Eskom	Standard	Technology

Title: **DESIGN STANDARD FOR TELEPROTECTION SYSTEMS**

Unique Identifier:	**240-90353855**
Alternative Reference Number:	**<n/a>**
Area of Applicability:	**Engineering**
Documentation Type:	**Standard**
Revision:	**2**
Total Pages:	**22**
Next Review Date:	**March 2025**
Disclosure Classification:	**Controlled Disclosure**

Compiled by	Approved by	Authorized by
Tejin Gosai	**Cornelius Naidoo**	**Richard McCurrach**
Chief Engineer Telecomms Tech & Support	**Manager Telecomms Technology and Support**	**Senior Manager PTM&C Engineering**
Date: 06/03/2020	Date: 6/3/2020	Date: 10/3/2020

Supported by SCOT/SC

Kgomotso Setlhapelo

SCOT/SC Chairperson

Date: 6 March 2020

PCM Reference: **240-53458797**

SCOT Study Committee Number/Name: **Telecommunication SC**

Content

Figures

Tables

Executive Summary

The document details the design of Teleprotection systems describing the different technologies, equipment, implementation and philosophies. The different implementations between Transmission and Distribution are also detailed.

1. Introduction

Teleprotection systems form part of the overall protection schemes designed to protect high voltage lines and certain primary plant equipment. The function of teleprotection is to aid the protection scheme as well as speed up the fault clearance times depending on the type of protection scheme used.

Teleprotection under fault conditions reduces damage to equipment, prevents power system instability and allows for the rapid restoration of power flow after a fault occurs.

2. Supporting clauses

2.1 Scope

This document details the teleprotection philosophies to be used in Transmission and Distribution stations and provides a guideline on Teleprotection and Power Line Carrier designs, interfacing to Protection equipment/schemes and details the different Telecommunication mediums used.

2.1.1 Purpose

The purpose of this document is to assist the Applications and Planning departments in the compilation of the teleprotection designs and scope of works documents.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

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] 240-46264031 Fibre Optic Design Standard – Part 2: Substations

[2] 240-77422828 Teleprotection Equipment for use on Digital Telecommunications Channels or Dedicated Optical Fibre.

[3] IEC 60834 Teleprotection equipment of power systems

[4] 240-56362025 Power Line Carrier Frequency Planning Design Guide Standard

[5] 240-144089741 Impedance vs Current Differential Protection for EHV and HV Feeders: A Scheme Selection Standard.

[6] 240-97276914 Telecontrol Point Naming Standard for EMS and DMS

[7] 240-141828918 Scope of Work Template for Teleprotection Projects

[8] The South African Grid Code: The Network Code, version 10.0

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
ADLash™	Fibre Optic cables designed to be lashed to power line earth wires.
Dedicated fibre (dark fibre)	Fibre optic cores that are not managed by a telecommunication's management system and are dedicated for usage by a particular equipment or system.
Teed lines	A feeder with multiple connections.
"Z cable"	18 core 440V miniature control cable type with insulated stranded cores used for Teleprotection

2.3.2 Disclosure classification

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

2.4 Abbreviations

Abbreviation	Description
ABB	Asea Brown Boveri, PLC and Teleprotection Supplier
ADD	Advanced Digital Devices, Mini multiplexer and LL2100 Supplier
ADSS	All Dielectric Self Supporting
BER	Bit Error Rate
BME	Bandwidth Management Equipment
EA	Engineering Assistant (at Substation)
EHV	Extra High Voltage
ET	Eskom Telecommunications
FO	Fibre Optic
GEC	General Electric Corporation
HDPE	High Density Polyethylene
HF	High Frequency
HV	High Voltage
IDF	Intermediate Distribution Frame
kbps	kilobits per second
LME	Line Matching Equipment
MUX	Multiplexer
nm	Nanometer
OLTE	Optical Line Terminating Equipment
OPGW	Optical ground wire
OPPC	Optical phase conductor

PIA	Protection Interface Adaptor
PLC	Power Line Carrier
SEL	Schweitzer Engineering Laboratories, Protection Supplier
TPE	Teleprotection Equipment

2.5 Roles and responsibilities

The project applications and planning departments will be responsible to ensure that this document is utilized and implemented.

2.6 Process for monitoring

During teleprotection maintenance, when trip testing is performed and monitoring 'in-service' performance.

2.7 Related/supporting documents

This document supersedes TGL41-909.

3. General

The teleprotection design standard explains the teleprotection philosophies used and describes and lists most of the design requirements for the teleprotection systems.

This document provides the detail and the correct application of the various methods used to connect the line protection relays to the teleprotection equipment. The method most commonly used in Eskom is the 18 Z teleprotection cable for conveying tripping signals from the contacts of the protection relays to the various teleprotection equipment.

The document also details the association of the telecommunication mediums with the teleprotection and protection systems.

3.1 Teleprotection Philosophy

Teleprotection forms part of the protection system and shall always follow the protection requirements and philosophies.

In Eskom, there are two different teleprotection philosophies implemented, one is for Distribution power lines (132 kV and lower voltages) and the other is for Transmission power lines (above 132 kV).

3.1.1 Distribution Philosophy

The Distribution protection philosophy consists of a 'Main' protection scheme and a 'Back-Up' protection scheme. The 'Main' protection scheme for feeders would comprise of the Current Differential and/or the Line Impedance scheme. The 'Back up' protection would typically be the overcurrent and earth fault with no teleprotection required.

Distribution does not have any specific requirements on which applications require teleprotection. However, The South African Grid Code (The Network Code) does state that for powerlines emanating from Transmission Stations: "Distance protection systems applied on feeders of nominal voltages 88kV and above shall be equipped with teleprotection facilities to enhance the speed of operation. On 132kV and 88kV radial feeders supplying load only (without connected generation) instantaneous tripping for faults on the protected line can be facilitated either by making use of teleprotection or by using over reaching zones.". Therefore in Distribution, only one teleprotection system would be used if required.

3.1.2 Transmission Philosophy

Transmission normally has two protection systems, termed Main 1 and Main 2 which are independent from one another to ensure diversity and redundancy. The related teleprotection systems would also use two totally separate teleprotection systems to ensure diversity and redundancy. The teleprotection systems are also termed, Main 1 (M1) and Main 2 (M2).

To ensure that each teleprotection system uses separate telecommunication paths, Eskom developed the philosophy which is displayed in Table 1. From the table, the telecommunication paths used is dependent on the type of protection scheme implemented.

Table 1: Telecommunications paths vs. Protection schemes

Protection Scheme	PLC + PLC	ET Network (Bearer) + PLC	Dedicated Fibre (Dark Fibre) + PLC	Dedicated Fibre (Dark Fibre) (Separate Cables)
Dual Impedance	✔	✔	✔	✔
Impedance + Current diff	X	X	✔	✔
Dual Current diff	X	X	X	✔

Note: Microwave Teleprotection should not be used together with Current Differential schemes. The reason is that ET's network is migrating to fibre optic cables and there is a strong possibility that ET would utilise the same fibre optic cable used for the Current Differential scheme. This would compromise the teleprotection requirements as there would be a common point of failure.

3.1.2.1 Current Differential Recommended Philosophy

a) For lines shorter than 30km, the protection scheme selection document, 240-144089741, should be used to determine if the current differential protection should be selected or not.

b) If current differential protection is to be used, then an optical budget for the respective fibre cable system needs to be calculated to ensure that the correct fibre optic driver is chosen and is within the limits and range.

c) If the current differential protection is not chosen, then the choice of the protection schemes in relation to the telecommunications mediums should follow Table 1.

3.2 Telecommunication Mediums

Both Eskom Distribution and Transmission currently utilize the following telecommunications mediums for teleprotection requirements, which are the ET Network, fibre optic systems and PLCs. The characteristics and performance of the telecommunications mediums must conform to the telecommunication requirements detailed in the IEC 60834 standard.

3.2.1 Eskom Telecommunications network

At present, most of Eskom's telecommunications requirements and infrastructure is dependent on the ET network. The ET network consists of a number of microwave radio links operating in the 7 GHz, 8 GHz, 13 GHz, 15 GHz, 23 GHz and 38 GHz range. The ET network also uses fibre optic links operating on single mode fibre, wavelengths 1310 nm and 1550 nm.

The current telecommunication performance requirements for teleprotection for both Transmission and Distribution power lines are:

a) Availability = 99,16%

b) Latency ≤ 10 ms.

c) BER $\leq 1 \times 10^{-3}$

3.2.1.1 Interfaces

Typical data output signals are synchronous/asynchronous RS232, 64kbps X.21, RS422, and other protocols.

3.2.2 Fibre Optic systems

The fibre-optic cables used by Eskom are:

a) Optical Ground Wire (OPGW)

b) All Dielectric Self Supporting (ADSS)

c) Lashed all-dielectric cable ('AdLash™')

d) Helically Wrapped Fibre (WRAP)

e) Duct Fibre Cable

Fibre-optic systems are preferred in that they are immune to interference and are more resilient during line fault conditions. The teleprotection systems that require dedicated fibre optic cores are current differential protection schemes and standalone teleprotection units.

The design and installation of the fibre-optic cable system shall follow the appropriate Eskom standards. However, only a small percentage of Eskom's power lines have fibre-optic cables installed, which necessitates the use of the other telecommunication mediums.

3.2.3 Power Line Carrier systems

The PLC system is a point-to-point telecommunication medium and communicates between substations by superimposing a telecommunication signal onto the power line. The main functions for the PLCs in Eskom are for teleprotection requirements and in a few substations they provide auxiliaries such as telecontrol and speech functions.

The PLC performance requirements for teleprotection are:

a) Availability ≥ 99 %

b) Latency ≤ 10ms

3.3 Teleprotection and PLC design considerations

The project and planning engineers should utilise the Teleprotection Scope of Works document, 240-141828918, in conjunction with this document to compile the scope of works and application diagrams. These documents would ensure compliance to standards and simplify the project documents.

3.3.1 PLC output power

For any PLC link on a line, a path profile calculation needs to be done. Normally 100 Watt PLCs will be ordered for all 400 kV and 765 kV power lines. However, there may be a few examples of very short lines in the network where 50 Watt systems may be ample in terms of attenuation. The parallel amplifiers in the 100 W PLC sets provide useful redundancy in case of amplifier failure for important lines. On short lines reflections may be present and the higher outputs will accommodate HF attenuators to alleviate reflection problems.

Depending upon the importance, configuration and length of 220 kV and 275 kV lines, a 50 Watt PLC would normally suffice but a 100 Watt rating might be required for lines that have a higher loss (e.g. long lines and Teed lines).

At 132 kV and lower voltages 50 Watt PLCs should be used and, only by exception, with very unfavourable line conditions, e.g. multiple Teed lines, necessitate the use of a 100 Watt PLC. When any doubt exists as to which PLC rating should be used, the PTM&C Telecommunications Department must be consulted.

3.3.2 Line Trap phase location

A PLC propagation study (modal propagation) utilising a software program is done on a particular line to determine the positions of the line traps on the phases of a power line in the feeder bay. Table 2 below shall be populated by the relevant lines and substations engineers.

Table 2: Line Parameters

Tower Type(s)	
Line Length (km)	
Line Voltage (kV)	
Phase Conductors (Type)	
Earth Conductors (Type)	
Number of Phase Conductors in Bundle	
Bundle Spacing (mm)	
Attachment Position (Horizontal (x) & Vertical (y)) for all 3 Phase Conductors (Red/White/Blue) (m)	
Attachment Position (Horizontal (x) & Vertical (y)) for all Earth Conductors (m)	
Sag Phase Conductors (if available) (m)	
Sag Earth Conductors (if available) (m)	
Number of Transpositions	
Transposition locations (km)	
Transposition Swap sequences	
Phasing drawing displaying the Line Phasing which corresponds to the substation phasing diagrams at both ends of the line. (Should be provided by Substations department)	

3.3.3 Frequency allocation

The PLC frequencies are allocated according to the procedure 240-56362025. The PLC database and PLC frequency diagrams are used to ensure that the correct PLC frequency is allocated. The PLC frequency allocation is completed by PTM&C Telecommunications department for Eskom.

If there are powerline stubs and T-offs, these details need to be provided before the PLC frequencies can be allocated. The stubs and T-offs could completely attenuate the PLC signal at a particular frequency.

Table 3 shall be populated by the relevant PTM&C Planning engineers.

Table 3: Checklist for requesting PLC frequencies from PTM&C Telecomms

Checklist of Required Information when requesting PLC Frequencies			
No.	**Item**	**Comments**	**Check Y/N**
1	Powerline Network diagram	A diagram showing the power network topology.	
2	Project Execution Plan	In order to save costs, PLCs can be juggled around to accommodate the project execution plan.	
3	Teleprotection plan for new project	To determine the new requirement	
4	As-built PLC frequency allocations at local and remote substations	Photographs of all Carrier Panels at local and Remote Substations clearly displaying the frequencies.	

3.3.4 PLC equipment

Table 4 below depicts the PLC equipment currently utilised by Eskom with descriptions of amplifiers and power supplies.

Table 4: PLC equipment specifications

PLC equipment	Amplifier	Power Supply	Tripping Channels	Notes
ETI 21/41/101 (incl. NSD 41 TPE)	20/40/80W	48 V DC	2	No spares available
ETL 41/81 (incl. NSD 50 TPE)	40/80W	48 V DC	2	No spares available
ETL 500 (incl. NSD 550 TPE)	40/80W	48 V DC	3	No spares available. A 2 kHz PLC can only be used for Teleprotection and has a limit on the frequency range from 30 to 250 kHz. A 4 kHz PLC has a range from 30-500 kHz and are used to facilitate auxiliaries.
ETL 600 (incl. NSD 600 TPE)	40/80W	48 V DC	3	The PLCs could either be 2 kHz or 4 kHz.
ETL 651/6101 (incl. NSD 600 TPE)	50/100W	48 V DC	3	The PLCs could either be 2 kHz, 4 kHz or 8 kHz.

3.3.5 Teleprotection design considerations

The Teleprotection equipment is normally the standalone unit which is installed in the protection panels. There are also some installed in their separate cabinets. The teleprotection units either could utilise dedicated fibre optic cables or ET network using an X.21 port.

Table 5: TPE specifications

TPE equipment	Communications Option	Power Supply	Channels	Notes
NSD 70	X.21 (ET network)	48 V DC	2	No spares available
DIP 5000	X.21 or dedicated fibre (40km and 100 km)	48/110/220 V DC	3	No spares available
NSD 570	X.21 or dedicated fibre (40km and 100 km)	48/110/220 V DC	3	Spares available

3.4 Contact base interfaces

There are three basic interfacing systems used in Eskom for interconnection between the contact based protection relaying equipment and associated teleprotection equipment as described in detail below, namely System A, System B and System C.

3.4.1 System A interface

The general aspects of this version of interface are illustrated in Figure 1 and are generally applicable to all phase 1 protection schemes.

It can be seen that both the "trip send" and "trip receive" wetting voltages are derived from the protection equipment, and can be either 110 V_{DC} or 220 V_{DC} depending on the station battery. The cable for the interconnection between the protection and teleprotection equipment is the "Z cable".

As the 110/220 V_{DC} battery can be considered as "dirty" i.e. subject to high levels of noise and surges because it is effectively extended into the HV yard environment. Therefore, the teleprotection "trip send" input needs to have a high burden or surge withstand capability as specified in the Eskom specification, 240-77422828.

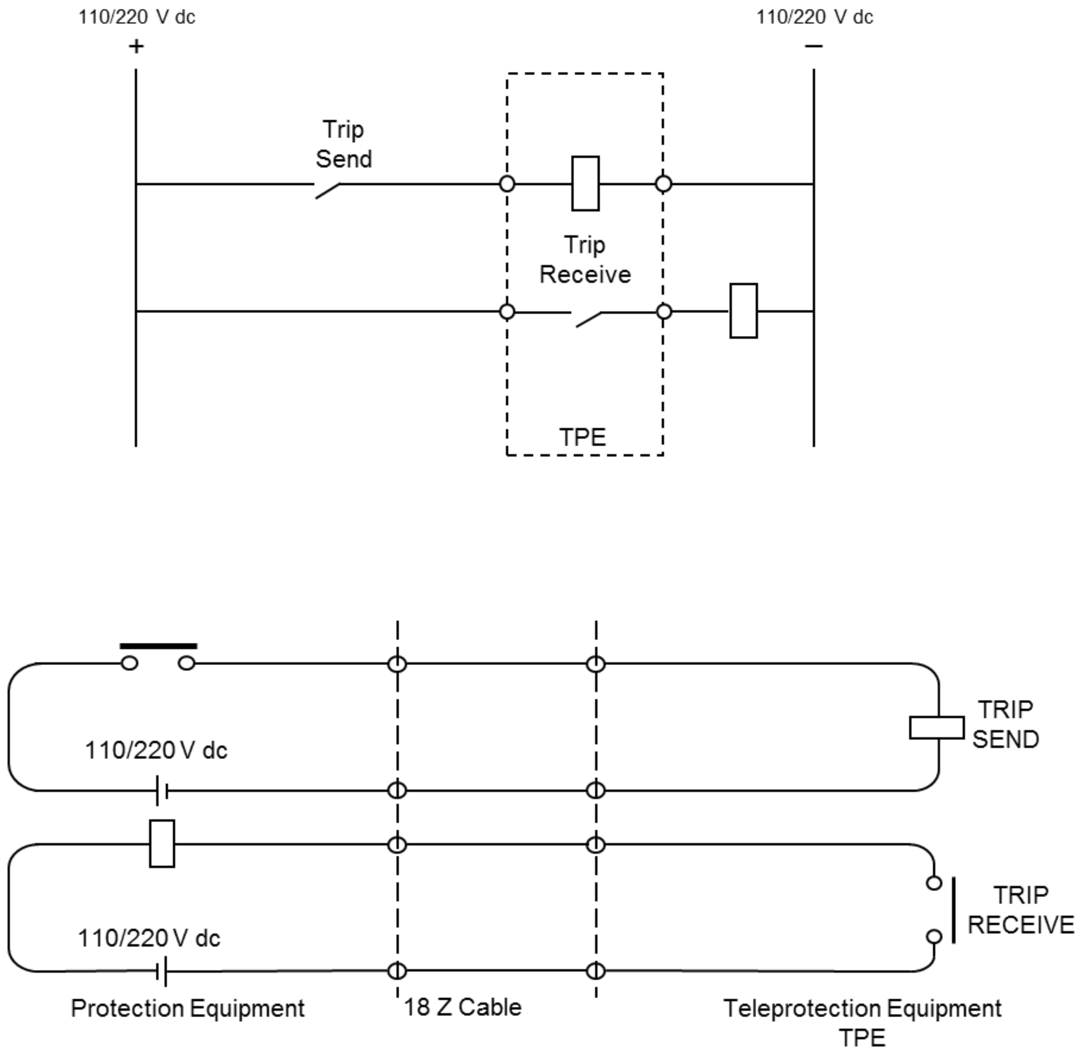


Figure 1: System A interface

3.4.2 System B interface

This is shown in Figure 2 and is generally used with phase 2 protection schemes.

In this case the "trip send" wetting voltage is supplied by the teleprotection equipment, and the trip receive contact is interrogated by a voltage derived from the protection equipment. In other words, each party provides the other with a potential free contact and a wetting voltage using a 12 Z or 18 Z teleprotection cable.

The "trip send" input is not required to have the same degree of transient suppression as for system A, as both wetting supplies are "clean" i.e. do not leave the relay or the communications room environment, and the burden can be greatly reduced. This of course means that smaller, and hence faster, relays can be used, improving overall system performance. This system is being phased out in Eskom. When teleprotection is been refurbished then the protection scheme must be modified.

Note: The new PLC and TPE equipment only function on either System A or System C schemes. When the new equipment is installed, then the System B protection schemes must be modified or refurbished to a System C scheme.

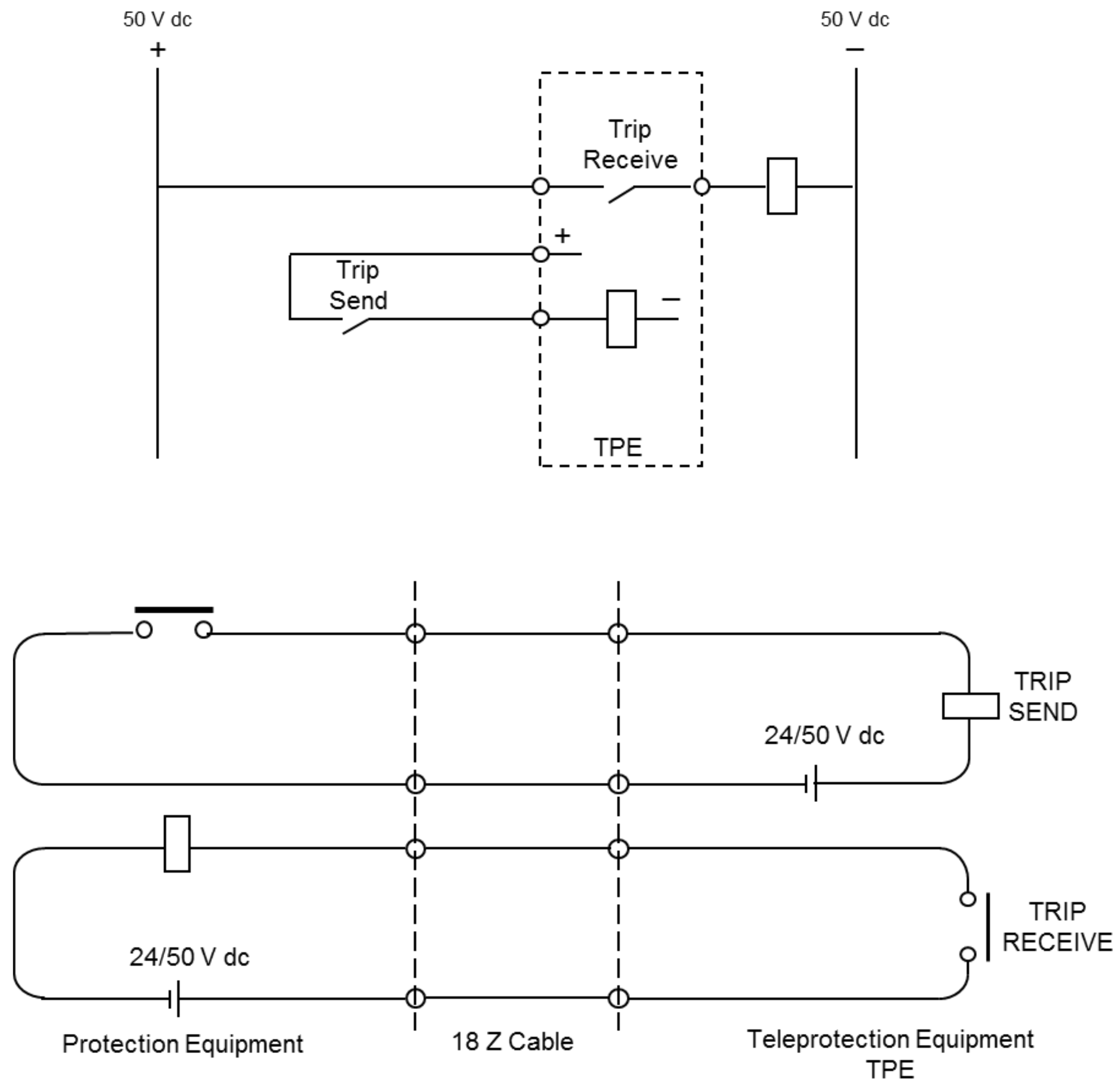


Figure 2: System B interface

3.4.3 System C interface

This is shown in the attached Figure 3 and is used mainly with phase 3 onwards protection schemes.

System C is very similar to System A, i.e. both the “trip send’ and “trip receive” 50 V_{DC} interrogating voltages are derived from the protection panel.

The prime reason for the introduction of this type of interface is to simplify the overall system, i.e. only one wetting voltage source is needed. This rationalisation simplifies the monitoring of the interface system.

As for System “A”, the interconnection between the teleprotection equipment and the protection panel used, is a “Z” type armoured cable.

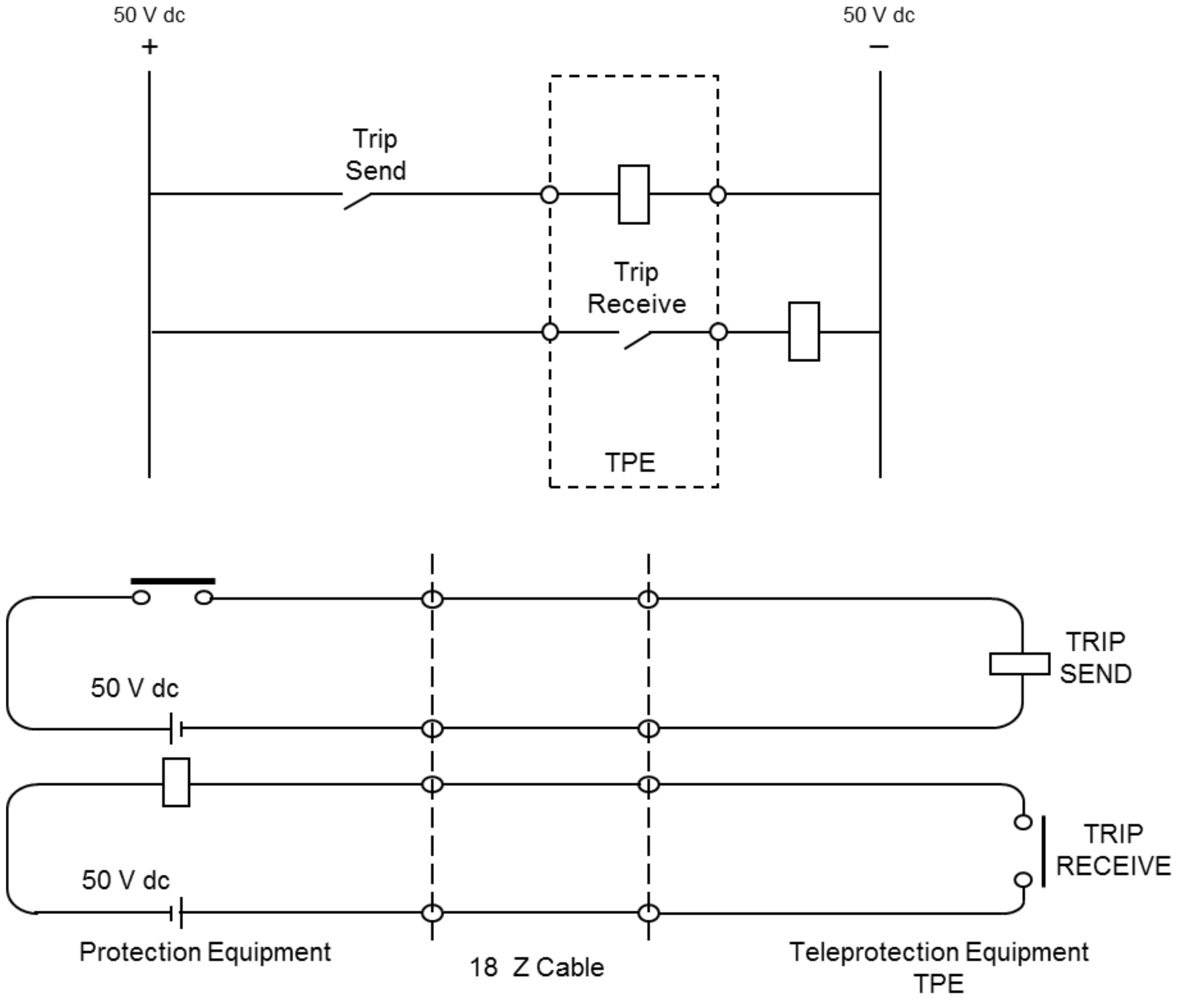


Figure 3: System C interface

3.5 Protective relay technology phases

Existing protective relay technologies employed in Eskom can be categorised into one of four "phases", as summarised in Table 6, including an indication of the phase (Ph) number, applicable time period of installation and designed life, key attributes and their interface with SCADA.

Table 6: Summary of protective relay technology phases and their interfaces to SCADA

Ph	Relay technology	Time period	Attributes	SCADA interface
1	Electromechanical induction discs, balance beams, mechanical timers	Prior to 1982. Designed working life in excess of 40 years.	Robust design and construction. Separate relays provided for each function. Multiple relays provided per scheme. Minimal number of settings (low 10's). No event records available unless by discrete recording device.	Provided as a separate system to the protection functions. Not commonly provided in Distribution-level equipment. Subsequently retrofitted, but often for critical functions only. Analogue values often not reported.

Ph	Relay technology	Time period	Attributes	SCADA interface
2	Electronic Printed circuit boards with discrete components. Modularised relays	1982 – 1993. Design life 10 - 15 years.	Limited integration of functions into devices. Electronic component and card failures, especially power supplies, relatively frequent. Frequently prioritised for refurbishment ahead of Phase 1 equipment. Settings via DIP switches and potentiometers, still a minimal number of settings (low 10's).	Separate system to protection as per Phase 1. Protection schemes catering for SCADA interface as standard. Binary and analogue information reported.
3	Early numerical Microprocessor-based multifunction relays	1994 – 2001. Design life 15 - 20 years.	Relays with multifunction capability. Limited functional integration implemented: hesitation to "put eggs in one basket". Settings entered via PC software or typed into relay. Number of settings increased to low 100's. Event and disturbance records available, but low sampling rate and small storage capacity.	Similar to Phase 2, but greater number of points reported (less grouping of information).
	Late numerical Microprocessor based multifunction relays with enhanced communication	2001 – present. Design life 15 – 20 years.	As per Phase 3, but with enhanced processing and communication capabilities, more advanced algorithms. Multifunction capabilities of IEDs increasingly used, evolving to "two relay" solutions per scheme (dual mains, or main and back-up). Significant programmable logic features for user customisation. Programmable logic replaces copper wiring within the scheme. Settings increased to low-to-mid 1000's, often with logic programming using graphical tools.	Initially as per Phase 3. Serial communication used between relays and RTU's starting from 2006. Ethernet communication became available as an option on new scheme contracts starting in 2010. Capability for significantly more discrete points to be reported to SCADA. Analogue measurements reported in primary quantities by IEDs, significantly reducing commissioning errors.

3.6 Teleprotection interface cable

The teleprotection interface cable, known as a Z cable, is manufactured with 18 cores. Eskom standardised on using only the "18 Z" cable. This cable is armoured to provide mechanical and electrical protection.

The colours for the "18 Z" type Cable is shown in Table 9. As can be seen in the table, the colour of each core is assigned to a signal or Teleprotection alarm. It should also be noted that each colour has its own polarity.

The protection trip signals originate from the protection panel and connect to the Teleprotection PIAs as shown in Table 7. PIA1 is wired for protection channel A which is used for directional earth fault tripping. PIA2 is wired for protection channel B which is used for permissive tripping. PIA3 is wired for protection channel C which is used for direct transfer tripping. Table 7 lists the connection of the protection channels to the PIAs/connectors using the 18 Z cable.

3.7 Current differential scheme

The current differential protection relays are installed on both ends of an EHV/HV power line to protect that line. The relays communicate with each other using data signals transmitted via the fibre optic cable. When there is a fault on the power line which results in a change of the current vectors (amplitude and direction), both protection relays communicate with each other to confirm the fault and would decide on tripping the breakers at each end of the power line. The latency of the link needs to be constant in order to correlate the reading of the phase angles between the two relays. Therefore the preferred communication medium for current differential scheme is fibre optic cables as minimum and constant latencies are obtained.

Eskom standardised on the use of single mode (SM) fibre for teleprotection applications. It is standard practice, however, that all current differential (Current diff) unit protection relays in Transmission (and Distribution) make use of a dedicated fibre pair (or two fibre cores), between the two substations.

3.7.1 Fibre Drivers

The following items are recommendations for fibre drivers:

a) For a wavelength of 1310 nm – short/medium range: 0 - 40km

b) For a wavelength of 1550 nm – medium/long range: 40 - 100km

c) The breaker and a half scheme requires four fibre cores instead of the usual two.

d) The 3 or 4 way current differential scheme requires a ring topography that would need four fibre optic cores.

3.8 PLC/TPE Equipment

Table 7 displays the current PLC and Teleprotection types and relates the number of channels and protection functions that can be accommodated.

Table 7: Current PLC/TPE and Protection equipment

PLC/TPE	Available Channels	Protection Scheme	Required Channels	Channel Use	Protection Channel	Protection Interface type
ABB ETI	2	Phase 1	1	Ch1	B	System A & B
		Phase 2	2	Ch1 & Ch2	B & C	System A & B
NSD70 ABB ETL 41/81	2	Phase 1	1	Ch1	B	System A & C
		Phase 2	2	Ch1 & Ch2	B & C	System A & C
		Phase 3 & onwards	3 (third channel not available)	Ch1 & Ch2 No E/F Acc	B & C	System A & C
ABB ETL500 ABB ETL600 NSD570 DIP5000	3	Phase 1	1	Ch2	B	System A & C
		Phase 2	2	Ch2 & Ch3	B & C	System A & C
		Phase 3 & onwards	3	Ch1, Ch2 & Ch3	A, B & C	System A & C

Note:	
Channel A – Directional Earth Fault Channel B – Permissive Tripping Channel C – Direct Transfer Trip/ Breaker Fail	System A – Protection Trip Send and Receive 110 & 220 VDC System B – TPE Trip Send and Protection Receive 24 & 50 VDC System C – Protection Trip Send and Receive 50 VDC

Table 8 displays the PLC and Teleprotection types that require replacement and relates the compatibility with the different protection relays and functions.

Table 8: PLC/TPE equipment for Refurbishment Projects

PLC/TPE	Available Channels	Protection Scheme	Required Channels	Channel Use	Protection Channel	Protection Interface type
ABB ETI	2	**The ABB ETI PLC shall be replaced.** **Note:** 1) The ABB ETI PLC is not compatible with the System C protection schemes as the PLC does not provide the 48V DC signalling protection requirements (System C). 2) Only 2 channels available whereas the new Protection Schemes require 3 channels.				
NSD70 ABB ETL 41/81	2	**The ABB NSD 70 and ETL 41/81 PLC shall be replaced.** **Note:** 1) Only 2 channels available whereas the new Protection Schemes require 3 channels.				
ABB ETL500 ABB ETL600 NSD570 DIP5000	3	Phase 1	1	Ch2	B	System A & C
		Phase 2	2	Ch2 & Ch3	B & C	System A & C
		Phase 3 & onwards	3	Ch1, Ch2 & Ch3	A, B & C	System A & C

Note:

Channel A – Directional Earth Fault Channel B – Permissive Tripping Channel C – Direct Transfer Trip/ Breaker Fail	System A – Protection Trip Send and Receive 110 & 220 VDC System B – TPE Trip Send and Protection Receive 24 & 50 VDC System C – Protection Trip Send and Receive 50 VDC

Table 9: Cable colour and connection markings

PIA	Protection Channel	Protection Signal	Polarity	PIA terminal ABB PLC & TPE	DIP5000 Connector	Z-Cable	Ferrule M1	Ferrule M2
PIA 1	CH A Directional Earth Fault	Send (Tx)	+	S1a	P13/4	Red (R)	T111	T311
			-	S1b	P13/3	Blue (Be)	T102	T302
		Receive (Rx)	+	R1a	P11/3	Brown (Bn)	T101	T301
			-	R1b	P11/4	Light Green (L Gn)	T105	T305
		Alarm	+	F1a	P16/7	Yellow with Red (Y/R)	*	*
			-	F1b	P16/8	White with Red (W/R)	*	*
PIA	**Protection Channel**	**Protection Signal**	**Polarity**	**PIA term**	**DIP5000 Connector**	**Z-Cable**	**Ferrule M1**	**Ferrule M2**
PIA 2	CH B Permissive Tripping	Send (Tx)	+	S2a	P13/6	Grey (Gy)	T113	T313
			-	S2b	P13/5	Violet (V)	T102	T302
		Receive (Rx)	+	R2a	P11/5	Orange (O)	T101	T301
			-	R2b	P11/6	Pink (Pk)	T107	T307
		Alarm	+	F2a	P16/10	Red with Blue (R/Be)	*	*
			-	F2b	P16/11	Green with Red (Gn/R)	*	*

PIA	Protection Channel	Protection Signal	Polarity	PIA term	DIP5000 Connector	Z-Cable	Ferrule M1	Ferrule M2
PIA 3	CH C Direct Transfer Tripping	Send (Tx)	+	S3a	P13/8	Green (Gn)	T115	T315
			-	S3b	P13/7	Black (Bk)	T102	T302
		Receive (Rx)	+	R3a	P11/7	White (W)	T101	T301
			-	R3b	P11/8	Yellow (Y)	T109	T309
		Alarm	+	F3a	P16/10	Red with Black (R/Bk)	*	*
			-	F3b	P16/11	Red with Brown (R/Bn)	*	*

Note:

1) “ * “ - See control/protection drawings for the alarm connections.

2) For the ABB PLC and NSD units the PIA terminal connections in Table 8 above and Annex A must be used.

3) For the Actom DIP 5000 units the PIA terminal connections in Table 8 above and Annex B must be used.

The Teleprotection and PLC alarms are allocated by the control applications engineer. For Transmission, the alarm naming convention must follow the specification 240-97276914 as listed in Table 10.

Table 10: Alarms

Point Name	Point Name ID	Description	Meaning Action	Controller's Action
		Main_1_SSB_TPE_ETI_Rx	A receive alarm on the ETI type PLC Main1	Call the Teleprotection technician in the Grid
		Main_1_SSB_TPE_ETI_Tx	A transmit alarm on the ETI type PLC Main1	Call the Teleprotection technician in the Grid
		Main_1_SSB_TPE_ETL_Rx	A receive alarm on the ETL 41/81 type PLC Main1	Call the Teleprotection technician in the Grid
		Main_1_SSB_TPE_ETL_Tx	A transmit alarm on the ETL 41/81 type PLC Main1	Call the Teleprotection technician in the Grid
		Main_1_SSB_TPE_ETL5_Hardware	A hardware failure on the ETL 541/581 type PLC Main1	Call the Teleprotection technician in the Grid
		Main_1_SSB_TPE_ETL5_Link	A telecommunications failure on the ETL 541/581 type PLC Main1	Call the Teleprotection technician in the Grid
		Main_1_SSB_TPE_ETL6_Hardware	A hardware failure on the ETL 641/681 type PLC Main1	Call the Teleprotection technician in the Grid
		Main_1_SSB_TPE_ETL6_Link	A telecommunications failure on the ETL 641/681 type PLC Main1	Call the Teleprotection technician in the Grid
		Main_1_SSB_TPE_ETL61_Hardware	A hardware failure on the ETL 651/6101 type PLC Main1	Call the Teleprotection technician in the Grid
		Main_1_SSB_TPE_ETL61_Link	A telecommunications failure on the ETL 651/6101 type PLC Main1	Call the Teleprotection technician in the Grid
		Main_1_TPE_DIP5000_General	A general alarm, (hardware, telecoms) on the DIP 5000 Teleprotection unit Main1	Call the Teleprotection technician in the Grid

Point Name	Point Name ID	Description	Meaning Action	Controller's Action
		Main_1_TPE_NSD570_General	A general alarm, (hardware, telecoms) on the NSD 570 Teleprotection unit Main1	Call the Teleprotection technician in the Grid
		Main_1_TPE_NSD70_General	A general alarm, (hardware, telecoms) on the NSD 70 Teleprotection unit Main1	Call the Teleprotection technician in the Grid
		Main_2_SSB_TPE_ETI_Rx	A receive alarm on the ETI type PLC Main 2	Call the Teleprotection technician in the Grid
		Main_2_SSB_TPE_ETI_Tx	A transmit alarm on the ETI type PLC Main 2	Call the Teleprotection technician in the Grid
		Main_2_SSB_TPE_ETL_Rx	A receive alarm on the ETL 41/81 type PLC Main 2	Call the Teleprotection technician in the Grid
		Main_2_SSB_TPE_ETL_Tx	A transmit alarm on the ETL 41/81 type PLC Main 2	Call the Teleprotection technician in the Grid
		Main_2_SSB_TPE_ETL5_Hardware	A hardware failure on the ETL 541/581 type PLC Main 2	Call the Teleprotection technician in the Grid
		Main_2_SSB_TPE_ETL5_Link	A telecommunications failure on the ETL 541/581 type PLC Main 2	Call the Teleprotection technician in the Grid
		Main_2_SSB_TPE_ETL6_Hardware	A hardware failure on the ETL 641/681 type PLC Main 2	Call the Teleprotection technician in the Grid
		Main_2_SSB_TPE_ETL6_Link	A telecommunications failure on the ETL 641/681 type PLC Main 2	Call the Teleprotection technician in the Grid
		Main_2_SSB_TPE_ETL61_Hardware	A hardware failure on the ETL 651/6101 type PLC Main 2	Call the Teleprotection technician in the Grid
		Main_2_SSB_TPE_ETL61_Link	A telecommunications failure on the ETL 651/6101 type PLC Main 2	Call the Teleprotection technician in the Grid
		Main_2_TPE_DIP5000_General	A general alarm, (hardware, telecoms) on the DIP 5000 Teleprotection unit Main 2	Call the Teleprotection technician in the Grid
		Main_2_TPE_NSD570_General	A general alarm, (hardware, telecoms) on the NSD 570 Teleprotection unit Main 2	Call the Teleprotection technician in the Grid
		Main_2_TPE_NSD70_General	A general alarm, (hardware, telecoms) on the NSD 70 Teleprotection unit Main 1	Call the Teleprotection technician in the Grid

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

Name and surname	Designation
Prudence Madiba	Senior Manager – GX
Isabel Fick	Senior Manager – Eskom Telecommunications
Maureen Mokone	Senior Manager – GIT (Acting)
Botse Sikhwitshi	Senior Manager – Group Security Senior Manager (Acting)

5. Revisions

Date	Rev	Compiler	Remarks
March 2020	2	T. Gosai	Revised due to document review date & added requirements for PLC frequency allocations.
April 2015	1	J. Schutte	Reformat/template change to SCOT. Restructured and summarised content. Document number changed to 240-90353855
Oct 2008	0	P. T. Griffith	New document (TGL41-909)

6. Development team

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

- A Pereira

7. Acknowledgements

Not applicable.

Annex A – Interface diagram for the ABB PLCs and NSD equipment for three tripping channels, using one 18 Z teleprotection cable

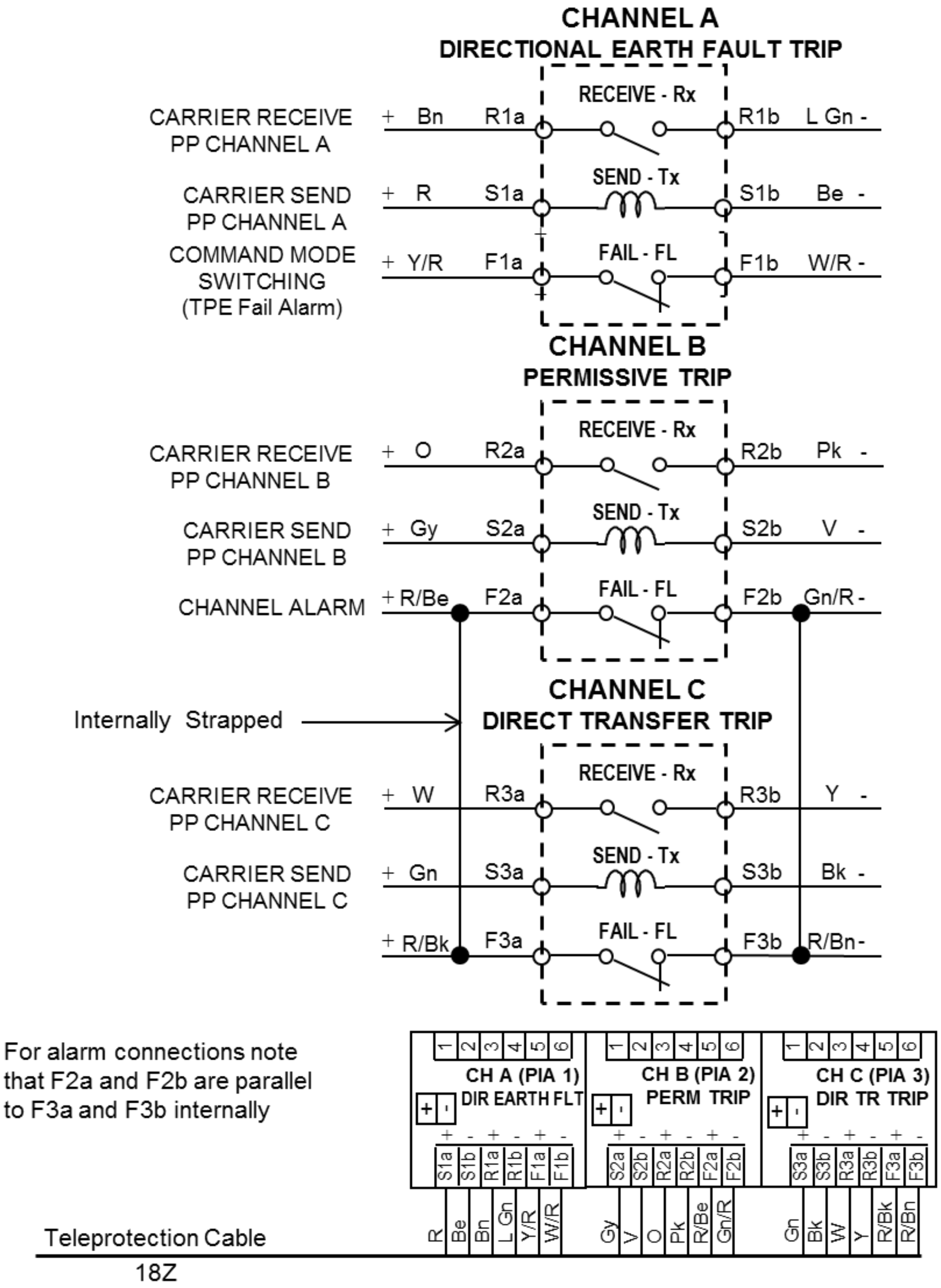
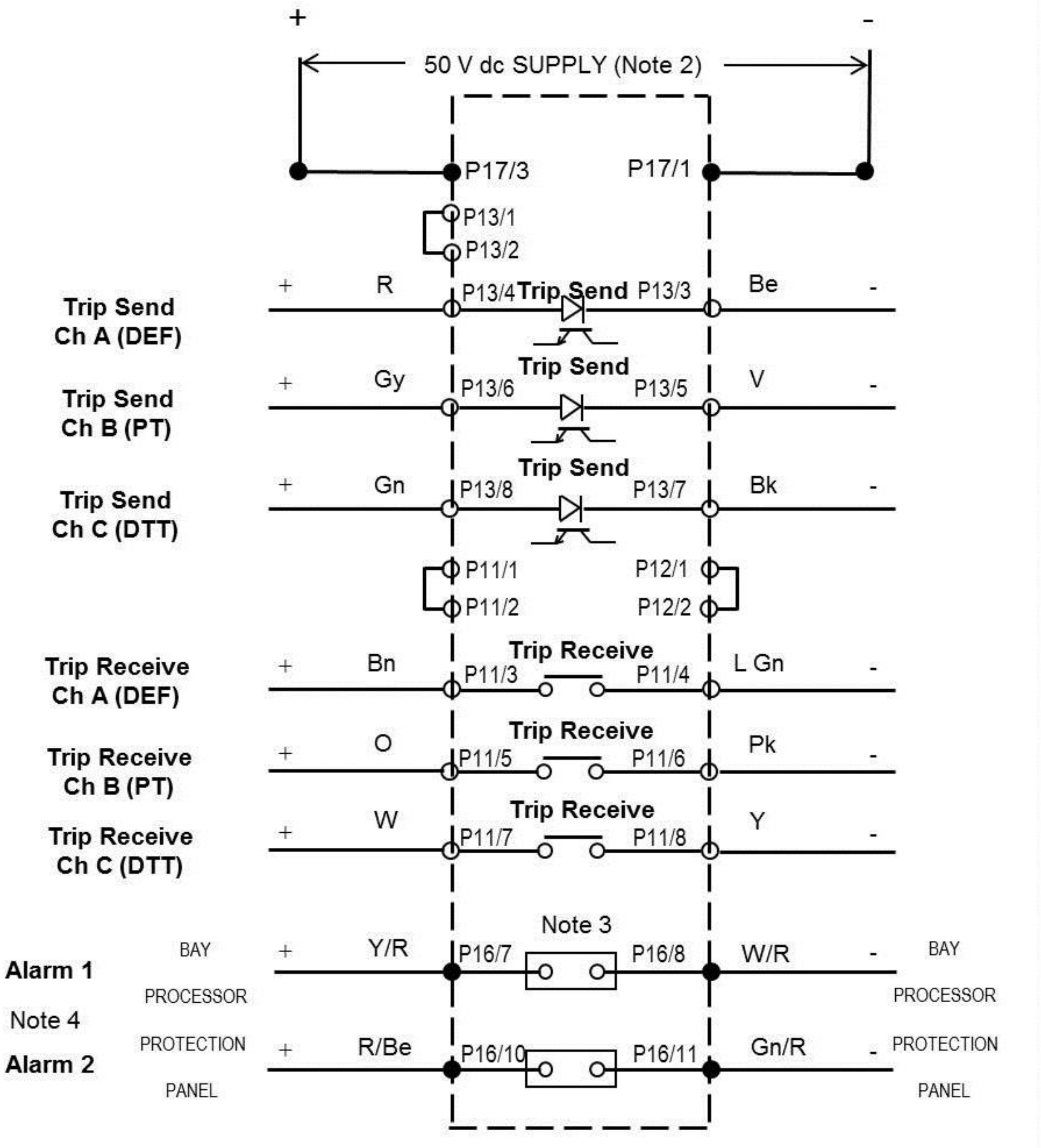


Figure A.1: ABB 18 Z Cable Connection

Annex B – Interface diagram for the DIP5000 equipment for three tripping channels, using one 18 Z teleprotection cable



Note1. The "trip send" and "trip receive" signals and operating power supply of the DIP 5000 is wired internally to the phase 4 and 5 protection panels.

Note 2. The operating voltage of the DIP 5000 installed in a protection panel is 110/220 V dc.

Note 3. Alarm Contacts closes for fail condition.

Note 4. **No alarms are extended for Phase 4 applications.**

Figure B.1: DIP 5000 18 Z Cable Connection