NUMERICAL INTEGRATED FEEDER PROTECTION RELAY
ANZ 114/214[AN SERIES]

User Manual

ALUMINIUM INDUSTRIES LIMITED
RELAYS DIVISION
THIRUVANANTHAPURAM

ANZ 114/ANZ 214

Numerical Integrated Feeder Protection Relay

CONTENTS

ALUMINIUM INDUSTRIES LIMITED
Relays Division

SAFETY REQUIREMENTS

ALUMINIUM INDUSTRIES LIMITED
Relays Division

CONTENTS

INTRODUCTION

Before using this product, be sure to read this chapter carefully.

This chapter describes safety precautions when using the relay. Before installing and using the equipment, read and understand this chapter thoroughly.

It's not a secret – electricity can be dangerous and when things go wrong lives can be at stake!

Electrical engineers are Industrial safety doctors, so it's our duty to keep employees health and maintain a quality of life that we all deserve by providing safe work practices to avoid electrical accidents.

How much electricity is dangerous?????

CURRENT	EFFECT
0.5 – 3mA	Tingling sensations
3 – 10mA	Muscle contractions (painful)
10 – 40mA	"can't let go" phenomena
40 – 75mA	Respiratory paralysis (possibly fatal)
75 – 200mA	Ventricular fibrillation (likely fatal)
200 – 500mA	Heart clamps tight
>1.5A	Tissue and organs began to burn

Fact: A 15 amp circuit breaker was designed to protect equipment – not people!

The relay is developed with zero percentage of risk factor by its own design. The current carrying paths and circuits are isolated from the metal case and structure. Suitable clearance depending on the type of insulation required for different classes are provided.
The relay confirms to Product safety requirement standard IEC 60255-27.

HEALTH AND SAFETY

It deals with the handling of relay in proper way. An individual to be considered as 'qualified' with regard to certain equipment in the workplace, but 'unqualified' as to other equipment. "An employee, who is undergoing on the job training and who, in the course of such training, has demonstrated the ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person also considered to be a qualified person for the performance of those duties."

The following requirements must be met, in the order given, before circuits or equipments are re-energized, even temporarily.

- People handling the equipment should be aware about the relay safety handlet.
- Ensure that the product is in the off condition before working on the conducting or terminal side.
- A qualified person must conduct tests and visual inspections, as necessary, to verify that tools electrical jumpers, shorts, grounds and other such devices have been removed, so that the circuits and equipments can be safely re-energized.
- Employees exposed to the hazards associated with re-energizing the circuit or equipment must be warned to stay clear of the circuits and equipment.
- Each lock and tag must be removed by the employee who applied it or someone else under that employee's direct supervision.
- A visual determination that all employees are clear of the circuits and equipments must be made.

For any queries related to relays, feel free to contact ALIND.

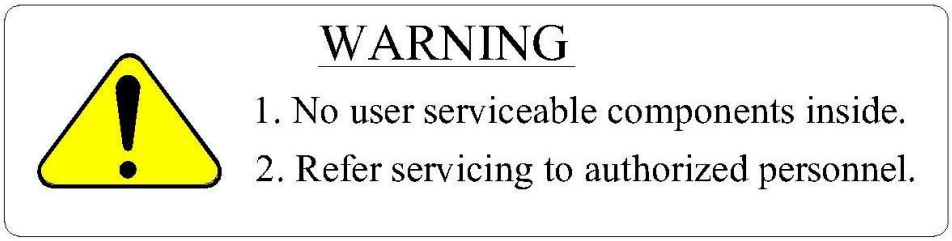
SYMBOLS AND LABELS USED IN THE RELAY

1. FRONT SIDE

Caution: refer to equipment documentation

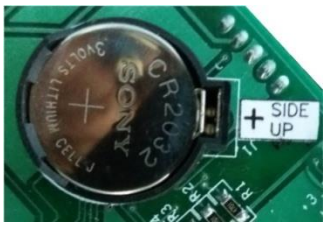
Caution: risk of electric shock

2. REAR SIDE



Protective Conductor (*Earth) terminal

Functional/Protective Conductor (*Earth) terminal.



CMOS Battery provided for the RTC (Real Time Clock) purpose.
Confirm polarity of the battery while replacing.

WARNING

Current transformer circuit

Never allow the current transformer (CT) secondary circuit connected to this equipment to be opened while the primary system is live. Opening the CT circuit will produce a dangerous high voltage.

Exposed terminals

Do not touch the terminals of this equipment while the power is on, as the high voltage generated is dangerous.

Residual voltage

Hazardous voltage can be present in the DC circuit just after switching off the DC power supply. It takes about 30 seconds for the voltage to discharge.

CAUTION

Earth

Earth the earthing terminal of the equipment securely.

Operation conditions

Use the equipment within the range of ambient temperature, humidity and dust as detailed in the specification and in an environment free of abnormal vibration.

Ratings

Before applying AC voltage and current or DC power supply to the equipment, check that they conform to the equipment ratings.

Printed circuit board

Do not attach and remove the printed circuit board while the DC power to the equipment is on, as this may cause the equipment to malfunction.

External circuit

When connecting the output contacts of the equipment to an external circuit, carefully check the supply voltage used and prevent the connected circuit from overheating.

Connection cable

Carefully handle the connection cable without applying excessive force.

Modification

Do not modify this equipment, as this may cause the equipment to malfunction, and any such cases, warranty may be affected.

DECOMMISIONING AND DISPOSAL

De-commissioning

The supply input (auxiliary) for the equipment may include capacitors across the supply or to earth. To avoid electric shock or energy hazards, after completely isolating the supplies to the equipment, the capacitors should be safely discharged via the external terminals prior to de-commissioning.

Disposal

When disposing of this equipment, do so in a safe manner according to local regulations. It is recommended that incineration and disposal to water courses is avoided. Ensure the relay is in de energized condition and take precautions to avoid short circuits.

TECHNICAL SPECIFICATIONS FOR SAFETY

1. Protective class

IEC 60255-27:2005	Class I (This equipment requires a protective conductor (earth) connection to ensure user safety.

2. Environment

IEC 60255-27:2005	Pollution degree 2 (Normally only non-conductive pollution occurs except occasionally a temporary conductivity caused by condensation is to be expected.)

3. Overvoltage Category

IEC 60255-27:2005	Category III (The auxiliary energizing circuits of the equipment are connected to a common battery, common mode transient voltages of a relatively high value may appear on the supply leads, and differential mode voltages may arise from switching in other circuits connected to the same battery source.

4. Contact data	Test voltage across open contact: 1 kV DC for 1 min

INTRODUCTION

CONTENTS

AN SERIES (ALIND NUMERICAL SERIES)

- Advanced Digital Fourier Transform based Numerical algorithm design using 16-bit Digital Signal Controller (DSC).
- Compact Construction covering several protection modules saving panel space.
- Man-Machine Communication through 20x4 character LCD display and LEDs.
- Self supervision of both hardware and software units.
- Interface ability with SCADA is achieved through IEC 60870-5-103 communication protocol.
- Facility for storing fault waveforms (Disturbance recorder) and events with date and Time stamping. At a time a total of 5000 events and 200 latest fault waveforms (Disturbance recorder) will be stored in the relay.
- Graphical User Interface for Harmonic analysis, DC analysis and di/dt analysis can be done on the uploaded fault waveforms with facility for report generation.
- Facility to access/modify the relay settings both online as well as through menu in local PC through SCADA at RCC.
- Relay Indication (LED) reset from RCC.
- Suitable password protection.
- IP 54 grade enclosure protection.
- GPS time Synchronization Facility.
- Settable CT and PT ratios.
- CB close and open command initiation from relay through RCC.

PREVIOUS HISTORY OF FEEDER PROTECTION RELAYS

AZ 1114

Distance Relay.
Static Type.
First product in Traction Feeder Protection.
Without reclosing facility.

AZ 1114+

Integrated feeder protection relay
Micro-processor based.
With reclosing facility.

AZM 1114+

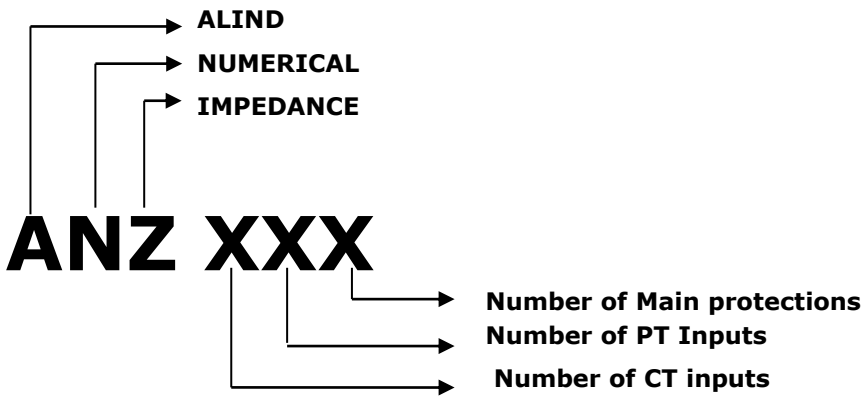
Numerical Integrated feeder protection relay
Miniaturized feeder protection module.
Disturbance & event recorder.
Built in counter facility.

AZM 1114+ (AN Series)

Numerical Integrated feeder protection relay
Miniaturized feeder protection module.
Built in counter facility.
Plug in type modular construction.
Disturbance & event recorder.
SCADA Interface (IEC 60870-5-103 Compatible).
Compact Design.

ANZ RELAYS

The relays are the modified versions of our AZM 1114+ (AN Series) relay. The relay incorporates Three Zone distance Protection with polygonal characteristics, Wrong Phase coupling Protection, Instantaneous / Definite Time OCR stages, Potential Fuse Failure Protection, thermal overload, harmonic restraint feature with an inbuilt Intelligent Auto-reclosure system.



ANZ 114: The relay conforms to RDSO specification No. TI/SPC/PSI/PROTCT/5070 (Rev. 1) and TI/SPC/PSI/PROTCT/4050. ANZ 114 (AN Series)relay is a comprehensive Integrated Feeder Protection relay for the protection of conventional 27 KV AC single phase, 50Hz Over Head Equipment (OHE).

ANZ 214: The relay conforms to RDSO specification no. TI/SPC/PSI/PROTCT/7100 (07/2012). ANZ 214 (AN Series)relay is a comprehensive Integrated Feeder Protection relay for the protection of 2x 25 KV (AT feeding system) AC single phase, 50Hz Over Head Equipment (OHE).

MAIN FUNCTIONS

Sl No.	PARTICULARS	ANZ 114	ANZ 214
1.	**MAIN PROTECTIONS**		
1.1	Distance protection element (DP)	✓	✓
1.1.1	Zone 1 Extension (DP)	✓	✓
1.1.2	Three Zone Distance Protection	✓	✓
1.2	Wrong phase coupling protection (WPC)	✓	
1.3	PT fuse failure trip/alarm (PTFF)	✓	✓
1.4	Over current protection	✓	✓
1.4.1	High set instantaneous element (OCR)	✓	✓
1.4.2	Two Stage Definite Time OCR	✓	✓
1.4.3	Directional Element (DP, Inst.OCR, Def. Time OCR)	✓	✓
2.	**ADDITIONAL FUNCTIONS**		
2.1	Local breaker backup (LBB)	✓	✓
2.2	Auto re-closure and lockout	✓	✓
2.3	Auto reclose Bypass (ARB)	✓	✓
2.4	SOTF (Switch On To Fault) protection	✓	✓
2.5	2nd Harmonics	✓	✓
2.6	Thermal Overload	✓	✓
3.	**STATUS INPUTS**		
3.1	AP/ GP low Alarm	✓	✓
3.2	AP/ GP Trip and Lock	✓	✓
3.3	ARB Input	✓	✓
3.4	Trip Circuit Supervision	✓	✓
3.5	Relay Fail	✓	✓
3.6	CB control Local/remote	✓	✓
3.7	Lockout reset from remote	✓	✓

GENERAL FUNCTIONS

Sl No.	PARTICULARS	ANZ 114	ANZ 214
1.	Password protection	✓	✓
2.	Event Memory	5000	5000
3.	Disturbance recorder waveforms	200	200
4.	50 cycles (45 pre and 5 post fault) of fault waveform for both V & I	✓	✓
5.	**COMMUNICATION**		
5.1	GUI Interface	Mini USB	Mini USB
5.2	Isolated RS 485 Interface	✓	✓
5.3	Communication Protocol Interface- IEC 60870-5-103	✓	✓
5.4	GPS Time Synchronization Facility	✓	✓
5.5	Date/time synchronization through PC	✓	✓
6.	**MONITORING**		
6.1	Z value	✓	✓
6.2	Phase Angle	✓	✓
6.3	Voltage	✓	✓
6.4	Current	✓	✓
6.5	Fault Distance	✓	✓
6.6	Resistance	✓	✓
6.7	Reactance	✓	✓
6.8	Thermal Value	✓	✓
6.9	Selectable CT ratio:5-5000/5A	✓	✓
6.10	Selectable PT ratio:110-30000/110V	✓	✓
6.11	Counters for each element(DP, WPC, PTFF, OCR, TOL, LBB)	✓	✓ Except WPC
7.	**USER INTERFACE**		
7.1	Test facility in Relay setting Mode(offline)	✓	✓
7.2	Compact Module	✓	✓
7.3	Plug In Type	✓	✓

HANDLING INSTALLATIONS & CASE DIMENSIONS

ALUMINIUM INDUSTRIES LIMITED
Relays Division

CONTENTS

HANDLING OF RELAY

Protective relays generally of robust construction require careful treatment prior to installation on site. Care must be taken when unpacking and installing the relays so that none of the parts are damaged. Relays must be handled by skilled personnel. The following should be taken into account while handling the relay:

- The relay use components that are sensitive to electrostatic discharges. The relay comprises of various semi-conductor devices which can damage if touched by means of direct contact. Handle the cards in static free environment since electrostatic discharge can affect performance of the relay or cause damage to the cards.
- The electronic circuits are well protected by the metal case and the internal module should not be withdrawn unnecessarily.
- The relay is normally shipped in separately packed condition. After unpacking, see if there is any mechanical damage to the cabinet, the nameplate, terminal blocks etc. Damage of any such sort identified shall be intimated to works.
- Avoid plugging in/ pulling out the cards when the power is ON.
- Do not apply CT inputs when auxiliary supply is switched OFF.
- If the cards are withdrawn for testing, ensure proper positioning while replacing.
- Keep the relays in well-packed condition in a dust-free dry environment without direct exposure to sunlight.

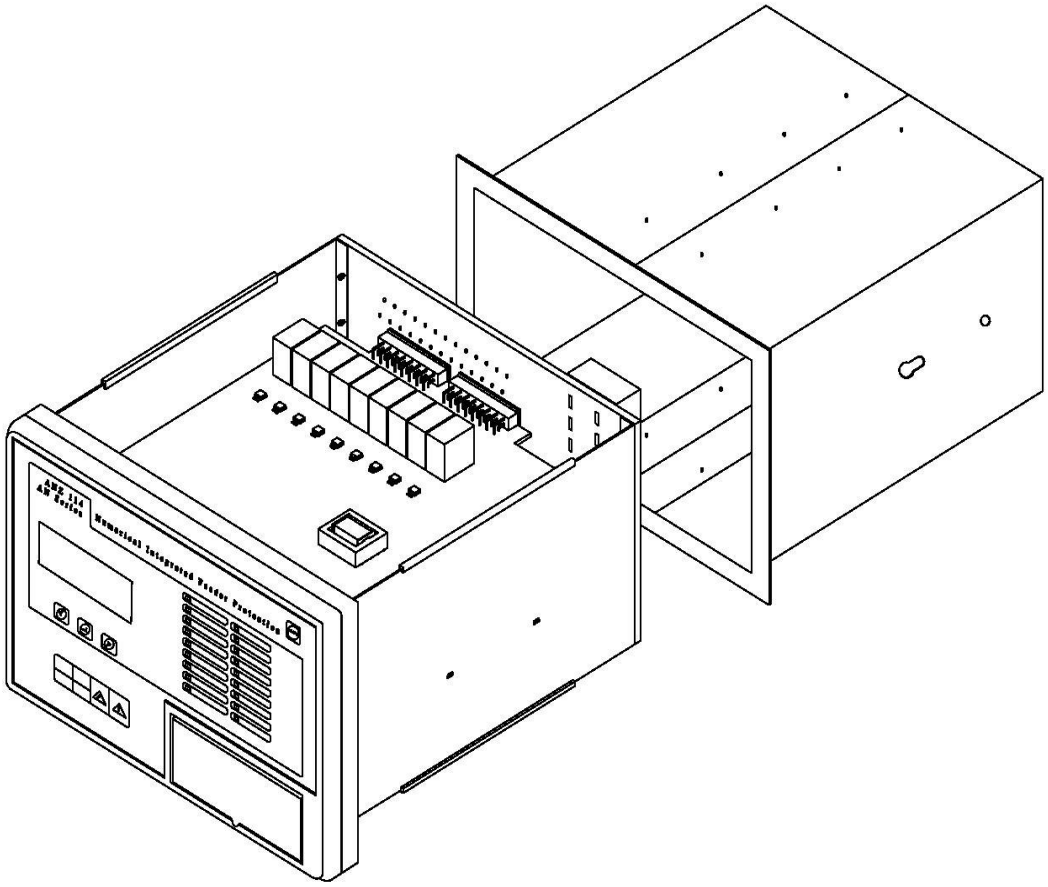
The relay is shipped from factory after detailed testing by our Quality Control Department. However, according to the customer requirement the relay settings/ functions can be verified before commissioning at respective sites with proper testing kits.

STORAGE

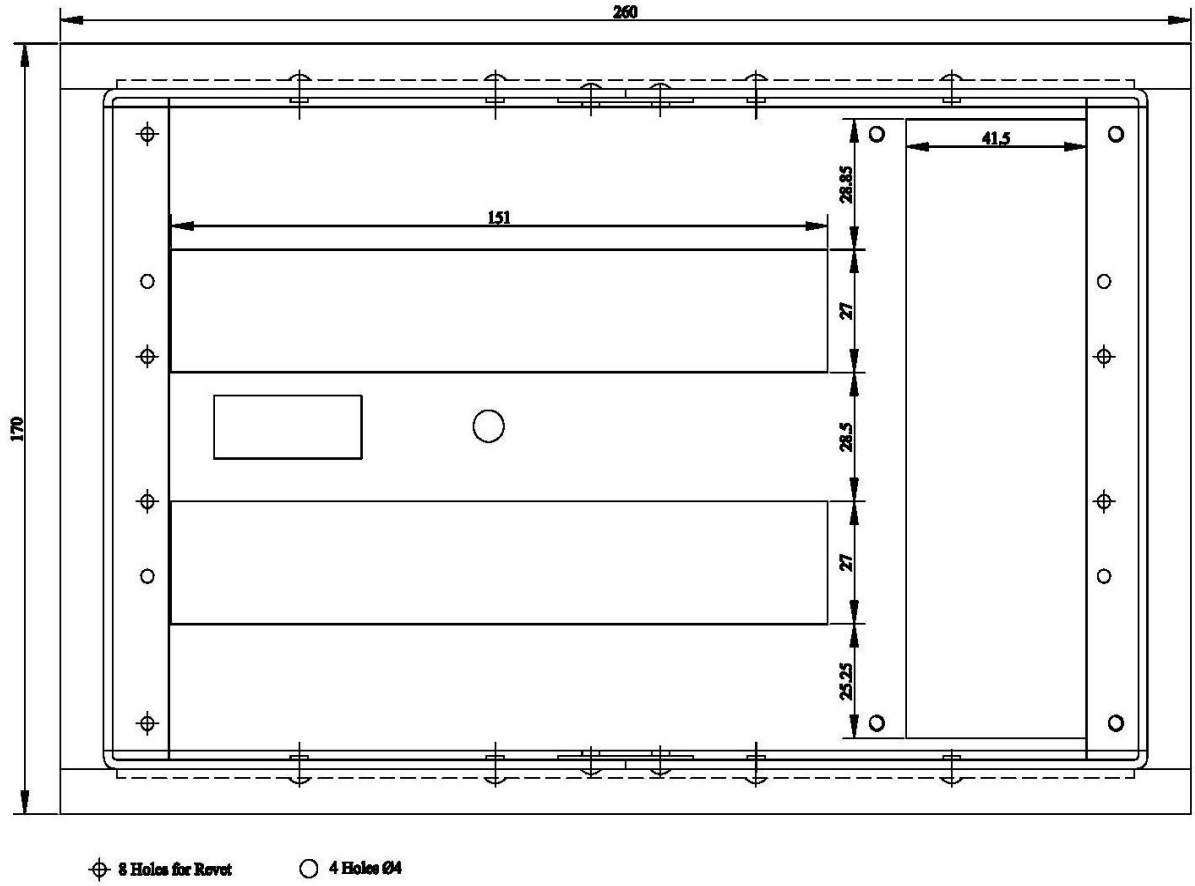
If relays are not to be installed immediately upon receipt they should be stored in a place free from dust and moisture in their original boxes. At most care should be taken while storage.

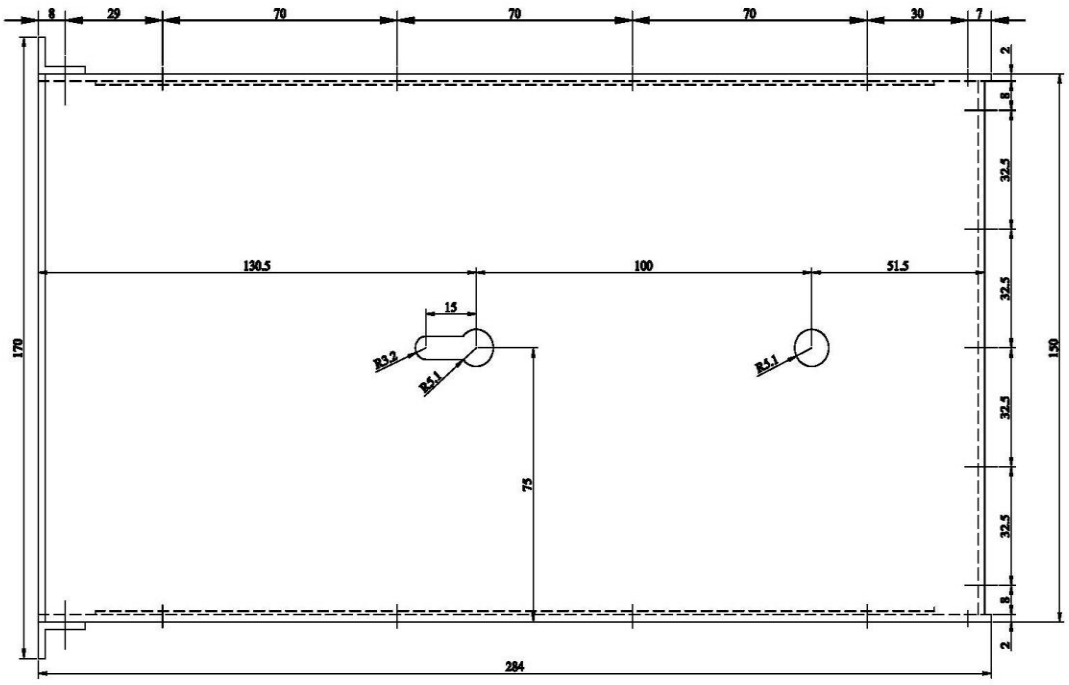
Storage temperature: -25ºC to +70ºC.

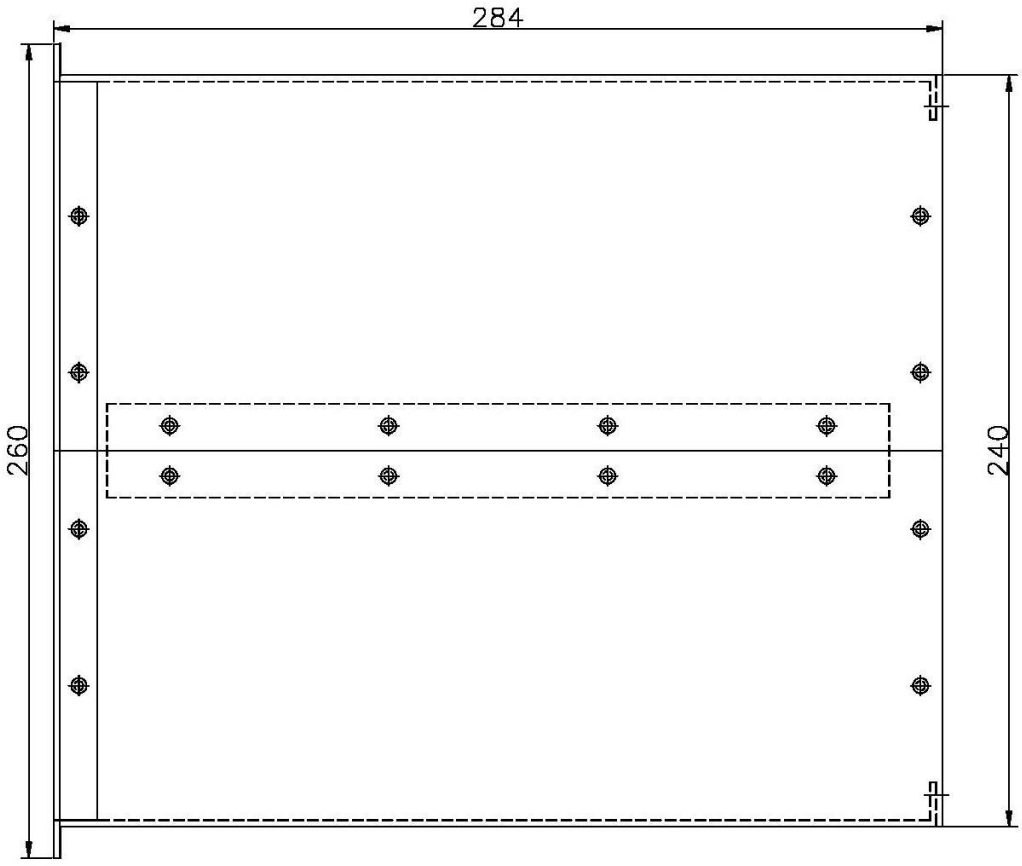
RELAY AND RACK MOUNTING



CASE DIMENSIONS




8
29
70
70
70
30
7
2
8
32.5
32.5
32.5
32.5
8
2
130.5
100
51.5
15
R3.2
R5.1
R5.1
75
170
150
284


284
260
240

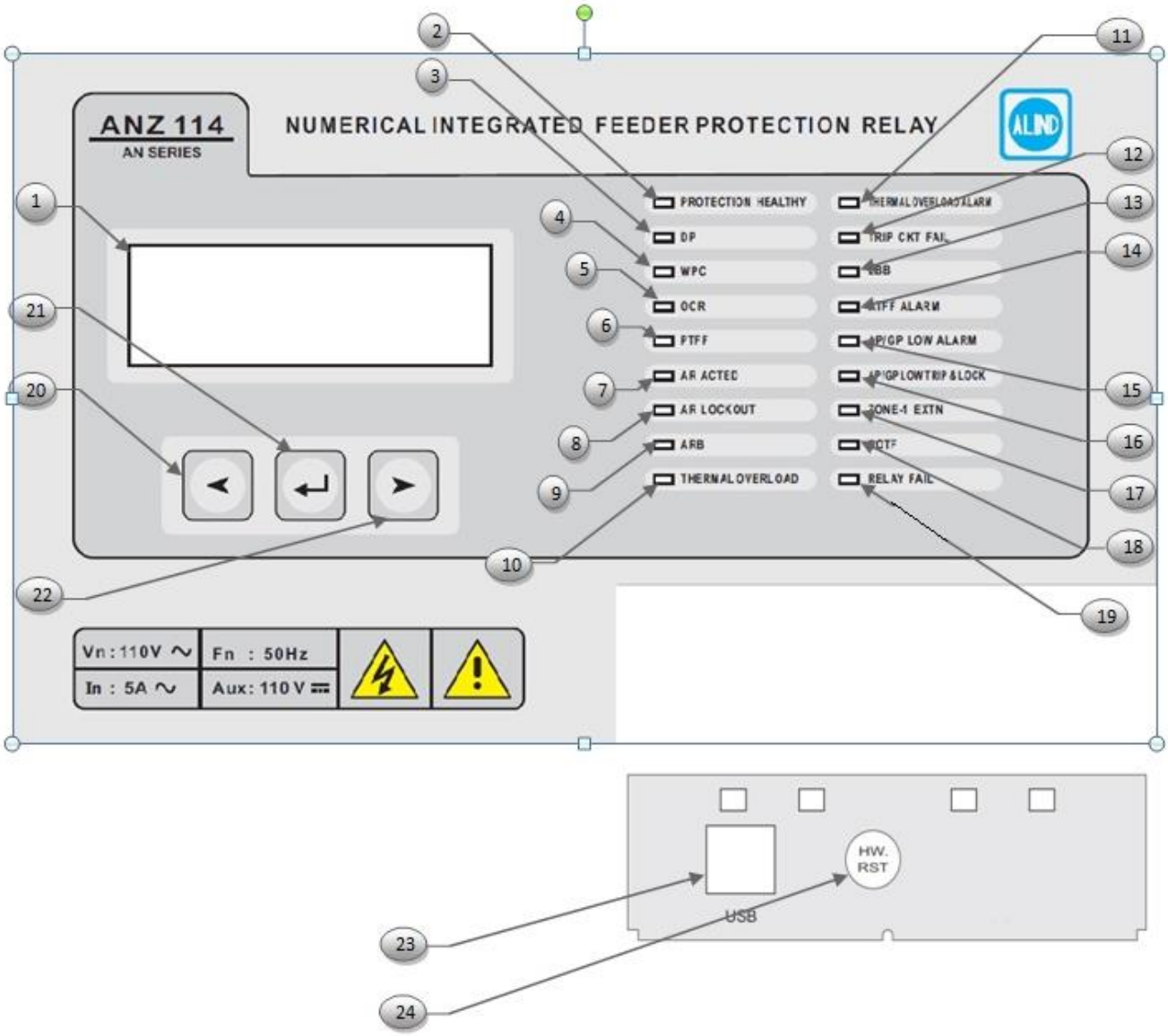
TOP VIEW

USER GUIDE

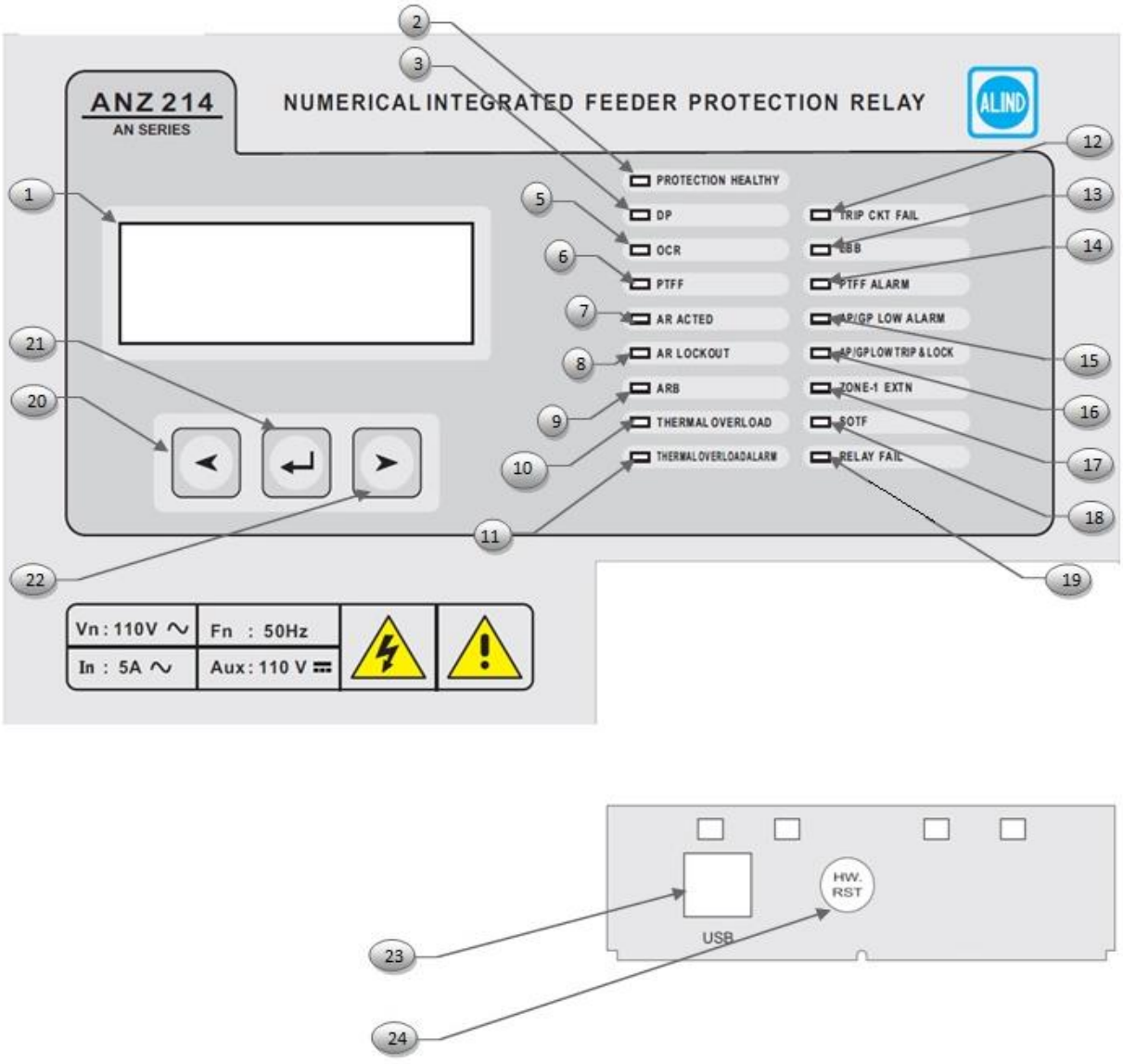
ALUMINIUM INDUSTRIES LIMITED
Relays Division

CONTENTS

FRONT PANEL INDICATIONS



ANZ 214


ANZ 214
AN SERIES
NUMERICAL INTEGRATED FEEDER PROTECTION RELAY
ALIND
PROTECTION HEALTHY
DP
OCR
PTFF
AR ACTED
AR LOCKOUT
ARB
THERMAL OVERLOAD
THERMAL OVERLOADALARM
TRIP CKT FAIL
CBB
PTFF ALARM
AP/GP LOW ALARM
AP/GP LOW TRIP & LOCK
ZONE-1 EXTN
SOTF
RELAY FAIL
Vn : 110V
Fn : 50Hz
In : 5A
Aux : 110 V
HW. RST
USB
1
2
3
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

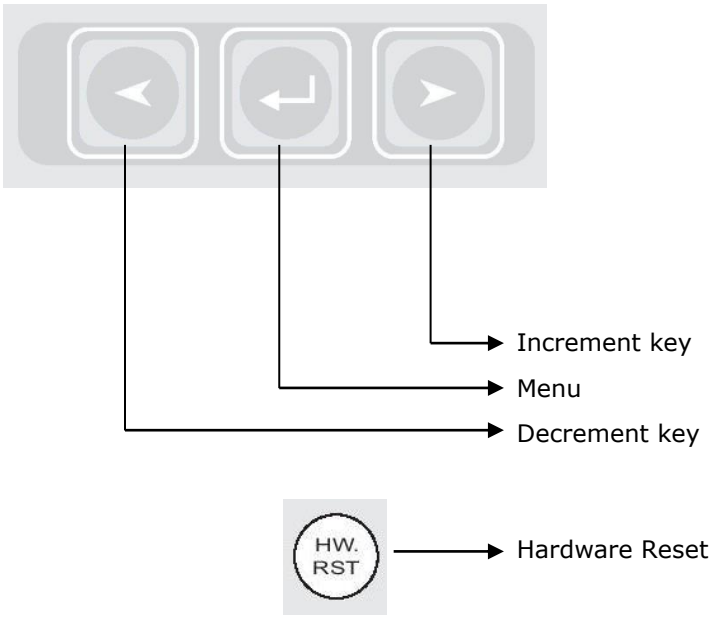
No	Legend	ANZ 114	ANZ 214
1.	LCD DISPLAY	✓	✓
2.	PROTECTION HEALTHY (Green/Amber)	✓	✓
3.	DP (Red)	✓	✓
4.	WPC (Red)	✓	
5.	OCR (Red)	✓	✓
6.	PTFF (Red)	✓	✓
7.	AR ACTED (Red)	✓	✓
8.	AR LOCKOUT (Red)	✓	✓
9.	ARB (Red)	✓	✓
10.	Thermal Overload (Red)	✓	✓
11.	Thermal Overload Alarm (Red)	✓	✓
12.	TRIP CKT FAIL (Red)	✓	✓
13.	LBB (Red)	✓	✓
14.	PTFF ALARM (Red)	✓	✓
15.	APGP LOW ALARM (Red)	✓	✓
16.	APGP LOW TRIP & LOCK (Red)	✓	✓
17.	ZONE1 EXTN (Red)	✓	✓
18.	SOTF (Red)	✓	✓
19.	RELAY FAIL (Red)	✓	✓
20.	>	✓	✓
21.	↵	✓	✓
22.	<	✓	✓
23.	USB	✓	✓
24.	H.RST	✓	✓

LCD DISPLAY

A 20 x 4 LCD display is provided for easy viewing of parameters, relay settings, fault event records, date& time, error counter etc. The display backlit can be made ON by pressing any push button key except H.Rst key and the display backlit leaves for about 5 seconds. Backlit automatically turns on when any tripping occurs on the relay.

Navigation Keys

The relay is provided with four switches.



Menu key

* Main key for entering relay setting mode.
* If you want to select anything in the setting mode we can use this key.
* To reset the relay from tripping mode.

Increment key

* If you want to raise any particular setting, we can use this option.
* For saving any particular changes in the relay you can hire this key.
* For viewing new options in the relay we can use this key.

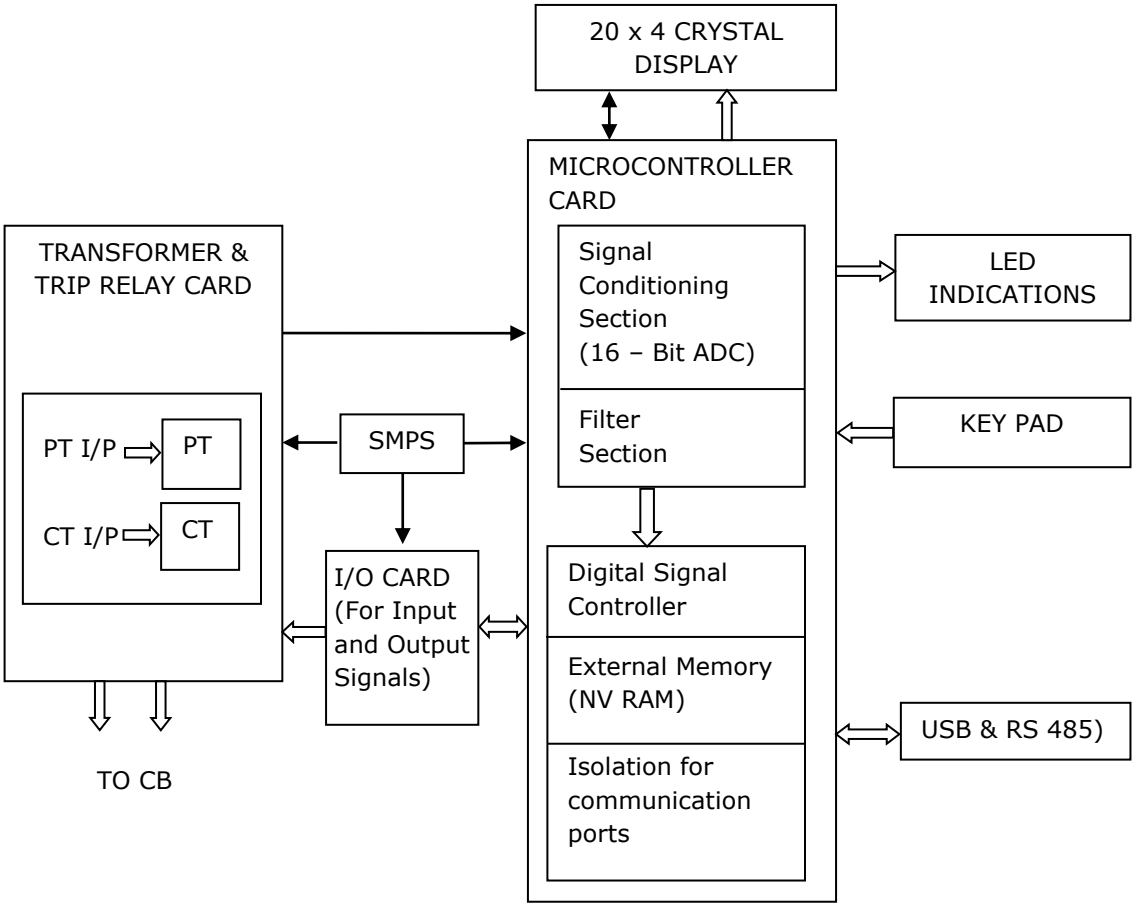
Decrement key

* If you want to lower any particular setting, we can use this option.
* No need to save any unwanted mistakes in the relay you can use this key.
* If you want to verify any previous settings in the relay you can opt this key.

INTERNAL ARCHITECTURE AND BLOCK DIAGRAM

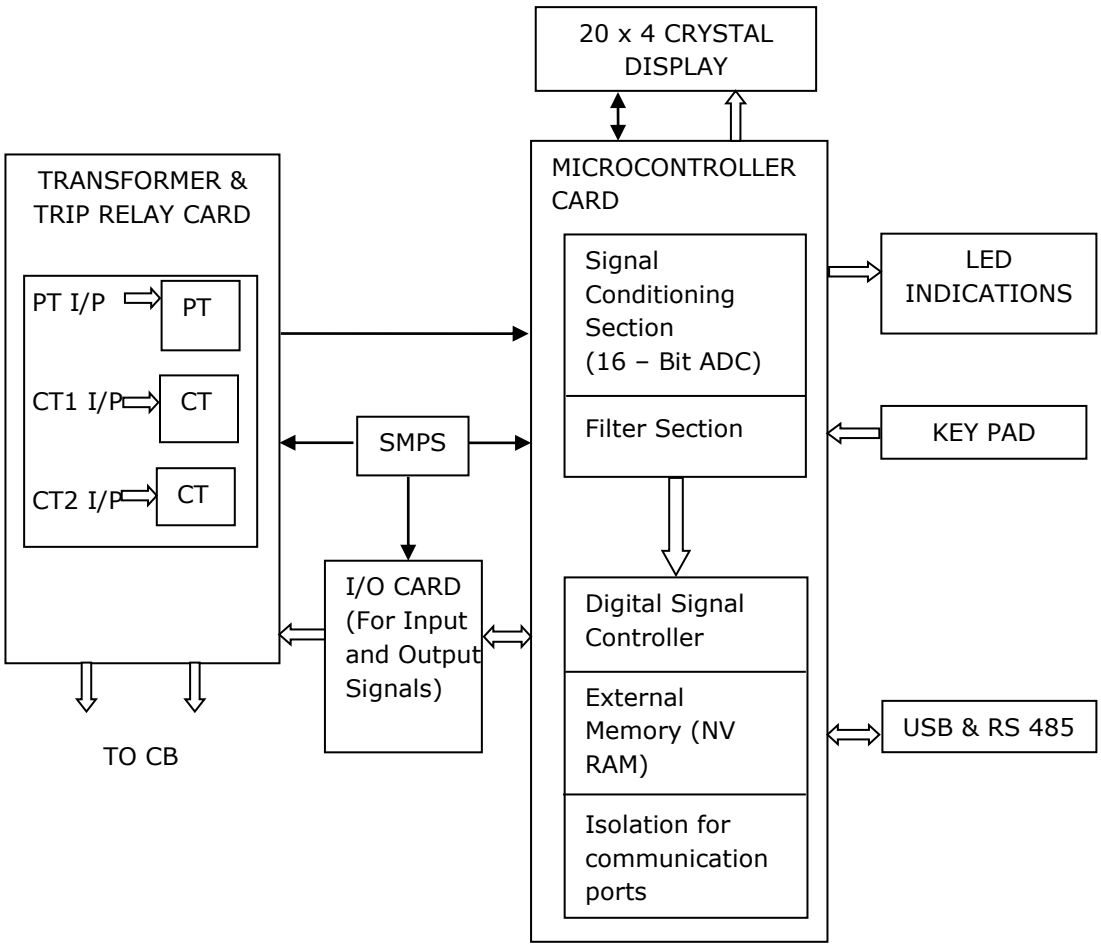
INTERNAL SYSTEM LEVEL ARCHITECTURE- ANZ 114

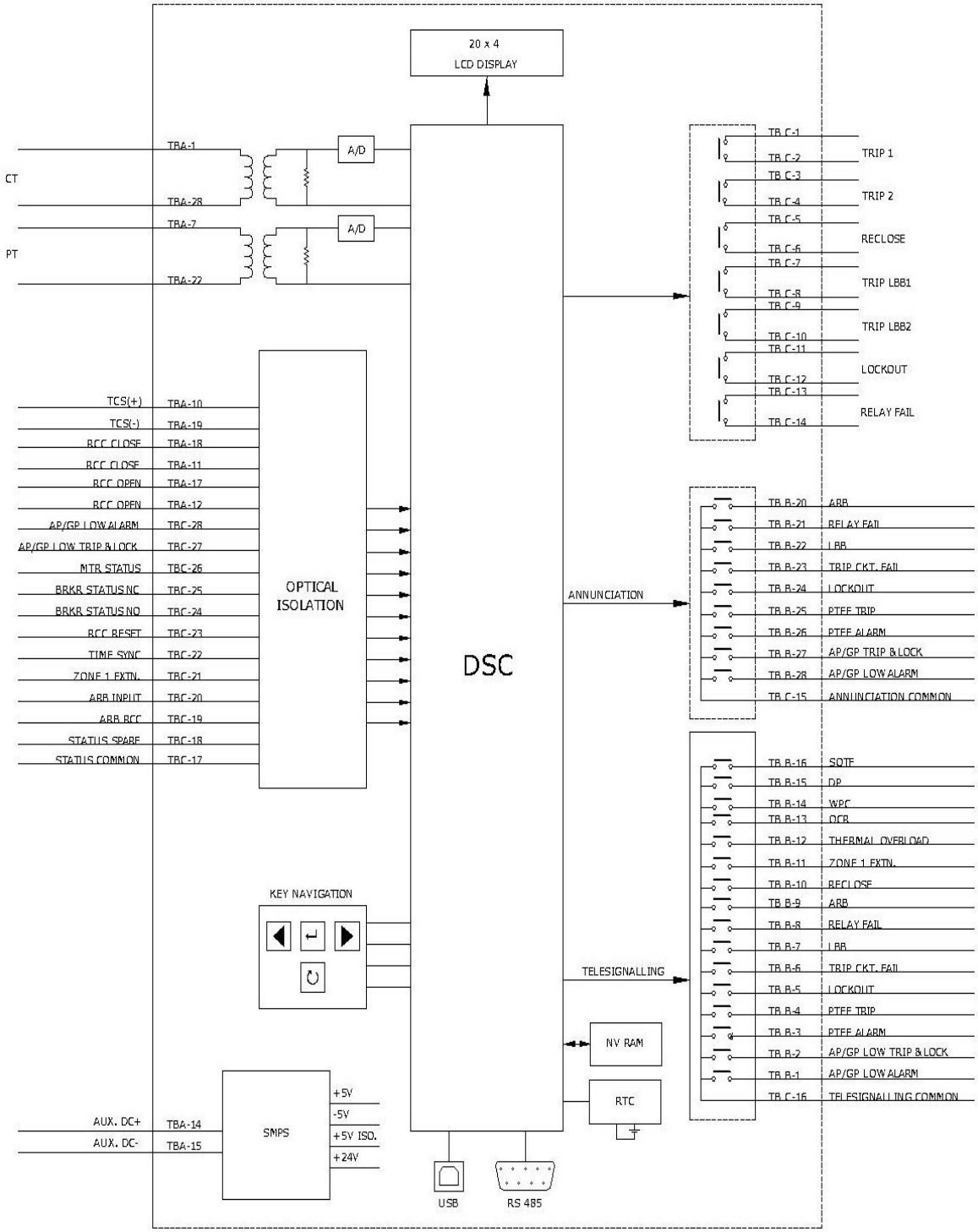
The internal system level architecture of relay including card to card architecture in brief is shown below.

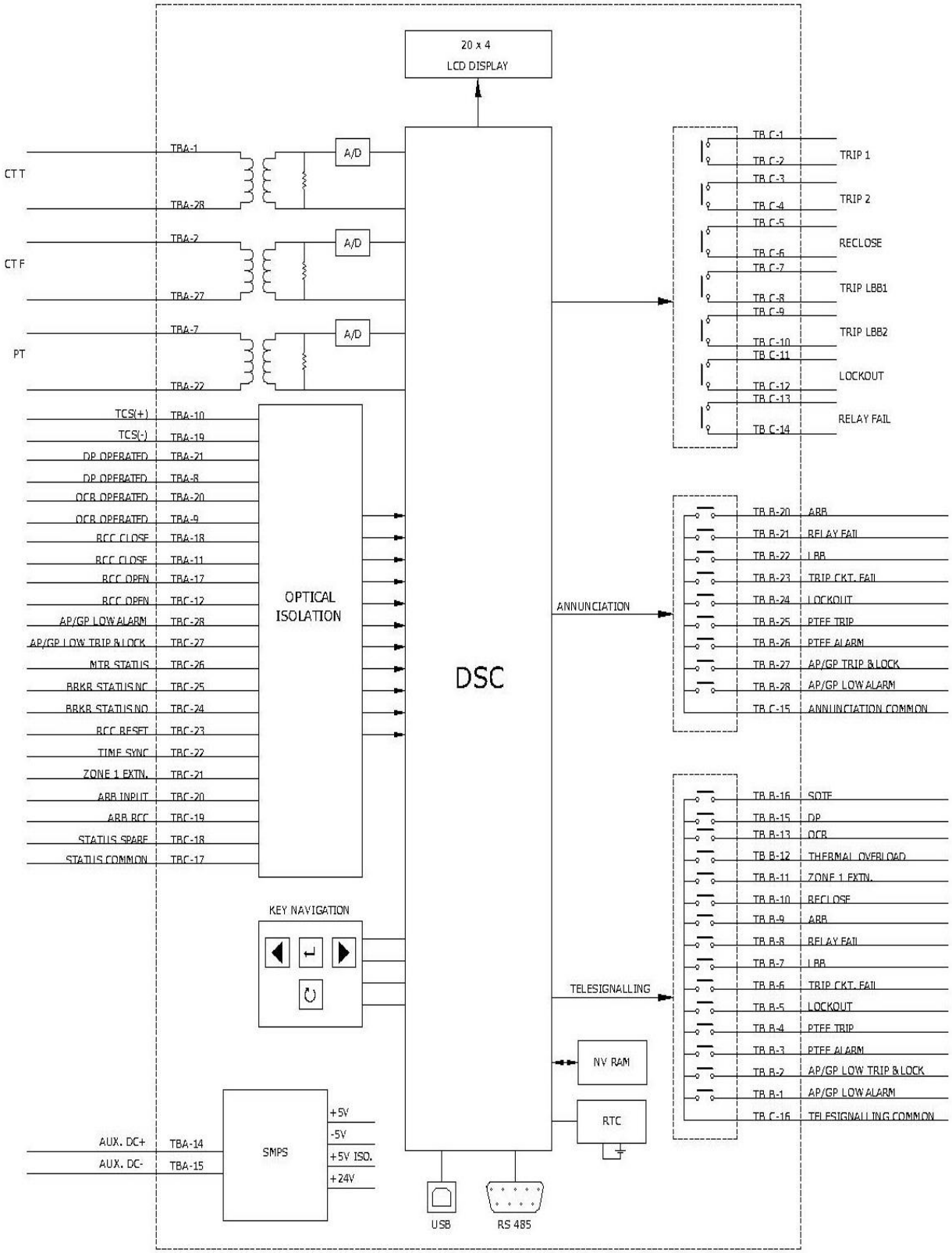


INTERNAL SYSTEM LEVEL ARCHITECTURE- ANZ 214

The internal system level architecture of ANZ 214 relay including card to card architecture in brief is shown below.




20 x 4
LCD DISPLAY
DSC
A/D
A/D
CT
PT
TBA-1
TBA-28
TBA-7
TBA-22
TRIP 1
TRIP 2
RECLOSE
TRIP LBB1
TRIP LBB2
LOCKOUT
RELAY FAIL
TCS(+) TBA-10
TCS(-) TBA-19
BCC CLOSE TBA-18
BCC CLOSE TBA-11
BCC OPEN TBA-17
BCC OPEN TBA-12
AP/GP LOW ALARM TBC-28
AP/GP LOW TRIP & LOCK TBC-27
MTR STATUS TBC-26
BRKR STATUS NC TBC-25
BRKR STATUS NO TBC-24
BCC RESET TBC-23
TIME SYNC TBC-22
ZONE 1 EXTN. TBC-21
ARB INPUT TBC-20
ARB BCC TBC-19
STATUS SPARE TBC-18
STATUS COMMON TBC-17
OPTICAL ISOLATION
ANNUNCIATION
ARB
RELAY FAIL
LBB
TRIP CKT. FAIL
LOCKOUT
PTFF TRIP
PTFF ALARM
AP/GP TRIP & LOCK
AP/GP LOW ALARM
ANNUNCIATION COMMON
SOTF
DP
WPC
OCR
THERMAL OVERLOAD
ZONE 1 EXTN.
RECLOSE
ARB
RELAY FAIL
LBB
TRIP CKT. FAIL
LOCKOUT
PTFF TRIP
PTFF ALARM
AP/GP LOW TRIP & LOCK
AP/GP LOW ALARM
TELESIGNALLING COMMON
TELESIGNALLING
KEY NAVIGATION
NV RAM
RTC
AUX. DC+ TBA-14
AUX. DC- TBA-15
SMPS
+5V
-5V
+5V ISO.
+24V
USB
RS 485


20 x 4
LCD DISPLAY
DSC
A/D
A/D
A/D
CT T
CT F
PT
TBA-1
TBA-28
TBA-2
TBA-27
TBA-7
TBA-22
TB C-1
TB C-2
TRIP 1
TB C-3
TB C-4
TRIP 2
TB C-5
TB C-6
RECLOSE
TB C-7
TB C-8
TRIP LBB1
TB C-9
TB C-10
TRIP LBB2
TB C-11
TB C-12
LOCKOUT
TB C-13
TB C-14
RELAY FAIL
TCS(+) TBA-10
TCS(-) TBA-19
DP OPERATED TBA-21
DP OPERATED TBA-8
OCR OPERATED TBA-20
OCR OPERATED TBA-9
BCC CLOSE TBA-18
BCC CLOSE TBA-11
BCC OPEN TBA-17
BCC OPEN TBC-12
AP/GP LOW ALARM TBC-28
AP/GP LOW TRIP & LOCK TBC-27
MTR STATUS TBC-26
BRKR STATUS NC TBC-25
BRKR STATUS NO TBC-24
BCC RESET TBC-23
TIME SYNC TBC-22
ZONE 1 EXTN. TBC-21
ABB INPUT TBC-20
ABB BCC TBC-19
STATUS SPARE TBC-18
STATUS COMMON TBC-17
OPTICAL ISOLATION
ANNUNCIATION
TB B-20 ABB
TB B-21 RELAY FAIL
TB B-22 LBB
TB B-23 TRIP CKT. FAIL
TB B-24 LOCKOUT
TB B-25 PTEF TRIP
TB B-26 PTEF ALARM
TB B-27 AP/GP TRIP & LOCK
TB B-28 AP/GP LOW ALARM
TB C-15 ANNUNCIATION COMMON
TB B-16 SOTF
TB B-15 DP
TB B-13 OCR
TB B-12 THERMAL OVERLOAD
TB B-11 ZONE 1 EXTN.
TB B-10 RECLOSE
TB B-9 ABB
TB B-8 RELAY FAIL
TB B-7 LBB
TB B-6 TRIP CKT. FAIL
TB B-5 LOCKOUT
TB B-4 PTEF TRIP
TB B-3 PTEF ALARM
TB B-2 AP/GP LOW TRIP & LOCK
TB B-1 AP/GP LOW ALARM
TB C-16 TELESIGNALLING COMMON
TELESIGNALLING
KEY NAVIGATION
NV RAM
RTC
AUX. DC+ TBA-14
AUX. DC- TBA-15
SMPS
+5V
-5V
+5V ISO.
+24V
USB
RS 485

1. DSP Controller

The dsPIC DSC (Digital Signal Controller) is a 16-bit modified Harvard RISC (Reduced Instruction Set Computer) machine that combines the control advantages of a high-performance 16-bit microcontroller with the high computation speed of a fully implemented Digital Signal Processor (DSP).

The DSP controller continuously monitors the currents and voltages. Based on this the controller performs different calculations and whenever an abnormal condition occurs it distinguishes the type of fault and issues trip command to the circuit breaker.

2. Data Acquisition

The Current signals are scaled and isolated using Current Transformer (CT). The Voltage signals are scaled and isolated using Potential Transformer (PT). These isolated analog signals are filtered to minimize the effects of electromagnetic interference and noise in the high frequency range.

The analog signals are then fed to the Analog to Digital Converter which has a 16 bit resolution. The DSP controller will take the 32 samples per cycles of each Current and Voltage for the computational purpose. If any fault occurs the parameters will be stored in to the non-volatile memory with date and time stampings and this can be downloaded for further analysis in the disturbance recorder.

3. Power Supply Module

This module gives the necessary regulated voltages like +5V, -5V, and +24V to various cards in the module. The normal operating voltage range is 45 VDC to 170 VDC. The +24V is used for driving the output relays in the I/O card and O/P relay card. The +5V and -5V is supplied to the processor, I/O card and Display PCB for normal relay operations. The isolated +5V is dedicated to the communication ports of the relay.

4. Communication Module

The relay is having 2 communications port, USB and RS 485. The relay is using IEC 60870-5-103 communication protocol for communication through RS485 and USB (Proprietary).

USB Communication Port

USB port is provided for uploading/downloading relay settings and events.

1. The software is capable of analyzing the peak, RMS & average values of current & voltage, Harmonic analysis of current & voltage waveforms and determination of fault clearing time, resistance, reactance, and phase angle of waveforms.
2. Waveform pointed by user displays the voltage, current & sample value of the particular point.

RS 485 Communication Port

RS 485 port is provided for SCADA connectivity. Using RS485 port online fault data of critical parameters, disturbance record (Waveform), event record (Trip data, R, X, FD, etc.), Automatic Supervision and Control (healthiness of Relay), Alarm and Event Handling, Data Acquisition, Calculating and Reporting, Parameter Setting, Resetting Indicating LEDs, Trip Circuit supervision, Relay Fail Indication etc can be downloaded. The communication complies with IEC 60870-5-103 protocol.

5. Man Machine Interface

Man Machine Interface is through a 20x4 LCD display and keys in the front panel of the relay. Necessary LEDs are provided in front panel for indicating the operation of different element.

6. Disturbance Recorder

The relay has the facility to record 50 cycles (45 pre-fault and 5 post faults) of fault waveforms. Latest 200 waveforms of Voltage and Current can be stored in the relay. This data is retrievable through USB & RS485 communication ports using UI software and SCADA respectively.

7. Event Recorder & Disturbance Recorder

The relay is capable of storing 5000 number of events with date and time stamping of 1ms accuracy. The event data comprise of:

Tripping of different protection elements (I, V, R, X, PA, DI, Fault clearing time, Fault date & time)

Trip circuit supervision

Relay pick up

Relay reset

Relay blocked due to harmonics or any other restraints

Auto-reclose acted

Auto-reclose lockout

Auto-reclose bypass

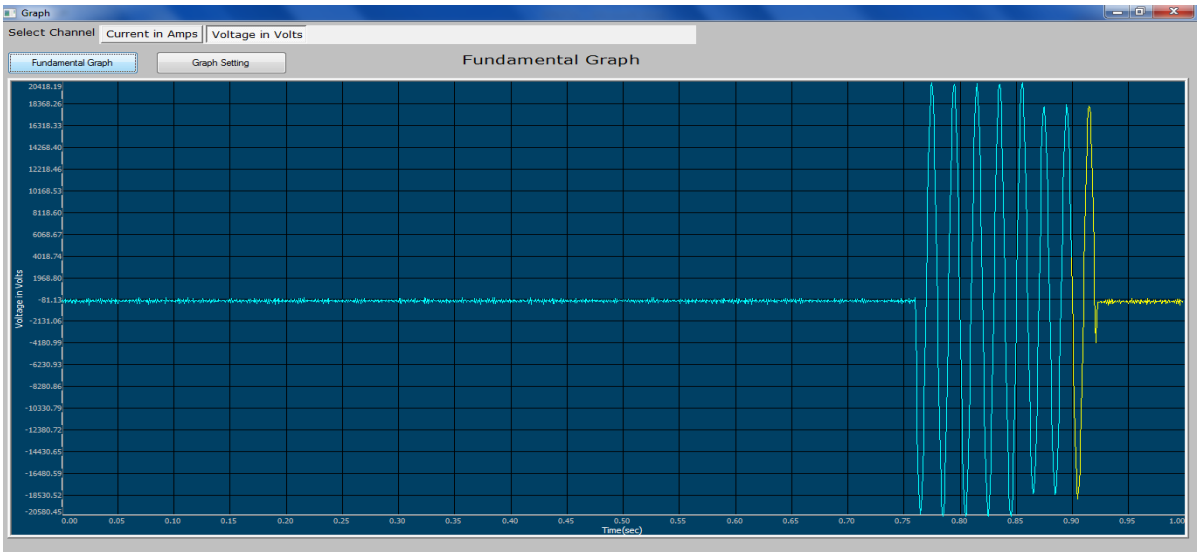
CB Trip

CB Close

Change of status input

Relay setting changed (GUI & Keypad)

Relay Fail.



ENERGIZING THE RELAY

1. Before turning ON the relay, proper earthing should be provided.
2. Visual Inspection for any physical damage in housing, display etc. shall be checked.
3. Operating voltage range: **45 to 170 VDC.**
   Operating voltage: **110 V DC.**
4. Prefer regulated power supply of 110VDC.
5. Auxiliary power supply shall be provided to the terminals 14 & 15 of TB-A with the help of an MCB.
6. Switch on the power supply. Measure the voltage between the terminals 14 & 15 of TB-A, and ensure that the voltage is within the normal operating range.
7. After the relay is powered ON, the following shall be noticed.
8. Protection healthy LED glow green in color which indicates that the relay is functioning OK, otherwise it goes amber.

PCB DESCRIPTION

The relay comprises of the following hardware.

Main PCBs. –Display PCB, Communication PCB, Controller PCB, Stack PCB, Trip relay & transformer PCB, SMPS PCB, I/O & status PCB, Back panel PCB.

Display PCB: The Display PCB is mounted at the front plate of the unit. It consists of the 20x4 LCD, LED indications, Keyboard circuits, and LED controller.

Controller PCB: The Controller PCB is mounted on the back side of the Display PCB. This PCB consists of major components such as DSP controllers, ADC and its filter circuits, Memory ICs, RTC. The Analog signals are filtered and digitized in this board. The DSP takes decision based on this digital samples and initiates necessary commands.

Communication PCB: The communication PCB is mounted at the front side. This PCB supports the communication through USB for data exchange. Also the Hardware Reset Switch is mounted in this PCB.

Stack PCB: Internal communications between the PCB's are ensured with the help of stack PCB.

Trip relay &Transformer PCB: All the CTs, PTs and Tripping Relays are assembled in this board. This board will give necessary trip commands to the master trip relay or breaker which is installed in the yard. Necessary relay initiating signals are wired to these output relays from the Controller Board.

SMPS PCB: The SMPS PCB provides the necessary Power supply voltages to the different PCBs mounted inside the relay. The SMPS is a DC-DC converter. The SMPS provides +24V, +5V, -5V and isolated +5 V. The +24 V supply is used for the driving the output relays in the I/O PCB and Trip Relay PCB. The +5V and -5V is supplied to the controller PCB, Display PCB, and I/O PCB for normal operations. The isolated +5V is dedicated to the communications ports of the relay.

I/O & status PCB: The I/O PCB deals with the necessary I/O lines such as Input status lines and Digital Output contacts. A separate controller provided in this board performs the necessary I/O operations in conjunction with the DSP controller in the Processor PCB. The I/O PCB is mounted vertically on to the stack PCB.

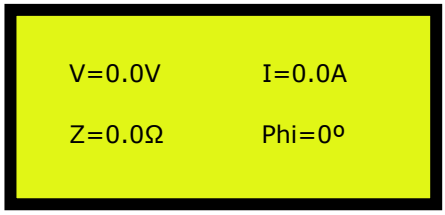
Back PCB: This PCB consists of terminal blocks for external interface with the site and power connectors which connects SMPS, I/O and CT PT PCB's. The RS 485 port is also mounted in this PCB. The terminal block (TB-A) is having CT shorting facility. Since the rack with Terminal Blocks is having the CT shorting facility, the relay can be withdrawn.

RELAY SETTINGS AND ALGORITHM

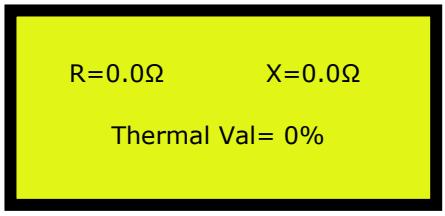
After Power ON, the relay boot screen shows

Then comes the online parameter display

Window 1:



Window 2:



To scroll between online displays, press **Right** key after holding ↵ key.

Setting Mode

Press and hold ↵ for 5 seconds

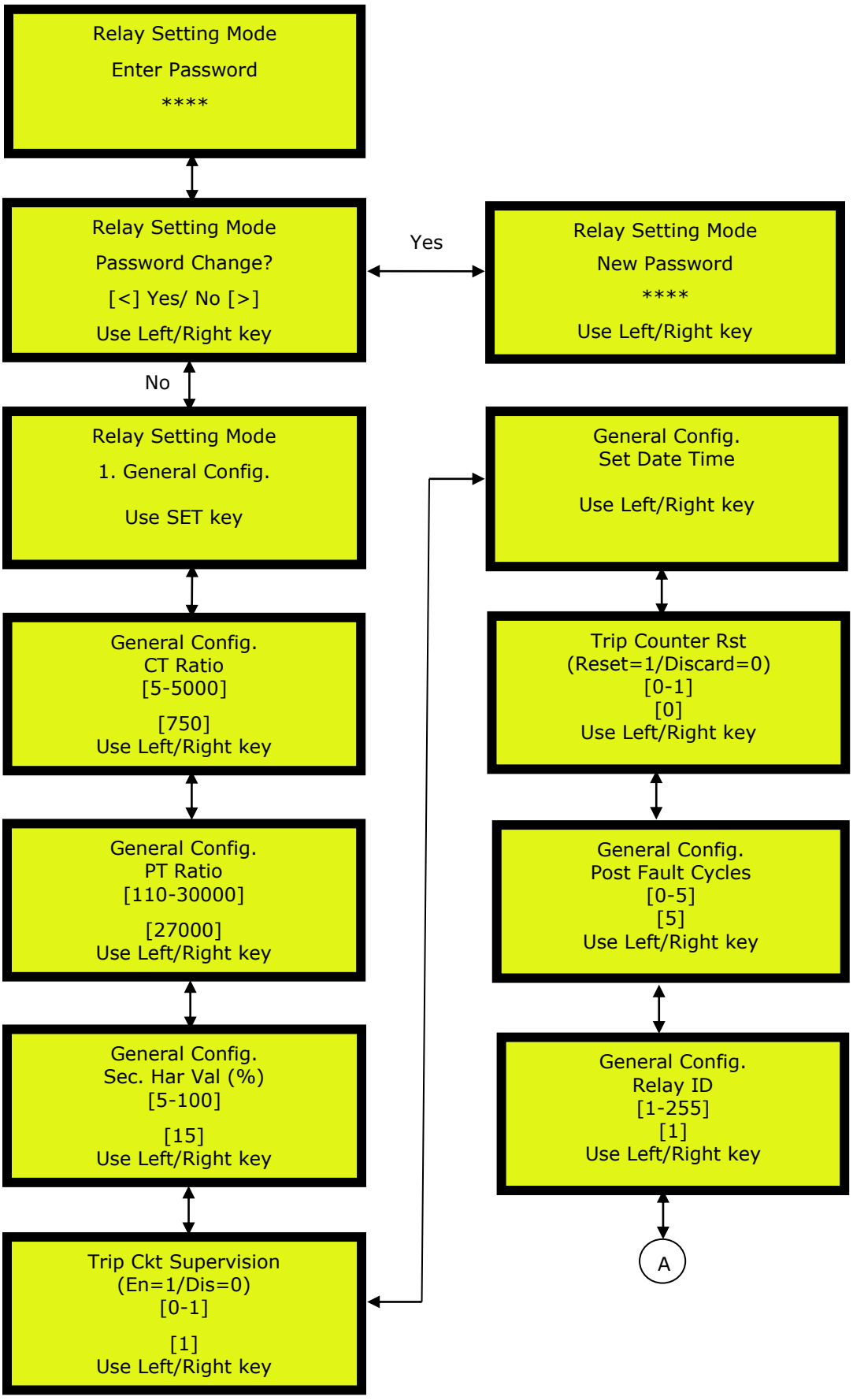
Relay will enter to setting mode.

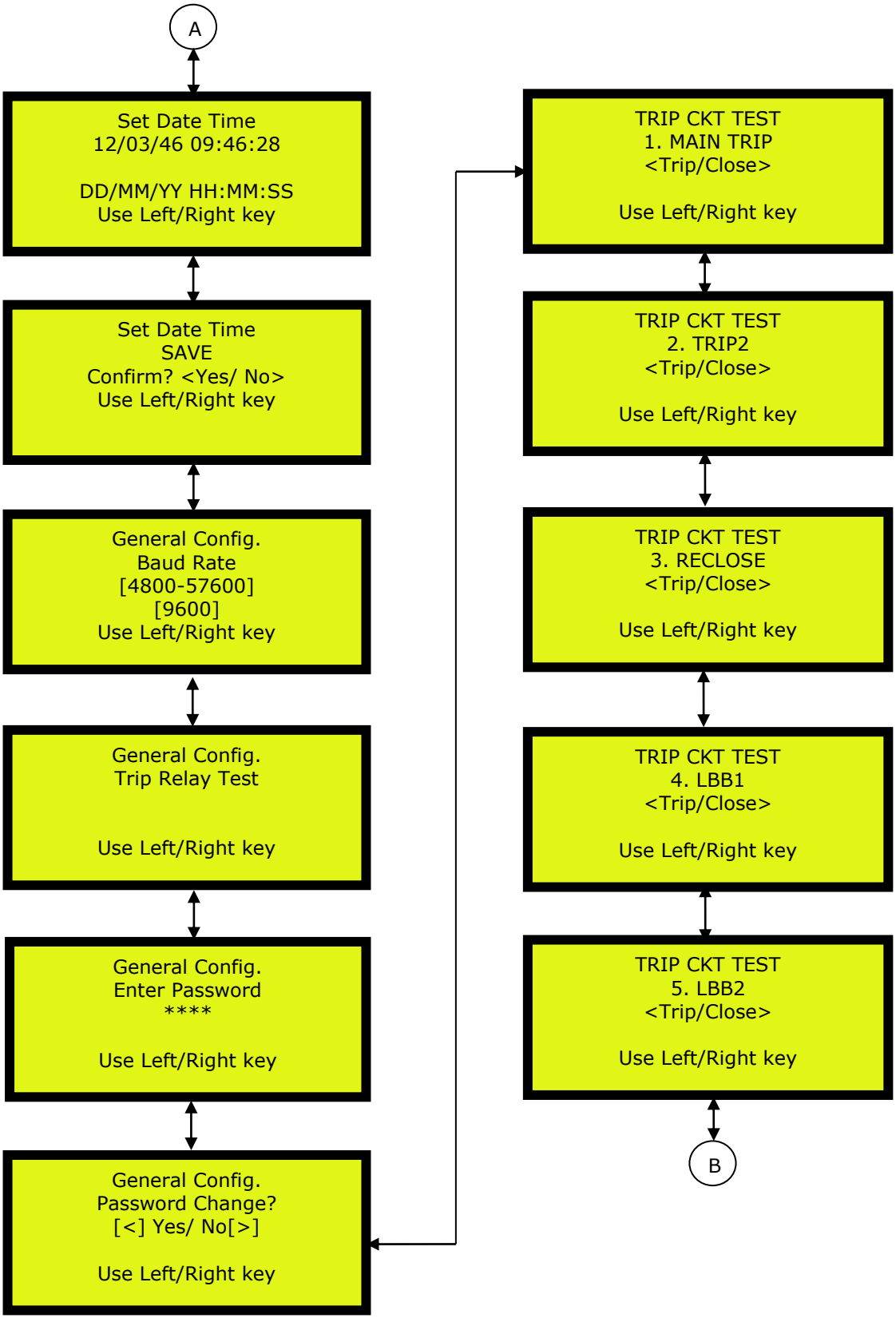
Enter the password and press ↵ key. The default password setting is '1000'

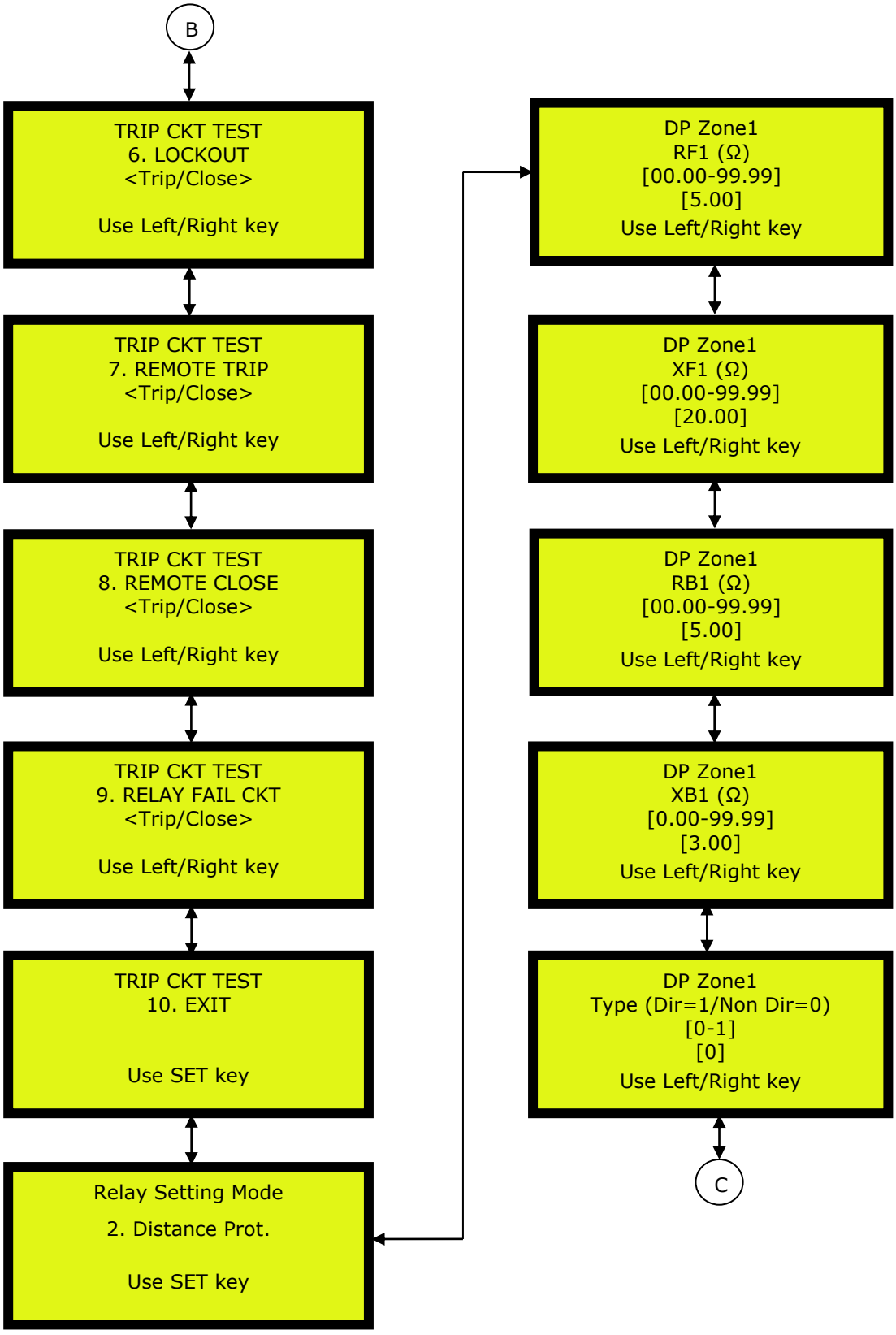
To change settings:

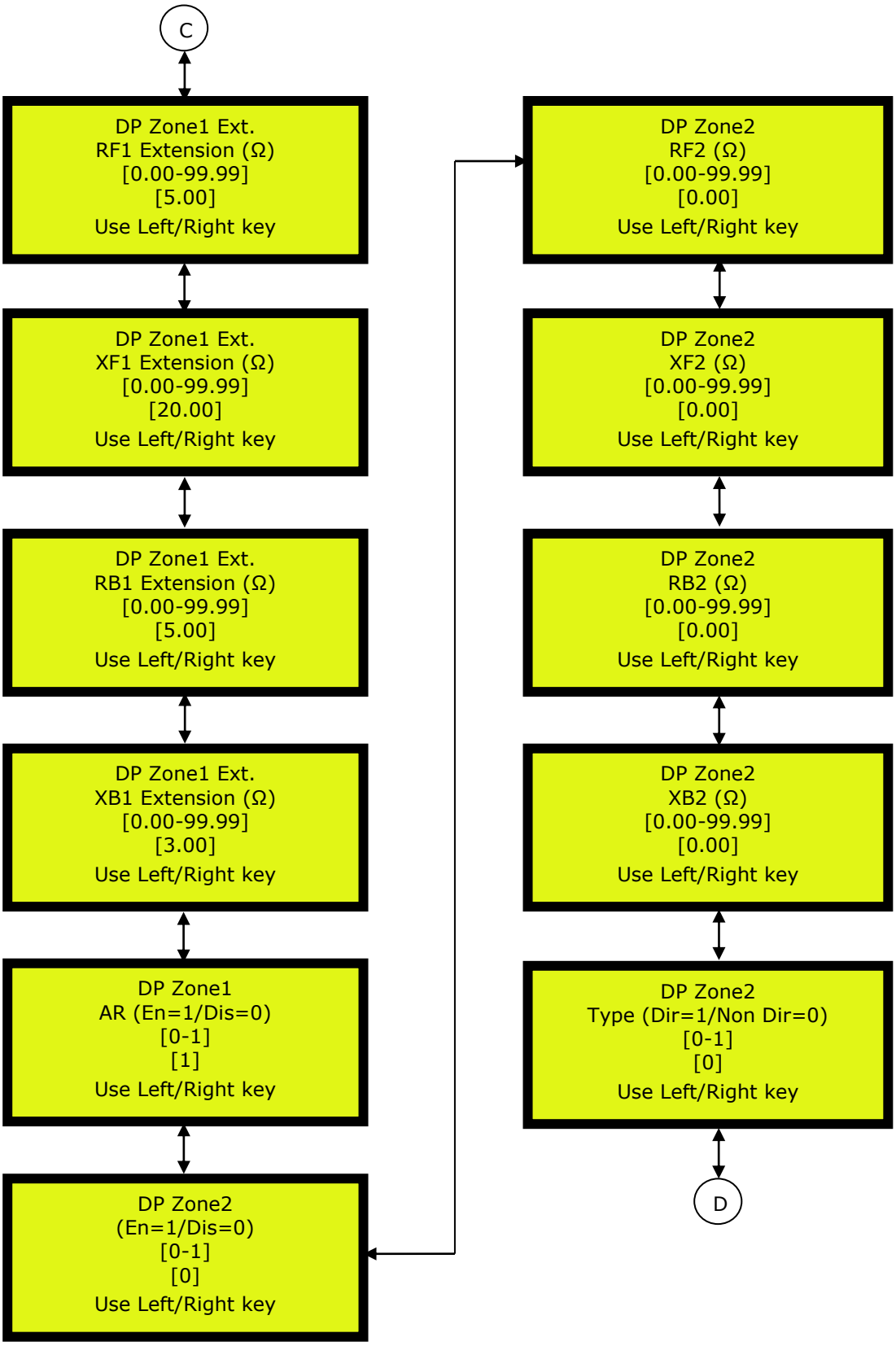
a) Press ↵ to change the settings.
b) Press **Right** key to increment
c) Press **Left** key to decrement
d) Press ↵ to accept change.
e) To coming back to main **MENU** while operating, press **Left** and **Right** key simultaneously.
f) Repeat the process for all settings
g) After completing the settings, the relay shows the message **'SETTINGS UPDATED'** and returns to the operating mode.

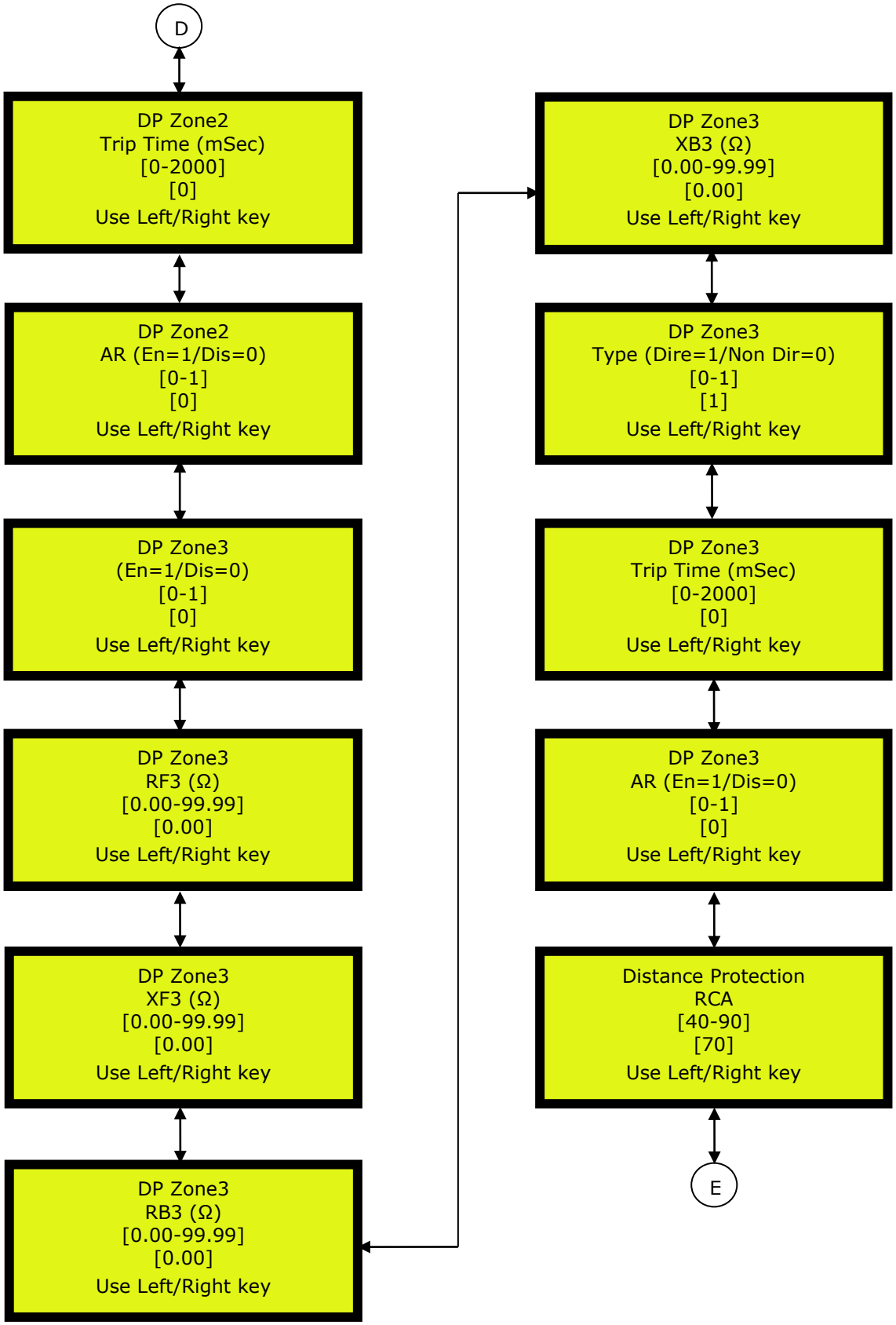
Relay Settings Algorithm

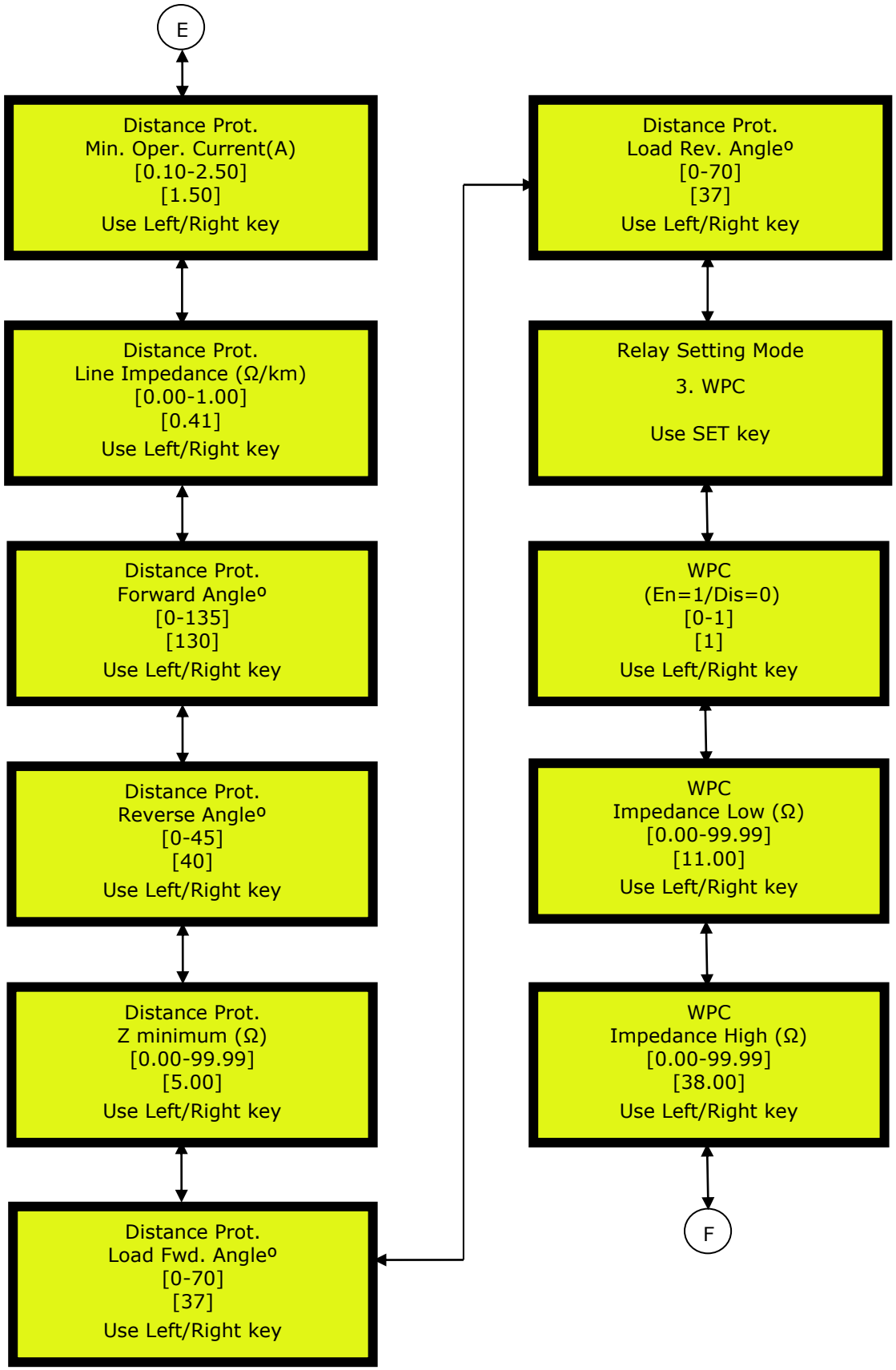


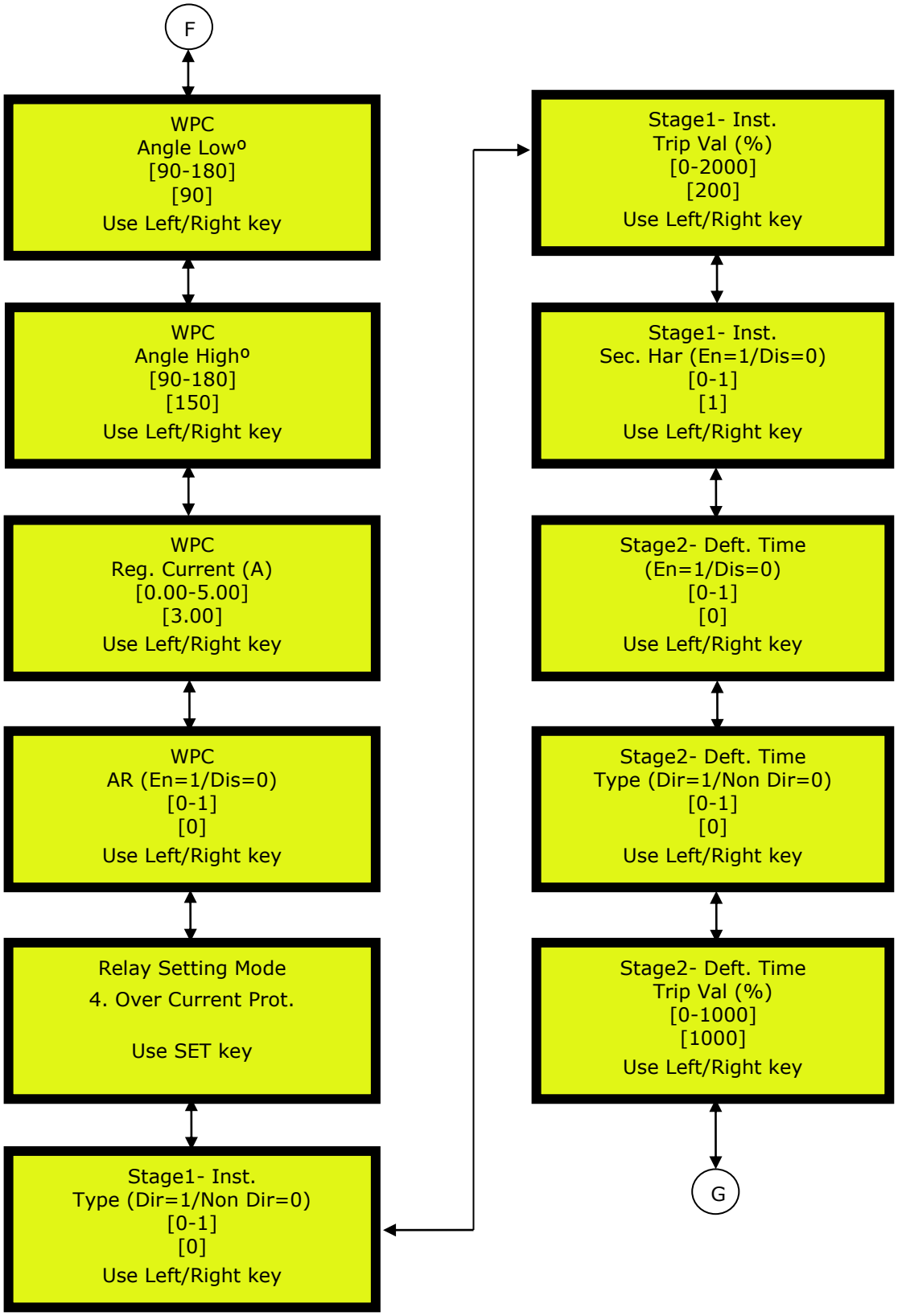

A
Set Date Time
12/03/46 09:46:28
DD/MM/YY HH:MM:SS
Use Left/Right key
Set Date Time
SAVE
Confirm? <Yes/ No>
Use Left/Right key
General Config.
Baud Rate
[4800-57600]
[9600]
Use Left/Right key
General Config.
Trip Relay Test
Use Left/Right key
General Config.
Enter Password
****
Use Left/Right key
General Config.
Password Change?
[<] Yes/ No[>]
Use Left/Right key
TRIP CKT TEST
1. MAIN TRIP
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
2. TRIP2
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
3. RECLOSE
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
4. LBB1
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
5. LBB2
<Trip/Close>
Use Left/Right key
B

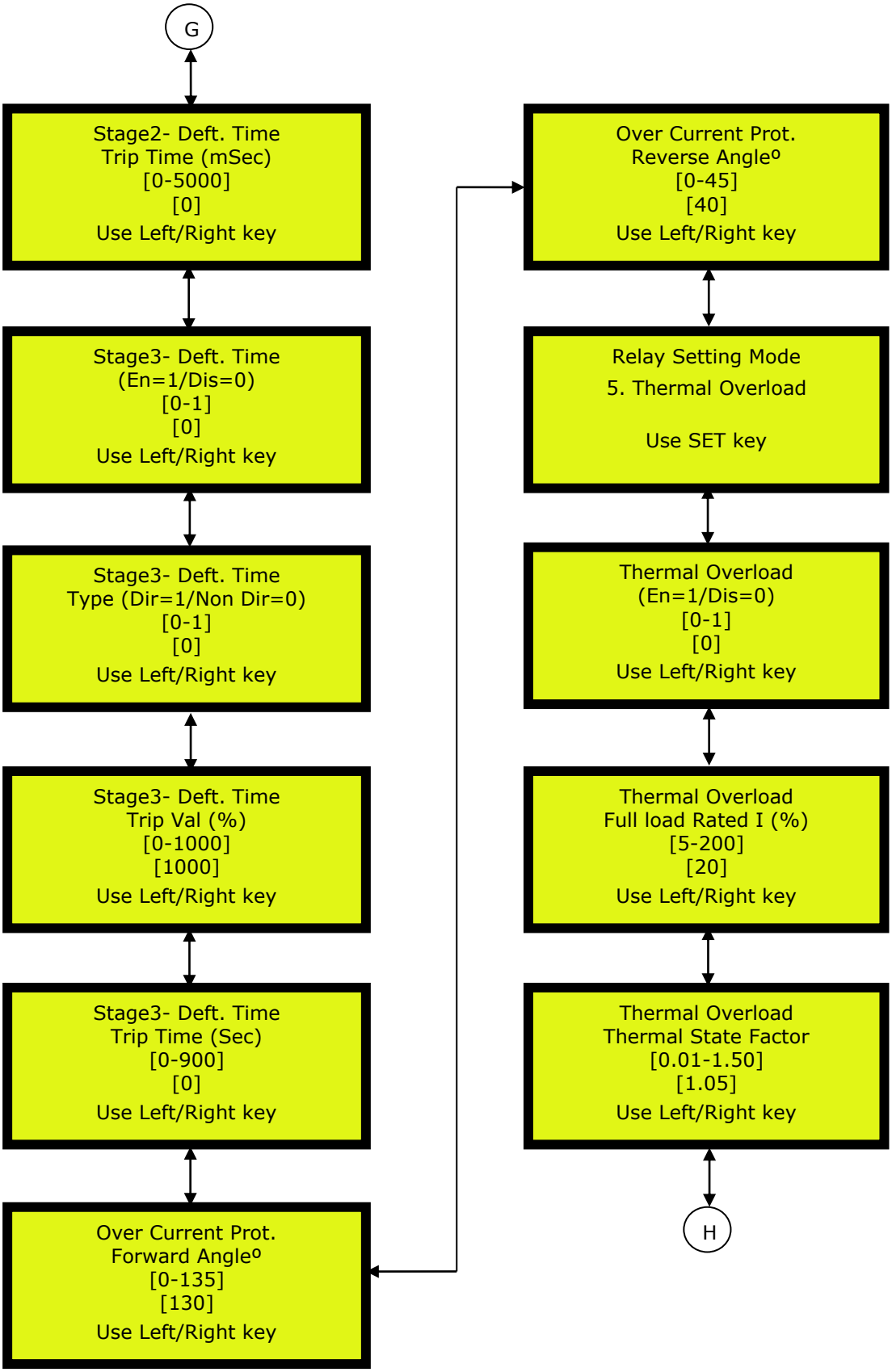

B
TRIP CKT TEST
6. LOCKOUT
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
7. REMOTE TRIP
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
8. REMOTE CLOSE
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
9. RELAY FAIL CKT
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
10. EXIT
Use SET key
Relay Setting Mode
2. Distance Prot.
Use SET key
DP Zone1
RF1 (Ω)
[00.00-99.99]
[5.00]
Use Left/Right key
DP Zone1
XF1 (Ω)
[00.00-99.99]
[20.00]
Use Left/Right key
DP Zone1
RB1 (Ω)
[00.00-99.99]
[5.00]
Use Left/Right key
DP Zone1
XB1 (Ω)
[0.00-99.99]
[3.00]
Use Left/Right key
DP Zone1
Type (Dir=1/Non Dir=0)
[0-1]
[0]
Use Left/Right key
C

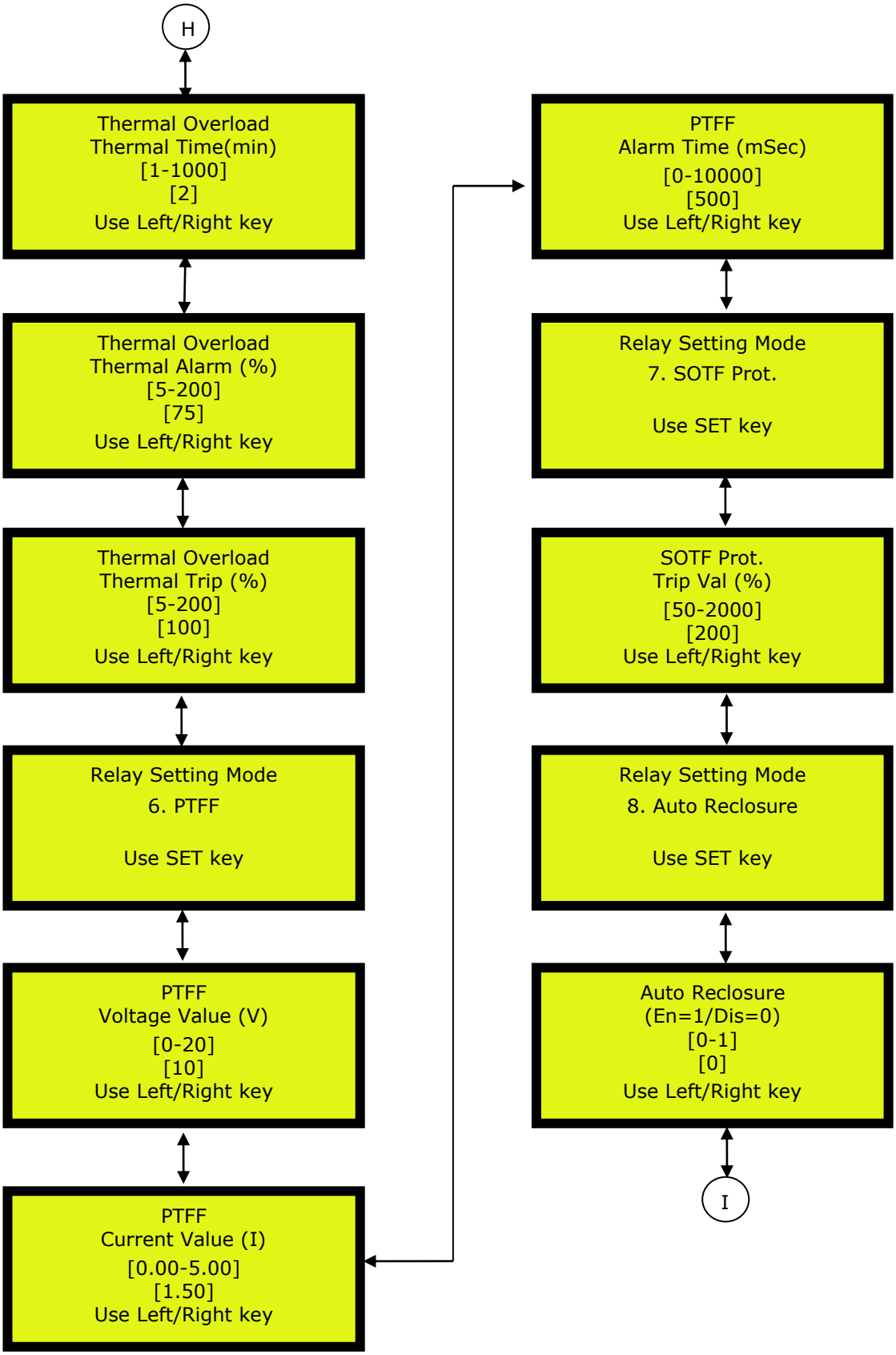

C
DP Zone1 Ext.
RF1 Extension (Ω)
[0.00-99.99]
[5.00]
Use Left/Right key
DP Zone1 Ext.
XF1 Extension (Ω)
[0.00-99.99]
[20.00]
Use Left/Right key
DP Zone1 Ext.
RB1 Extension (Ω)
[0.00-99.99]
[5.00]
Use Left/Right key
DP Zone1 Ext.
XB1 Extension (Ω)
[0.00-99.99]
[3.00]
Use Left/Right key
DP Zone1
AR (En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
DP Zone2
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
DP Zone2
RF2 (Ω)
[0.00-99.99]
[0.00]
Use Left/Right key
DP Zone2
XF2 (Ω)
[0.00-99.99]
[0.00]
Use Left/Right key
DP Zone2
RB2 (Ω)
[0.00-99.99]
[0.00]
Use Left/Right key
DP Zone2
XB2 (Ω)
[0.00-99.99]
[0.00]
Use Left/Right key
DP Zone2
Type (Dir=1/Non Dir=0)
[0-1]
[0]
Use Left/Right key
D

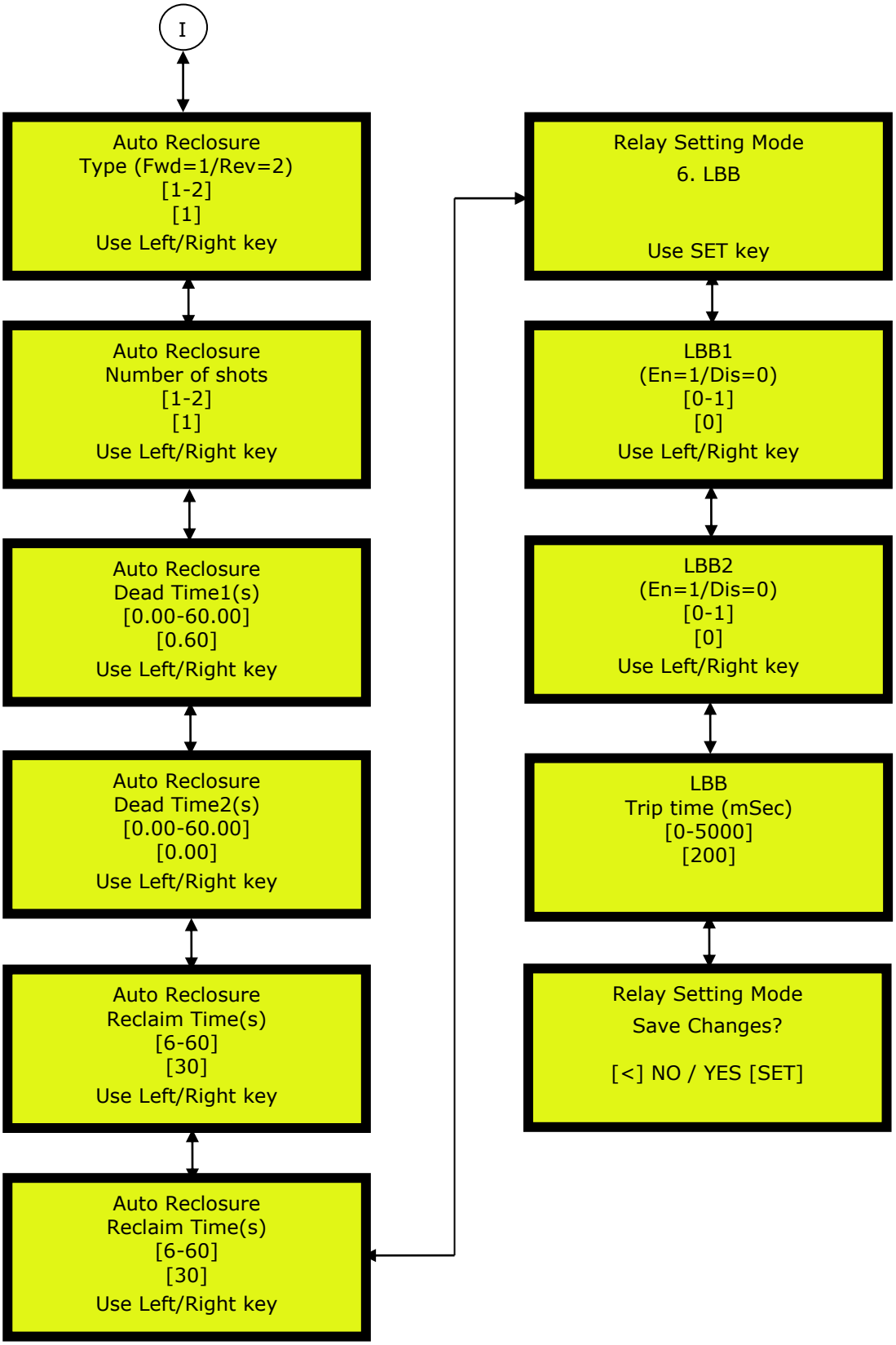

D
DP Zone2
Trip Time (mSec)
[0-2000]
[0]
Use Left/Right key
DP Zone2
AR (En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
DP Zone3
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
DP Zone3
RF3 (Ω)
[0.00-99.99]
[0.00]
Use Left/Right key
DP Zone3
XF3 (Ω)
[0.00-99.99]
[0.00]
Use Left/Right key
DP Zone3
RB3 (Ω)
[0.00-99.99]
[0.00]
Use Left/Right key
DP Zone3
XB3 (Ω)
[0.00-99.99]
[0.00]
Use Left/Right key
DP Zone3
Type (Dire=1/Non Dir=0)
[0-1]
[1]
Use Left/Right key
DP Zone3
Trip Time (mSec)
[0-2000]
[0]
Use Left/Right key
DP Zone3
AR (En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
Distance Protection
RCA
[40-90]
[70]
Use Left/Right key
E


E
Distance Prot.
Min. Oper. Current(A)
[0.10-2.50]
[1.50]
Use Left/Right key
Distance Prot.
Line Impedance (Ω/km)
[0.00-1.00]
[0.41]
Use Left/Right key
Distance Prot.
Forward Angleº
[0-135]
[130]
Use Left/Right key
Distance Prot.
Reverse Angleº
[0-45]
[40]
Use Left/Right key
Distance Prot.
Z minimum (Ω)
[0.00-99.99]
[5.00]
Use Left/Right key
Distance Prot.
Load Fwd. Angleº
[0-70]
[37]
Use Left/Right key
Distance Prot.
Load Rev. Angleº
[0-70]
[37]
Use Left/Right key
Relay Setting Mode
3. WPC
Use SET key
WPC
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
WPC
Impedance Low (Ω)
[0.00-99.99]
[11.00]
Use Left/Right key
WPC
Impedance High (Ω)
[0.00-99.99]
[38.00]
Use Left/Right key
F


F
WPC
Angle Low°
[90-180]
[90]
Use Left/Right key
WPC
Angle High°
[90-180]
[150]
Use Left/Right key
WPC
Reg. Current (A)
[0.00-5.00]
[3.00]
Use Left/Right key
WPC
AR (En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
Relay Setting Mode
4. Over Current Prot.
Use SET key
Stage1- Inst.
Type (Dir=1/Non Dir=0)
[0-1]
[0]
Use Left/Right key
Stage1- Inst.
Trip Val (%)
[0-2000]
[200]
Use Left/Right key
Stage1- Inst.
Sec. Har (En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
Stage2- Deft. Time
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
Stage2- Deft. Time
Type (Dir=1/Non Dir=0)
[0-1]
[0]
Use Left/Right key
Stage2- Deft. Time
Trip Val (%)
[0-1000]
[1000]
Use Left/Right key
G


G
Stage2- Deft. Time
Trip Time (mSec)
[0-5000]
[0]
Use Left/Right key
Stage3- Deft. Time
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
Stage3- Deft. Time
Type (Dir=1/Non Dir=0)
[0-1]
[0]
Use Left/Right key
Stage3- Deft. Time
Trip Val (%)
[0-1000]
[1000]
Use Left/Right key
Stage3- Deft. Time
Trip Time (Sec)
[0-900]
[0]
Use Left/Right key
Over Current Prot.
Forward Angleº
[0-135]
[130]
Use Left/Right key
Over Current Prot.
Reverse Angleº
[0-45]
[40]
Use Left/Right key
Relay Setting Mode
5. Thermal Overload
Use SET key
Thermal Overload
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
Thermal Overload
Full load Rated I (%)
[5-200]
[20]
Use Left/Right key
Thermal Overload
Thermal State Factor
[0.01-1.50]
[1.05]
Use Left/Right key
H


H
Thermal Overload
Thermal Time(min)
[1-1000]
[2]
Use Left/Right key
Thermal Overload
Thermal Alarm (%)
[5-200]
[75]
Use Left/Right key
Thermal Overload
Thermal Trip (%)
[5-200]
[100]
Use Left/Right key
Relay Setting Mode
6. PTFF
Use SET key
PTFF
Voltage Value (V)
[0-20]
[10]
Use Left/Right key
PTFF
Current Value (I)
[0.00-5.00]
[1.50]
Use Left/Right key
PTFF
Alarm Time (mSec)
[0-10000]
[500]
Use Left/Right key
Relay Setting Mode
7. SOTF Prot.
Use SET key
SOTF Prot.
Trip Val (%)
[50-2000]
[200]
Use Left/Right key
Relay Setting Mode
8. Auto Reclosure
Use SET key
Auto Reclosure
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
I


I
Auto Reclosure
Type (Fwd=1/Rev=2)
[1-2]
[1]
Use Left/Right key
Auto Reclosure
Number of shots
[1-2]
[1]
Use Left/Right key
Auto Reclosure
Dead Time1(s)
[0.00-60.00]
[0.60]
Use Left/Right key
Auto Reclosure
Dead Time2(s)
[0.00-60.00]
[0.00]
Use Left/Right key
Auto Reclosure
Reclaim Time(s)
[6-60]
[30]
Use Left/Right key
Auto Reclosure
Reclaim Time(s)
[6-60]
[30]
Use Left/Right key
Relay Setting Mode
6. LBB
Use SET key
LBB1
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
LBB2
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
LBB
Trip time (mSec)
[0-5000]
[200]
Relay Setting Mode
Save Changes?
[<] NO / YES [SET]

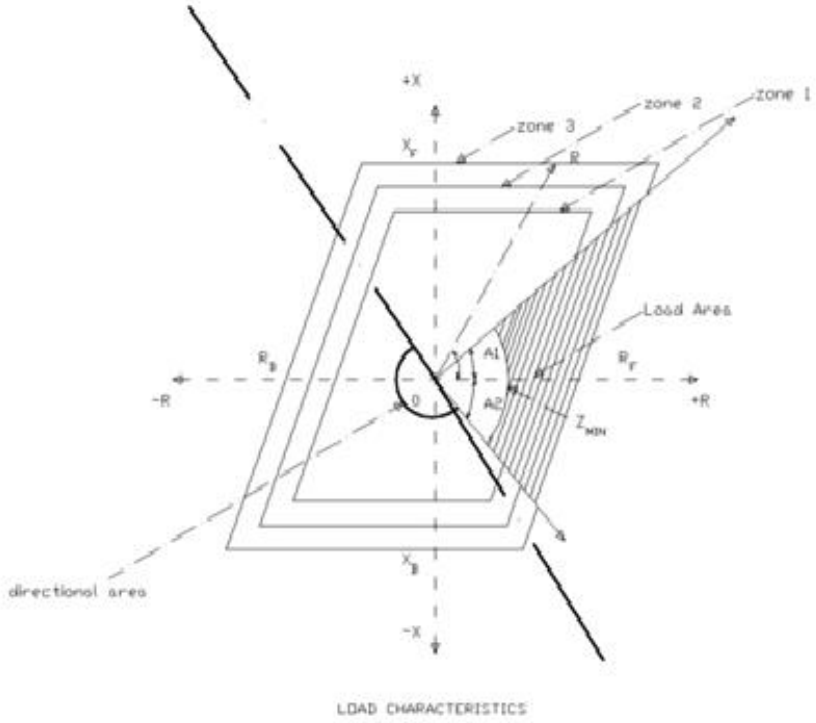
TECHNICAL DATA & CHARACTERISTIC CURVES

ALUMINIUM INDUSTRIES LIMITED
Relays Division

CONTENTS

DESCRIPTION OF PROTECTION FUNCTIONS

I) Distance protection



LOAD CHARACTERISTICS

DESIGNATION	DESCRIPTION
R	Resistance axis in the parallelogram
X	Reactance axis in the parallelogram
Zone1	
RF1	Forward resistance in zone1
RB1	Reverse resistance in zone 1
XF1	Forward reactance in zone 1
XB1	Reverse reactance in zone 1
Zone2	
RF2	Forward resistance in zone 2
RB2	Reverse resistance in zone 2
XF2	Forward reactance in zone 2
XB2	Reverse reactance in zone 2
Zone3	
RF3	Forward resistance in zone 3
RB3	Reverse resistance in zone 3
XF3	Forward reactance in zone 3
XB3	Reverse reactance in zone 3
RCA	Relay characteristics angle
Z min	Minimum impedance
A1	Forward Angle
A2	Reverse Angle

The relay is an impedance based relay with three zone distance protection with polygonal characteristics with four impedance settings- Forward resistance (RF), Reverse resistance (RB), Forward reactance (XF), Reverse reactance (XB) Minimum Impedance, Forward and Reverse angle which can be set independently. The R and X values are calculated by sampling the current and voltage waveforms and compared with the polygonal characteristics. If they fall within the characteristics then the relay will provide the tripping command.

II) Zone Extension

The relay has got special feature of Zone Extension in which the reach of the Distance protection can be extended. There is separate setting for Zone Extension. This feature is very useful when one of the TSS is bypassed for maintenance and the protection zone is to be increased. This feature can be Enabled/Disabled by giving 110V DC (+ve) pulse to the relay locally or through RCC.

III) Wrong Phase Coupling Protection (for ANZ 114 only)

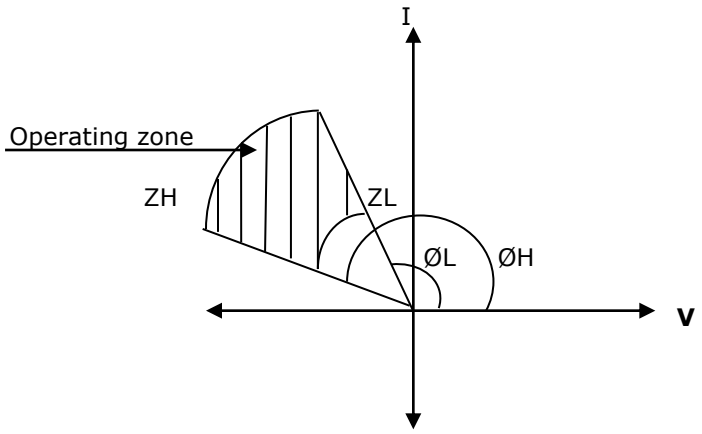
If two traction substations are fed with two different power supply phases then there is always possibility of phase-to-phase short circuit in SP. In such case, measured impedance angle falls in the second quadrant. The relay has three separate settings for WPC condition.

i) Regenerative current (0-3A)

ii) Angle (90-180)

iii) Impedance-low limit and high limit (0-70)

If all the preset condition is satisfies, then the relay will initiates the trip command



IV) Instantaneous over current protection

The relay is having Instantaneous over current setting. When current value gets more than the setting value the relay initiates the trip command.

V) Auto Reclose and Lockout Logic

The relay is provided with selectable (1 or 2) shot auto reclose function with enable/disable option. Once auto reclosed the relay starts the dead timer. After dead time the reclose command is executed and the reclaim time starts.

During reclaim time if the relay trips further, then the relay goes to lockout condition. Then only the manual closing of CB is possible.

VI) PT Fuse Failure Logic

The PT Fuse Failure protection is by monitoring the PT voltage and Current.

If the PT voltage is less and current is more than the set value the relay generates PT fuse failure Trip.

On breaker closed / ON condition, if PT voltage and current is less than the set values for a specified time (PTFF Time), the relay will generate a PTFF alarm

VII) Thermal Overload protection

Thermal overload protection prevents the electrical equipment when the operating temperature exceeds the maximum designed temperature.

Trip time is given by $t = \zeta \ln ((K^2 - A)/ (K^2 - \text{Thermal. Trip}))$

Where, t= trip time in seconds
ζ=thermal time constant (Te, in seconds) of the equipment to be protected
K=Thermal overload=$I_{eq}/k*IFLA$
A=Initial thermal state
Thermal trip= trip thermal state

(Where Ieq= equivalent current corresponding to largest value of phase current, IFLA=full load rated current given by national standard or by the supplier, k=factor associated to thermal state formula)

VIII) Switch On To Fault:

If the breaker is closing to an existing fault condition, the relay will immediately sense this condition and will trip the respective breaker in the order of one cycle.

For this, the relay monitors the fault voltage in the range of 50 to 60 V and the SOTF settings for the detection of an SOTF condition.

IX) Trip Circuit Supervision

The relay continuously monitors the trip supply through the NC contact of the Circuit breaker in closed condition. If any discontinuity is observed, the relay generates alarm signal.

TECHNICAL SPECIFICATIONS

Sl. No	Specification	REF.	Particulars
1.	**Auxiliary Supply**	V_{DC}	45 to 170 VDC
2.	**Current Input(rated)**	In	5 Amps
3.	**Voltage Input(rated)**	Un	110V
4.	**Frequency**	Fn	50 Hz
5.	**VA burden on CT**		Less than 0.5 VA
6.	**VA burden on PT**		Less than 0.5 VA
7.	**VA burden on Aux**		Less than 15 Watts(energized) Less than 10 watts(de-energized)
8.	**Operating Temp Range**		-10°C to + 60 °C
9.	**Max. & Minimum relative humidity**		100% & 22%
10.	**Continuous Current Carry Capacity of CT**		3In; 15A
11.	**Thermal Withstand for CT**		40In for 1 sec
12.	**Continuous voltage carrying capacity of PT**		1.15 of rated value
13.	**Thermal withstand for PT**		2 times rated value for 10 sec
14.	**Contact details**		
15.	a)Current carrying capacity		5A
	b) Making and carry for 3 sec at 250V,50Hz		30A
	c) Making capacity at 250V,50-60Hz AC		5A
	d)Breaking Capacity AC 220V, 50-60Hz, Cos Ǿ=0.4 DC 220V, L/R= 45ms		 5A 0.5A
16.	**Resetting Time**		150-200ms
17.	**Baud Rate**		4800-57600
18.	**Trip Circuit Test**		Yes / No
19.	**Type of communication ports**		USB and RS485
20.	**Unit ID**		1-255
21.	**Overall dimensions** Width Height Depth		 263 mm 173 mm 330 mm
22.	**Weight**		6.9 kg approx.

GENERAL SETTINGS

ANZ 114

General Settings		Particulars
Password protection (YES/NO)		**0000-9999**
1. General settings		
i) CT Ratio		5-5000A in steps of 5A
ii) PT Ratio		110 to 30000
iii) Local Breaker Backup (LBB1)		Enable/Disable
iv) Local Breaker Backup (LBB2)		Enable/Disable
v) LBB Trip time		0 to 5000msec in steps of 1msec
vi) Second Harmonic Setting		5% to 100% in steps of 1%
vii) Trip circuit Supervision		Enable/Disable
viii) Trip counter Reset		Yes/No
ix) Post fault cycles		0-5 in steps of 1
x) Relay ID		1-255
xi) Baud Rate		4800-57600 in steps of 200
xii) Trip Relay Test		(Yes/No)
xiii) Date & Time setting		(Yes/No) DD/MM/YY HH:MM:SS
2. Distance Protection		
i) Zone 1	Forward Resistance RF1	00.01 to 99.99 in steps of 0.01 ohm
	Forward Reactance XF1	00.01 to 99.99 in steps of 0.01 ohm
	Backward Resistance RB1	00.01 to 99.99 in steps of 0.01 ohm
	Backward Reactance XB1	00.01 to 99.99 in steps of 0.01 ohm
	Dir/Non Dir	
ii) Zone1 Extension	Forward Resistance RF1Extn	00.01 to 99.99 in steps of 0.01 ohm
	Forward Reactance XF1 Extn	00.01 to 99.99 in steps of 0.01 ohm
	Backward Resistance RB1Extn	00.01 to 99.99 in steps of 0.01 ohm
	Backward Reactance XB1Extn	00.01 to 99.99 in steps of 0.01 ohm
	Zone 1 AR	(Enable/Disable)
iii) Zone 2	EN/DIS	
	Dir/Non Dir	
	Forward Resistance RF2	00.01 to 99.99 in steps of 0.01 ohm
	Forward Reactance XF2	00.01 to 99.99 in steps of 0.01 ohm

	Backward Resistance RB2	00.01 to 99.99 in steps of 0.01 ohm
	Backward Reactance XB2	00.01 to 99.99 in steps of 0.01 ohm
	Zone 2 Time Z2T	10 to 2000 ms in steps of 1 ms
	Zone 2 AR	(Enable/Disable)
iv) Zone 3	EN/DIS	
	Dir/Non Dir	
	Forward Resistance RF3	00.01 to 99.99 in steps of 0.01 ohm
	Forward Reactance XF3	00.01 to 99.99 in steps of 0.01 ohm
	Backward Resistance RB3	00.01 to 99.99 in steps of 0.01 ohm
	Backward Reactance XB3	00.01 to 99.99 in steps of 0.01 ohm
	Zone 3 Time Z3T	10 to 2000ms in steps of 1 ms
	Zone 3 AR	(Enable/Disable)
v) Relay Characteristics Angle		40 to 90º in steps of 1º
vi) Minimum Operating Current		0.1 to 2.5A in steps of 0.01 A
vii) Line Impedance		0.00 to 1.0 in steps of .01ohm
viii) Z Minimum		00.00 to 99.99 in steps of 0.01 ohm
ix) Load Forward Angle A1		0-70º in steps of 1°
x) Load Reverse Angle A2		0-70º in steps of 1°
3) Wrong Phase Coupling Protection (EN/DIS)		
i) WPC Impedance Low		00.00 to 99.99 in steps of 0.01 ohm
ii) WPC Impedance High		00.00 to 99.99 in steps of 0.01 ohm
iii) WPC Angle Low		90 – 180 in steps of 1°
iv) WPC Angle High		90 – 180 in steps of 1°
v) WPC Regenerative Current		0.1A to 5A in steps of 0.1A
vi) Auto Re-closure		(Enable/Disable)
4) OCR Protection		
i) Instantaneous OCR – stage 1		DIR/NON DIR
Setting range		0% – 2000% in steps of 1%
Second Harmonics		(Enable/Disable)
ii) Definite Time OCR - Stage 2		DIR/NON DIR
Setting range		10% -1000% in steps of 1%
Time Setting		1 to 5000ms in steps of 1 msec
iii) Definite Time OCR - Stage 3		DIR/NON DIR
Setting range		10% – 1000% in steps of 1%
Time Setting		1 to 300 sec in steps of 1sec
iv) Second Harmonic		En/Dis
v) Forward Angle Setting		0-135 in steps of 1 Deg
vi) Reverse Angle Setting		0-45 in steps of 1 Deg
5) Thermal overload protection (Enable/Disable)		

i) IFLA (Full Load Load Current)	5 to 200% in steps of 10%
ii) k (Thermal State Factor)	1 to 1.5 in steps of 0.01
iii) Te (Thermal Time)	1 to 1000 min in steps of 1 min.
iv) Thermal alarm	5 to 200% in steps of 1%
v) Thermal Trip	5 to 200% in steps of 1%
6) PT Fuse Protection	
i) PTFF Voltage	0 to 20 in steps of 1 V
ii) PTFF Current	0 to 5 in steps of 0.01 A
iii) PTFF Time	0-10000 msec in steps of 10 msec
7) Switch On To Fault Protection (SOTF)	50% to 2000% in steps of 10%
8) Auto Re-closure Section (Enable / Disable)	
i) Number of Shots	1- 2
ii) Re-closure Type	Fwd/Rev
iii) Dead Time 1	0 to 60.00 sec in steps of 0.01 sec
iv) Dead Time 2	0 to 60 sec in steps of 1 sec
v) Reclaim Time	6 to 60 Sec in steps of 1Sec
vi) ARB (Enable / Disable)	1A to 100A in steps of 1A

Operating Time	
i) Distance Protection (Zone 1, Zone 1 Extn, Zone 2, Zone 3)	30 +/- 10 msec
ii) WPC Protection	30 +/- 10 msec
iii) Instantaneous OCR Protection	Less than 25 ms
iv) PTFF Protection	30 +/- 10 msec
v) SOTF Protection	Less than 20 ms

ANZ 214

General Settings		Particulars
Password protection (YES/NO)		**0000-9999**
1. General settings		
i) CT Ratio		5-5000A in steps of 5A
ii) PT Ratio		110 to 30000
iii) Local Breaker Backup (LBB1)		Enable/Disable
iv) Local Breaker Backup (LBB2)		Enable/Disable
v) LBB Trip time		0 to 5000msec in steps of 1msec
vi) Second Harmonic Setting		5% to 100% in steps of 1%
vii) Trip circuit Supervision		Enable/Disable
viii) Trip counter Reset		Yes/No
ix) Post fault cycles		0-5 in steps of 1
x) Relay ID		1-255
xi) Baud Rate		4800-57600 in steps of 200
xii) Trip Relay Test		
xiii) Date & Time setting		(Yes/No) DD/MM/YY HH:MM:SS
2. Distance Protection		
i) Zone 1	Forward Resistance RF1	00.01 to 99.99 in steps of 0.01 ohm
	Forward Reactance XF1	00.01 to 99.99 in steps of 0.01 ohm
	Backward Resistance RB1	00.01 to 99.99 in steps of 0.01 ohm
	Backward Reactance XB1	00.01 to 99.99 in steps of 0.01 ohm
	Dir/Non Dir	
ii) Zone1 Extension	Forward Resistance RF1Extn	00.01 to 99.99 in steps of 0.01 ohm
	Forward Reactance XF1 Extn	00.01 to 99.99 in steps of 0.01 ohm
	Backward Resistance RB1Extn	00.01 to 99.99 in steps of 0.01 ohm
	Backward Reactance XB1Extn	00.01 to 99.99 in steps of 0.01 ohm
	Zone 1 AR	(Enable/Disable)
iii) Zone 2	EN/DIS	
	Dir/Non Dir	
	Forward Resistance RF2	00.01 to 99.99 in steps of 0.01 ohm
	Forward Reactance XF2	00.01 to 99.99 in steps of 0.01 ohm
	Backward Resistance RB2	00.01 to 99.99 in steps of 0.01 ohm

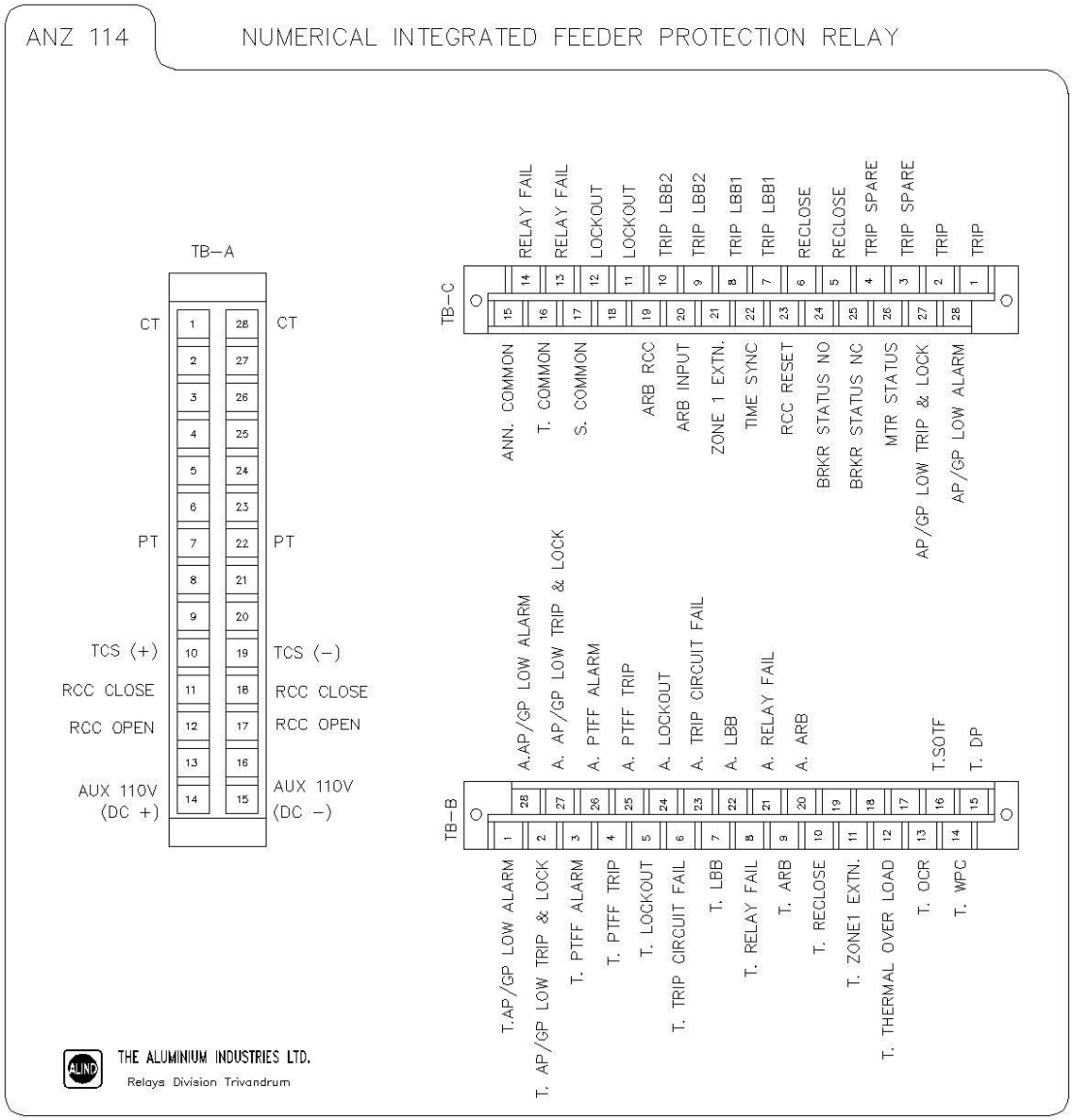
	Backward Reactance XB2	00.01 to 99.99 in steps of 0.01 ohm
	Zone 2 Time Z2T	10 to 2000 ms in steps of 1 ms
	Zone 2 AR	(Enable/Disable)
iv) Zone 3	EN/DIS	
	Dir/Non Dir	
	Forward Resistance RF3	00.01 to 99.99 in steps of 0.01 ohm
	Forward Reactance XF3	00.01 to 99.99 in steps of 0.01 ohm
	Backward Resistance RB3	00.01 to 99.99 in steps of 0.01 ohm
	Backward Reactance XB3	00.01 to 99.99 in steps of 0.01 ohm
	Zone 3 Time Z3T	10 to 2000ms in steps of 1 ms
	Zone 3 AR	(Enable/Disable)
v) Relay Characteristics Angle		40 to 90º in steps of 1º
vi) Minimum Operating Current		0.1 to 2.5A in steps of 0.01 A
vii) Line Impedance		0.00 to 1.0 in steps of .01ohm
viii) Z Minimum		00.00 to 99.99 in steps of 0.01 ohm
ix) Load Forward Angle A1		0-70º in steps of 1°
x) Load Reverse Angle A2		0-70º in steps of 1°
3) OCR Protection		
i) Instantaneous OCR – stage 1		DIR/NON DIR
Setting range		0% – 2000% in steps of 1%
Second Harmonics		(Enable/Disable)
ii) Definite Time OCR - Stage 2		DIR/NON DIR
Setting range		10% -1000% in steps of 1%
Time Setting		1 to 5000ms in steps of 1 msec
iii) Definite Time OCR - Stage 3		DIR/NON DIR
Setting range		10% – 1000% in steps of 1%
Time Setting		1 to 300 sec in steps of 1sec
iv) Second Harmonic		En/Dis
v) Forward Angle Setting		0-135 in steps of 1 Deg
vi) Reverse Angle Setting		0-45 in steps of 1 Deg
4) Thermal overload protection (Enable/Disable)		
i) IFLA (Full Load Load Current)		5 to 200% in steps of 10%
ii) k (Thermal State Factor)		1 to 1.5 in steps of 0.01
iii) Te (Thermal Time)		1 to 1000 min in steps of 1 min.
iv) Thermal alarm		5 to 200% in steps of 1%
v) Thermal Trip		5 to 200% in steps of 1%
5) PT Fuse Protection		
i) PTFF Voltage		0 to 20 in steps of 1 V
ii) PTFF Current		0 to 5 in steps of 0.01 A

iii) PTFF Time	0-10,000 msec in steps of 10 msec
6) Switch On To Fault Protection (SOTF)	50% to 2000% in steps of 10%
7) Auto Re-closure Section (Enable / Disable)	
i) Number of Shots	1- 2
ii) Re-closure Type	Fwd/Rev
iii) Dead Time 1	0 to 1.00 sec in steps of 0.01 sec
iv) Dead Time 2	0 to 60 sec in steps of 1 sec
v) Reclaim Time	6 to 60 Sec in steps of 1Sec
vi) ARB (Enable / Disable)	1A to 100A in steps of 1A

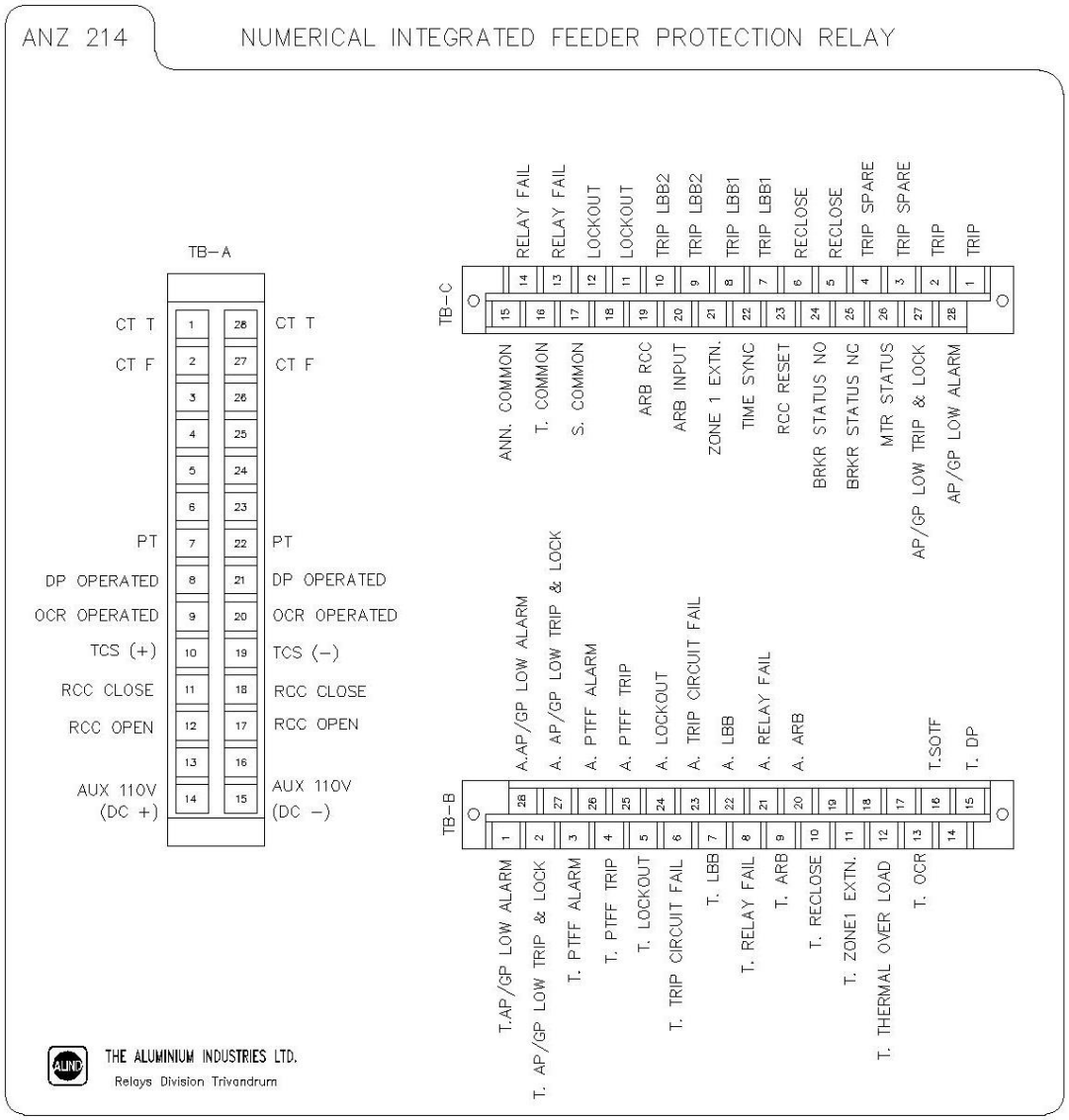
Operating Time	
i) Distance Protection (Zone 1, Zone 1 Extn, Zone 2, Zone 3)	30 +/- 10 msec
ii) Instantaneous OCR Protection	Less than 25 ms
iii) PTFF Protection	30 +/- 10 msec
iv) SOTF Protection	Less than 20 ms

TB DETAILS

ANZ 114



ANZ 214


ANZ 214
NUMERICAL INTEGRATED FEEDER PROTECTION RELAY
TB–A
CT T
CT F
PT
DP OPERATED
OCR OPERATED
TCS (+)
RCC CLOSE
RCC OPEN
AUX 110V (DC +)
AUX 110V (DC –)
TB–C
RELAY FAIL
LOCKOUT
TRIP LBB2
TRIP LBB1
RECLOSE
TRIP SPARE
TRIP
ANN. COMMON
T. COMMON
S. COMMON
ARB RCC
ARB INPUT
ZONE 1 EXTN.
TIME SYNC
RCC RESET
BRKR STATUS NO
BRKR STATUS NC
MTR STATUS
AP/GP LOW TRIP & LOCK
AP/GP LOW ALARM
TB–B
A.AP/GP LOW ALARM
A. AP/GP LOW TRIP & LOCK
A. PTFF ALARM
A. PTFF TRIP
A. LOCKOUT
A. TRIP CIRCUIT FAIL
A. LBB
A. RELAY FAIL
A. ARB
T.SOTF
T. DP
T.AP/GP LOW ALARM
T. AP/GP LOW TRIP & LOCK
T. PTFF ALARM
T. PTFF TRIP
T. LOCKOUT
T. TRIP CIRCUIT FAIL
T. LBB
T. RELAY FAIL
T. ARB
T. RECLOSE
T. ZONE1 EXTN.
T. THERMAL OVER LOAD
T. OCR
THE ALUMINIUM INDUSTRIES LTD.
Relays Division Trivandrum

SETTING GUIDELINES

1. Wrong Phase Coupling Protection

In the case of wrong phase coupling protection, there are no separate settings other than the impedance settings given. As per RDSO specification TI/SPC/PSI/PROTCT/6071, the relay will operate on WPC condition if all of the following conditions are satisfied.

a. The impedance measured by the relay in second quadrant of the R-X plane, i.e. phase angle between $\emptyset_{low}$ and $\emptyset_{high}$.
b. The impedance measured by the relay should be within the WPC impedance limits.
c. The regenerative current should be more than Reg. Current Setting.

2. Instantaneous Over current Protection

The current setting of over current element is usually set as 200% of the continuous current of the transformer.
A correcting factor of 1.15 is assumed to compensate the errors due to relay. CT's and PT's.
The transformer rated secondary current= 741 A

$$Is = \frac{741 \times 2 \times 5}{1.15 \times 750} = 8.59\ A$$

3. Auto Reclose Relay

This auto reclosing relay facilitates the reclosing of Feeder Circuit Breakers at the Traction Substations automatically once within the preset Dead time after tripping of the CB on fault. Please note that there are no separate setting calculations for Dead time 1, Dead time 2 and the Reclaim time.

3.1 Auto Re-closure Dead time

It is the time from the instant of fault detection up to the instant of closing of breaker by the Auto re-closure relay. It is settable from 0.1 to 1sec; normally dead time is set as 0.5sec. After the dead time the Auto re-closure relay recloses the breaker.

3.2 Auto Re-closure Reclaim Time

It is the duration, which the auto reclosing mechanism remains ineffective after the first re-closure of circuit breaker, irrespective of the persistence of the fault. In the reclaim time, if the fault persists, the Auto re-closure get locked out.

3.3 Number of shots and Dead time 2

The number of shots can be 1 or 2. If the number of shots is 1, there is only one dead time. After the dead time, circuit breaker is reclosed by the auto reclosing relay and simultaneously the reclaim time starts. If the number of shots is two, then after the first dead time, the second dead time starts. On completion of the 2^{nd} dead time, the breaker is closed by the relay and simultaneously, the reclaim time starts. If the fault persists in the reclaim time, the Auto re-closure goes into the lock out state.

3.4 Auto Re-closure Bypass current

If Short circuit current at 2.5 Km = 5000A
ARB current setting will be 50 % of 5000A = 2500A
So ARB setting chosen = 2000A
(CTR setting will be according to the CT ratio adopted. For 750/5, select 150)

CALCULATION OF R-X PARAMETERS SETTINGS FOR DISTANCE RELAY (ZONE 1/2/3 & ZONE 1 EXT)

Let us consider a conventional 132/ 25 kV TSS

Transformer rating	: 21.6 MVA
HV CT ratio	: 500/5 A
HV PT ratio	: 132000/110V
LV CT ratio	: 1500/5A
LV PT ratio	: 25000/110V
Feeder CT ratio	: 750/5A
Feeder PT ratio	: 25000/110V

The characteristics of Distance relay is shown in the figure given below. The relay characteristic angle is taken as the line angle of OHE and the load angle is taken as 36.9º corresponding to an average pf of 0.8.

Let the distance between adjacent TSS	= 80 km
Assuming OHE configuration	= 0.43 ohms/km
Impedance reach of distance relay	= 80 X 0.43
	= 34.4 ohms

Calculation of Forward Reactance (X_F)

Effective Impedance

(Considering CT, PT errors)	= Z_L
	=34.4 X 1.25
	= 43 ohms
Therefore, X_F	= Z_L x sin (RCA) x [CT ratio/PT ratio]
	= 43 x sin 70ºx [(750/5)/ (25000/110)]
	= 26.67ohm.

Calculation of Forward Resistance (R_F)

Peak load impedance (Z_{PL})	= [25000/150% of rated tfr. current] x [Ct ratio/PT ratio]
Rated Secondary current	= 741 A
Therefore, Peak load Impedance (Z_{PL})	= [25000/ (1.5 x 741)] x 0.66
	= 14.84 ohms

In order to accommodate arc resistance & tolerance of CT, PT & relay

Impedance Z	= 70% of Z_{PL}
	= 0.70 x 14.84
	= 10.39 ohms

As seen from the figure above,

Reactance X	= AB x tan (RCA)
Also, X	= Z x sin (load angle corresponding to 0.8 pf)
Hence, AB	= Z x $\frac{\sin (36.9)}{\text{Tan (RCA)}}$

	= 0.2185 Z
Also, OB	= Z x cos (36.9)
	= 0.7997 Z
Forward resistance R_F	= OB –AB
	= 0.7997Z -0.2185Z
	= 0.5812 Z
Therefore, R_F	= 0.812 x 10.39
	= 6.04 ohms

(0.5182 is a constant for 70º OHE)

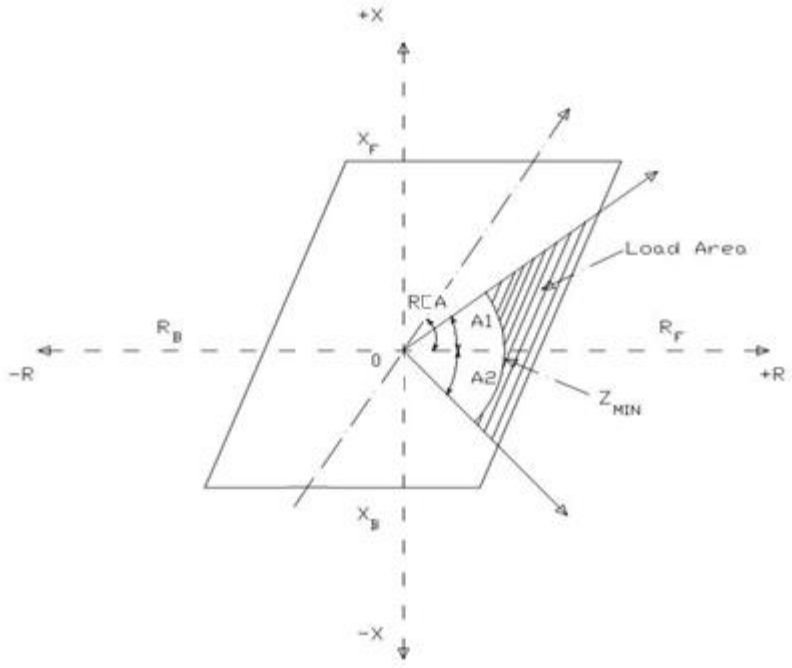
Calculation of Backward Resistance (R_B)

Backward Resistance, R_B	= Forward Resistance R_F
	= 6.04 ohms

Calculation of Backward Reactance (X_B)

Backward Reactance, R_B	= 25% of XF
	= 0.25 x 26.67
	= 6.67 ohms

X_B is taken as 25% of X_F considering that the distance between adjacent TSS's as 80 km. If the distance is less than this, X_B can be taken as 10% to 15 % of X_F.



LOAD CHARACTERISTICS

RELAY CONFORMING STANDARDS

The relay conforms to the following standards:

Sl No.	Standards	Description
I.	IEC 60255-16	Impedance Measuring Relay.
II.	IEC 60255-151	Functional Requirements for Over/Under Current Protection.
III.	IEC 60255-5	Insulation coordination of measuring relays and protection equipment- requirements and tests.
IV.	IEC 60255-1	Measuring relays and protection equipment- Common requirements.
V.	IEC 60255-21-1	Vibration Tests (Sinusodial)
VI.	IEC 60255-21-2	Shock and Bump Tests
VII.	IEC 60255-21-3	Seismic Tests
VIII.	IEC 60255-27	Product Safety Requirement.
IX.	IEC 60255-26	Electromagnetic Compatibility Requirement.
X.	IEC 60529	Degrees of Protection provided by enclosures (IP Code)
XI.	IEC 61810-2	Reliability.
XII.	IS 2705 (Part II, III&IV)	Protective current transformers.
XIII.	IS 3156 (Part II/III)	Measuring/protective voltage transformers.
XIV.	IS 3231 (Part 1 to 3)	Electrical relays for power system protection.
XV.	IS 8686	Static protective relays.
XVI.	IEC 60068-2	Environmental tests.
XVII.	IEC 60529	IP 54 Test
XVIII.	IEC 60870-5-103	Communication Protocol

TROUBLESHOOTING

ALUMINIUM INDUSTRIES LIMITED
Relays Division

Under normal working conditions, the 'PROTECTION HEALTHY LED' provided in the front panel of the relay glows green. The same LED turns amber to recognize any fault inside the relay itself. Following are certain guidelines for the relay to identify the nature of fault and necessary checking procedures to be adopted at site so that relay can be rectified suitably.

Sl. No.	Faults	Checks	Causes
1	No power ON Indication or No display.	1. Check the auxiliary DC supply to the relay rear terminals TB A-14: +110VDC TB A-15: -110VDC 2. Check the continuity of the output terminal, after disconnecting the wires.	1. Due to power supply failure, the LED turns off. 2. The varistor may short circuited to protect internal circuitry on transients
2	Current Not reading/ Out of tolerance limit.	1. Refer TB sticker for CT inputs. 2. Check for the earthing of CT. 3. Check if the terminals of TB-A is connected properly or for any lose contact. 4. Check CT ratio and multiplying factor if any. 5. Check the continuity of the output terminal, after disconnecting the wires. After checking of the above, measure the current using calibrated Clamp-On meter. If not OK, intimate to works.	1. The CT connector is having shorting facility. If the connector is not tight, CT secondary may get some low resistance path through the connector itself. 2. If CT is not properly earthed, there is a chance of leakage current that may cause error in CT reading.
3	Voltage not reading/Out of tolerance limit.	1. Refer TB sticker for PT inputs. 2. Check if the terminals of TB-A is Connected properly or for any lose contact. 3. Check PT ratio. 4. Check the continuity of the output terminal, after disconnecting the wires. After checking of the above, measure the voltage using calibrated multi-meter. If not OK, intimate to works.	1. The fuse of the PT in the yard may blown out. 2. The varistor may short circuited to protect internal circuitry on transients.
4	Relay Fail Indication	1. Intimate to works. 2. Press H.RST key in the relay front panel.	1. Supply variation to internal PCB's. 2. DC supply fail.

SCADA COMMUNICATION INTERFACE AS PER IEC 60870-5-103 PROTOCOL

TYPE – ANZ 114

DESIGNED AS PER RDSO SPECIFICATION NO.
TI/SPC/PSI/PROTCT/7100 (07/2012)

ALUMINIUM INDUSTRIES LIMITED
RELAYS DIVISION

OVERVIEW

IEC 60870-5-103 PROTOCOL

The IEC 60870-5-103 protocol is designed for use with the data transmission between IED's like protection equipment and control systems. The protocol defines application service data units which specify the message layout and contents, and describing the situations in which messages are sent. The companion standard IEC 60870-5-103 is derived from the IEC 60870-5 protocol standard definition and specifies a functional profile for basic tele control tasks. The IEC 60870-5 protocol stack is based on the reduced reference model called "Enhanced Performance Architecture" (EPA). This architecture includes only three layers of the ISO OSI model: the physical layer, link layer and application layer. Either a fiber optic system or copper wire based transmission system is used in this companion standard between the protection equipment and the control system.

The copper wire based transmission shall comply with the **EIA RS-485** standard. Due to the characteristics of the EIA RS-485 standard a maximum number of 32 units of load can be connected to one physical line.

1. TERMS, SERVICES AND DEFINITIONS

1.1 ADDRESS SETTING

IEC protocol is a multipoint protocol. This means that one master can communicate with multiple slaves on the same communication line. Due to this a given slave must have a unique id with which to address it – relay address. Relay address must lie in the range 1 to 254. Address 255 is reserved as a global broadcast address.

1.2 GENERAL INFORMATION

Messages representation is expressed with the associated:
− INFORMATION NUMBER: **INF**
− ASDU TYPE: **TYP**
− CAUSE OF TRANSMISSION: **COT**
− FUNCTION NUMBER: **FUN.**

1.3 ASDU (Application Service Data Units) Supported by the IED:

- Initialization (Reset/FCB)
- Time Synchronization
- Time Tagged Messages
- Spontaneous messages
- General Interrogation
- General command
- Cyclic measurements

STANDARD ASDUS IN MONITORING DIRECTION

#	DESIGNATION	SUPPORTED	REMARK
ASDU 1	Time-tagged message	YES	All available events and binary information with time stamp. Also the information from modules in additional module slot.
ASDU 2	Time-tagged message with relative time	YES	-
ASDU 3	Measurands I	NO	-
ASDU 4	Time-tagged measurands with relative time	YES	-
ASDU 5	Identification	YES	-
ASDU 6	Time synchronization	YES	-
ASDU 7	General Interrogation	YES	-
ASDU 8	General interrogation termination	YES	-
ASDU 9	Measurands II	YES	-
ASDU 10	Generic data	NO	-
ASDU 11	Generic identification	NO	-
ASDU 23	List of Recorded disturbances	YES	-
ASDU 26	Ready for transmission of disturbance data	YES	-
ASDU 27	Ready for transmission of channel	YES	-
ASDU 28	Ready for transmission of tags	YES	-
ASDU 29	Transmission of tags	YES	-
ASDU 30	Transmission of disturbance values	YES	-
ASDU 31	End of transmission	YES	-

STANDARD ASDUS IN CONTROL DIRECTION

#	DESIGNATION	SUPPORTED	REMARK
ASDU 6	Time synchronization	YES	-
ASDU 7	General interrogation	YES	-
ASDU 10	Generic data	NO	-
ASDU 20	General command	YES	-
ASDU 21	Generic command	NO	-
ASDU 24	Order for disturbance data transmission	YES	-
ASDU 25	Acknowledgement for disturbance data transmission	YES	-

1.4 INITIALIZATION

When the IED is connected to the communication system or if the communication parameters have been changed, a reset command is required to initialize the entire communications. A reset to the communication function is affected by means of a reset command from the control system. This is generally transmitted by the control system when:

- The control system is initialized
- The protection equipment does not respond during a certain period

This reset command does not affect the protection function, but only resets the communication part of the protection equipment. The reset command can be transmitted as

- Reset Frame Count Bit (FCB) or
- Reset Communication unit (CU)

In the case of reset FCB, the internal FCB bit in the protection equipment is set to '0'. Messages in the transmission buffer are not deleted.

In the case of CU, the messages in the transmission buffer are additionally deleted.

1.5 TIME SYNCHRONIZATION

Usually the time synchronize command is used to synchronize time of all secondary devices on a network. This command is also used to set the time of an individual secondary section. This command updates the current date and time from the master to slave.

1.6 TIME TAGGED MESSAGES

Two types of ASDU can be generated for events:
− ASDU 1: time-tagged message
− ASDU 2: time-tagged message with relative time
In the following list of processed events, FUNCTION NUMBERS (FUN) are used for Public range, respectively for current and voltage protections data.

1.7 SPONTANEOUS MESSAGES

These messages include a sub-assembly of the events, which are generated on the relay. The messages considered are concerning highest priority events. An event is always generated on the rising edge of the information; some can be generated also on falling edge.
In the list below (**Address Mapping**), events generated only on rising edge will be tagged with a '↑'.

1.8 GENERAL INTERROGATION

General interrogation is used to retrieve the state of certain events at the time of interrogation. A General Interrogation cycle is initiated by sending an initialization of General Interrogation ASDU of Type 7 to the address of the station to interrogate. The completion of a General Interrogation cycle will be signified by a General Interrogation Termination message.

1.9 GENERAL COMMAND

The Instruction/Command that is given to change the state of the IED through Master via ASDU 20, after executing one command, the relay sends an acknowledgement message, which contains the result of command execution. If a state change is the consequence of the command, it must be sent in an ASDU 1 with COT 1, 9. If the relay receives another command message from the master station before sending the Acknowledgement message, it will be discarded. Commands which are not processed by the relay are rejected with a negative acknowledgement message.

1.10 CYCLIC MEASUREMENTS

Measurands values are stored in lower levels of communication that is, Class 2 events, before polling by master station. In **ASDU 9** the following values are stored (with a rate such as: 2.4 * rated value = 4096).

2. TMW TEST HARNESS

The **Communication Protocol Test Harness** is a Windows application that simulates a typical Master or Slave device. It can be configured through a Graphical User Interface (GUI) and/or scripts to provide automated testing or simulation of a device. Tasks such as polling, performing control operations, and setting input or output values are done through this test software.

ALIND has implemented the IEC 60870-5 Tele-control Companion Standard 103 in the **ANZ 114** for communication with a controlling system. The IEC 60870-5 Tele-control Companion Standard TMW Test harness test set can be used as a communication protocol for exchanging information between Control Centre(s) (controlling station) and their substations (controlled station(s)). The information exchanged can be for status messages and commands.

3. LINK LAYER AND PHYSICAL CONNECTION

IEC 60870-5-2 offers a selection of link transmission procedures using a control field and the optional address field. Links between stations may be operated in either an unbalanced or a balanced transmission mode. Appropriate function codes for the control field are specified for both modes of operation. If the links from a central control station (controlling station) to several outstations (controlled stations) share a common physical channel, then these links must be operated in an unbalanced mode to avoid the possibility of more than one outstation attempting to transmit on the channel at the same time. The sequence in which the various outstations are granted access to transmit on the channel is then determined by an application layer procedure in the controlling station. The companion standard specifies whether an unbalanced or a balanced transmission mode is used, together with which link procedures (and corresponding link function codes) are to be used. The companion standard specifies an unambiguous address (number) for each link. Each address may be unique within a specific system, or it may be unique within a group of links sharing a common channel. The latter needs a smaller address field but requires the controlling station to map addresses by channel number.

The protocol uses frames and these frames contain octets that are transmitted as least significant first, without idle time. If transmission have been performed between Master and the Slave the slave will respond to the message with Link status Acknowledgement.

- **Rear serial port for SCADA Interface – EIA RS -485**

4. SYSTEM OR DEVICE CONFIGURATION

A Controlled station definition is used in this companion standard.

4.1 PHYSICAL LAYER

The physical layer defines the hardware-dependent specifications of the IEC 60870-5-103 communication interface.

4.1.2 ELECTRICAL INTERFACE

EIA RS-485
Note: EIA RS-485 standard defines unit loads so that 32 of them can be operated on one line.

4.1.3 TRANSMISSION SPEED

Supported Standard transmission speed;

9600 bit/s, 19200 bit/s and 57600 bit/s

4.2 LINK LAYER

The data link layer (link layer) defines the frame formats and the transmission procedures of the IEC communication.

4.3 APPLICATION LAYER

The application layer defines the information elements for structuring application data and the communication service functions.

4.4 TRANSMISSION MODE FOR APPLICATION DATA

Mode 1 (Least significant octet first), as defined in clause 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

4.5 COMMON ADDRESS OF ASDU

One octet is used in this companion standard.

4.6 INFORMATION OBJECT ADDRESS

Two octets are used in this companion standard and those were in Structured and Unstructured format.

4.7 CAUSE OF TRANSMISSION

One octet is used in this companion standard.

4.8 LENGTH OF APDU

(System-specific parameter, specify the maximum length of the APDU per system).
The maximum length of the APDU is 253 (default). The maximum length may be reduced per system.

5. PROTOCOL MAPPING

SYSTEM FUNCTIONS IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
End of general interrogation	-	8	255	0	10	GLB
Time synchronization	-	6	255	0	8	GLB
Reset FCB	-	5	128	2	3	According to main FUN
Reset CU	-	5	128	3	4	According to main FUN
Reset CU/Start/Restart	-	5	128	4	5	According to main FUN

STATUS INDICATION IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FN.NO.	INF.NO.	COT	COM
Protection Healthy/Active	-	1	128	18	1	↑
LED Reset	-	1	128	19	1	↑
Local Parameter Settings (Change)	-	1	128	22	1	↑
AP/GP Low Alarm	X	1	128	30	1,9	↑↓
AP/GP Trip & Lock	X	1	128	31	1,9	↑↓
MTR Status	X	1	128	29	1,9	↑↓
CB NC (FDR CB OPEN)	X	1	128	136	1,9	↑↓
CB NO (FDR CB CLOSE)	X	1	128	137	1,9	↑↓
Zone 1 EXTN. (Enable/Disable)	X	1	128	28	1,9	↑↓
Relay Fail	-	1	128	40	1	↑

SUPERVISION INDICATIONS IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FN.NO.	INF.NO.	COT	COM
Trip circuit supervision	X	1	128	36	1,9	↑↓
VT Fuse failure	X	1	128	38	1,9	↑↓
Thermal Over Load Alarm	X	1	128	201	1,9	↑↓

AUTO RECLOSER INDICATION IN (MONITOR DIRECTIONS)

DESCRIPTION	GI	ASDU TYPE	FN.NO.	INF.NO.	COT	COM
ARR Operated	X	1	128	16	1,9	↑↓
ARB (RCC) / ARB Input	X	1	128	27	1,9	↑↓

FAULT INDICATION IN (MONITOR DIRECTIONS)

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Breaker Failure (LBB)	X	2	128	85	1,9	↑↓
Start/Pickup Zone 1	X	2	126	110	1,9	↑↓
Start/Pickup Zone 2	X	2	126	111	1,9	↑↓
Start/Pickup Zone 3	X	2	126	112	1,9	↑↓
Start/Pickup Zone 1 EXT.	X	2	126	161	1,9	↑↓
Start/Pickup WPC	X	2	126	105	1,9	↑↓
Start/Pickup I> INST.OCR	X	2	126	123	1,9	↑↓
Start/Pickup I>>DEF.OCR Stage1	X	2	126	124	1,9	↑↓
Start/Pickup I>>> DEF.OCR Stage2	X	2	126	125	1,9	↑↓
Start/Pickup Thermal Over Load	X	2	126	200	1,9	↑↓
SOTF	-	2	126	106	1	↑
PTFF Start/Pickup (VT)	X	2	127	84	1,9	↑↓
Trip Zone 1	-	2	128	78	1	↑↓
Trip Zone 2	-	2	128	79	1	↑↓
Trip Zone 3	-	2	128	80	1	↑↓
Trip Zone 1 EXTN.	-	2	128	162	1	↑↓
Trip WPC	-	2	128	100	1	↑↓
AR LOCKOUT	X	2	128	107	1,9	↑↓
Trip Thermal over Load	-	2	128	202	1	↑↓
Trip VT (PTFF TRIP)	-	2	128	138	1	↑↓
I> INST.OCR	-	2	128	90	1	↑↓
I>> DEF.OCR Stage1	-	2	128	91	1	↑↓
I>>> DEF.OCR Stage2	-	2	128	104	1	↑↓

MEASURAND IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Measurand supervision I	-	9	128	148	2	↑↓
Measurand supervision V	-	9	128	148	2	↑↓

TIME TAGED MEASURAND IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Fault Current – I	-	4	128	141	1	↑↓
Fault Voltage – V	-	4	128	151	1	↑↓
Fault Reactance - X in OHMS	-	4	128	73	1	↑↓
Fault Resistance - R	-	4	128	75	1	↑↓
Fault Distance – FD	-	4	128	74	1	↑↓

STANDARD INFORMATION NUMBERS IN CONTROL DIRECTION

SYSTEM FUNCTIONS IN CONTROL DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Initiation of general interrogation	-	7	255	0	9	GLB
Time Synchronization	-	6	255	0	8	GLB

GENERAL COMMANDS IN CONTROL DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
RCC RESET	-	20	128	19	20	↑(PULSE)
CB (O/o Open)	-	20	128	124	20	↑(PULSE)
CB (C/c Close)	-	20	128	125	20	↑(PULSE)
ARB Enable/Disable	-	20	128	122	20	↑↓(PULSE)
Zone 1 – Extension Enable/Disable	-	20	128	123	20	↑↓(PULSE)

6. DISTURBANCE DATA RECORDER

In digital protection equipment, analogue currents and voltages are sampled with given sampling rates, to be processed by the protection functions. Additionally, these samples may be stored in order to be a basis for a disturbance recorder function.
In the protection equipment, disturbance recording includes:
• Analogue values (disturbance values), digitally coded as currents IL1, IL2, IL3, IN and voltages VL1, VL2, VL3, VEN;
• Binary values (indications), recorded as tags, for example start/pick-up and trip indications.

6.1 DISTURBANCE RECORDER FILES TRANSFER/DISTURBANCE RECORDINGS

• The transfer functionality is based on the Disturbance recorder function. The analog and binary signals recorded will be reported to the master by polling. The two hundred disturbances (customized) that are recorded are available for transfer to the master.

• The data function blocks include the function type and the information number for each channel. The analog channels, that are reported, are those connected to the disturbance function blocks. The two hundred disturbance are belongs to the private range because of customization and transfers the multiples of 20 latest list of disturbance records.

• In Disturbance recordings the following elements are used in the ASDUs (Application Service Data Units) defined in the standard. Analog signals, 4-channels (MAX): the channel number for each channel has to be specified. Channels used in the public range are 1 to 8 i.e.

6.2 ACTUAL CHANNEL INFO

CHANNEL(ACC)		
FUN	ACC	
FUN	1	Ir
FUN	2	Iy
FUN	3	Ib
FUN	4	Ie / I
FUN	5	V1
FUN	6	V2
FUN	7	V3
FUN	8	Vn/V4

#Some Relays channels were customized in-order to meet compatibility with Master application software

• After analog channel transmission the Tags (digital channels) are transmitted through another ASDU, Tags are the digital signals, the IED (Protection Equipment) contains a maximum of 32 digital Tags, and the information element includes Function type, Information number, and Fault number along with the tag position.

6.3 DEVIATIONS FROM THE STANDARD

Information sent in the disturbance upload is specified by the standard; however, some of the information handlings are customized in-order to meet customer requirements. This section describes all data that is not exactly as specified in the standard.

LIST OF STANDARD ASDU IN DISTURBANCE RECORDING

#	DESIGNATION	SUPPORTED	REMARK
ASDU 7	**General Interrogation**	***Yes***	**-**
ASDU 8	**General interrogation termination**	***Yes***	**-**
ASDU 23	**List of recorded disturbance**	***Yes***	**-**
ASDU 26	**Ready for transmission of disturbance data**	***Yes***	**-**
ASDU 27	**Ready for transmission of channel**	***Yes***	**-**
ASDU 28	**Ready for transmission of tags**	***Yes***	**-**
ASDU 29	**Transmission of tags**	***Yes***	**-**
ASDU 30	**Transmission of disturbance values**	***Yes***	**-**
ASDU 31	**End of transmission**	***Yes***	**-**

STANDARD ASDUS IN CONTROL DIRECTION

#	DESIGNATION	SUPPORTED	REMARK
ASDU 24	**Order for disturbance data transmission**	***Yes***	**-**
ASDU 25	**Acknowledgement for disturbance data transmission**	***Yes***	**-**

6.4 GENERIC DISTURBANCE ORDER COMMAND.

Generic disturbance order command allows the selection of fault, function type of specific relays and most importantly it consists of Type of order command (TOO).The TOO command has specific task like it can poll different ASDU's with a positive or negative acknowledgement.

6.5 TOO (TYPE OF ORDER)

TOO specifies the type of order, for example selection, request, and abort of transmission of disturbance data, channels, tags, and list of recorded disturbances.

7.0 ADVANCED FEATURES ADDED

1. DR PHYSICAL ERASE

7.1 DR PHYSICAL ERASE

Up-to two hundred disturbances are made available in Relay, due to certain storage limitation, once a DR is polled and saved, the DR will be erased permanently and the same will access directly through Alind relay soft. Software

8. ANALOG CHANNEL INFORMATION IN ANZ 114

ANZ 114		
FUN	ACC	PARAMETER
128	**1**	**I**
128	2	x
128	3	x
128	4	x
128	**5**	**V**
128	6	x
128	7	x
128	8	x

9. DIGITAL CHANNEL (TAGS) INFORMATION IN ANZ 114

ANZ 114			
TAG POSSITION	FUN/INF NUMBER	SEMANTICS ACCORDING TO TAG POSSITION	INPUT/ OUTPUT
0	128/84	GENERAL PICKUP	OUTPUT
1	128/68	GENERAL TRIP	OUTPUT
2	128/78	ZONE 1 TRIP	OUTPUT
3	128/79	ZONE 2 TRIP	OUTPUT
4	128/80	ZONE 3 TRIP	OUTPUT
5	128/100	WPC TRIP	OUTPUT
6	128/90	I> TRIP	OUTPUT
7	128/91	I>> TRIP	OUTPUT
8	128/104	I>>> TRIP	OUTPUT
9	128/138	PTFF (VT) TRIP	OUTPUT
10	128/202	THERMAL OVERLOAD (49RMS) TRIP	OUTPUT
11	128/162	ZONE 1 EXT. TRIP	OUTPUT
12	126/106	SOTF	OUTPUT
13	128/16	AUTO RECLOSE OPERATED	OUTPUT
14	128/85	BREAKER FAILURE	OUTPUT
15	128/27	AUTO RECLOSE BLOCK INPUT - LOG I/P - 1	INPUT
16	128/34	AUTO RECLOSE BLOCK RCC - LOG I/P - 2	INPUT
17	128/28	ZONE 1 EXT. - LOG I/P - 3	INPUT
18	255/0	TIME SYNC - LOG I/P - 4	INPUT
19	128/19	RCC RESET - LOG I/P - 5	INPUT
20	128/136	CB NC (OPEN) - LOG I/P - 6	INPUT
21	128/137	CB NO (CLOSE) - LOG I/P - 7	INPUT
22	128/29	MTR STATUS - LOG I/P - 8	INPUT
23	128/31	AP/GP LOW TRIP & LOCK - LOG I/P - 9	INPUT
24	128/30	AP/GP LOW ALARM - LOG I/P - 10	INPUT
25	128/36	TRIP CIRCUIT SUPERVISION - LOG I/P - 11	INPUT

SCADA COMMUNICATION INTERFACE AS PER IEC 60870-5-103 PROTOCOL

TYPE – ANZ 214

DESIGNED AS PER RDSO SPECIFICATION NO.
TI/SPC/PSI/PROTCT/7100 (07/2012)

ALUMINIUM INDUSTRIES LIMITED
RELAYS DIVISION

OVERVIEW

IEC 60870-5-103 PROTOCOL

The IEC 60870-5-103 protocol is designed for use with the data transmission between IED's like protection equipment and control systems. The protocol defines application service data units which specify the message layout and contents, and describing the situations in which messages are sent. The companion standard IEC 60870-5-103 is derived from the IEC 60870-5 protocol standard definition and specifies a functional profile for basic tele control tasks. The IEC 60870-5 protocol stack is based on the reduced reference model called "Enhanced Performance Architecture" (EPA). This architecture includes only three layers of the ISO OSI model: the physical layer, link layer and application layer. Either a fiber optic system or copper wire based transmission system is used in this companion standard between the protection equipment and the control system.

The copper wire based transmission shall comply with the **EIA RS-485** standard. Due to the characteristics of the EIA RS-485 standard a maximum number of 32 units of load can be connected to one physical line.

1. TERMS, SERVICES AND DEFINITIONS

1.1 ADDRESS SETTING

IEC protocol is a multipoint protocol. This means that one master can communicate with multiple slaves on the same communication line. Due to this a given slave must have a unique id with which to address it – relay address. Relay address must lie in the range 1 to 254. Address 255 is reserved as a global broadcast address.

1.2 GENERAL INFORMATION

Messages representation is expressed with the associated:
− INFORMATION NUMBER: **INF**
− ASDU TYPE: **TYP**
− CAUSE OF TRANSMISSION: **COT**
− FUNCTION NUMBER: **FUN.**

1.3 ASDU (Application Service Data Units) Supported by the IED:

- Initialization (Reset/FCB)
- Time Synchronization
- Time Tagged Messages
- Spontaneous messages
- General Interrogation
- General command
- Cyclic measurements

STANDARD ASDUS IN MONITORING DIRECTION

#	DESIGNATION	SUPPORTED	REMARK
ASDU 1	Time-tagged message	YES	All available events and binary information with time stamp. Also the information from modules in additional module slot.
ASDU 2	Time-tagged message with relative time	YES	-
ASDU 3	Measurands I	NO	-
ASDU 4	Time-tagged measurands with relative time	YES	-
ASDU 5	Identification	YES	-
ASDU 6	Time synchronization	YES	-
ASDU 7	General Interrogation	YES	-
ASDU 8	General interrogation termination	YES	-
ASDU 9	Measurands II	YES	-
ASDU 10	Generic data	NO	-
ASDU 11	Generic identification	NO	-
ASDU 23	List of Recorded disturbances	YES	-
ASDU 26	Ready for transmission of disturbance data	YES	-
ASDU 27	Ready for transmission of channel	YES	-
ASDU 28	Ready for transmission of tags	YES	-
ASDU 29	Transmission of tags	YES	-
ASDU 30	Transmission of disturbance values	YES	-
ASDU 31	End of transmission	YES	-

STANDARD ASDUS IN CONTROL DIRECTION

#	DESIGNATION	SUPPORTED	REMARK
ASDU 6	Time synchronization	YES	-
ASDU 7	General interrogation	YES	-
ASDU 10	Generic data	NO	-
ASDU 20	General command	YES	-
ASDU 21	Generic command	NO	-
ASDU 24	Order for disturbance data transmission	YES	-
ASDU 25	Acknowledgement for disturbance data transmission	YES	-

1.4 INITIALIZATION

When the IED is connected to the communication system or if the communication parameters have been changed, a reset command is required to initialize the entire communications. A reset to the communication function is affected by means of a reset command from the control system. This is generally transmitted by the control system when:

- The control system is initialized
- The protection equipment does not respond during a certain period

This reset command does not affect the protection function, but only resets the communication part of the protection equipment. The reset command can be transmitted as

- Reset Frame Count Bit (FCB) or
- Reset Communication unit (CU)

In the case of reset FCB, the internal FCB bit in the protection equipment is set to '0'. Messages in the transmission buffer are not deleted.

In the case of CU, the messages in the transmission buffer are additionally deleted.

1.5 TIME SYNCHRONIZATION

Usually the time synchronize command is used to synchronize time of all secondary devices on a network. This command is also used to set the time of an individual secondary section. This command updates the current date and time from the master to slave.

1.6 TIME TAGGED MESSAGES

Two types of ASDU can be generated for events:
− ASDU 1: time-tagged message
− ASDU 2: time-tagged message with relative time
In the following list of processed events, FUNCTION NUMBERS (FUN) are used for Public range, respectively for current and voltage protections data.

1.7 SPONTANEOUS MESSAGES

These messages include a sub-assembly of the events, which are generated on the relay. The messages considered are concerning highest priority events. An event is always generated on the rising edge of the information; some can be generated also on falling edge.
In the list below (**Address Mapping**), events generated only on rising edge will be tagged with a '↑'.

1.8 GENERAL INTERROGATION

General interrogation is used to retrieve the state of certain events at the time of interrogation. A General Interrogation cycle is initiated by sending an initialization of General Interrogation ASDU of Type 7 to the address of the station to interrogate. The completion of a General Interrogation cycle will be signified by a General Interrogation Termination message.

1.9 GENERAL COMMAND

The Instruction/Command that is given to change the state of the IED through Master via ASDU 20, after executing one command, the relay sends an acknowledgement message, which contains the result of command execution. If a state change is the consequence of the command, it must be sent in an ASDU 1 with COT 1, 9. If the relay receives another command message from the master station before sending the Acknowledgement message, it will be discarded. Commands which are not processed by the relay are rejected with a negative acknowledgement message.

1.10 CYCLIC MEASUREMENTS

Measurands values are stored in lower levels of communication that is, Class 2 events, before polling by master station. In **ASDU 9** the following values are stored (with a rate such as: 2.4 * rated value = 4096).

2. TMW TEST HARNESS

The **Communication Protocol Test Harness** is a Windows application that simulates a typical Master or Slave device. It can be configured through a Graphical User Interface (GUI) and/or scripts to provide automated testing or simulation of a device. Tasks such as polling, performing control operations, and setting input or output values are done through this test software.

ALIND has implemented the IEC 60870-5 Tele-control Companion Standard 103 in the **ANZ 214** for communication with a controlling system. The IEC 60870-5 Tele-control Companion Standard TMW Test harness test set can be used as a communication protocol for exchanging information between Control Centre(s) (controlling station) and their substations (controlled station(s)). The information exchanged can be for status messages and commands.

3. LINK LAYER AND PHYSICAL CONNECTION

IEC 60870-5-2 offers a selection of link transmission procedures using a control field and the optional address field. Links between stations may be operated in either an unbalanced or a balanced transmission mode. Appropriate function codes for the control field are specified for both modes of operation. If the links from a central control station (controlling station) to several outstations (controlled stations) share a common physical channel, then these links must be operated in an unbalanced mode to avoid the possibility of more than one outstation attempting to transmit on the channel at the same time. The sequence in which the various outstations are granted access to transmit on the channel is then determined by an application layer procedure in the controlling station. The companion standard specifies whether an unbalanced or a balanced transmission mode is used, together with which link procedures (and corresponding link function codes) are to be used. The companion standard specifies an unambiguous address (number) for each link. Each address may be unique within a specific system, or it may be unique within a group of links sharing a common channel. The latter needs a smaller address field but requires the controlling station to map addresses by channel number.

The protocol uses frames and these frames contain octets that are transmitted as least significant first, without idle time. If transmissions have been performed between Master and the Slave the slave will respond to the message with Link status Acknowledgement.

- **Rear serial port for SCADA Interface – EIA RS -485**

4. SYSTEM OR DEVICE CONFIGURATION

A Controlled station definition is used in this companion standard.

4.1 PHYSICAL LAYER

The physical layer defines the hardware-dependent specifications of the IEC 60870-5-103 communication interface.

4.1.2 ELECTRICAL INTERFACE

EIA RS-485
Note: EIA RS-485 standard defines unit loads so that 32 of them can be operated on one line.

4.1.3 TRANSMISSION SPEED

Supported Standard transmission speed;

9600 bit/s, 19200 bit/s and 57600 bit/s

4.2 LINK LAYER

The data link layer (link layer) defines the frame formats and the transmission procedures of the IEC communication.

4.3 APPLICATION LAYER

The application layer defines the information elements for structuring application data and the communication service functions.

4.4 TRANSMISSION MODE FOR APPLICATION DATA

Mode 1 (Least significant octet first), as defined in clause 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

4.5 COMMON ADDRESS OF ASDU

One octet is used in this companion standard.

4.6 INFORMATION OBJECT ADDRESS

Two octets are used in this companion standard and those were in Structured and Unstructured format.

4.7 CAUSE OF TRANSMISSION

One octet is used in this companion standard.

4.8 LENGTH OF APDU

(System-specific parameter, specify the maximum length of the APDU per system).
The maximum length of the APDU is 253 (default). The maximum length may be reduced per system.

5. PROTOCOL MAPPING

SYSTEM FUNCTIONS IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
End of general interrogation	-	8	255	0	10	GLB
Time synchronization	-	6	255	0	8	GLB
Reset FCB	-	5	128	2	3	According to main FUN
Reset CU	-	5	128	3	4	According to main FUN
Reset CU/Start/Restart	-	5	128	4	5	According to main FUN

STATUS INDICATION IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Protection Healthy/Active	-	1	128	18	1	↑
LED Reset	-	1	128	19	1	↑
Local Parameter Settings (Change)	-	1	128	22	1	↑
AP/GP Low Alarm	X	1	128	30	1,9	↑↓
AP/GP Trip & Lock	X	1	128	31	1,9	↑↓
MTR Status	X	1	128	29	1,9	↑↓
CB NC (FDR CB OPEN)	X	1	128	136	1,9	↑↓
CB NO (FDR CB CLOSE)	X	1	128	137	1,9	↑↓
Zone 1 EXTN. (Enable/Disable)	X	1	128	28	1,9	↑↓
Relay Fail	-	1	128	40	1	↑

SUPERVISION INDICATIONS IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Trip circuit supervision	X	1	128	36	1,9	↑↓
VT Fuse failure (ALARM)	X	1	128	38	1,9	↑↓
Thermal Over Load Alarm	X	1	128	201	1,9	↑↓

AUTO RECLOSER INDICATION IN (MONITOR DIRECTIONS)

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
ARR Operated	X	1	128	16	1,9	↑↓
ARB (Reclose Block) / ARB Input	X	1	128	27	1,9	↑↓

FAULT INDICATION IN (MONITOR DIRECTIONS)

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Breaker Failure (LBB)	X	2	128	85	1,9	↑↓
Start/pickup Zone 1	X	2	126	110	1,9	↑↓
Start/pickup Zone 2	X	2	126	111	1,9	↑↓
Start/pickup Zone 3	X	2	126	112	1,9	↑↓
Start Zone 1 EXT.	X	2	126	161	1,9	↑↓
Start/Pickup I> INST.OCR	X	2	126	123	1,9	↑↓
Start/Pickup I>>DEF.OCR Stage2	X	2	126	124	1,9	↑↓
Start/Pickup I>>> DEF.OCR Stage3	X	2	126	125	1,9	↑↓
Thermal Over Load Start/Pickup	X	2	126	200	1,9	↑↓
PTFF Start/Pickup (VT)	X	2	127	84	1,9	↑↓
SOTF	-	2	126	106	1	↑
Trip Zone 1	-	2	128	78	1	↑↓
Trip Zone 2	-	2	128	79	1	↑↓
Trip Zone 3	-	2	128	80	1	↑↓
Trip Zone 1 EXTN.	-	2	128	162	1	↑↓
AR LOCKOUT	X	2	128	107	1,9	↑↓
Thermal over Load Trip	-	2	128	202	1	↑↓
VT TRIP (PTFF TRIP)	-	2	128	138	1	↑↓
I> INST.OCR	-	2	128	90	1	↑↓
I>> DEF.OCR Stage1	-	2	128	91	1	↑↓
I>>> DEF.OCR Stage2	-	2	128	104	1	↑↓

MEASURAND IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Measurand supervision I-F	-	9	128	148	2	↑↓
Measurand supervision I -T	-	9	128	148	2	↑↓
Measurand supervision I –Total	-	9	128	148	2	↑↓
Measurand supervision V	-	9	128	148	2	↑↓

TIME TAGED MEASURAND IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Fault Reactance - X in OHMS	-	4	128	73	1	↑↓
Fault Resistance - R	-	4	128	75	1	↑↓
Traction Fault Current – I	-	4	128	141	1	↑↓
Feeder Fault current – I	-	4	128	142	1	↑↓
Fault Voltage – V	-	4	128	151	1	↑↓
Fault Impedance – Z	-	4	128	74	1	↑↓

STANDARD INFORMATION NUMBERS IN CONTROL DIRECTION

SYSTEM FUNCTIONS IN CONTROL DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Initiation of general interrogation	-	7	255	0	9	GLB
Time Synchronization	-	6	255	0	8	GLB

GENERAL COMMANDS IN CONTROL DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
LED (RCC) RESET	-	20	128	19	20	↑ (PULSE)
CB (O/o Open)	-	20	128	124	20	↑ (PULSE)
CB (C/c Close)	-	20	128	125	20	↑ (PULSE)
ARB Reset	-	20	128	122	20	↑↓ (PULSE)
Zone 1 – Extension Enable/Disable	-	20	128	123	20	↑↓ (PULSE)

6. DISTURBANCE DATA RECORDER

In digital protection equipment, analogue currents and voltages are sampled with given sampling rates, to be processed by the protection functions. Additionally, these samples may be stored in order to be a basis for a disturbance recorder function.
In the protection equipment, disturbance recording includes:
• Analogue values (disturbance values), digitally coded as currents IL1, IL2, IL3, IN and voltages VL1, VL2, VL3, VEN;
• Binary values (indications), recorded as tags, for example start/pick-up and trip indications.

6.1 DISTURBANCE RECORDER FILES TRANSFER/DISTURBANCE RECORDINGS

• The transfer functionality is based on the Disturbance recorder function. The analog and binary signals recorded will be reported to the master by polling. The two hundred disturbances (customized) that are recorded are available for transfer to the master.

• The data function blocks include the function type and the information number for each channel. The analog channels, that are reported, are those connected to the disturbance function blocks. The two hundred disturbance are belongs to the private range because of customization and transfers the multiples of 20 latest list of disturbance records.

• In Disturbance recordings the following elements are used in the ASDUs (Application Service Data Units) defined in the standard. Analoge signals, 4-channels (MAX): the channel number for each channel has to be specified. Channels used in the public range are 1 to 8 i.e.

6.2 ACTUAL CHANNEL INFO

CHANNEL(ACC)		
FUN	ACC	
FUN	1	Ir
FUN	2	Iy
FUN	3	Ib
FUN	4	Ie / I
FUN	5	V1
FUN	6	V2
FUN	7	V3
FUN	8	Vn/V4

#Some Relays channels were customized in-order to meet compatibility with Master application software

• After analog channel transmission the Tags (digital channels) are transmitted through another ASDU, Tags are the digital signals, the IED (Protection Equipment) contains a maximum of 32 digital Tags, and the information element includes Function type, Information number, and Fault number along with the tag position.

6.3 DEVIATIONS FROM THE STANDARD

Information sent in the disturbance upload is specified by the standard; however, some of the information handlings are customized in-order to meet customer requirements. This section describes all data that is not exactly as specified in the standard.

LIST OF STANDARD ASDU IN DISTURBANCE RECORDING

#	DESIGNATION	SUPPORTED	REMARK
ASDU 7	**General Interrogation**	***Yes***	**-**
ASDU 8	**General interrogation termination**	***Yes***	**-**
ASDU 23	**List of recorded disturbance**	***Yes***	**-**
ASDU 26	**Ready for transmission of disturbance data**	***Yes***	**-**
ASDU 27	**Ready for transmission of channel**	***Yes***	**-**
ASDU 28	**Ready for transmission of tags**	***Yes***	**-**
ASDU 29	**Transmission of tags**	***Yes***	**-**
ASDU 30	**Transmission of disturbance values**	***Yes***	**-**
ASDU 31	**End of transmission**	***Yes***	**-**

STANDARD ASDUS IN CONTROL DIRECTION

#	DESIGNATION	SUPPORTED	REMARK
ASDU 24	**Order for disturbance data transmission**	***Yes***	**-**
ASDU 25	**Acknowledgement for disturbance data transmission**	***Yes***	**-**

6.4 GENERIC DISTURBANCE ORDER COMMAND.

Generic disturbance order command allows the selection of fault, function type of specific relays and most importantly it consists of Type of order command (TOO).The TOO command has specific task like it can poll different ASDU's with a positive or negative acknowledgement.

6.5 TOO (TYPE OF ORDER)

TOO specifies the type of order, for example selection, request, and abort of transmission of disturbance data, channels, tags, and list of recorded disturbances. The following ranges of TOO are used with the different ASDUs:

7. ANALOG CHANNEL INFORMATION IN ANZ 214

ANZ 214		
FUN	ACC	PARAMETER
128	**1**	**I - t**
128	**2**	**I - f**
128	3	x
128	4	x
128	**5**	**V**
128	6	x
128	7	x
128	8	x

8. DIGITAL CHANNEL (TAGS) INFORMATION IN ANZ 214

ANZ 214			
TAG POSSITION	FUN/INF NUMBER	SEMANTICS ACCORDING TO TAG POSSITION	INPUT/ OUTPUT
0	128/84	GENERAL PICKUP	OUTPUT
1	128/68	GENERAL TRIP	OUTPUT
2	128/78	ZONE 1 TRIP	OUTPUT
3	128/79	ZONE 2 TRIP	OUTPUT
4	128/80	ZONE 3 TRIP	OUTPUT
5	128/90	INST. OCR I> TRIP	OUTPUT
6	128/91	DEF. OCR STAGE 2 I>> TRIP	OUTPUT
7	128/104	DEF. OCR STAGE 3 I>>> TRIP	OUTPUT
8	128/138	VT (PTFF) TRIP	OUTPUT
9	128/202	THERMAL OVERLOAD TRIP	OUTPUT
10	128/162	ZONE 1 EXT. TRIP	OUTPUT
11	126/106	SOTF	OUTPUT
12	128/16	Auto Reclose OPERATED	OUTPUT
13	128/85	BREAKER FAILURE	OUTPUT
14	128/27	ARB (RECLOSE BLOCK) - LOG I/P - 1	INPUT
15	128/34	AUTO RECLOSE BLOCK INPUT - LOG I/P - 1	INPUT
16	128/28	ZONE 1 EXT. - LOG I/P - 2	INPUT
17	255/0	TIME SYNC - LOG I/P - 3	INPUT
18	128/19	RCC RESET - LOG I/P - 4	INPUT
19	128/136	CB NC (OPEN) - LOG I/P - 5	INPUT
20	128/137	CB NO (CLOSE) - LOG I/P - 6	INPUT
21	128/29	MTR STATUS - LOG I/P - 7	INPUT
22	128/31	AP/GP LOW TRIP & LOCK - LOG I/P - 8	INPUT
23	128/30	AP/GP LOW ALARM - LOG I/P - 9	INPUT

24	128/36	TRIP CIRCUIT SUPERVISION - LOG I/P - 10	INPUT

TEST REPORT

ALUMINIUM INDUSTRIES LIMITED
Relays Division

FUNDAMENTAL WAVE CHARACTERISTICS TEST

I) DISTANCE PROTECTION ELEMENT TESTS

i) Minimum operating current test

Settings:

RF1 = 5 ohms RB1 = 5 ohms
XF1 = 20 ohms XB1 = 3 ohms RCA = 70 deg

SETTINGS (%)	OPERATING CURRENT (A)	ERROR (%)	STATUS
0.5			OPERATED / NOT OPERATED
1.5			OPERATED / NOT OPERATED

Allowable tolerance limit in Impedance value is ±5%

Zone 1

Settings:

RF1 = 5 ohms RB1 = 5 ohms RCA = 70 deg
XF1 = 20 ohms XB1 = 3 ohms Z Mininum = 2 ohm
Forward Angle = 40 degree Reverse Angle = 40 degree

PHASE ANGLE (Φ)	CURRENT (A)	VOLTAGE RANGE			VOLTAGE (V)	IMPEDANCE RANGE			IMPEDANCE Z_{OBS}= V/I
		Vmin	V	Vmax		Zmin	Z	Zmax	
0	5	9.50	10.09	10.50		1.90	2.01	2.10	
20	5	9.50	10.09	10.50		1.90	2.01	2.10	
100	5	44.63	47.42	49.33		8.92	9.48	9.86	
150	5	22.66	24.08	25.04		4.53	4.81	5.00	
200	5	29.13	30.95	32.20		5.82	6.19	6.44	
250	5	15.16	16.11	16.76		3.03	3.22	3.35	
320	5	22.17	23.55	24.50		4.43	4.71	4.90	
350	5	9.50	10.09	10.50		1.90	2.01	2.10	

Allowable tolerance limit in Impedance value is ±5%

Zone 2

Settings:

RF2 = 6 ohms RB2 = 6 ohms RCA = 85 deg
XF2 = 20 ohms XB2 = 6 ohms Z Mininum = 3 ohm
Forward Angle = 30 degree Reverse Angle = 30 degree

PHASE ANGLE (Φ)	CURRENT (A)	VOLTAGE RANGE			VOLTAGE (V)	IMPEDANCE RANGE			IMPEDANCE Z_{OBS}= V/I
		Vmin	V	Vmax		Zmin	Z	Zmax	
10	5	14.25	15.14	15.75		2.85	3.02	3.15	
50	5	49.50	52.59	54.71		9.90	10.51	10.94	
120	5	49.50	52.59	54.71		9.90	10.51	10.94	
180	5	28.50	30.28	31.50		5.70	6.05	6.30	
210	5	34.66	36.82	38.31		6.93	7.36	7.66	
260	5	28.94	30.75	31.98		5.78	6.15	6.39	
300	5	32.91	34.96	36.37		6.58	6.99	7.27	
340	5	14.25	15.14	15.75		2.85	3.02	3.15	

Allowable tolerance limit in Impedance value is ±5%

Zone 3

Settings:

RF3 = 8 ohms RB3 = 4 ohms RCA = 65 deg
XF3 = 40 ohms XB3 = 4 ohms Z Mininum = 4 ohm
Forward Angle = 30 degree Reverse Angle = 30 degree

PHASE ANGLE (Φ)	CURRENT (A)	VOLTAGE RANGE			VOLTAGE (V)	IMPEDANCE RANGE			IMPEDANCE Z_{OBS}= V/I
		Vmin	V	Vmax		Zmin	Z	Zmax	
20	5	19.00	20.19	21.00		3.80	4.03	4.20	
110	5	24.35	25.87	26.91		4.87	5.17	5.38	
170	5	17.82	18.94	19.70		3.56	3.78	3.94	
230	5	24.80	26.35	27.41		4.96	5.27	5.48	
260	5	19.29	20.50	21.32		3.85	4.10	4.26	
310	5	24.80	26.35	27.41		4.96	5.27	5.48	
340	5	19.00	20.19	21.00		3.80	4.03	4.20	
350	5	19.00	20.19	21.00		3.80	4.03	4.20	

Allowable tolerance limit in Impedance value is ±5%

Zone 1 Ext

Settings:

RF3 = 6 ohms RB3 = 6 ohms RCA = 70 deg
XF3 = 30 ohms XB3 = 6 ohms Z Mininum = 2 ohm
Forward Angle = 40 degree Reverse Angle = 40 degree

PHASE ANGLE (Φ)	CURRENT (A)	VOLTAGE RANGE			VOLTAGE (V)	IMPEDANCE RANGE			IMPEDANCE Z_{OBS}= V/I
		Vmin	V	Vmax		Zmin	Z	Zmax	
10	5	9.50	10.09	10.50		1.90	2.01	2.10	
40	5	53.56	56.91	59.20		10.71	11.38	11.84	
100	5	53.56	56.91	59.20		10.71	11.38	11.84	
150	5	27.19	28.89	30.05		5.43	5.77	6.01	
190	5	30.92	32.85	34.18		6.18	6.57	6.83	
240	5	32.91	34.96	36.37		6.58	6.99	7.27	
280	5	28.94	30.75	31.98		5.78	6.15	6.39	
320	5	28.50	30.28	31.50		5.70	6.05	6.30	

Allowable tolerance limit in Impedance value is ±5%

iv) Fault distance measurement

Settings: RF1 = 5 ohms RB1 = 5 ohms RCA = 70 deg Ohms/km = 0.45
XF1 = 20 ohms XB1 = 3 ohms CT ratio = 750/5 PT ratio = 27000/110

PHASE ANGLE Ø	CURRENT (A)	VOLTAGE (V)	IMPEDANCE Z=V / I	DISPLAYED FAULT LOCATION IN KM	ACTUAL FAULT LOCATION= (X / (0.45*SIN(RCA))
0	10	25	2.5		0
20	10	30	3.0		3.95
90	5	60	12.0		46.25

Allowable tolerance limit is ±2%

II) WRONG PHASE COUPLING ELEMENT TEST

i) Regenerative Current Limiting Test

Settings:

WPC_{low}=11 ohms, WPC_{high}=38 ohms, WPC angle low=90, WPC angle high=150. Applied angle 120

REGENERATIVE CURRENT (A)	VOLTAGE (V)	CURRENT (A)	STATUS OF WPC ELEMENT
0.5	15		Operated/ Not Operated
1.5	35		Operated/ Not Operated
3.0	40		Operated/ Not Operated

Allowable tolerance limit in Current value is ±5%

ii) WPC Operating Phase Angle Test

Settings:

WPC low = 11 ohm, WPC High = 38 ohm, Regenerative Current = 3A

PHASE ANGLE SETTING	VOLTAGE IN VOLTS (V)	CURRENT IN AMP (I)	IMPEDANCE (OHMS) Z = V / I	OBSERVED PHASE ANGLE
Low = 90	100	5	20	
High =180				

Allowable tolerance limit in phase angle value is ±5%

iii) Wrong Phase Coupling Impedance Test

Settings: WPC angle low=90, WPC angle high=150

SETTING		PHASE ANGLE DEGREE	VOLTAGE (V)	CURRENT (A)	IMPEDANCE Z_{OBS}=V/I (OHMS)	% ERROR BETWEEN Z_{OBS} AND Z LIMIT	STATUS OF WPC ELEMENT
Low	2	120		5			Operated/ Not Operated
High	20	120		5			Operated/ Not Operated

Allowable tolerance limit in Impedance value is ±5%

III) POTENTIAL TRANSFORMER FUSE FAILURE TEST

i) Potential Transformer Fuse failure (Trip) element Operating Value Test

PTFF SETTINGS		VOLTAGE APPLIED (V)	CURRENT INJECTED (A)	% ERROR IN OPERATING VOLTAGE	% ERROR IN OPERATING CURRENT	STATUS OF PTFF ELEMENT
V	I					
10V	3A	7.00		---		Operated/Not Operated
			5.00		---	Operated/Not Operated
20V	5A	18.00		---		Operated/Not Operated
			7.00		---	Operated/Not Operated

Allowable tolerance limit in Current & Voltage is ±5%

IV) OVER-CURRENT ELEMENT OPERATING VALUE TEST

i) High-set Instantaneous OCR Stage1

a) Element: Non Directional

OCR SETTING (%)	OPERATING VALUE (A)	ERROR (%)
80		
100		
180		

Allowable tolerance limit in Impedance value is ±5%

ii) Definite time Over-Current element Operating Value Test

a) Definite time OCR Stage-2 (OCR Stage-3 disabled)

Element: Non directional

DEFINITE OCR 1 (%)	OPERATING VALUE (A)	DROP OFF VALUE (A)	DROP OFF/ PICK UP RATIO
40			
100			

Allowable tolerance limit in Current is ±5%

b) Definite time OCR Stage-3 (OCR Stage-2 disabled)

Element: Non Directional

DEFINITE OCR 2 (%)	OPERATING VALUE (A)	DROP OFF VALUE (A)	DROP OFF/ PICK UP RATIO
40			
100			

Allowable tolerance limit in Current is ±5%

V) AUTO RECLOSURE BYPASS (ARB) TEST

a) Zone 1

ARB SETTING (A)	FAULT CURRENT APPLIED (A)	%ERROR	STATUS OF ARB
10			Operated / Not Operated
15			Operated / Not Operated

Allowable tolerance limit is ±5%

b) ARB Verification through input status

Apply +110 VDC to TB C-17 and verify that ARB element operates and check the output contact in TB C -16 and TB B-9.

Result: Operated / Not Operated

VI) SWITCH ON TO FAULT (SOTF) TEST

Set the SOTF setting as 10A. Keeping the voltage at 50V, inject a current above the set value of SOTF.

SOTF SETTING (%)	BREAKER STATUS	OPERATING VALUE (A)	SOTF STATUS
200	ON	---	Operated / Not Operated
	OFF		Operated / Not Operated

Allowable tolerance limit is ±5%

OPERATING TIME TEST

I) Operating Time Test for DPR

i) Zone 1

Settings:

RF1 = 5 ohms RB1 = 5 ohms XF1 = 20 ohms XB1 = 3 ohms RCA = 70 deg
Zone1 Extension, Zone2 and Zone3 in disable mode.

PHASE ANGLE DEG.	CT CURRENT (A)	PT VOLTAGE (V)	OPERATING TIME (ms)
60	5.0	4.5	
280	10.0	8.0	

Operating time measured should be within 40ms.

ii) Zone 2

Settings:

RF2=6.00 ohms RB2=6.00 ohms XF2=20.00 ohms XB2=6.00 ohms RCA =85deg
Zone1 ,Zone1 Ext & Zone3 in disable mode.

ZONE 2 TIME DELAY	PHASE ANGLE DEG.	CT CURRENT (A)	PT VOLTAGE (V)	OPERATING TIME (ms)
100	10	5	20	
250	10	5	20	

Allowable tolerance limit is ± 5%

iii) Zone 3

Settings:

RF3=6.00 ohms RB3=6.00 ohms XF3=60.00 ohms XB3=6.00 ohms RCA=65deg
Zone 1, Zone1 Ext & Zone 2 in disable mode

ZONE 3 TIME DELAY	PHASE ANGLE	CURRENT (A)	VOLTAGE(V)	OPERATING TIME (ms)
100	10	5	15	
500	10	5	15	

Allowable tolerance limit is ± 5%

II) Operating Time Test for Wrong-Phase Coupling Element

Setting:

WPC Lower limit =6 ohm WPC Higher limit = 20 ohm

PHASE ANGLE LAG(DEG)	VOLTAGE (V)	INITIAL CURRENT (A)	FINAL CURRENT (A)	OPERATING TIME (ms)
120	50	0	5	
140	50	0	5	

Operating time measured should be within 40ms

II) Operating Time Test OCR

i) Stage 1- Inst. OCR

OCR SETTING	CT CURRENT (A)		OPERATING TIME(ms)
	INITIAL	FINAL	
80%	2	10	
100%	2	15	

Operating time measured should be within 25ms.

ii) Def. Time OCR Stage-2
OCR Stage 3 disabled

DEFINITE OCR STAGE-1 (%)	INJECTED CURRENT (A)	TIME SETTING (ms)	OBSERVED VALUE (ms)
40	3A	100	
100	8A	200	

Allowable tolerance limit is ±5%

iii) Def. Time OCR Stage-3
OCR Stage-2 disabled

DEFINITE OCR STAGE-3 (%)	INJECTED CURRENT (A)	TIME SETTING (S)	OBSERVED VALUE (S)
40	3A	10	
100	8A	50	

Allowable tolerance limit is ±5%

III) Operating Time Test for PTFF Trip

PTFF SETTINGS		VOLTAGE APPLIED (V)	CURRENT INJECTED (A)	OPERATING TIME (ms)
V	I			
10V	1.5A	8.0V	2.0A	
10V	1.5A	7.0V	3.0A	

Observation: PT Fuse Failure relay was operated within the limit of 40ms

IV) Lockout Verification

Lockout condition is initiated by simulating another master trip contact during the reclaim time. When such a condition is simulated the relay goes into lockout state and the corresponding indication and contacts are verified.

Result: Operated / Not Operated

Lockout Reset from Remote

Lockout condition is initiated by simulating another master trip contact during the reclaim time. When such a condition is simulated, the relay goes into lockout state. This lockout state can be reset by short the TB Point TB C-23 (Reset from RCC) & 17 (+110 V).

Result: Operated / Not Operated

V) Thermal Over load Protection

Thermal Trip (%)	Full load current (IFLA)	Time constant	k	Irms	Initial value A	T calculated	T obtained	Error
100	20	1	1	4	0	3.872		
50	40	3	1.05	6	0	11.37		
50	40	3	1.05	6	20	6.912		

Allowable tolerance limit is ±5%

VI) Local Breaker Backup (LBB) Trip:

Settings:

OCR setting = 100% Injected current = 10A

LBB TIME SETTING	BREAKER STATUS	LBB STATUS	LBB + OCR TIME (ms)
200ms	Operated	Not Operated	
	Not operated	Operated	
500ms	Operated	Not Operated	
	Not operated	Operated	

Allowable tolerance limit is ±5%

STATUS VERIFICATION

STATUS	STATUS INPUT	OUTPUT CONTACT VERIFICATION
FDR BRKR AP/GP LOW ALARM	Short TB-C 17 & 28	
FDR BRKR AP/GP TRIP & LOCK	Short TB- C 17 & 27	

ALUMINIUM INDUSTRIES LTD

Relays division, Kavinpuram, Vilappilsala (P.O)

Thiruvananthapuram Kerala India-695 573

Ph: 0471-2379704, 2379503

Email: alindrelays@yahoo.com