmRh=5.27 kΩ Rg=10.79 ΩRs=4.68 kΩ R9= 26.2 Ω Rs=5.46 kΩ R9= 6.09 ΩR5=4.20 kΩ $L= 2.0 m \rho - w/AUTO$ L= 1.0m P-w/AUTO L= 3.0m P-w/AUTO T-135A T-1135A T-1135A Reading-4 (4 Meter) Reading-5 (5 Meter) Reading-6 (7 Meter) 049/387 \$004 10/08 09:4 0277/387 \$004 10/08 09:4 046/387 \$004 10/08 09:4 2= 48.3 ΩmRh=1.91 kΩ 68.4 ΩmRh=3.10 kΩ ρ= 71.1 ΩmRh=4.47 kΩ R9= 1.1 Ω R5=2.33 kΩ R9= 2.18 ΩRs=4.13 kΩ R9= 2.83 ΩRs=4.55 kΩ 7.0m P-w/AUTO L= 4.0m P-W/AUTO T-135 T-1354 T-135A Reading-7 (10 Meter) Reading-8 (15 Meter) Reading-9 (20 Meter) 052/387 S004 10/08 10:00 050/387 \$004 10/08 09: 0**55**1/387 S004 10/08 09:5 24.6 ΩmRh= 399 21.3 Ωm Rh= 623 28.2 ΩmRh= 904 R9=0.262 ΩRs=1.29 kΩ R9=0.170 ΩRs=1.73 kΩ R9= 0.45 ΩRs=2.42 kg L= 20.0m P-w/AUTO T-1354 T-135 T-135



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6. T-1B4A		
Geo Location		
○ 日本		
Reading-1 (1 Meter)	Reading-2 (2 Meter)	Reading-3 (3 Meter)
NOEE/387 S003 10/07 15:24 ρ= 14.8 Ωm Rh=1.99 kΩ R9= 2.36 Ω Rs=1.96 kΩ L= 1.0m ρ-w/AUTO	N034/387 \$003 10/07 15:27 ρ= 15.7 Ωm Rh=2.52 kΩ Rg= 1.25 Ω Rs=3.13 kΩ L= 2.0m ρ-w/AUTO	SOBS/387 S003 10/07 15:31 ρ= 25.6 Ωm Rh=2.19 kΩ R9= 1.36 Ω Rs=1.05 kΩ L= 3.0m
Reading-4 (4 Meter)	Reading-5 (5 Meter)	Reading-6 (7 Meter)
10866/387 S003 10/07 15:32 ρ= 26.1 Ωm Rh=2.25 kΩ Rg= 1.04 Ω Rs= 806 Ω L= 4.0m ρ-w/AUTO	NORM/387 S003 10/07 15:34 ρ= 23.2 cm Rh=1.39 kc R9= 0.74 c Rs= 687 c L= 5.0m ρ-w/AUTO	NOBE /387 S003 10/07 15:35 ρ = 14.5 Ωm Rh = 606 Ω Rg = 0.33 Ω Rs = 850 Ω L = 7.0m ρ - w/RUTO
Reading-7 (10 Meter)	Reading-8 (15 Meter)	Reading-9 (20 Meter)
NOE9/387 S003 10/07 15:38 P= 12.5 Ωm Rh= 339 Ω Rg= 0.2 Ω Rs= 322 Ω L= 10.0m	S0240/387 S003 10/07 15:40 ρ= 9.4 Ωm Rh= 526 Ω Rg= 0.1 Ω Rs= 256 Ω L= 15.0m	N041/387 S003 10/07 15:42 P= 12.5 Ωm Rh= 373 Ω Rg= 0.1 Ω Rs= 279 Ω L= 20.0m



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11. Station-B Extra			
	Geo Location		
Reading-1 (1 Meter)	Reading-2 (2 Meter)	Reading-3 (3 Meter)	
B122/387 S008 10/12 14:40 P=179.0 \(\overline{m}\) Rh=4.98 \(\overline{m}\) Rg= R9= 28.5 \(\overline{m}\) Rs=3.56 \(\overline{m}\) Rg= L= 1.0m P-w/AUTO Station-B Extra Reading-4 (4 Meter)	STE20/387 \$008 10/12 14:38 ρ=115.1 Ωm Rh=5.73 kΩ R9= 9.16 Ω Rs=2.19 kΩ L= 2.0m ρ-w/AUTO Station-B Extra Reading-5 (5 Meter)	M110/387 S008 10/12 14:38 ρ=115.3 Ωm Rh=4.78 kΩ Rg= 6.12 Ω Rs=1.61 kΩ L= 3.0m ρ-w/AUTO Station-β Extra Reading-6 (7 Meter)	
P=109.8 Ωm Rh=4.50 kΩ P=4.37 Ω Rs=1.93 kΩ L=4.0m P=4.37	NT117/387 S008 10/12 14:37 ρ= 85.7 Ωm Rh=4.29 kΩ R9= 2.73 Ω Rs=1.75 kΩ L= 5.0m ν/AUTO	M110/387 S008 10/12 14:35 P= 55.4 Ωm Rh=2.55 kΩ R9= 1.26 Ω Rs=2.00 kΩ L= 7.0m P-w/AUTO	
Reading-7 (10 Meter)	Reading-8 (15 Meter)	Reading-9 (20 Meter)	
F15/387 S008 10/12 14:31 ρ=140.1 Ωm Rh=4.40 kΩ Rg= 2.23 Ω Rs=4.11 kΩ L= 10.0m ρ-w/AUTO	TFEQ/387 S008 10/12 14:30 P= 53.7 Ωm Rh=3.97 kΩ R9= 0.57 Ω Rs=1.98 kΩ L= 15.0m P= 0.57 Ω Rs=1.98 kΩ L= 15.0m P= 0.57 Ω Rs=1.98 kΩ	MEE/387 S008 10/12 14:25 ρ= 69.9 Ωm Rh=3.72 kΩ Rg=0.557 Ω Rs=2.19 kΩ L= 20.0m ρ-w/AUTO	



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132B		
Geo Location		
Reading-1 (1 Meter)	Reading-2 (2 Meter)	Reading-3 (3 Meter)
M120/387 S011 10/12 16:00 P=243.7 Ωm Rh=2.63 kΩ Rg= 38.8 Ω Rs=4.58 kΩ L= 1.0m P-w/AUTO	MB2/387 S011 10/12 15:59 ρ= 77.7 Ωm Rh=2.58 kΩ R9= 6.19 Ω Rs=4.36 kΩ L= 2.0m ρ-w/AUTO	MBS/387 S011 10/12 15:59 ρ= 52.5 ΩmRh=3.00 kΩ Rg= 2.79 ΩRs=3.42 kΩ L= 3.0m ρ-w/AUTO
Reading-4 (4 Meter)	Reading-5 (5 Meter)	Reading-6 (7 Meter)
\$1137/387 \$011 10/12 15:58 \$\rho\$= 50.0 \$\overline{mathcases}\$ ms=2.62 k\$\overline{mathcases}\$ \$P\$= 50.0 \$\overline{mathcases}\$ ms=3.28 k\$\overline{mathcases}\$ \$P\$= 1.99 \$\overline{mathcases}\$ ms=3.28 k\$\overline{mathcases}\$ \$L\$= 4.0m \$\rho\$-w/AUT0\$	N1836/387 S011 10/12 15:57 P= 69.7 Ωm Rh=2.20 kΩ Rg= 2.22 Ω Rs=3.36 kΩ L= 5.0m P-w/AUTO	STREE/387 S011 10/12 15:56 P= 28.1 Ωm Rh=2.43 kΩ R9= 0.64 Ω Rs=3.29 kΩ L= 7.0m P-w/AUTO
Reading-7 (10 Meter)	Reading-8 (15 Meter)	Reading-9 (20 Meter)
N132/387 S011 10/12 15:54 P= 28.2 ∞m Rh=2.88 k∞ Rg= 0.45 ∞ Rs=3.37 k∞ L= 10.0m P-w/AUTO	STREE/387 S011 10/12 15:51 ρ= 22.6 Ωm Rh=1.55 kΩ Rg= 0.24 Ω Rs=3.78 kΩ L= 15.0m ρ-w/AUTO	N1892/387 S011 10/12 15:49 ρ= 40.2 Ωm Rh=1.28 kΩ R9= 0.32 Ω Rs=3.05 kΩ L= 20.0m ρ= 0.32 Ω Rs=3.05 kΩ



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16. T-2B5C		
	Geo Location	
teo An Ci Bio andrinara andrina		
Reading-1 (1 Meter)	Reading-2 (2 Meter)	Reading-3 (3 Meter)
$F=61.9 \ \Omega m Rh=1.71 \ k_{\Omega} Rg= 9.86 \ \Omega Rs=1.59 \ k_{\Omega} I= 1.0m \ \rho-w/AUTO$ T=2850 Reading-4 (4 Meter) T=2850 T=2800 T=2850 T=28000 T=28000 T=28000 T=28000 T=28000 T=28000000 T=28000000000000	T150/387 S017 10/14 11:48 P=163.2 Ωm Rh=1.84 kΩ Rg=12.99 Ω Rs=1.62 kΩ L= 2.0m P-w/AUTO T=2550 Reading-5 (5 Meter) T158/387 S017 10/14 11:41 P= 31.9 Ωm Rh= 799 Ω Rg=1.018 Ω Rs=1.62 kΩ L= 5.0m P-w/AUTO	T155/387 S017 10/14 11:45 P= 36.4 Ωm Rh=1.85 kΩ R9=1.932 Ω Rs=1.03 kΩ L= 3.0m P-w/AUTO T=2850 Reading-6 (7 Meter)
T-2650	T-2850	Deading 0 (20 Mater)
Reading-7 (10 Meter)	Reading-8 (15 Meter)	Reading-9 (20 Meter)
\$1152/387 \$017 10/14 11:37 ρ= 41.4 Ωm Rh= 647 Ω R9=0.659 Ω Rs= 678 Ω L= 10.0m ρ-w/AUTO	M151/387 S017 10/14 11:35 ρ= 32.3 ΩmRh= 689 Ω R9=0.343 ΩRs= 582 Ω L= 15.0m μ= 15.0m ρ=0.343	N150/387 S017 10/14 11:34 P= 21.9 ΩmRh= 694 Ω R9=0.175 Ω Rs= 657 Ω L= 20.0m P= w/AUTO



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20. T-2B7C (Additional Point -2)		
	Geo Location	
COOLECCAROM		
Reading-1 (1 Meter)	Reading-2 (2 Meter)	Reading-3 (3 Meter)
11.6 Ωm Rh= 104 Ω P= 11.6 Ωm Rh= 104 Ω R9=1.855 Ω Rs= 30 Ω L= 1.0m P-w/AUTO	N367/387 S041 12/02 10:18 ρ= 5.7 Ωm Rh= 50 Ω Rg=0.458 Ω Rs= 48 Ω L= 2.0m ρ-w/AUTO	N866 /387 S041 12/02 10:18 P= 4.8 Ωm Rh= 35 Ω Rg=0.258 Ω Rs= 33 Ω L= 3.0m P-w/AUTO ►
Reading-4 (4 Meter)	Reading-5 (5 Meter)	Reading-6 (7 Meter)
NS05/387 S041 12/02 10:17 ρ= 3.6 Ωm Rh= 47 Ω Rg=0.144 Ω Rs= 49 Ω L= 4.0m ρ-w/AUTO	$\begin{array}{c} (x-x_3) \ \partial_x g_{2-L} \\ \hline \hline \\ \hline $	$\frac{(2-X_3)}{X_3} 3 X_3 X_3 X_3 X_3 X_3 X_3 X_3 X_3 X_3 X$
Reading-7 (10 Meter)	Reading-8 (15 Meter)	Reading-9 (20 Meter)
1308/387 S041 12/02 10:16 ρ= 2.8 Ωm Rh= 62 Ω R9=0.065 Ω Rs= 49 Ω L= 7.0m ρ-w/AUTO	N361/387 S041 12/02 10:14 P= 0.0 Ωm Rh= 39 Ω R9=0.000 Ω Rs= 50 Ω < L= 15.0m P-w/AUTO	18:00/387 \$041 12/02 10:09 P= 5.5 Ωm Rh= 129 Ω R9=0.044 Ω Rs= 88 Ω L= 20.0m P-w/AUTO



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24. Station–A, Additional Point-2		
Geo Location		
Reading-1 (1 Meter)	Reading-2 (2 Meter)	Reading-3 (3 Meter)
№239/387 S032 12/01 13:23 P= 3.6 ΩmRh= 25 Ω Rg=0.583 ΩRs= 19 Ω L= 1.0m P-w/AUTO Station -A (Ex.Point-2)	1233/387 S032 12/01 13:22 ρ= 2.7 Ωm Rh= 25 Ω Rg=0.222 Ω Rs= 20 Ω L= 2.0m ρ-w/AUTO	1287/387 S032 12/01 13:22 ρ= 2.5 Ωm Rh= 22 Ω Rg=0.133 Ω Rs= 18 Ω L= 3.0m
Reading-4 (4 Meter)	Reading-5 (5 Meter)	Reading-6 (7 Meter)
T2330/387 S032 12/01 13:22 ρ= 2.3 Ωm Rh= 27 Ω Rg=0.093 Ω Rs= 18 Ω L= 4.0m ρ-w/AUTO	12235/387 S032 12/01 13:21 ρ= 2.2 Ωm Rh= 24 Ω R9=0.071 Ω Rs= 17 Ω L= 5.0m ρ-w/AUTO	N2821/387 S032 12/01 13:20 P= 2.3 Ωm Rh= 25 Ω Rg=0.053 Ω Rs= 15 Ω L= 7.0m P-w/AUTO
Reading-7 (10 Meter)	Reading-8 (15 Meter)	Reading-9 (20 Meter)
N2228/387 \$032 12/01 13:14 ρ= 3.0 Ωm Rh= 31 Ω Rg=0.048 Ω Rs= 15 Ω L= 10.0m ρ-w/AUTO	N232/387 S032 12/01 13:06 Re=0.000 Ω Fst= 0.0Hz Rh= 0 Ω Ust= 0.0U Rs= 0 Ω 4-w/AUTO	1/281/387 S032 12/01 13:05 ρ= 0.0 Ωm Rh= 0 R9=0.000 Ω Rs= 0 L= 1.0m ρ-w/AUTO



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25. Station – A, Additional Point-3		
	Geo Location	
COC LOCATION		
Reading-1 (1 Meter)	Reading-2 (2 Meter)	Reading-3 (3 Meter)
1310/387 S032 12/01 14:15 P= 88.7 Ωm Rh= 605 Ω R9=14.13 Ω R5= 426 Ω L= 1.0m P-w/AUTO Reading-4 (4 Meter)	1809/387 S032 12/01 14:15 P= 44.1 Ωm Rh= 910 Ω R9= 3.51 Ω Rs= 415 Ω L= 2.0m P-w/AUTO Reading-5 (5 Meter)	Rg=1.223 Ω Rs= 560 Ω Control 14:14 L= 3.0 Ω ρ-ω/Αυτο
1 1	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	1 1 </td
Reading-7 (10 Meter)	Reading-8 (15 Meter)	Reading-9 (20 Meter)
1304/387 S032 12/01 14:09 ρ= 20.1 Ωm Rh= 914 Ω Rg=0.320 Ω Rs= 679 Ω L= 10.0m	18108/387 S032 12/01 14:07 ρ= 43.7 Ωm Rh=1.22 kΩ R9=0.464 Ω Rs= 441 Ω L= 15.0m ρ-w/AUTO	1 1 </td



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28. Station–A, Additional Point -1(Right side)		
	Geo Location	
Reading-1 (1 Meter)	Reading-2 (2 Meter)	Reading-3 (3 Meter)
NBT9/387 S033 12/01 15:01 ρ=191.6 Ωm Rh=1.32 kΩ R9= 30.5 Ω Rs=1.08 kΩ L= 1.0m ρ-w/AUTO	1318/387 \$033 12/01 15:01 ρ= 86.4 Ωm Rh=2.72 kΩ R9= 6.88 Ω Rs=1.49 kΩ L= 2.0m ρ-w/AUTO	NBT7/387 S033 12/01 15:00 ρ= 56.7 Ωm Rh=2.05 kΩ R9= 3.01 Ω Rs=1.26 kΩ L= 3.0m ρ-w/AUTO
Reading-4 (4 Meter)	Reading-5 (5 Meter)	Reading-6 (7 Meter)
SBIG/387 S033 12/01 14:59 P= 31.2 Ωm Rh=2.62 kΩ P=1.245 Ω Rs=1.71 kΩ L= 4.0m	31-24 Y-100000 X8115//387 S033 12/01 14:59 ρ= 19.8 Ωm Rh=1.89 kΩ R9=0.631 Ω Rs=1.75 kΩ L= 5.0m ρ-w/AUTO	1917 1917 1918 Ω R9=0.441 Ω R9=0.441 Ω N P 1000 N
Reading-7 (10 Meter)	Reading-8 (15 Meter)	Reading-9 (20 Meter)
N313/387 S033 12/01 14:57 ρ= 30.0 Ωm Rh=2.28 kΩ Rg=0.478 Ω Rs=1.32 kΩ L= 10.0m ρ-w/AUTO	B12/387 S033 12/01 14:56 P= 53.2 Ωm Rh=2.55 kΩ Rg=0.565 Ω Rs=1.28 kΩ L= 15.0m	N311/387 S033 12/01 14:54 ρ= 64.5 Ωm Rh=1.97 kΩ R9=0.514 Ω Rs=1.42 kΩ L= 20.0m



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