Eskom	Standard	Technology

Title: **POWER LINE CARRIER AND ASSOCIATED COUPLING EQUIPMENT: COMMISSIONING AND MAJOR MAINTENANCE PROCEDURE**

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Content

Figures

1. Introduction

The purpose of this document is to provide a procedure for the commissioning and/or major maintenance of Power Line Carrier (PLC) Systems, with or without, integrated Teleprotection equipment, and including the associated coupling equipment.

2. Supporting clauses

2.1 Scope

This document covers the procedures required for the commissioning and/or major maintenance of all Power Line Carrier equipment (with or without integrated Teleprotection equipment) as well as Power Line Carrier Coupling equipment used in Eskom.

2.1.1 Purpose

The purpose of the document is to ensure that the functional requirements for commissioning and major maintenance on the TPE, PLC and associated coupling equipment are met.

2.1.2 Applicability

This document shall apply to Transmission Division.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001, Quality Management Systems.

[2] 240-75975613, Standard for the Installation of a Telecomms Equipment Cabinet.

[3] 240-114967625, Operating Regulations for High Voltage Systems (ORHVS).

[4] 240-91461878, Teleprotection Trip Testing.

[5] 240-122859919, (TPC41-84) PLC System Coupling Device Maintenance.

[6] 240-122850198, (TPC41-89) Line trap Maintenance.

[7] TRMTI055, ETL/NSD50 Alarm Separation.

[8] 240-90353855, Design Standard For Teleprotection Systems.

[9] 240-75975613, Standard For The Installation Of Power Telecomms Equipment.

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Coupling Equipment	This equipment is used for isolating and coupling Power Line Carrier signals, and is usually found in Transmission and Distribution substation yards and also in Power Station High Voltage (HV) yards, and is connected to the High Voltage power line. The coupling equipment consists of the Line Trap and Line Matching Equipment.
dB	The ratio of two powers, typically that at the output of a device/ component compared to that at the input to express the gain or loss in a component or system. $$X_{dB} = 10\ log_{10} \frac{Pout}{Pin}$$
dBm	The absolute power level of a signal (Px) expressed in relation to a signal with a power level of 1 mW . $$dBm = 10\ log_{10} \frac{Px}{1mW}$$ (1mW into 600 Ω produces a voltage of 0.775V and = 0dbm)
dBu / dBv	The dBu(ABB/BBC) or dBv(Telettra) is used by some manufacturers for ease of measurement when doing high impedance measurements on their systems. When levels are indicated in dBu/dBv all readings are done on the 600Ω, high input impedance scale of a level measuring set, even at 150 Ω and 75 Ω measuring points. This eliminates the need to constantly change impedance settings or inputs and reduces the possibility of human error. Caution must be taken that dBv referred to in relation to equipment of European origin is not confused with the American (radio) standard where dBv is referred to 1V $$\frac{dBu}{dBv} = 20\ log_{10} \frac{V}{0.775\ volts}$$ where V is the voltage being measured ONLY at 600 Ω measurement points dBu/dBv = dBm Note: To convert dBu/dBv to dBm a correction factor can be used. At 600 Ω 1mW = 0dBm = 0.775V = 0dBu/dBv At 150 Ω 1mW = 0dBm = 0.387V = -6dBu/dBv (add 6dB to dBv to convert to dBm) At 75 Ω 1mW = 0dBm = 0.274V = -9dBu/dBv (add 9dB to dBv to convert to dBm) In the context of this document the units of dBv and dBu are identical. The actual unit used in the reference text refers to the unit used by the equipment manufacturer or in the original line–up documentation of the specific Power Line Carrier under consideration. If an attenuation pad is utilised for measurements using the above units, ensure that it is calibrated and compatible with the measurement techniques used (e.g. Balanced or unbalanced)
Responsible employee (person)	An employee (person) who has been authorised in writing to be responsible for ensuring that the work on electrical apparatus covered by the Operating Regulations for High Voltage Systems can be carried out safely.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
2W	2 Wire
4W	4 Wire
CC	Coupling Capacitor
CCU	Carrier Combining Unit
CT	Current Transformer
CVT	Capacitive Voltage Transformer
EB	Electrisik Bureau (supplier of LME equipment)
HF	High Frequency
HV	High Voltage
LME	Line Matching Equipment
LT	Line Trap
ORHVS	Operating Regulations for High Voltage Systems
PLC	Power Line Carrier
PPE	Personal Protective Equipment
Rx	Receive (Receiver)
SLMS	Selective Level Measuring Set
TU	Tuning Unit
Tx	Transmit (Transmitter)

2.5 Roles and responsibilities

Not applicable.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

This document supersedes TPC41-532.

3. Commissioning and Testing Methodology

The procedure lists the safety requirements, test instruments and methods for testing the PLC system and associated coupling equipment.

3.1 Requirements

3.1.1 Test instruments

a) S.L.M.S. and tracking oscillator e.g. W&G SPM3/PS3, SPM31, SPM33, PSM137 etc.

b) Impedance, return loss measuring test set/ attachment e.g. W&G SFZ1.

c) Variable dummy load/ test unit for LME insertion loss. (Details may be found in 240-122859919/TPC41-84: PLC System Coupling Device Maintenance Procedure)

d) Multi-meter e.g. “Fluke”.

e) Equipment specific test cords, extender cards, dummy loads.

3.1.2 Safety requirements

There are definite hazards inherent in working in an HV environment and strict observance of regulations, an alert and responsible attitude, awareness of safety risks and common sense is required if staff are to work safely.

a) All work to be done in the HV yard shall be in strict accordance with 240-114967625, “Operating Regulations for High Voltage Systems” (ORHVS), and under control of a Responsible Employee or authorised person as defined in ORHVS. The provisions of 240-114967625 will take precedence over any other reference to working procedures contained in this document.

b) Persons working in the HV yard should have completed additional training in safety awareness and the relevant sections of construction regulations.

c) Persons working in the HV yard shall use appropriate Personal Protective equipment (PPE) e.g. safety belts/harnesses, hard hats etc. as required.

Refer to the sections of 3.2.1, 3.2.1.2.1 and 3.2.1.2.2 pertaining to earthing and safety.

3.2 Commissioning/Testing of PLC Links

3.2.1 Coupling Equipment Testing

Note: When performing any tests on the coupling equipment, the line must be isolated and earthed.

3.2.1.1 Visual Inspection and Records

a) Check for correct configuration of coupling equipment by referring to figure A1 if CVTs are used and for LME mounting, connecting and earthing details. When CCs are used for the PLC coupling refer to figure A4a and A4b for the correct mounting.

b) Inspect the equipment as specified in Annex A and record the information on copies of the commissioning/test sheets in Annex B.

c) The conductor information (e.g. zebra etc.) can be obtained from the operating or line construction personnel.

d) Refer to figure A1 for the correct method of mounting the LME.

e) If there is any doubt about the coax cable impedance or condition, the cable should be terminated in 75 Ω and return loss measured to confirm the cable impedance. (In general it is reasonable to assume that older grey cables are 125 Ω and black cables are 75 Ω). The 125 Ω cables must be replaced.

3.2.1.2 Testing of Coupling Equipment

Test and measurement methods for coupling devices and Line Traps are explained in detail in the documents 240-122859919 (TPC41-84) “PLC System Coupling Device Maintenance” and 240-122850198 (TPC41-89) “Line trap Maintenance” which must be used together with this document.

3.2.1.2.1 Line Trap blocking response measurement

a) Line earths *must* be connected on the line side of the line trap. Observe all safety regulations. When working in or on the LT (e.g. replacing tuning units/surge arresters) always work between two earths. For added safety when working in or on line traps a shunt conductor can be connected between the ends of the line trap. If the line isolators, on the yard side of the trap, are not mounted in close proximity to the line trap or if a C.T. is connected between the line trap and the isolators, the interconnecting conductors may have to be disconnected, as they will introduce extra capacitance which may severely influence measurements. Any work on the HV conductors must only be done by, or with, co-operation of Operating Staff who are responsible for the integrity of connections on the primary plant. It may be preferable to test the functioning of the Tuning Unit (TU) by disconnecting one end of the TU and connecting the TU and surge arrestor in parallel with a suitable inductor to simulate the line trap inductance. It is very important afterwards to inspect and verify that all connections are correct. Remove any shunts or personal earths after completion of work.

b) Measure the blocking response by either using the constant current method or by making use of an impedance bridge (figure A4). The frequency range over which the tests must be performed, will be determined by the frequency rating of the specific tuning unit. Ensure that the line trap/tuning unit values are co-ordinated and suitable for the proposed PLC frequencies.

c) Record the results (on copies of the commissioning/test sheets in Annex B) and plot graphs from the results obtained.

d) Repeat steps in section 3.2.1.2.1 for additional traps.

Note:

1) A contract was established during the procurement of each type of equipment for a certain defined period, therefore there are different types of the Haefely-Trench and ABB line traps that require their specific tuning units and matching arrester.

2) BBC TLJO type line traps must always be refurbished with the TU/surge arrester/ bracket kits available for this purpose from ABB.

3.2.1.2.2 LME initial adjustment and testing of coupling components

a) For **ABB** LMEs strap the LME in accordance with the manufacturer's instructions as displayed inside the LME, taking into consideration the Line impedance (single or bundled conductor), CVT capacitance values and PLC operating frequencies.

b) For **EB** type LMEs do initial (compromise) programming according to figure A2 taking into consideration the Line impedance (single or bundled conductor), and PLC operating frequencies.

c) Optimise settings later by adjusting for maximum return loss when line is through end-to-end, line earths have been removed and opposite end is terminated in 75Ω. EB LMEs must always be replaced if possible or refurbished with the (soap bar) surge arrestor refurbishment kit and co-ax connector kits.

d) For PLC line frequencies below 100 kHz, **band-pass** LME filter characteristics are probably required depending on the other parameters (see figure A3 for some EB characteristics). Refer to the equipment manual. Band-pass (LF) characteristics can be realised in the standard EB LME by alternative strapping but for ABB equipment the A9BP LME is required for low frequency applications.

e) For single conductor/ phase configuration line impedance ≈ 320Ω

f) For bundle conductor/ phase configuration line impedance ≈ 240Ω

g) Measure the return loss, from the coax 2W input (single phase coupling) or CCU 2W input (multi phase coupling) in the communications room, with the LME(s) terminated in dummy load(s). Refer to figure A3. The measured return loss over the coupled band should be >12 dB.

h) Record the results (on copies of the commissioning/test sheets in Annex B) and plot graphs from the results obtained.

i) Measure the insertion loss from the coax (single phase coupling) or CCU 2W input (multi phase coupling) in the communications room with the LME(s) terminated in dummy load(s). Refer to figure A3.

Typical losses of components are:

LME loss…… 1.00dB *

Carrier Combiner loss…… 0.50dB *

Coax Cable loss…… 0.50dB **

Notes: *Figures above refer to typical installations. For frequencies near the limits of the PLC band, refer to the project design.

**Attenuation of coax cable (RG12 AU) = 0.16dB/100m @ 50kHz,

0.22dB/100m @ 100kHz

or 0.47dB/100m @ 500kHz

j) Record the appropriate results (on copies of the commissioning/test sheets in Annex B) and plot graphs from the results obtained.

If the return/insertion loss is incorrect, or assistance is not available to test from the Carrier room to the HV yard, each component must be tested separately i.e. CCU, coax cable and each LME. If problems are rectified and the insertion loss improves, return loss measurement must be repeated as extra losses in the CCU or coax cable could have masked poor return loss.

Note:

1) The earthing switch on any LME is primarily a safety device for the protection of maintenance/ commissioning staff. Always close the switch before doing any intrusive work in or on the LME.

2) Never break the connection between LME and CVT/CC or touch the disconnected CVT PLC (Carrier) connection unless the line is dead and visibly earthed. If the CVT Carrier terminal is open (ungrounded) the potential at that point will rise to that of the line. Always connect a working earth to the CVT carrier terminal if the LME to CVT connection is to be disconnected for testing. Even if the line is dead there may be a dangerous residual charge in the CVT capacitors.

3) Be sure to open the knife switch before testing the return loss or insertion loss of the LME.

3.3 Testing of Communication Path

The following tests must be performed before the line is commissioned: All working earths must be removed but the earths behind the LTs must remain. These tests will give an indication whether any PLC coupling problems exists.

a) Measure the overall transmission path losses over the required coupling band between the coax or CCU 2W input/output, in the communications rooms at each site, in one direction only, by transmitting a known level (typically 0 dBm) at one station and measuring selectively at the other site using 75Ω terminations on the test equipment.

Record the results (on copies of the commissioning/test sheets in Annex B) and plot graphs.

Consider the overall losses to determine if coupling problems exist.

Refer to the results of **3.2.1.2.2 i**), add:

Trap shunt loss ……..……. 2.50dB

Modal conversion loss (ph/ph flat horiz.line) 1.25dB

Total (Typical) coupling loss 4-6 dB/Line end

add:

Approx. Line loss @:

0.02 –0.03dB /km (275/400kV flat horiz. @100khz)

0.04 –0.06dB /km (275/400kV flat horiz. @ 400khz)

0.03 –0.04dB /km (275/400kV Delta . @ 100khz)

0.07 –0.08dB /km (275/400kV Delta @ 400khz)

Example: Flat horizontal line of 200kM with PLC operating at 200kHz.

coupling losses at both ends …… ….. 2 X 5 =10 dB

Line loss @ 200km X 0.03/km……..……. 200 X 0.03 = 6 dB

Total expected losses 16 dB

Notes:

- If measured losses are significantly higher than expected (say > 20db total loss in the above case) then the causes must first be investigated.
- Above examples are pessimistic and lower figures may well be experienced.
- Line transpositions can add ≤ 6dB to line loss.
- Newer tower/ line configurations (compact Δ, cable stayed towers etc.) especially where vertical strain towers are used, can have severe and unpredictable impact on attenuation response and must be referred to PTM&C, Technology for the PLC Propagation analysis.

b) Measure the return loss, from the coax or CCU 2W input in the communications room, with the far end terminated in 75 ohms. This test must be performed from each end. Record the results (on copies of the commissioning/test sheets in Annex B) and plot graphs. If the return loss is not > 12dB over the operational carrier band(s), optimise settings by adjusting the LME for maximum return loss. Refer to 3.2.1.2.2 i) and figure A2.

c) In the case of phase to phase coupling, measure a received pilot, if available, (or a test tone generated at the far end) at both ends, at an appropriate 2W HF measuring point and close the LME knife switches in turn while monitoring the received signal level. At either end if the level increases when one of the switches are closed, the phasing of the LMEs is incorrect. Reverse the input connection on one LME only and repeat 3.2.1.2.2.

d) In the case of three phase coupling the correct phasing of the LME connections is critical and extra care must be taken. There is only one correct way of phasing the LME connections and many opportunities exist for error. Refer to updated instructions, drawings or designs.

e) Do preliminary balancing of the PLC hybrid according to manufacturer's instructions.

3.4 Inspection, Testing and Adjustment of the PLC

Check and record the appropriate information on copies of Annex B before the line is commissioned:

a) Record the PLCs frequencies and teleprotection information.

b) Inspect whether the cabinets have been earthed to the station earth and check the integrity of the earth on the PLC cabinet, earth bars, cable glands etc. Ascertain that the cabinet earth is not bolted onto a painted surface without the benefit of "bite" washers or similar. Inspect cabling and lugging for soundness, frayed or exposed wires, wires crimped on insulation and neatness. Refer to Eskom standard 240-75975613, "Standard For The Installation Of Power Telecomms Equipment", for details.

c) Check and "ring out" the protection, speech and alarm cables to ensure that they are correct and confirm that cables are correctly numbered.

d) Ensure that all labelling is correct, both on the PLCs, Teleprotection and on the IDF.

e) Check whether all strapping (programming) and level settings on the PLCs and Teleprotection equipment are according to the appropriate Work Instruction and Alignment Schedule for the specific application or manufacturer's configuration details. Pay particular attention to protection interface modules and Protection Interface adapters (PIAs).

Notes:

- On ABB ETL equipment ensure that "TPE/Carrier fail" and "Alarm" outputs are galvanically separated by measuring for continuity between output contacts with the aid of an ohmmeter or similar.
- In order to avoid conflict between protection and alarm voltages that could lead to incorrect tripping on ETL/NSD50 equipment no external connections should ever be made to terminals 5a/5b and 10a/10b (NSD50 General alarm). Use 3a/b (NSD50 Tx alarm) and 4a/b (NSD50 Rx alarm) for alarm connections instead.

f) Connect the PLCs to line and line-up the PLCs end to end according to the relevant "Work Instruction and Alignment Schedule for Commissioning and Major Maintenance" and/or manufacturers configuration details and commissioning instructions. Equalisation and hybrid balancing must also be performed at this stage. Record the before and after equalisation levels on copies of the commissioning/test sheets in Annex B.

g) Ensure that all alarms operate correctly and test that they are extended to the relevant control centre. On the ETL41/81 PLC equipped with NSD 50 ensure that the modification to separate the ETL/NSD alarms have been done according to TRMTI055.

h) In accordance with 240-91461878, "Teleprotection Trip Testing" and in conjunction with protection department, perform end to end trip testing to ensure that the teleprotection is operating correctly.

i) With the line alive measure the noise levels in the appropriate band and record on the commissioning/test sheets in Annex B (note measurement bandwidth used, if not 24 Hz).

3.5 Line Parameter Influence on Signal Levels

Certain conditions that could influence the quality of the transmission path may change when the 'switching in' of the station is normal and the line is alive. On new conductors higher than normal corona noise can be expected that will decay significantly after a few days. If there is a problem with the signal levels on the PLC after a month, then the following measurements should be performed.

a) Measure the overall transmission path losses between the coax or CCU 2W input/output, in the communications rooms at each site, in one direction only, over the required coupling band. Record the results (on copies of the commissioning/test sheets in Annex B) and plot graphs.

b) Measure the return loss once again from the coax in the communications room, with the far end terminated in 75 ohms. Refer to figure A2. If necessary adjust the strappings on the LME to obtain a return loss > 12 dB over the operational PLC bands. Record the measurement results (on copies of the commissioning/test sheets in Annex B). Once the strappings have been finalised, record the details on copies of the commissioning/test sheets in Annex B and plot graphs from the final measurement results.

c) Measure the corona noise over the coupling band. During this measurement all PLCs on the line must be switched off and the coax cables to the PLCs must be terminated in 75Ω. Record the results (on copies of the commissioning/test sheets in Annex B) and plot graphs from the results obtained.

d) Check that the equalisation has remained within limits and re-adjust if necessary. Record the appropriate information on annex B.

e) Measure and record the level of the Tx and Rx pilots on an appropriate 2w HF test point. As the method of taking this measurement will vary for different types of PLC and test equipment the measurement method/ units must be detailed (e.g. dBm/dBu, attenuators etc.). When using attenuator pads attention must be paid to using unbalanced pads only with unbalanced (co-axial) instrument inputs. The difference between the Tx and Rx pilot levels will give an indication of the line loss and should correspond approximately with the loss measured in section 3.3 at the corresponding frequencies. Record on the commissioning/test sheets in Annex B.

f) Recheck the balancing of the hybrids.

3.6 Documents and Records

Copies of commissioning documentation and records must be distributed as follows:

a) Relevant Distribution Region / Grid Secondary Plant Manager.

b) Relevant Project Engineer/ Applications Engineer.

c) Site Copy

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Lenah Mothata	Senior Manager – Grids
Barry Clayton	Chief Engineer – Secondary Plant, Works Planning and Centralized Services
Sikelela Mkhabela	Senior Manager – DX
Prudence Madiba	Senior Manager – GX
Mfundiso Hina	Senior Manager – Eskom Telecommunications (Acting)
Maureen Mokone	Senior Manager – GIT (Acting)
Botse Sikhwitshi	Senior Manager – Group Security Senior Manager (Acting)

5. Revisions

Date	Rev	Compiler	Remarks
Oct 2020	2	T Gosai	Document had to be reviewed as the review date has passed. There are no major changes implemented.
Oct 2015	1	T Gosai	Document had to be reviewed as the review date has passed. There are no major changes implemented.

6. Development team

The following people were involved in the development of this document:

- Antonio Pereira
- Ashley van der Poel
- Zakhele Dlamini

7. Acknowledgements

Not applicable.

Annex A – Figures

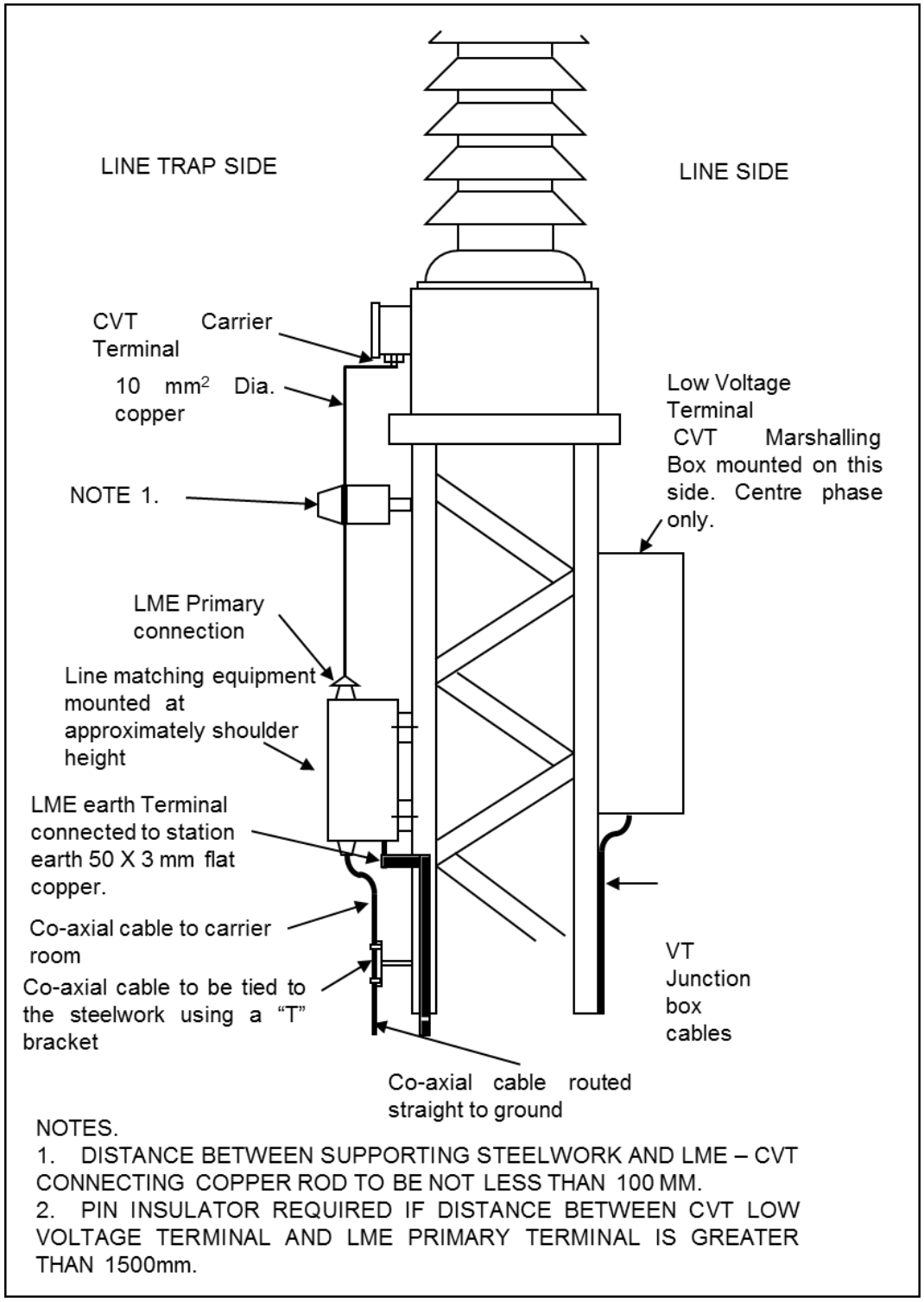
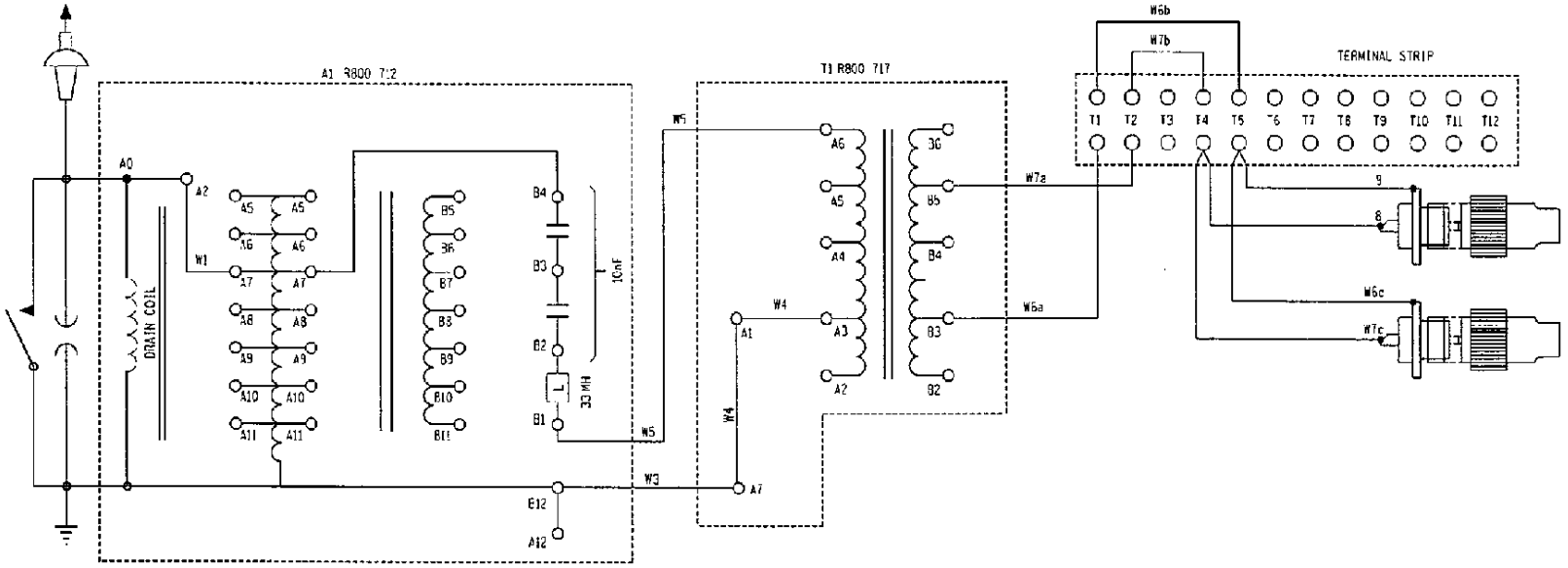


Figure A.1: LME – CVT Mounting, connection, earthing details



Transformer T1 impedances

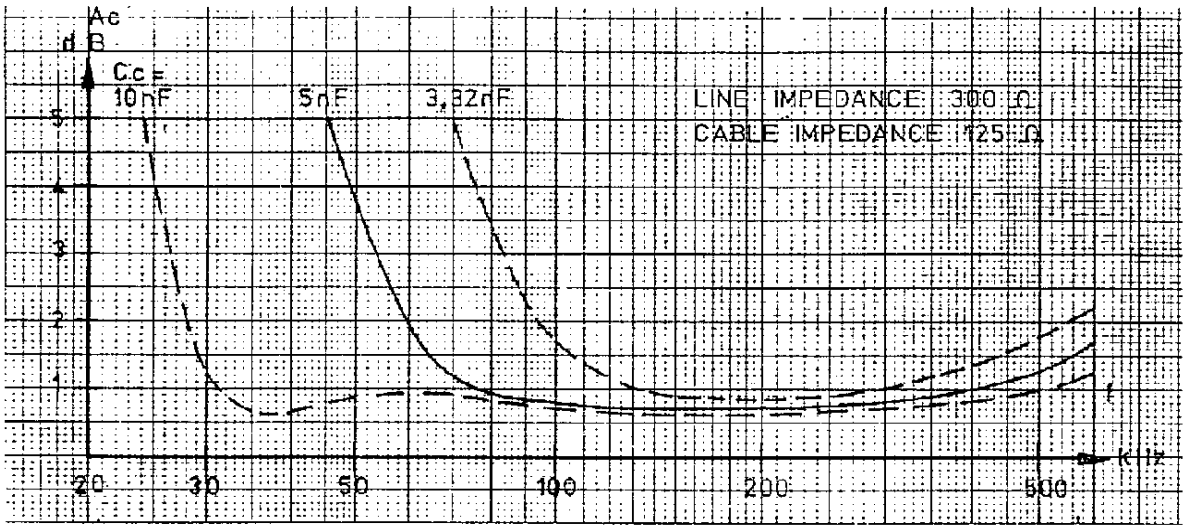
Line Side: A3 to A4 230 Ω
A5 300 Ω
A6 390 Ω

Cable side: B3 to B4 50Ω
B5 75 Ω
B2 to B5 125 Ω
B5 140 Ω

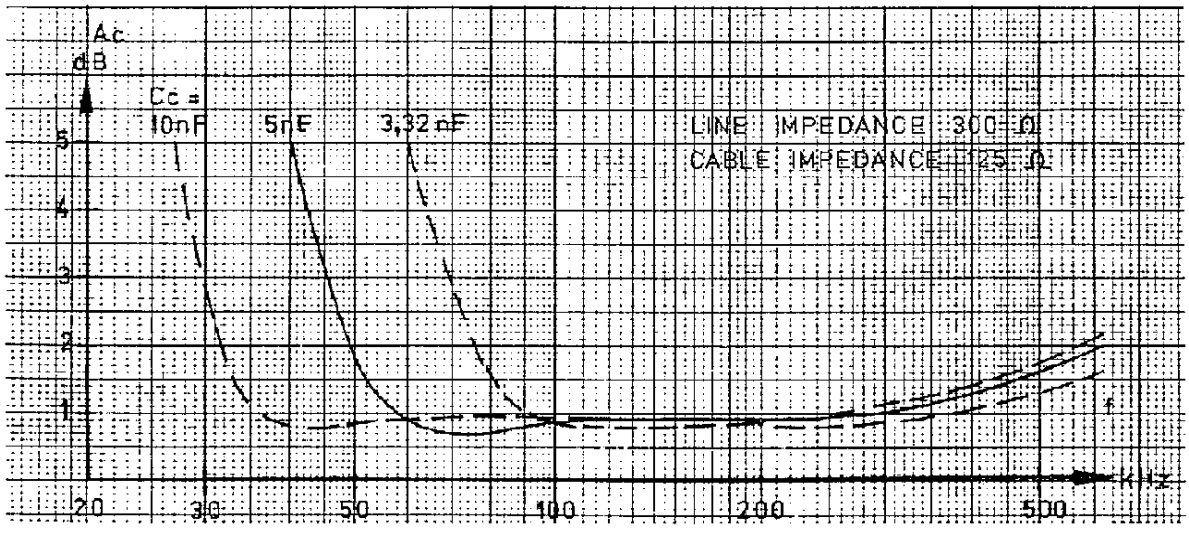
NOTES

- For frequencies lower than the cut-off of the H.P filter refer to EB instruction manual or Tx/Technology/Power Telecom.
- For most applications where the PLC operating frequencies are above 100kHz the default programming as in the figure above provides a good starting point for return loss adjustments. **Fine** adjustment can be achieved by changing the two straps that are indicated between terminals A2 & B4 and terminal A7 on transformer R800 712 to different inductance values. Generally for 275kV and 400 kV CVTs (typical 6000pF and 4400pF respectively) the lower capacitance values will require lower inductance, that is, higher terminal numbers e.g. from A2 & B4 to A8 or A9 or A10. (NB. Both wires must be in A7, A8, A9 or A10)
- The adjustments on T1 terminals A4, A5 & A6 cater for various line impedance e.g. term. A6=390Ω, A5=300Ω (both for single conductors) and A4=230Ω (bundled conductor). In difficult cases these straps may be changed to improve return loss. These will provide **coarse** adjustment.
- The older version of the LME does not have the 33uH inductor connected between B1 and B2 of transformer 800 717 R800 712. In this case A6 on R800 717 is connected directly to B2 on R800 712

Figure A.2: LME – EB Details



High-pass filter characteristic. Composite loss as a function of frequency



Modified high-pass filter,characteristic. Composite loss as a function of frequency

Figure A.3: LME (EB) filter characteristics with different capacitance

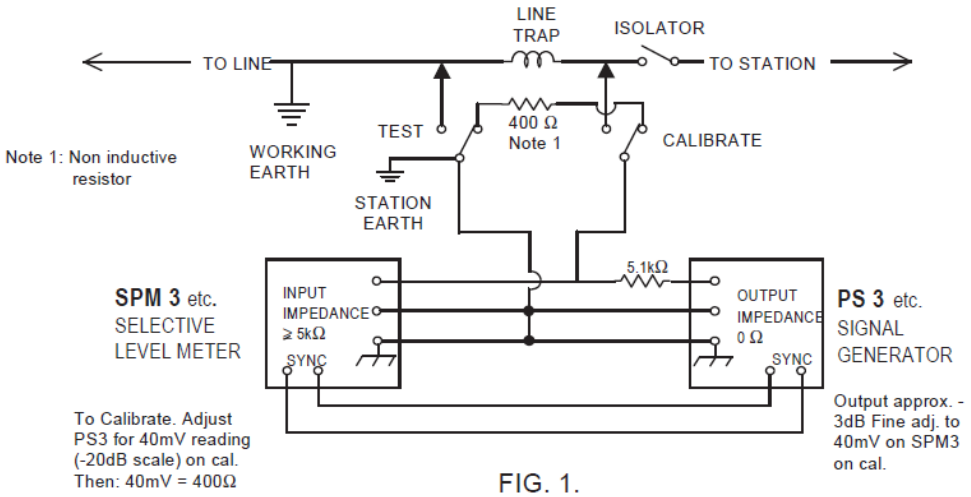


FIG. 1.
MEASURMENT OF LINE TRAP BLOCKING IMPEDANCE
(CONSTANT CURRENT SOURCE TECHNIQUE)

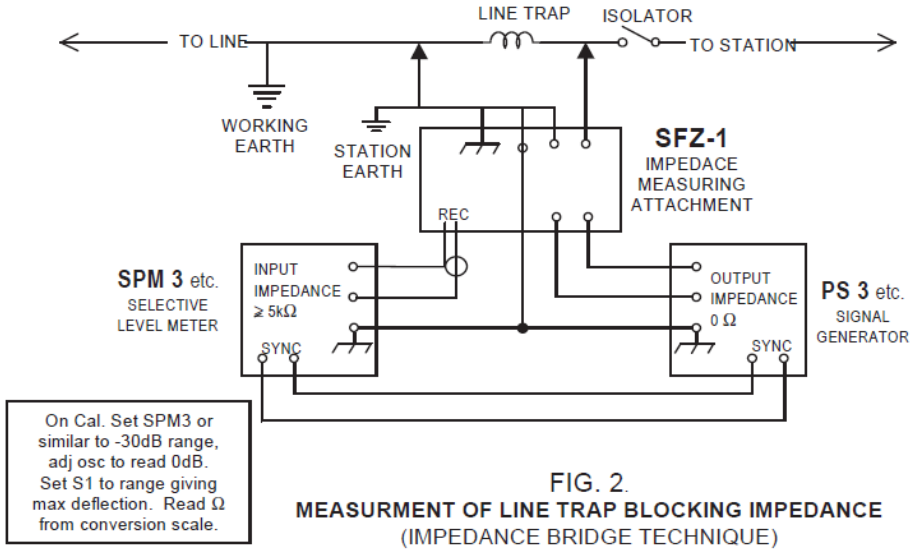


FIG. 2.
MEASURMENT OF LINE TRAP BLOCKING IMPEDANCE
(IMPEDANCE BRIDGE TECHNIQUE)

Figure A.4: Line Trap – Constant Current Method and Impedance Bridge Method

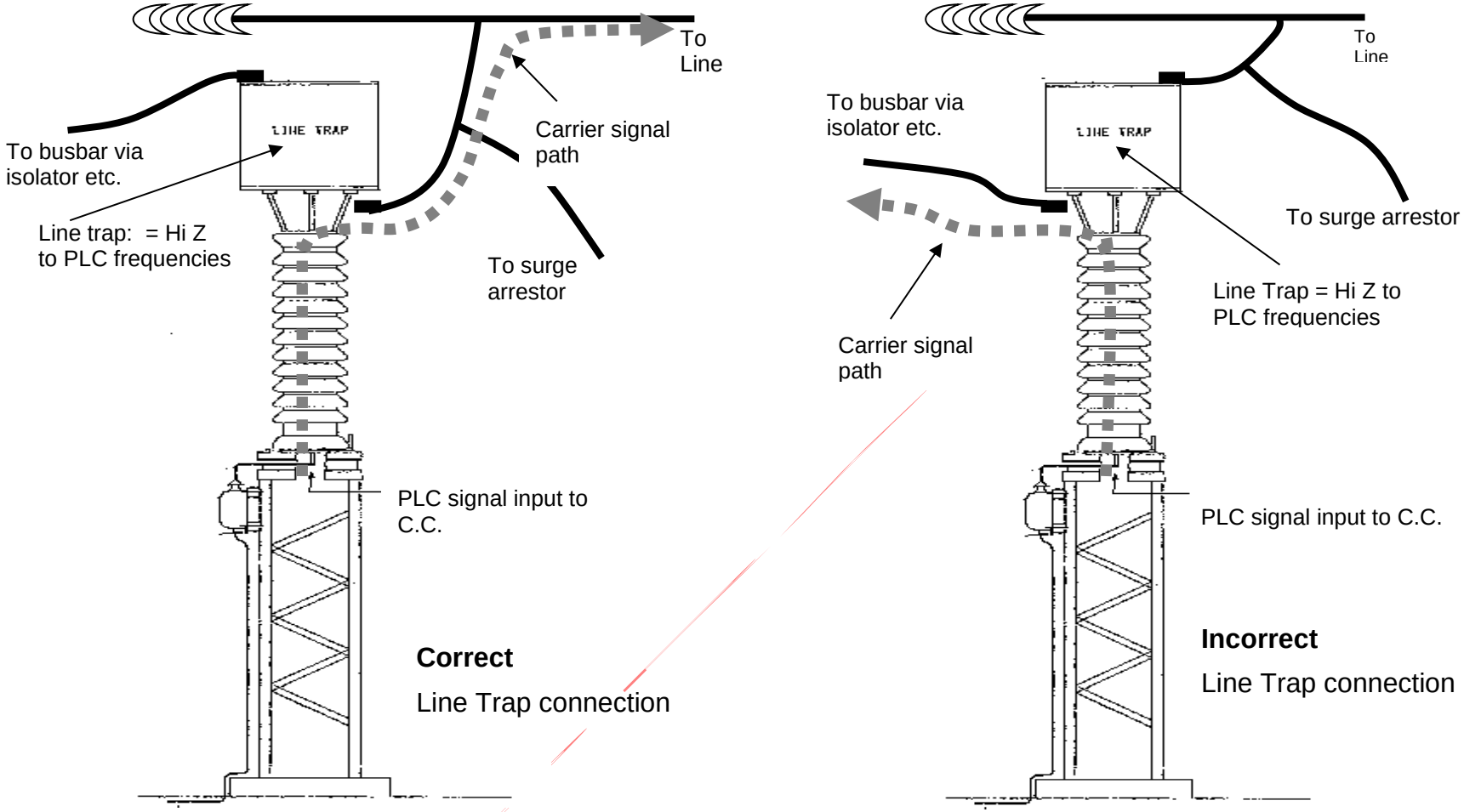


Figure A4a **Figure A4b**

Figure A.5: Correct and Incorrect Line Trap/ Coupling Capacitor Configuration

Annex B – Commissioning/Test Sheets

To be completed by the PLC Technician.

Technician :……(Print) **Date:**

Signed: Works Order (WBS) No.:

1) Line Details

Station: Direction:

Line Voltage: Feeder No: Line No:

	Single	Twin	Trip	Quad	Hex
Conductor Configuration:					

Tower Type

Flat Horizontal		Vertical	
Giraffe		Double circuit	
Delta,		Inverted Delta	
Cross rope Horizontal		Other (Specify)	

Detail

2) Line Trap Details

Record the following details:

1. Line phasing Looking towards the line	…….-∅	…….-∅	…….-∅
2. Line Trap Make			
3. Line Trap Type			
4. Serial Number			
5. Phases on which the LTs are installed			
6. Inductance	mH	mH	mH
7. Continuous Current	Amps	Amps	Amps
8. Fault Current	kA	kA	kA
9. Blocking Band	kHz	kHz	kHz
10. Creepage (25mm/kV or 31mm/kV)			
11. LTs installed on correct phases as per station electric drawing at both ends.			

12.	Correct LTs, surge arresters and tuning units installed	
13.	LTs, CCs/CVTs are correctly installed and earthed as per design guide.	
14.	Haefely LT cross arms drilled to let moisture escape.	

3) Tuning Unit Details

1.	Inductance	mH	mH	mH	
2.	Continuous Current	Amps	Amps	Amps	
3.	Fault Current	kA	kA	kA	
4.	Blocking Band	kHz	kHz	kHz	

4) CVT Details

1.	Make				
2.	Serial Number				
3.	Total Capacitance	nF	nF	nF	
4.	CVTs/CC are installed on the line side of the Line Traps.				
5.	No earth on CVT/cc LV connection point except uncoupled phase.				

5) LME Details

		……..-∅	……..-∅	……..-∅	
1.	Make				
2.	Serial Number				
3.	Type (e.g. A9-BS)				
4.	High pass or band pass.				
5.	Strappings of the LMEs				
6.	Correct LME installed as per application.				
7.	Separate coaxial cables from each LME to carrier room.				
8.	10 mm^2 un-insulated copper rod installed between the LME and CVT.				
9.	Support for the copper rod where CVT is mounted very high.				
10.	LME mounted ± 1.5 m from the ground.				
11.	LME mounted on station side of structure. (Shortest distance to the CVT terminal)				
12.	LME earthed with 50 x 3 mm flat copper or 10 mm^2 round copper.				
13.	For 3 phase coupling, the output of the LME to the CCU input X4, is reversed.				

6) Coaxial Cable Details

1.	Numbers (As per drawings)	R		W		B	
2.	Correct Coaxes (75Ω) Installed						
3.	Connection of coaxes to CCUs correct						

4. Coax Armouring earthed at both ends. | |

7) Carrier Combining Details

Coupling Arrangement:……

2. CCU make:.	
3. Couple and mark the correct coaxial cables to the inputs of CCU.	
4. Ensure correct CCU is installed.	
5. Ensure CCU is securely fixed and correctly earthed.	

8) Powerline Carrier Details:

Upper SSB

SSB No:		Type:	
Tx Freq		Order No:	
Rx Freq		Serial no:	
NSK 5 Modem		Power	

Line Protection	Channel 1:	Channel 2:	Channel 3:
	……. ……	…….....	……..

Lower SSB

SSB No:		Type:	
Tx Freq		Order No:	
Rx Freq		Serial no:	
NSK 5 Modem		Power	

Line Protection	Channel 1:	Channel 2:	Channel 3:
	……. ……	…….....	……..

The following must be checked:

1. Check that all equipment is supplied as per order.	
2. Ensure the cable numbers correspond with the drawings.	
3. Ensure that the cables are terminated correctly and mark up drawings.	
4. Ensure that the cabinet is correctly labelled.	
5 Check that rodent and vermin prevention measures are in place.	
6 Check that the coax inputs are fitted with gases discharge tubes.	

9) PLC Inspection and Alignment

	Y/N
A. LINE DEAD,	
1. Cabinets, gland plates, racking etc. correctly earthed.	
2. Protection, speech and alarm cables correctly wired and marked.	
3 PLC cabinet and frame correctly labelled.	
4. Alarms operating on PLCs (and alarm annunciator where applicable)	
5. Alarms tested to all control centres	
6. Local TPE & PIA levels performed and correctly strapped.	
7. End to end levels correct.	
8. Equalisation performed.	
9. PLC Serial/ order No, programming and alignment details recorded in alignment schedule	
10. Trip testing completed in accordance with 240-91461878	
B. LINE ALIVE	
1. Pilots measured?	
2. Noise measured in PLC operating frequency band?	
3. Hybrid balance rechecked?	
4. Equalisation rechecked? (only if speech functions used)	

10) End to End results over the PLC bandwidth (1 kHz steps)

Upper SSB No. ……		
Freq.	**Insertion Loss (dB)**	**Return Loss (dB)r**
Hz		
Hz		
Hz		
Hz		
Hz		
Hz		
Hz		

Lower SSB No. ……		
Freq.	**Insertion Loss (dB)**	**Return Loss (dB)r**
Hz		
Hz		
Hz		
Hz		
Hz		
Hz		
Hz		

Hz		
Hz		
Hz		
Hz		
Hz		

Hz		
Hz		
Hz		
Hz		
Hz		

11) Microwave Teleprotection

1.	Teleprotection unit installed in Teleprotection Cabinet		Protection Panel	
2.	Teleprotection equipment Serial No.		Order No:	
3.	Teleprotection Supply Voltage (50 or 220 Vdc)		Address	
4	Teleprotection unit correctly earthed.			
5.	Cables glanded and numbered correctly as per drawing			
6.	Alarms operating on TPE (and alarm annunciator where applicable)			
7.	Alarms tested to all control centres			
8.	Local TPE & PIA correctly strapped.			
9.	PFA tests done on the data channel for bit error rate.			

Remarks:_____

_____

_____

12) PLC Commissioning and Maintenance Test Record Sheet

PLC COMMISSIONING AND MAINTENANCE TEST RECORD

Works Order /WBS No				**Annexure A Sheet 4**	
Technician Name (Print)				**Sign.**	
Station:		**Distant Station**		**Line No**	**Date**

Freq. (kHz)	Line Trap Blocking (Ohms)			LME CHARACTERISTICS Insertion loss (dB)			LME CHARACTERISTICS Return loss (dB)			End to End tests Insertion loss(dB)	End to End tests Return loss (dB)	Noise(dBm/u) 24Hz Before Energising	Noise(dBm/u) 24Hz After Energising	Freq. (kHz)
	-∅	-∅	-∅	-∅	-∅	-∅	-∅	-∅	-∅					
20														20
40														40
60														60
80														80
100														100
120														120
140														140
160														160
180														180
200														200
220														220
240														240
260														260

Freq. (kHz)	Line Trap Blocking (Ohms)			LME CHARACTERISTICS Insertion loss (dB)			LME CHARACTERISTICS Return loss (dB)			End to End tests Insertion loss(dB)	End to End tests Return loss (dB)	Noise(dBm/u) 24Hz Before Energising	Noise(dBm/u) 24Hz After Energising	Freq. (kHz)
280														280
300														300
320														320
340														340
360														360
380														380
400														400
420														420
440														440
460														460
480														480
500														500

Tx Pilot	Level (dBm/u)	Freq. (kHz)	Specify Tx test point
SSB1			
SSB2			

Rx Pilot	Level (dBm/u)	Freq. (kHz)	Specify Rx test point
SSB1			
SSB2			