NUMERICAL INTEGRATED TRANSFORMER PROTECTION RELAY ANTP 202HV/LV/ 302 / 402 [AN SERIES]

User Manual

ALUMINIUM INDUSTRIES LIMITED
RELAYS DIVISION
THIRUVANANTHAPURAM

ANTP 202HV/LV/ 302/ 402

Numerical Integrated Transformer Protection Relay

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ALUMINIUM INDUSTRIES LIMITED
Relays Division

SAFETY REQUIREMENTS

ALUMINIUM INDUSTRIES LIMITED
Relays Division

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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.

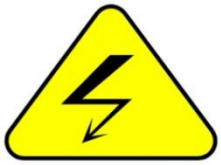
- People handling the equipment should be aware about the relay safety handlet.
- Ensure that the product is in the off condition before working on the conducting or terminal side.
- A qualified person must conduct tests and visual inspections, as necessary, to verify that tools electrical jumpers, shorts, 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

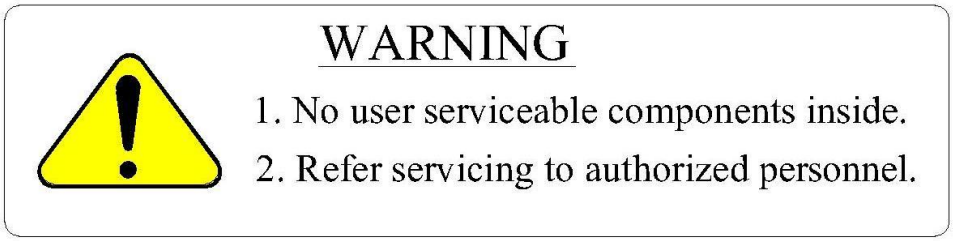
1. FRONT SIDE

Caution: refer to equipment documentation



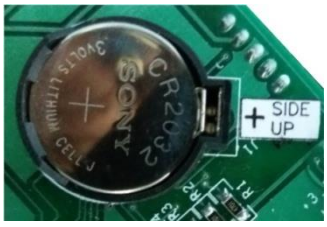
Caution: risk of electric shock

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

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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 ratios.
- CB close and open command initiation from relay through RCC.

PREVIOUS HISTORY OF TRANSFORMER PROTECTION RELAYS

TMAS 101a

Static Type.

ATP 214

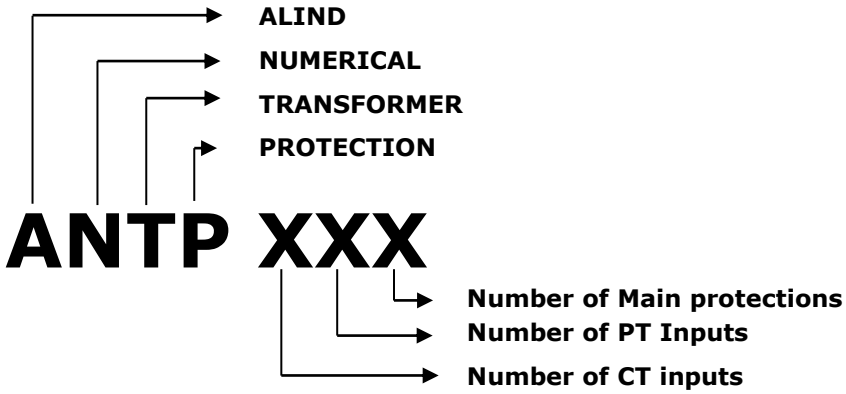
Numerical Integrated transformer protection relay

Disturbance & event recorder

Built in counter facility

ANTP

The relay is the modified version of our ATP 214 (AN Series) relay. The relay incorporates Instantaneous, IDMT curve, 3 stage definite time over current protection, Post over load protection.



ANTP 202HV/LV:

The relay conforms to RDSO specification No. TI/SPC/PSI/PROTCT/6071. ANTP 202 (AN Series) relay is a comprehensive Integrated Transformer Protection relay for the protection of conventional 27 KV AC single phase, 50Hz Over Head Equipment (OHE).

ANTP 402/ 302:

The relay conforms to RDSO specification No. TI/SPC/PSI/PROTCT/7100(07/2012). ANTP 402/ 302 (AN Series) relay is a comprehensive Integrated Transformer Protection relay for the protection of 2x25 KV (AT feeding system) AC single phase, 50Hz Over Head Equipment (OHE).

MAIN FUNCTIONS

Sl No.	PARTICULARS	ANTP 202 HV/LV	ANTP 302	ANTP 402
1.	**MAIN PROTECTIONS**			
1.1	IDMT OCR	✓	✓ (T & F)	✓ (3 phase)
1.2	Instantaneous OCR	✓	✓ (T & F)	✓ (3 phase)
1.3	Definite Time OCR	✓	(T & F)	✓ (3 phase)
1.4	Earth Fault	✓ (Restricted)	✓ (Restricted)	✓
1.5	Post Over Load	✓	(T & F)	✓ (3 phase)
2.	**STATUS INPUTS**			
2.1	Trip Circuit Supervision	✓	✓	✓
2.2	AP/GP Low Alarm	✓	✓	✓
2.3	AP/GP Low Trip & Lock	✓	✓	✓
2.4	Buchholz Alarm	✓		✓
2.5	Winding Temperature Alarm	✓	✓	
2.6	Oil Temperature Alarm	✓		✓
2.7	Low Oil Level Alarm	✓	✓	
2.8	Relay Fail	✓	✓	✓

GENERAL FUNCTIONS

Sl No.	PARTICULARS	ANTP 202 HV/LV	ANTP 302	ANTP 402
1.	Password protection	✓	✓	✓
2.	Event Memory	5000	5000	5000
3.	Disturbance recorder waveforms	200	200	200
4.	50 cycles (45 pre and 5 post fault) of fault waveform	✓	✓	✓
5.	**COMMUNICATION**			
5.1	GUI Interface	Mini USB	Mini USB	Mini USB
5.2	Isolated RS 485 Interface	✓	✓	✓
5.3	Communication Protocol Interface- IEC 60870-5-103	✓	✓	✓
5.4	GPS Time Sync Facility	✓	✓	✓
5.5	Date/time synchronization through PC	✓	✓	✓
6.	**MONITORING**			
6.1	Line Current	✓	✓	✓
6.2	Earth Current	✓	✓	✓
6.3	Selectable CT ratio:5-5000/5A	✓	✓	✓
6.4	Selectable Earth CT ratio: 5-5000/5A	✓	✓	✓
6.5	Counters for each element (IDMT, Inst. OCR, REF, Def. OCR, Post Over load)	✓	✓	✓
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

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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.

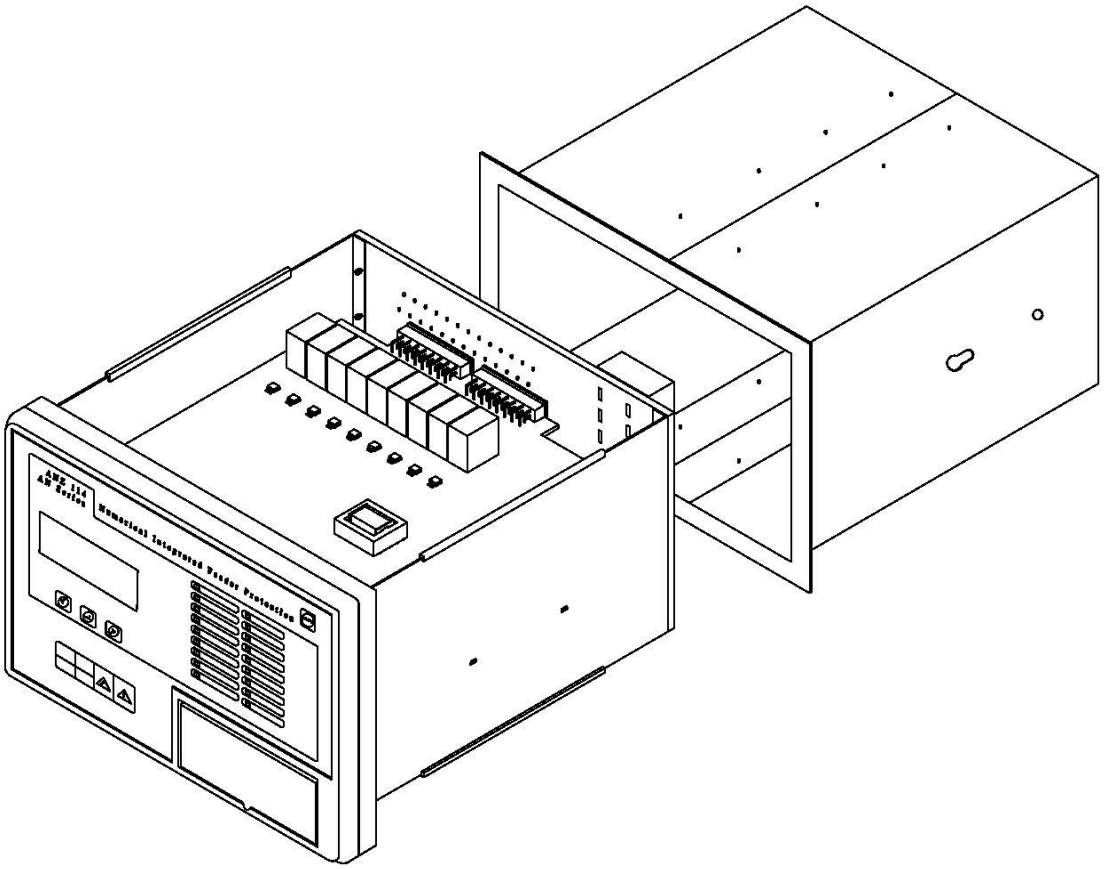
The relay is shipped from factory after detailed testing by our Quality Control Department. However, according to the customer requirement the relay settings/ functions can be verified before commissioning at respective sites with proper testing kits.

STORAGE

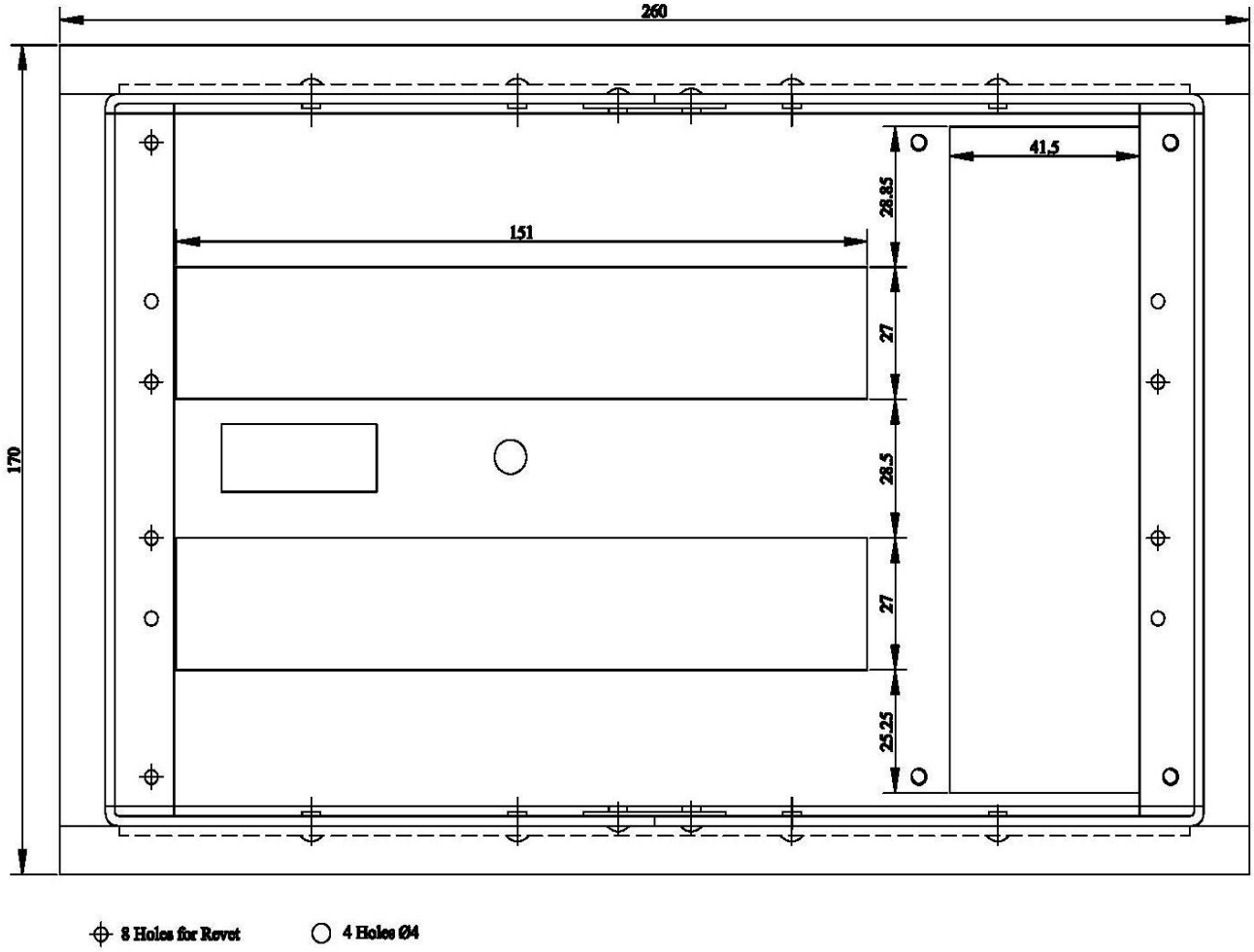
If relays are not to be installed immediately upon receipt they should be stored in a place free from dust and moisture in their original boxes. At most care should be taken while storage.

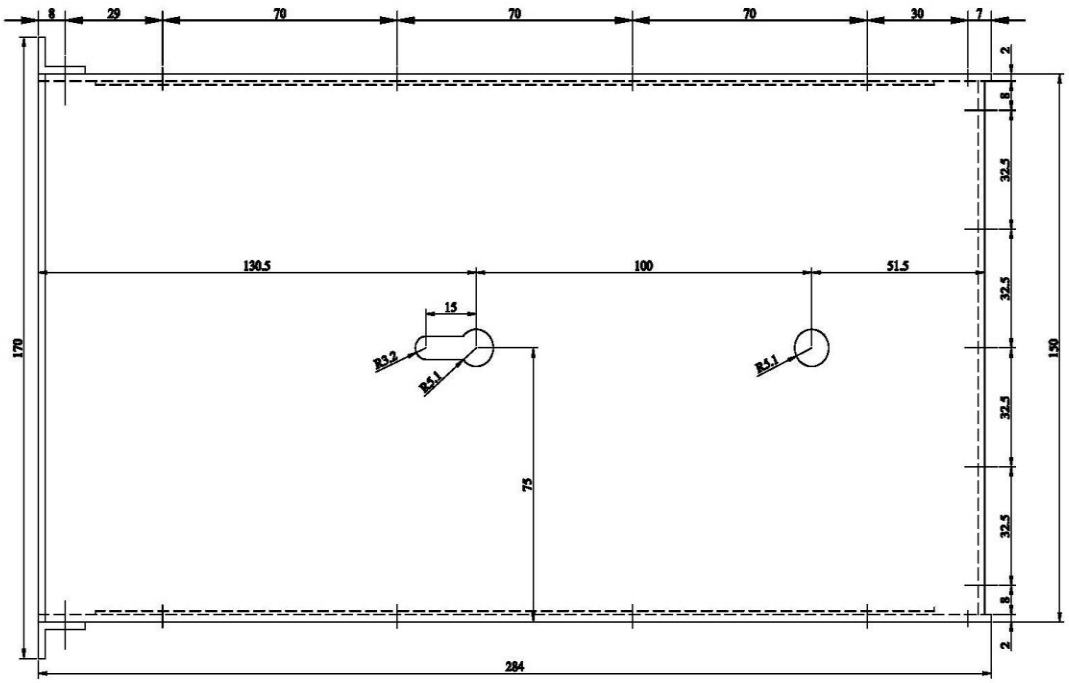
Storage temperature: -25ºC to +70ºC.

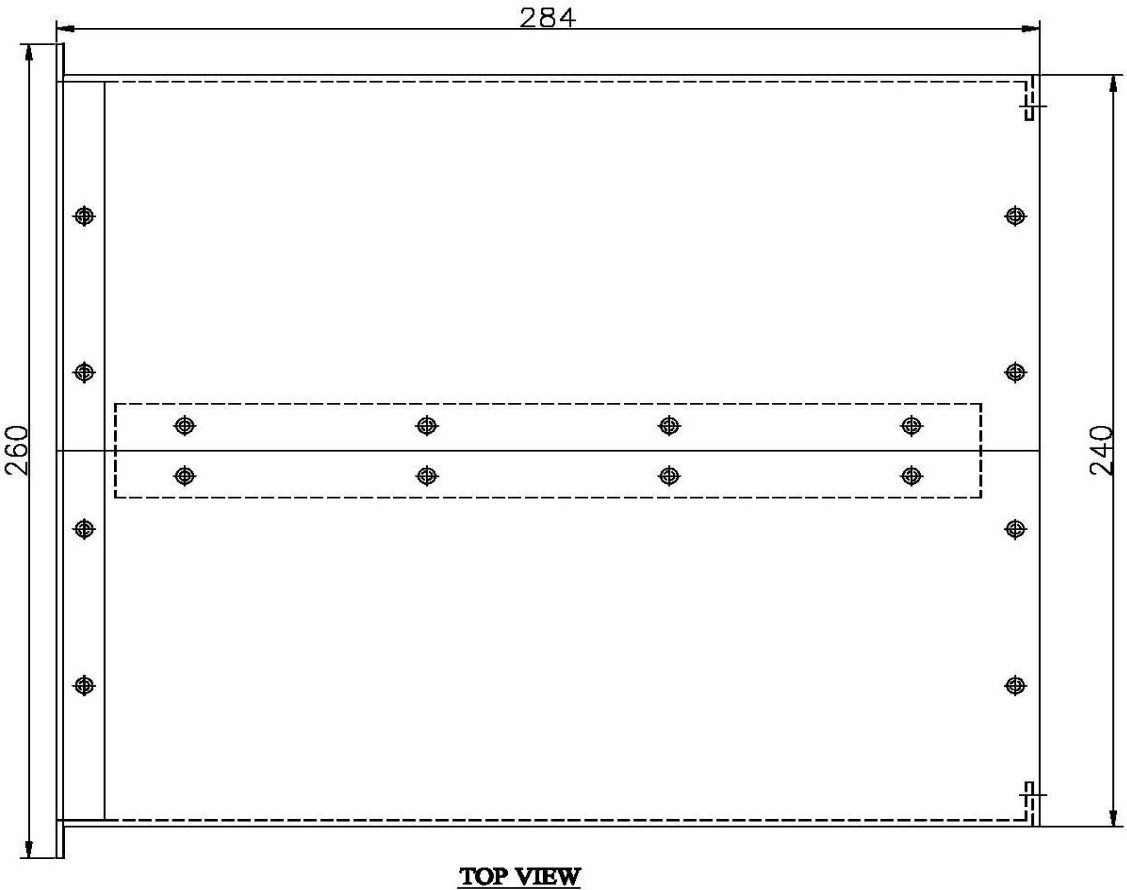
RELAY AND RACK MOUNTING



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
170
150
75
284


284
260
240

TOP VIEW

USER GUIDE

ALUMINIUM INDUSTRIES LIMITED
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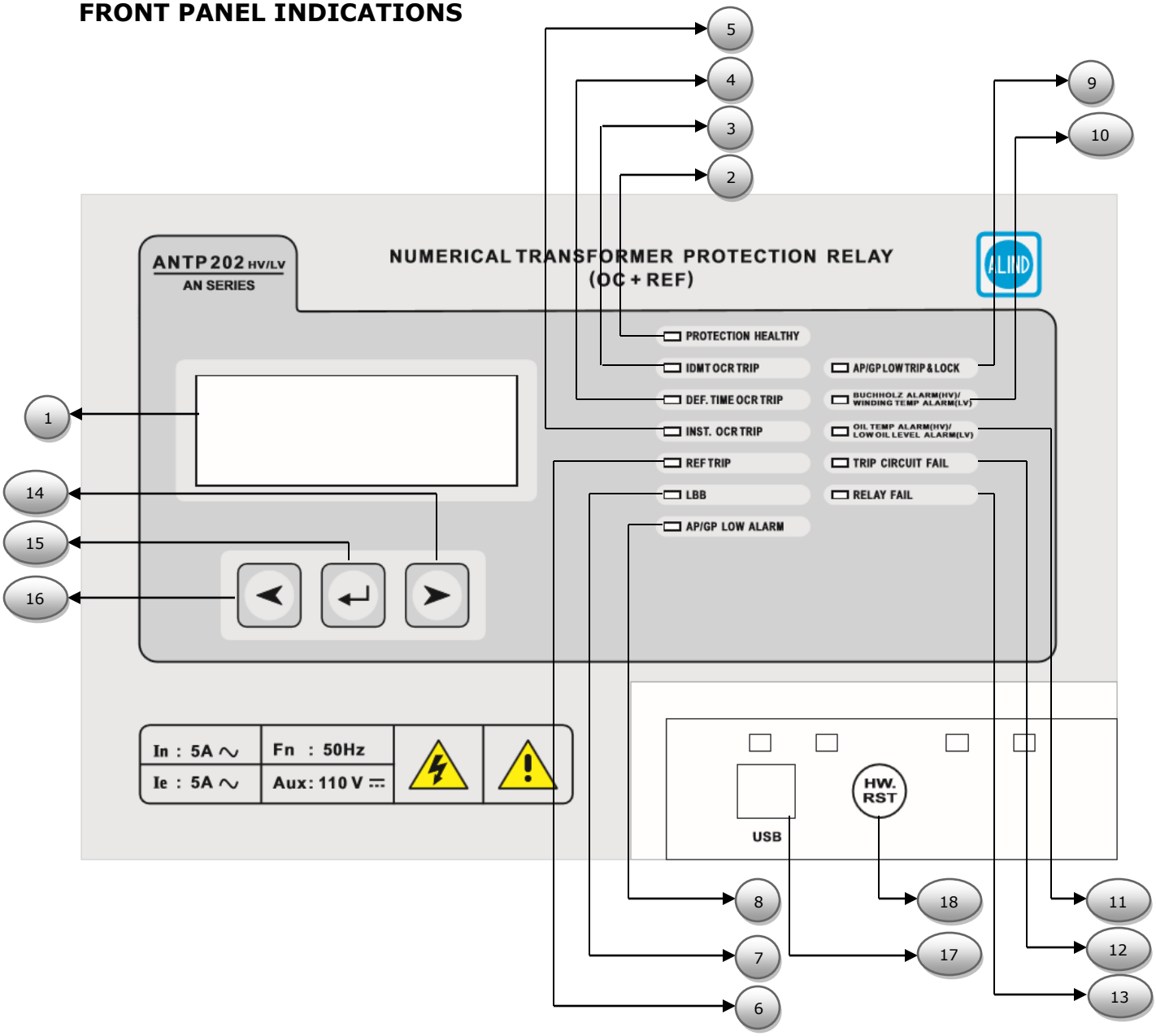
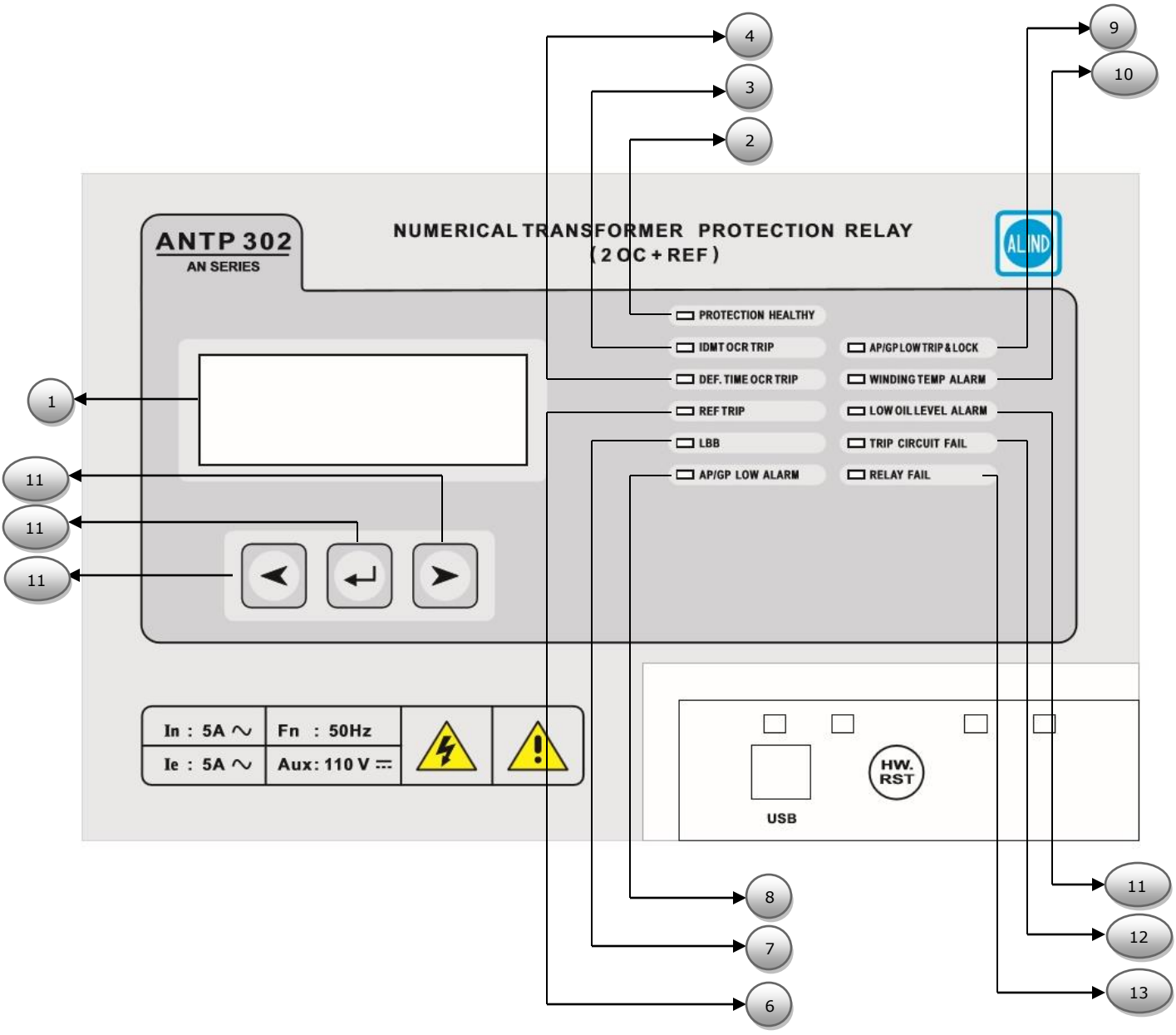
FRONT PANEL INDICATIONS



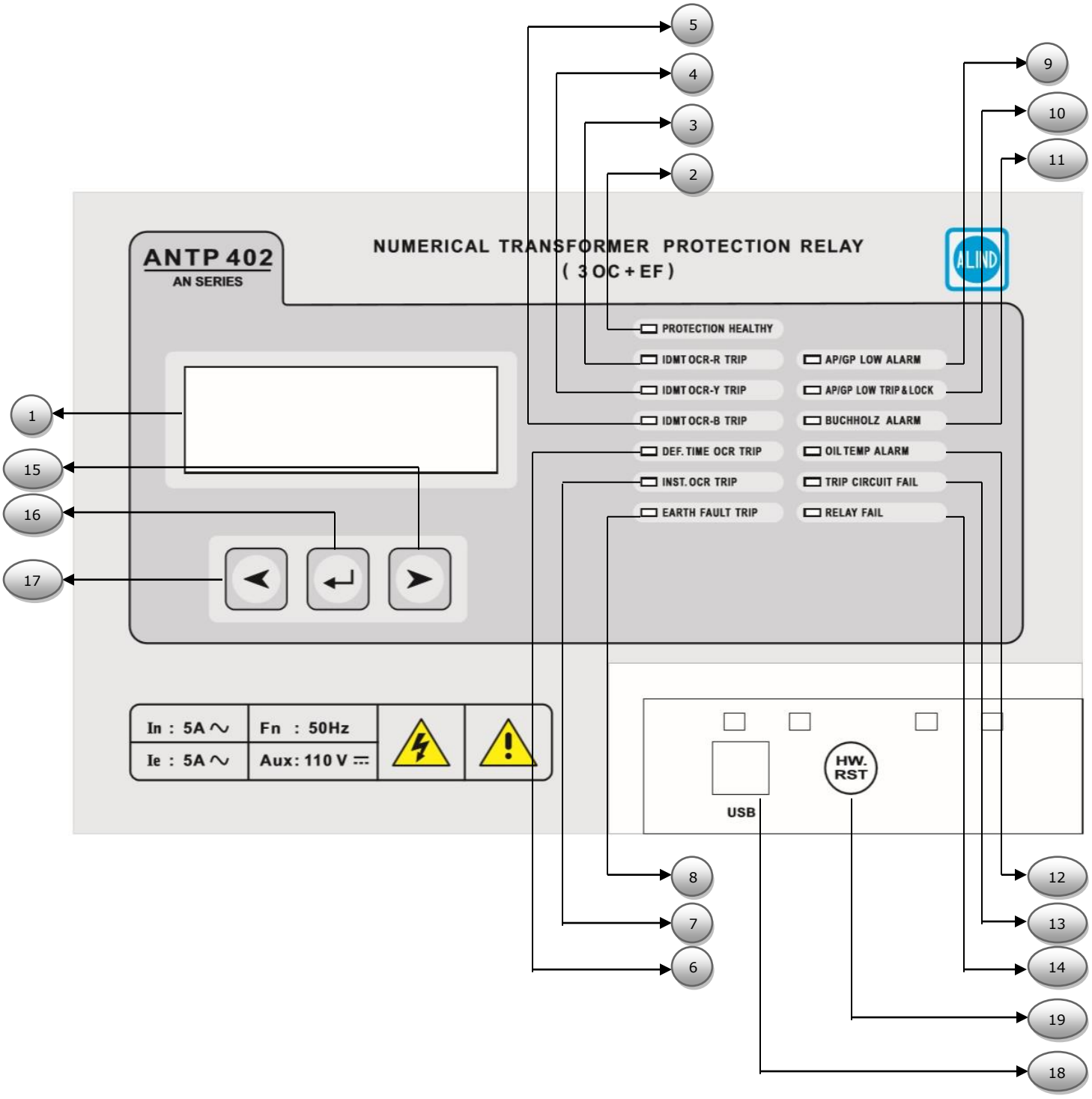

ANTP 302
AN SERIES
NUMERICAL TRANSFORMER PROTECTION RELAY
(2 OC + REF)
ALIND
PROTECTION HEALTHY
IDMT OCR TRIP
DEF. TIME OCR TRIP
REF TRIP
LBB
AP/GP LOW ALARM
AP/GP LOW TRIP & LOCK
WINDING TEMP ALARM
LOW OIL LEVEL ALARM
TRIP CIRCUIT FAIL
RELAY FAIL
In : 5A
Ie : 5A
Fn : 50Hz
Aux: 110 V
HW. RST
USB
1
2
3
4
6
7
8
9
10
11
11
11
11
12
13

No	Legend	ANTP 202 HV/LV	ANTP 302
1.	LCD DISPLAY	✓	✓
2.	PROTECTION HEALTHY (Green/Amber)	✓	✓
3.	IDMT OCR TRIP(RED)	✓	✓
4.	DEF. TIME OCR TRIP(RED)	✓	✓
5.	INST. OCR TRIP(RED)	✓	✓
6.	REF TRIP(RED)	✓	✓
7.	LBB(RED)	✓	✓
8.	AP/GP LOW ALARM(RED)	✓	✓
9.	AP/GP LOW TRIP & LOCK(RED)	✓	✓
10.	BUCHHOLZ ALARM(HV)/ (RED) WINDING TEMP ALARM(LV)	✓	✓*
11.	OIL TEMP ALARM(HV)/(RED) LOW OIL LEVEL ALARM(LV)	✓	✓**
12.	TRIP CIRCUIT FAIL(RED)	✓	✓
13.	RELAY FAIL(RED)	✓	✓
14.	>	✓	✓
15.	↵	✓	✓
16.	<	✓	✓
17.	USB	✓	✓
18.	H.RST	✓	✓

* -only Winding Temp. Alarm

** - only Low Oil Level Alarm

ANTP 402


ANTP 402
AN SERIES
NUMERICAL TRANSFORMER PROTECTION RELAY
(3 OC + EF)
PROTECTION HEALTHY
IDMT OCR-R TRIP
IDMT OCR-Y TRIP
IDMT OCR-B TRIP
DEF. TIME OCR TRIP
INST. OCR TRIP
EARTH FAULT TRIP
AP/GP LOW ALARM
AP/GP LOW TRIP & LOCK
BUCHHOLZ ALARM
OIL TEMP ALARM
TRIP CIRCUIT FAIL
RELAY FAIL
In : 5A ~
Ie : 5A ~
Fn : 50Hz
Aux: 110 V ⎓
HW. RST
USB
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

No	Legend	ANTP 402
1.	LCD DISPLAY	✓
2.	PROTECTION HEALTHY (Green/Amber)	✓
3.	IDMT OCR-R TRIP(RED)	✓
4.	IDMT OCR-Y TRIP(RED)	✓
5.	IDMT OCR-B TRIP(RED)	✓
6.	DEF. TIME OCR TRIP(RED)	✓
7.	INST. OCR TRIP(RED)	✓
8.	EARTH FAULT TRIP(RED)	✓
9.	AP/GP LOW ALARM(RED)	✓
10.	AP/GP LOW TRIP & LOCK(RED)	✓
11.	BUCHHOLZ ALARM(RED)	✓
12.	OIL TEMP ALARM(RED)	✓
13.	TRIP CIRCUIT FAIL(RED)	✓
14.	RELAY FAIL(RED)	✓
15.	>	✓
16.	↵	✓
17.	<	✓
18.	USB	✓
19.	H.RST	✓

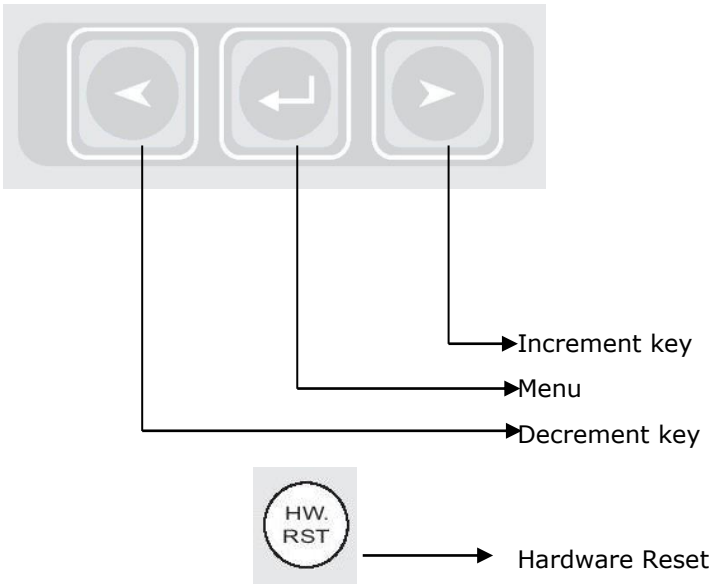
LCD DISPLAY

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 20 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.

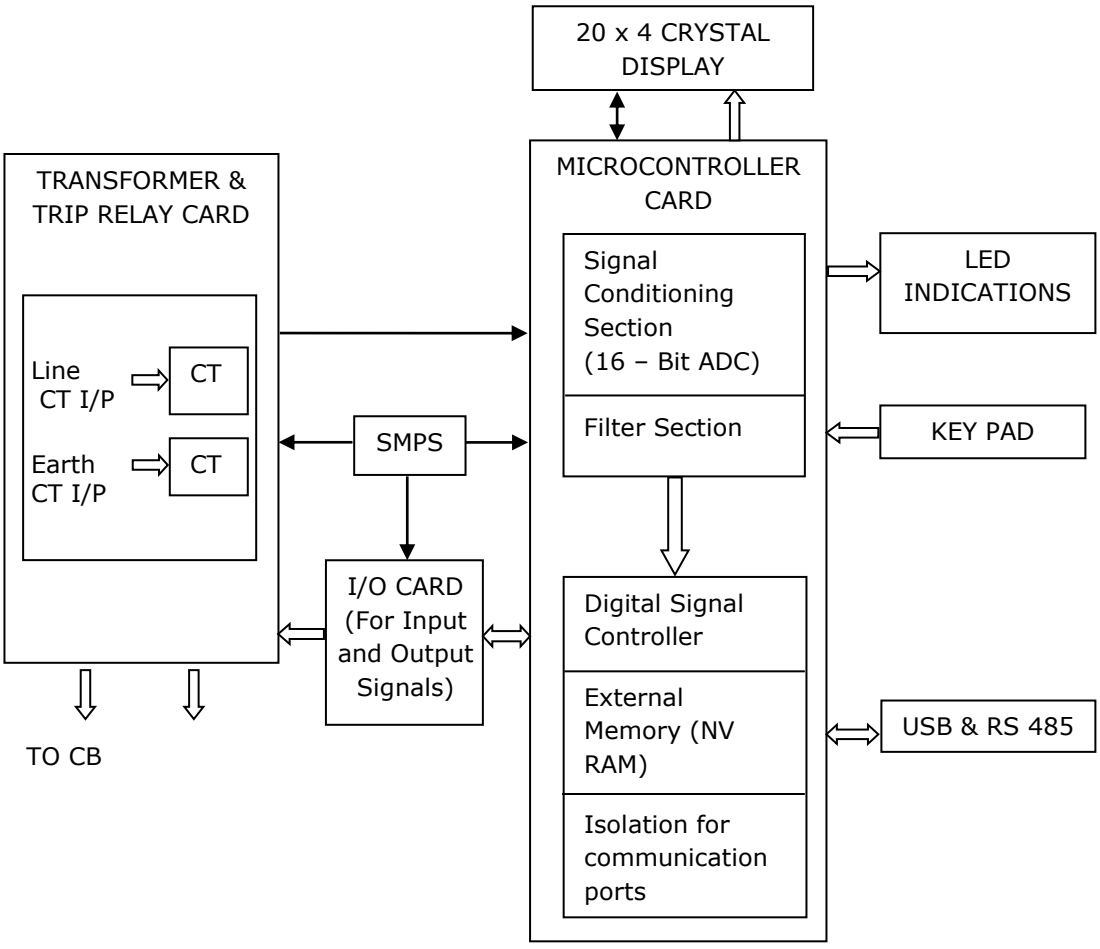
Decrement key

* 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

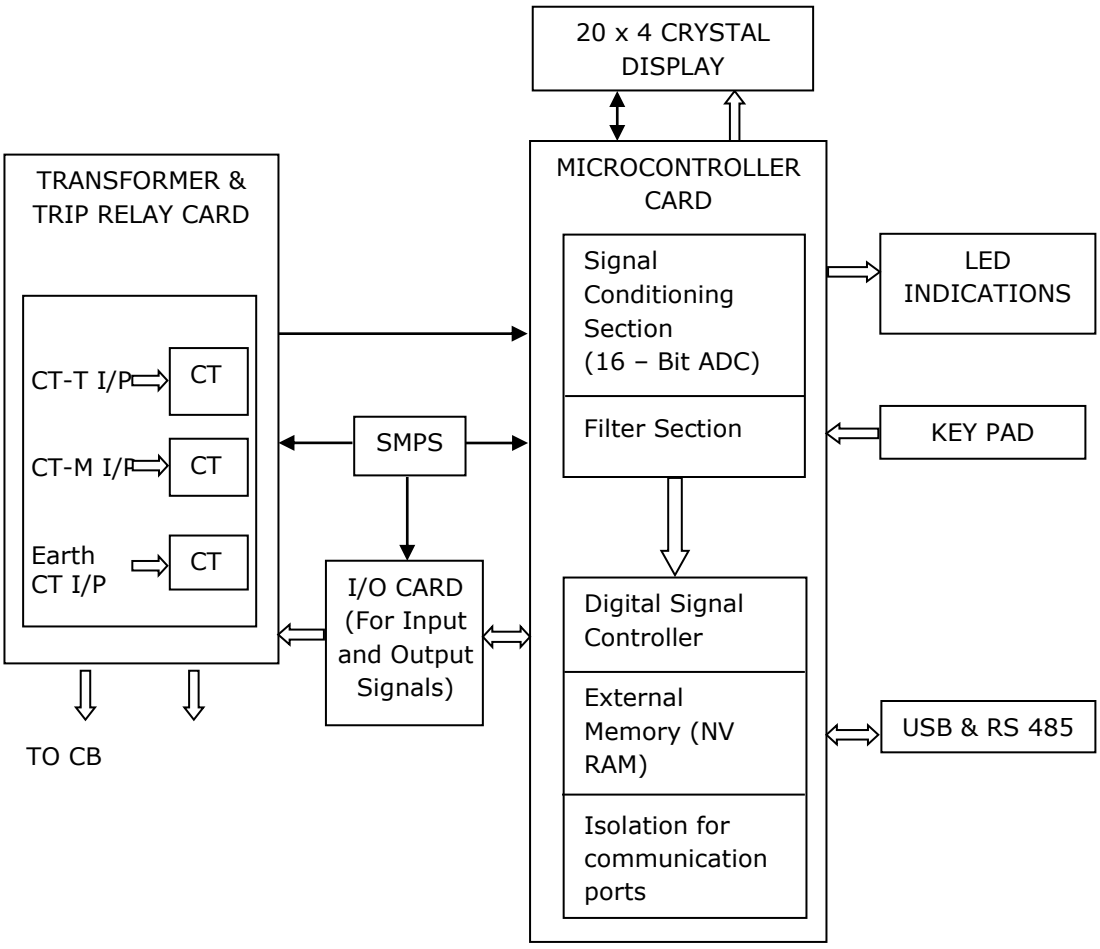
INTERNAL SYSTEM LEVEL ARCHITECTURE- ANTP 202 HV/LV

The internal system level architecture of ANTP 202 HV/LV relay including card to card architecture in brief is shown below.



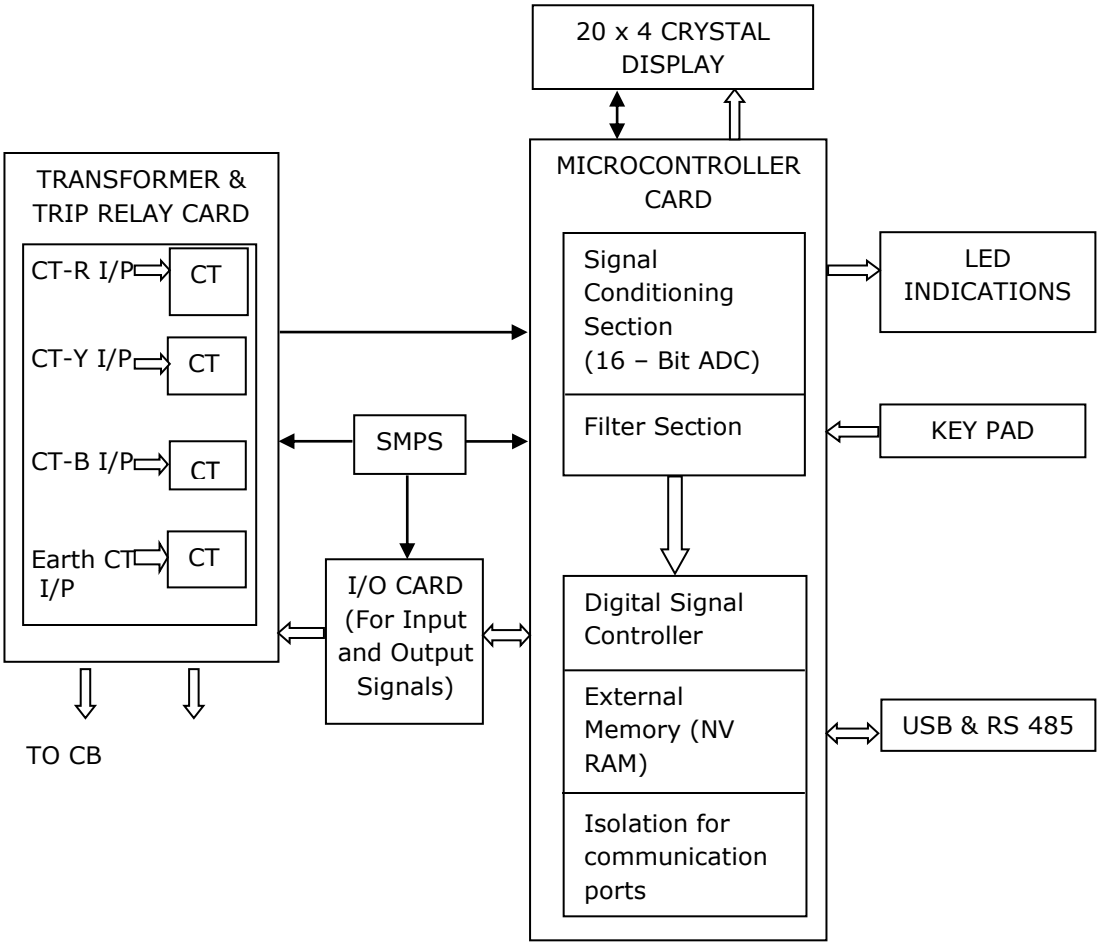
INTERNAL SYSTEM LEVEL ARCHITECTURE- ANTP 302

The internal system level architecture of ANTP 302 relay including card to card architecture in brief is shown below.



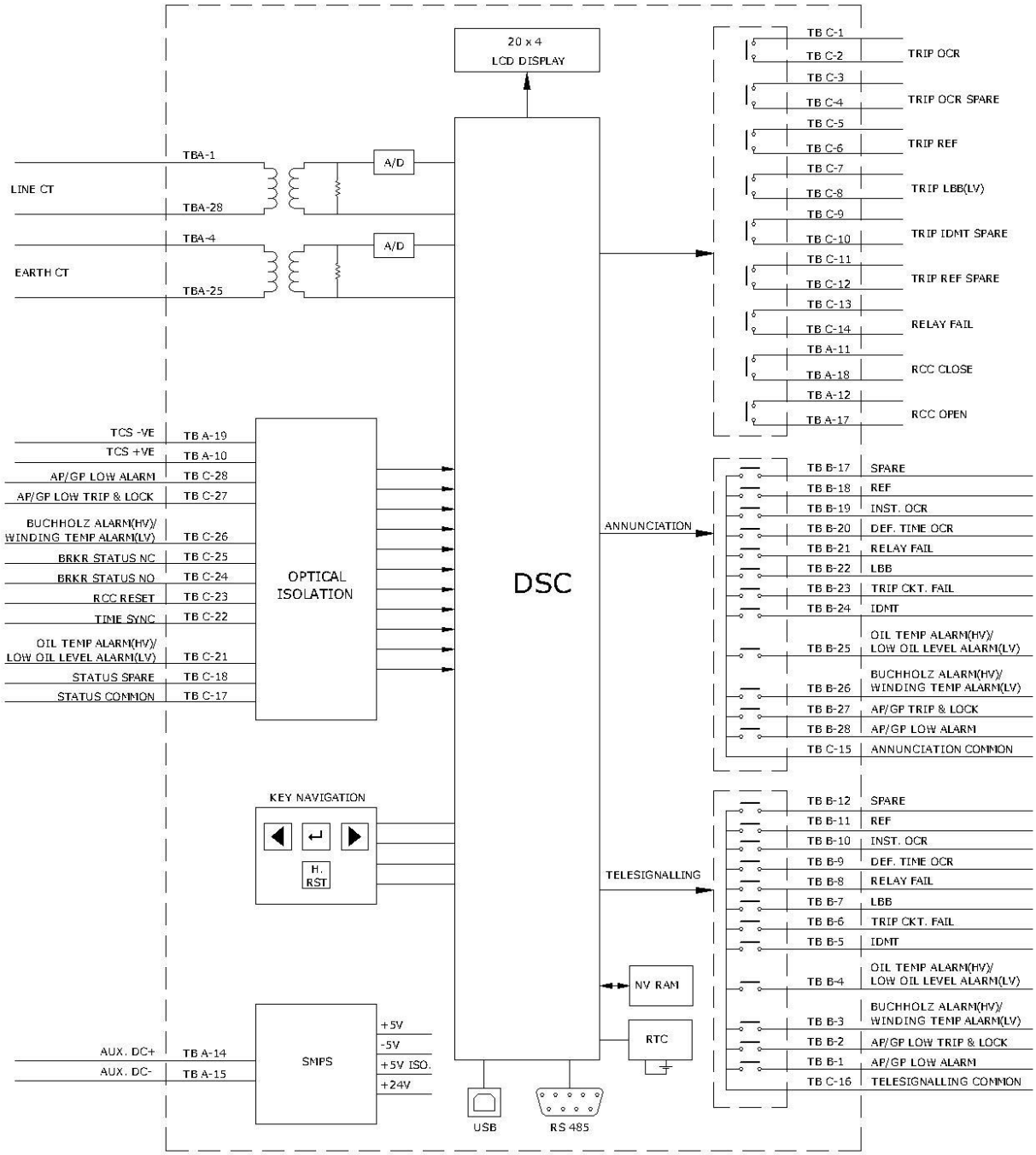
INTERNAL SYSTEM LEVEL ARCHITECTURE- ANTP 402

The internal system level architecture of ANTP 402 relay including card to card architecture in brief is shown below.

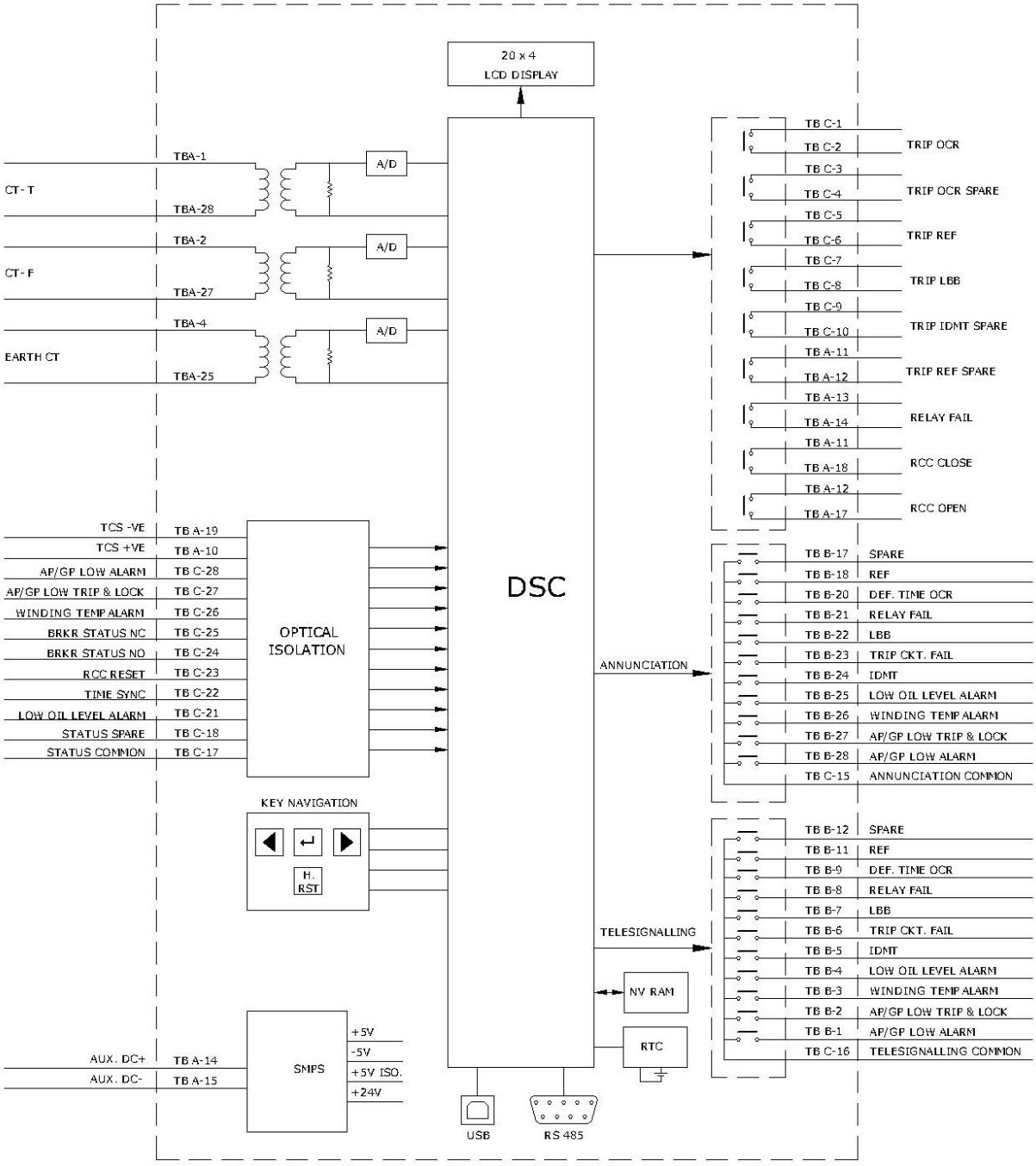


BLOCK DIAGRAM

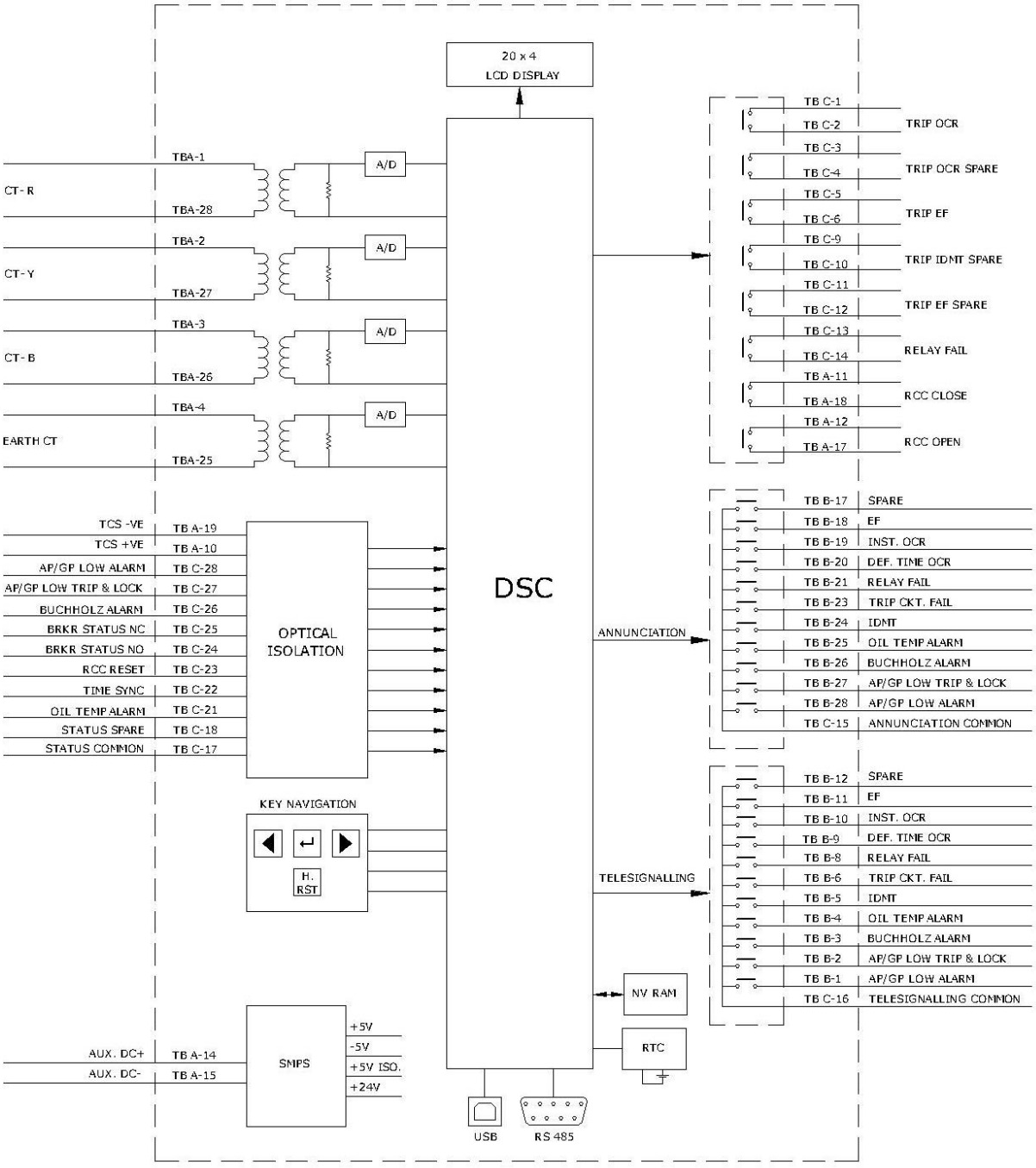
ANTP 202 HV /LV



ANTP 302


20 x 4
LCD DISPLAY
DSC
CT - T
TBA-1
TBA-28
CT - F
TBA-2
TBA-27
EARTH CT
TBA-4
TBA-25
A/D
A/D
A/D
TCS -VE
TCS +VE
AP/GP LOW ALARM
AP/GP LOW TRIP & LOCK
WINDING TEMP ALARM
BRKR STATUS NC
BRKR STATUS NO
RCC RESET
TIME SYNC
LOW OIL LEVEL ALARM
STATUS SPARE
STATUS COMMON
TB A-19
TB A-10
TB C-28
TB C-27
TB C-26
TB C-25
TB C-24
TB C-23
TB C-22
TB C-21
TB C-18
TB C-17
OPTICAL ISOLATION
KEY NAVIGATION
H. RST
AUX. DC+
AUX. DC-
TB A-14
TB A-15
SMPS
+5V
-5V
+5V ISO.
+24V
USB
RS 485
ANNUNCIATION
TELESIGNALLING
NV RAM
RTC
TB C-1
TB C-2
TRIP OCR
TB C-3
TB C-4
TRIP OCR SPARE
TB C-5
TB C-6
TRIP REF
TB C-7
TB C-8
TRIP LBB
TB C-9
TB C-10
TRIP IDMT SPARE
TB A-11
TB A-12
TRIP REF SPARE
TB A-13
TB A-14
RELAY FAIL
TB A-11
TB A-18
RCC CLOSE
TB A-12
TB A-17
RCC OPEN
TB B-17 SPARE
TB B-18 REF
TB B-20 DEF. TIME OCR
TB B-21 RELAY FAIL
TB B-22 LBB
TB B-23 TRIP CKT. FAIL
TB B-24 IDMT
TB B-25 LOW OIL LEVEL ALARM
TB B-26 WINDING TEMP ALARM
TB B-27 AP/GP LOW TRIP & LOCK
TB B-28 AP/GP LOW ALARM
TB C-15 ANNUNCIATION COMMON
TB B-12 SPARE
TB B-11 REF
TB B-9 DEF. TIME OCR
TB B-8 RELAY FAIL
TB B-7 LBB
TB B-6 TRIP CKT. FAIL
TB B-5 IDMT
TB B-4 LOW OIL LEVEL ALARM
TB B-3 WINDING TEMP ALARM
TB B-2 AP/GP LOW TRIP & LOCK
TB B-1 AP/GP LOW ALARM
TB C-16 TELESIGNALLING COMMON

ANTP 402


20 x 4
LCD DISPLAY
DSC
CT- R
CT- Y
CT- B
EARTH CT
TBA-1
TBA-28
TBA-2
TBA-27
TBA-3
TBA-26
TBA-4
TBA-25
A/D
TCS -VE
TCS +VE
AP/GP LOW ALARM
AP/GP LOW TRIP & LOCK
BUCHHOLZ ALARM
BRKR STATUS NC
BRKR STATUS NO
RCC RESET
TIME SYNC
OIL TEMP ALARM
STATUS SPARE
STATUS COMMON
TB A-19
TB A-10
TB C-28
TB C-27
TB C-26
TB C-25
TB C-24
TB C-23
TB C-22
TB C-21
TB C-18
TB C-17
OPTICAL ISOLATION
KEY NAVIGATION
H. RST
AUX. DC+
AUX. DC-
TB A-14
TB A-15
SMPS
+5V
-5V
+5V ISO.
+24V
USB
RS 485
NV RAM
RTC
ANNUNCIATION
TELESIGNALLING
TB C-1
TB C-2
TRIP OCR
TB C-3
TB C-4
TRIP OCR SPARE
TB C-5
TB C-6
TRIP EF
TB C-9
TB C-10
TRIP IDMT SPARE
TB C-11
TB C-12
TRIP EF SPARE
TB C-13
TB C-14
RELAY FAIL
TB A-11
TB A-18
RCC CLOSE
TB A-12
TB A-17
RCC OPEN
TB B-17 SPARE
TB B-18 EF
TB B-19 INST. OCR
TB B-20 DEF. TIME OCR
TB B-21 RELAY FAIL
TB B-23 TRIP CKT. FAIL
TB B-24 IDMT
TB B-25 OIL TEMP ALARM
TB B-26 BUCHHOLZ ALARM
TB B-27 AP/GP LOW TRIP & LOCK
TB B-28 AP/GP LOW ALARM
TB C-15 ANNUNCIATION COMMON
TB B-12 SPARE
TB B-11 EF
TB B-10 INST. OCR
TB B-9 DEF. TIME OCR
TB B-8 RELAY FAIL
TB B-6 TRIP CKT. FAIL
TB B-5 IDMT
TB B-4 OIL TEMP ALARM
TB B-3 BUCHHOLZ ALARM
TB B-2 AP/GP LOW TRIP & LOCK
TB B-1 AP/GP LOW ALARM
TB C-16 TELESIGNALLING COMMON

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. 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). 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 Current 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, Harmonic analysis of current waveforms and determination of fault clearing time.
2. Waveform pointed by user displays the 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), 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 Current can be stored in the relay. This data is retrievable through USB & RS 485 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, Fault clearing time, Fault date & time)

Trip circuit supervision

Relay pick up

Relay reset

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.

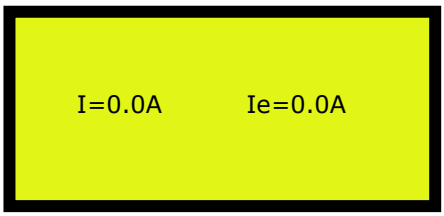
Back PCB: This PCB consists of terminal blocks for external interface with the site and power connector which connects SMPS, I/O and CT PT PCB's. The RS 485 port is also mounted in this PCB. The terminal block (TB-A) is having CT shorting facility. Since the rack with Terminal Blocks is having the CT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

RELAY SETTINGS AND ALGORITHM

ANTP 202

After Power ON, the relay boot screen shows

Then comes the online parameter display



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'

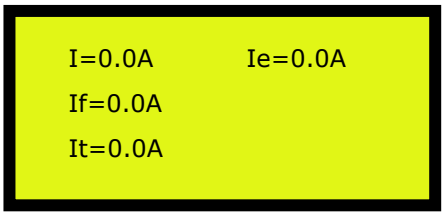
To change settings:

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.

ANTP 302

After Power ON, the relay boot screen shows

Then comes the online parameter display



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'

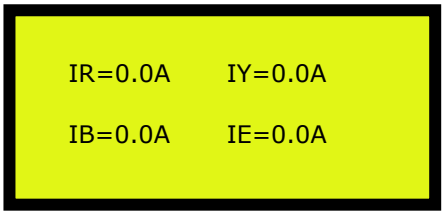
To change settings:

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.

ANTP 402

After Power ON, the relay boot screen shows

Then comes the online parameter display



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

Setting Mode

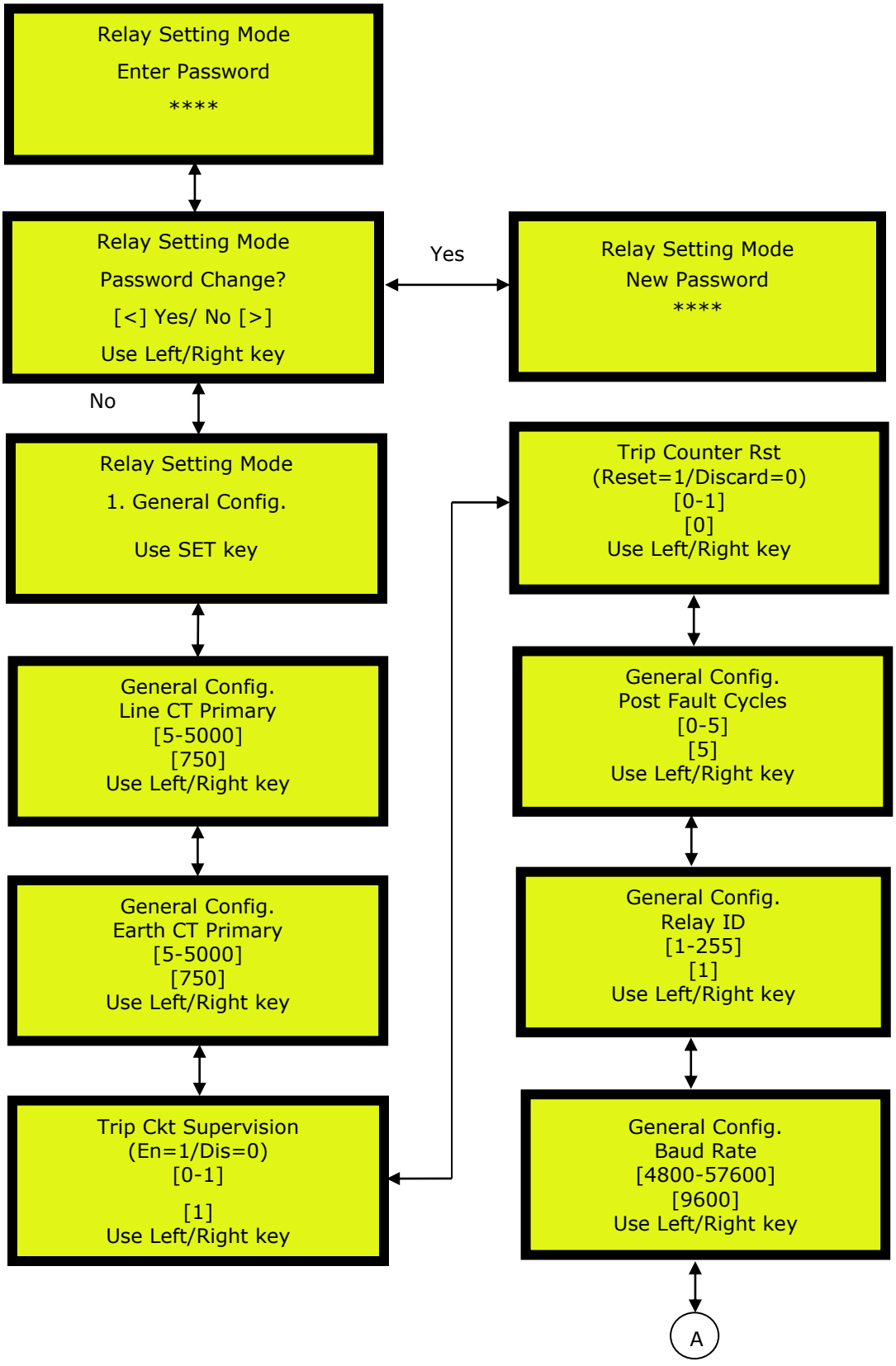
Press and hold ↵ for 5 seconds
Relay will enter to setting mode.
Enter the password and press ↵ key. The default password setting is '1000'

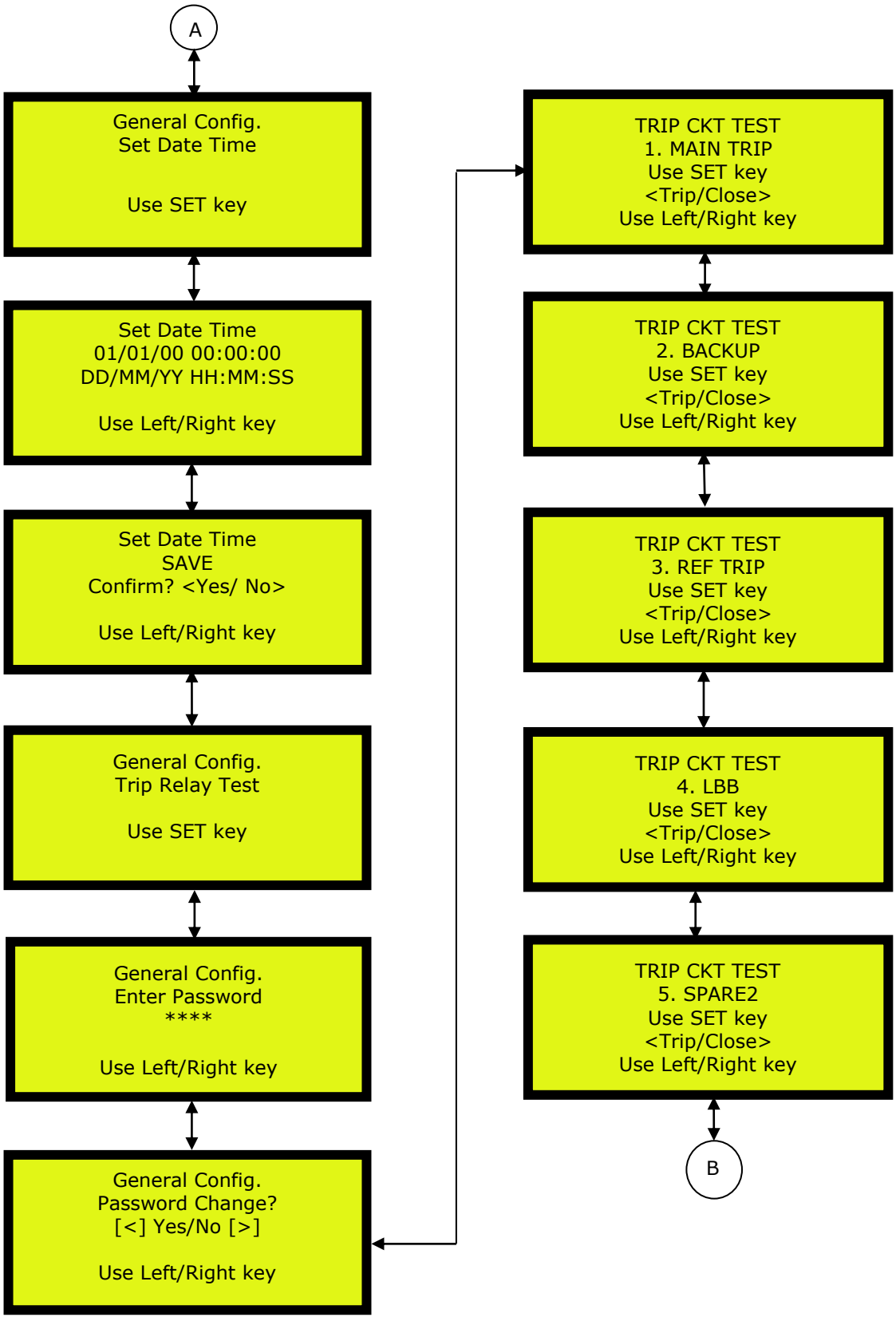
To change settings:

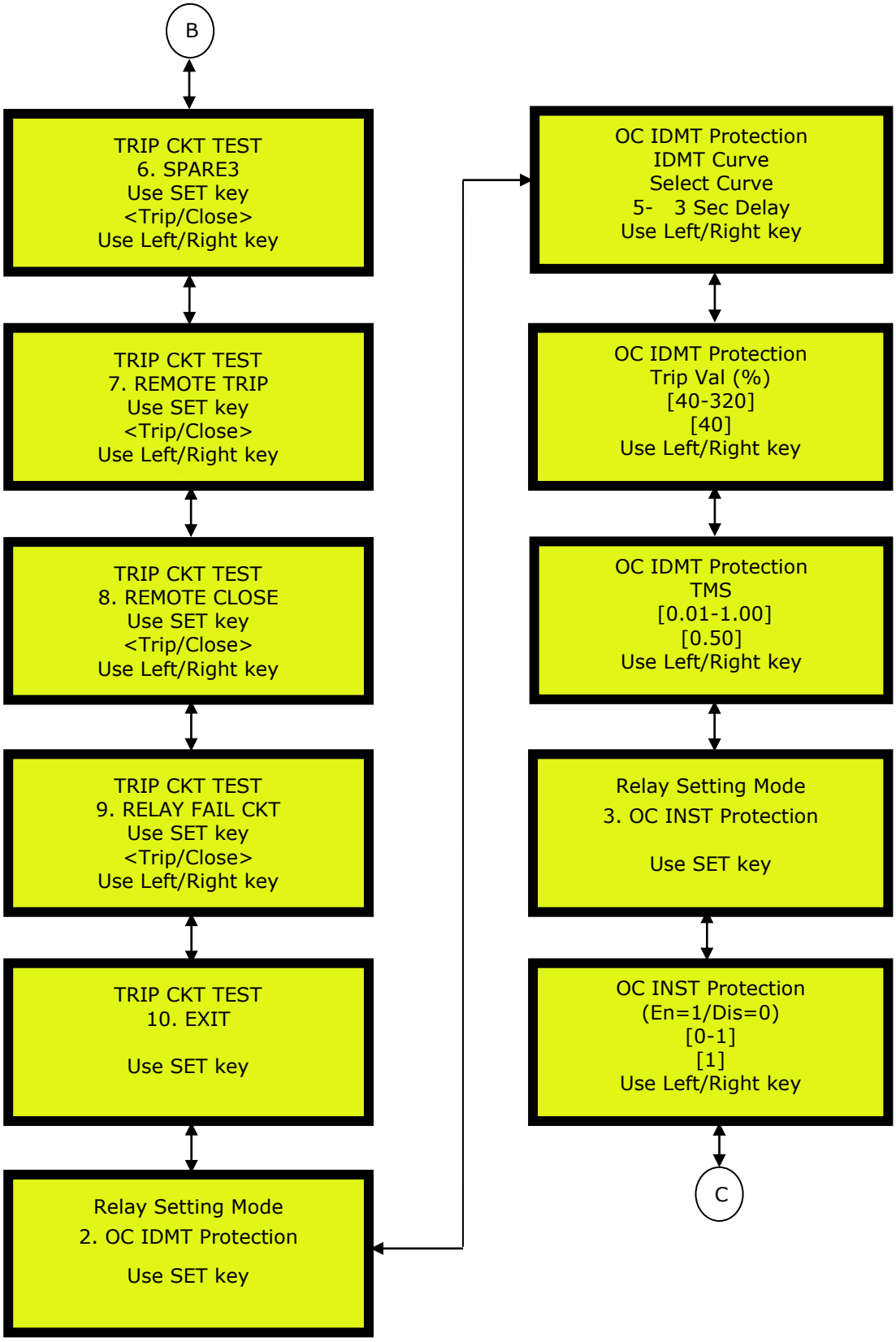
a) Press ↵ to change the settings.
b) Press **Right** key to increment
c) Press **Left** key to decrement
d) Press ↵ to accept change.
e) To coming back to main **MENU** while operating, press **Left** and **Right** key simultaneously.
f) Repeat the process for all settings
g) After completing the settings,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

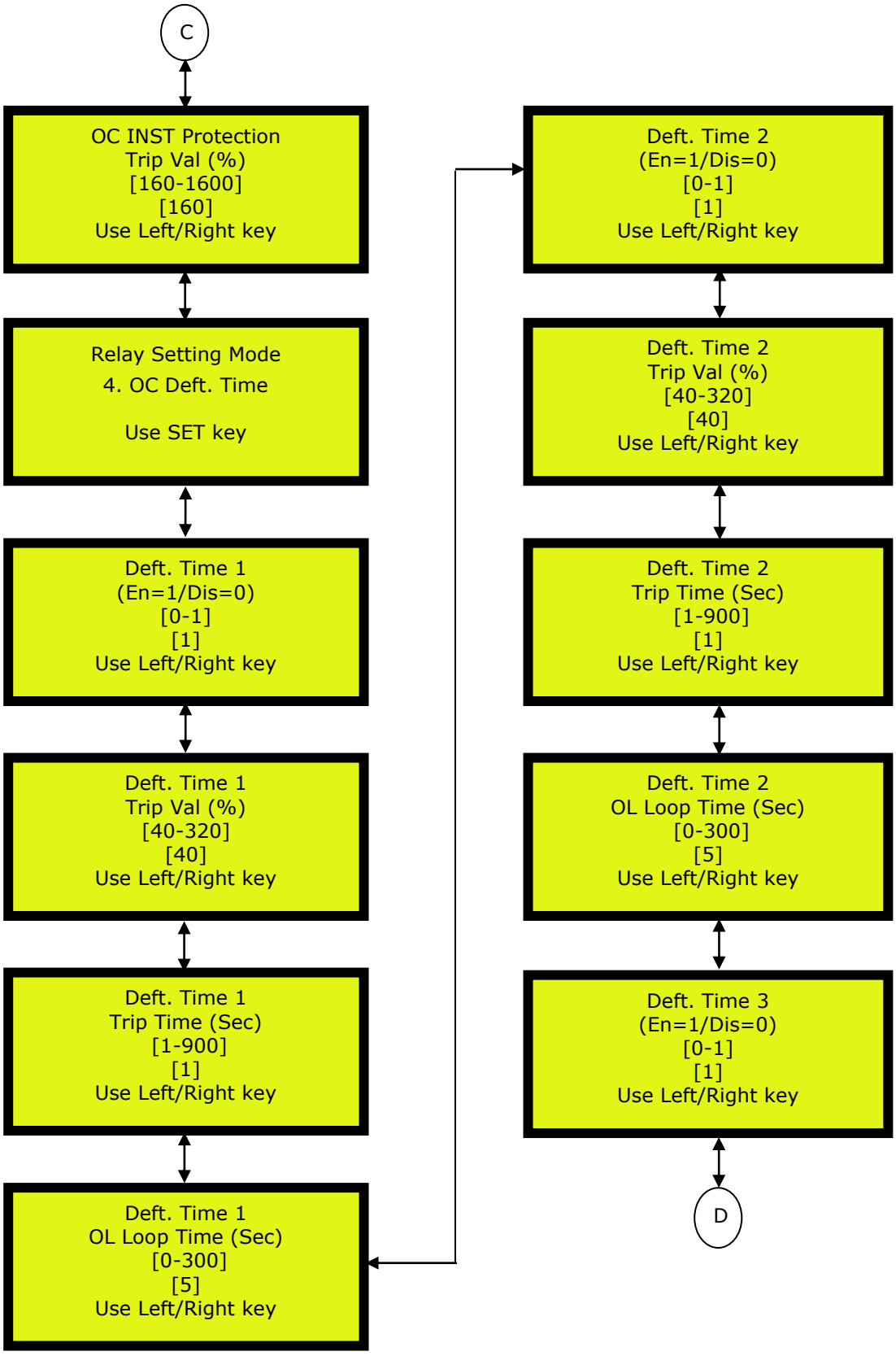
Relay Settings Algorithm

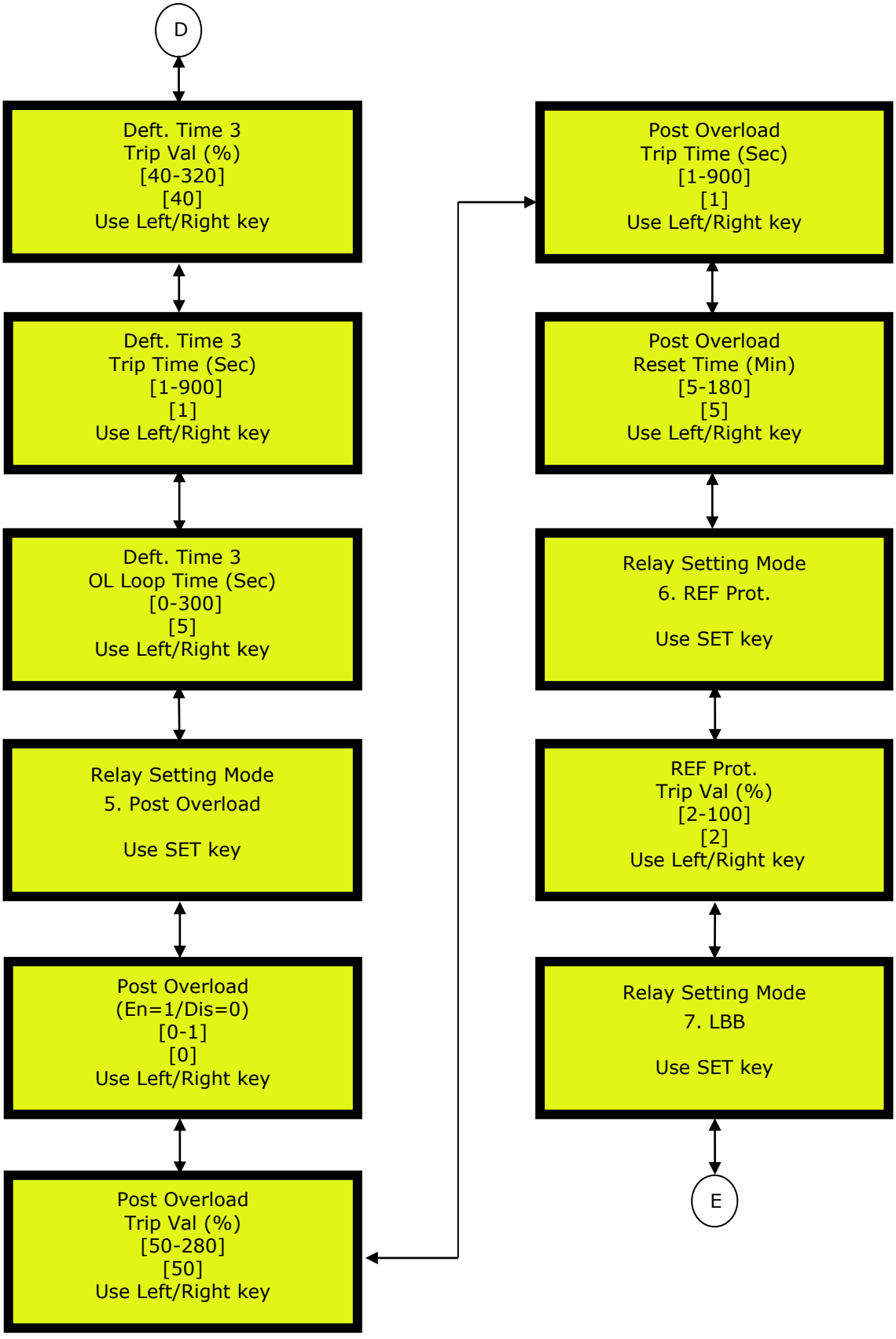
ANTP 202HV/LV

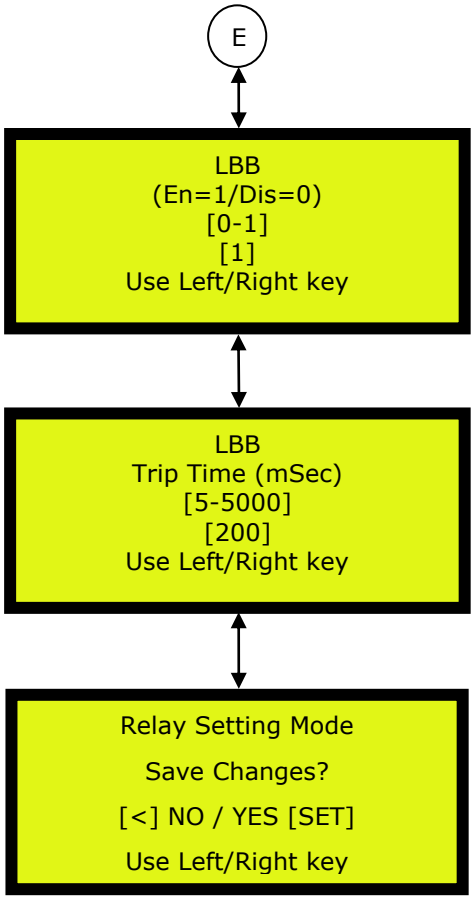



A
General Config.
Set Date Time
Use SET key
Set Date Time
01/01/00 00:00:00
DD/MM/YY HH:MM:SS
Use Left/Right key
Set Date Time
SAVE
Confirm? <Yes/ No>
Use Left/Right key
General Config.
Trip Relay Test
Use SET key
General Config.
Enter Password
****
Use Left/Right key
General Config.
Password Change?
[<] Yes/No [>]
Use Left/Right key
TRIP CKT TEST
1. MAIN TRIP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
2. BACKUP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
3. REF TRIP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
4. LBB
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
5. SPARE2
Use SET key
<Trip/Close>
Use Left/Right key
B

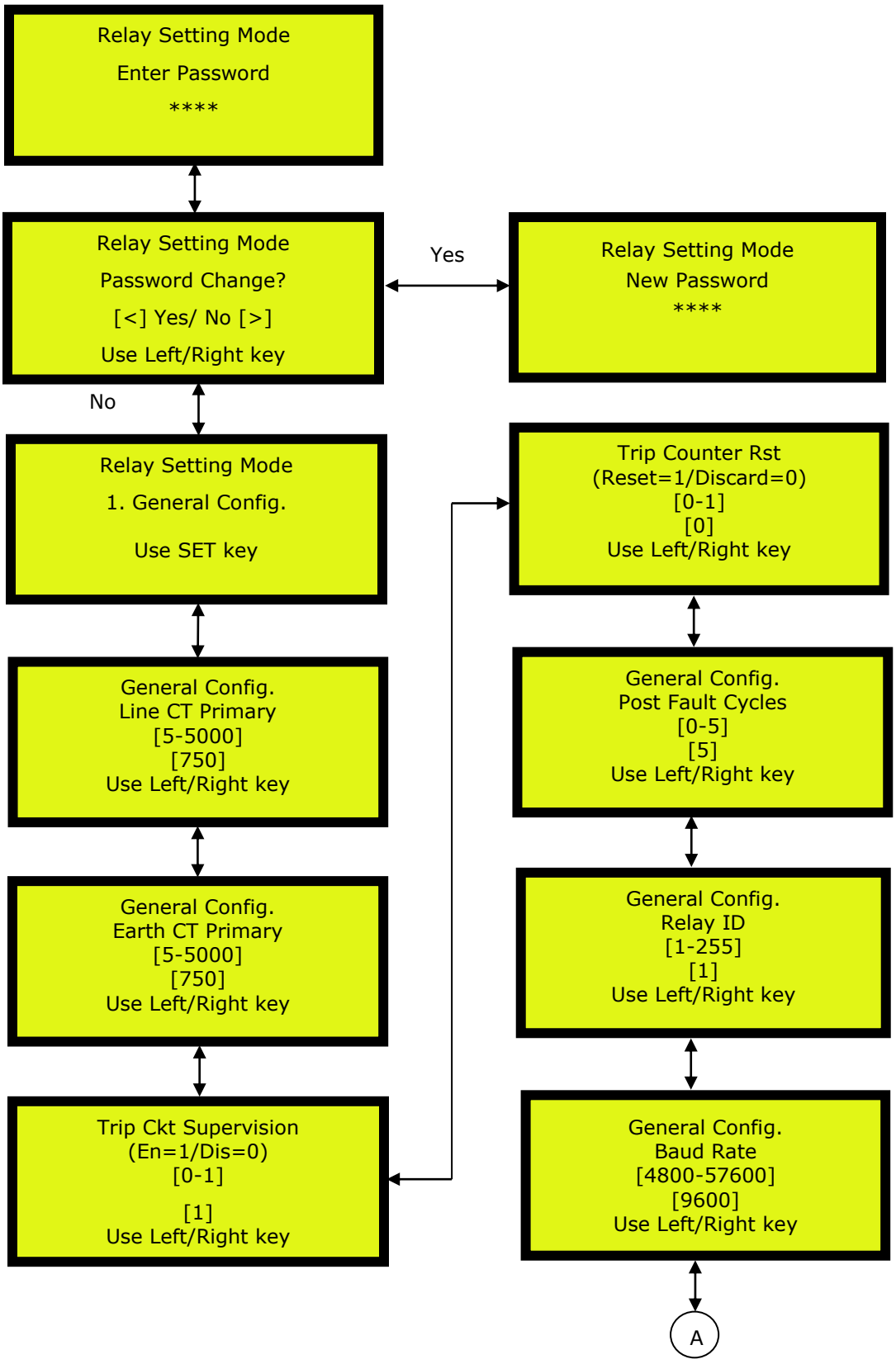

B
TRIP CKT TEST
6. SPARE3
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
7. REMOTE TRIP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
8. REMOTE CLOSE
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
9. RELAY FAIL CKT
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
10. EXIT
Use SET key
Relay Setting Mode
2. OC IDMT Protection
Use SET key
OC IDMT Protection
IDMT Curve
Select Curve
5- 3 Sec Delay
Use Left/Right key
OC IDMT Protection
Trip Val (%)
[40-320]
[40]
Use Left/Right key
OC IDMT Protection
TMS
[0.01-1.00]
[0.50]
Use Left/Right key
Relay Setting Mode
3. OC INST Protection
Use SET key
OC INST Protection
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
C

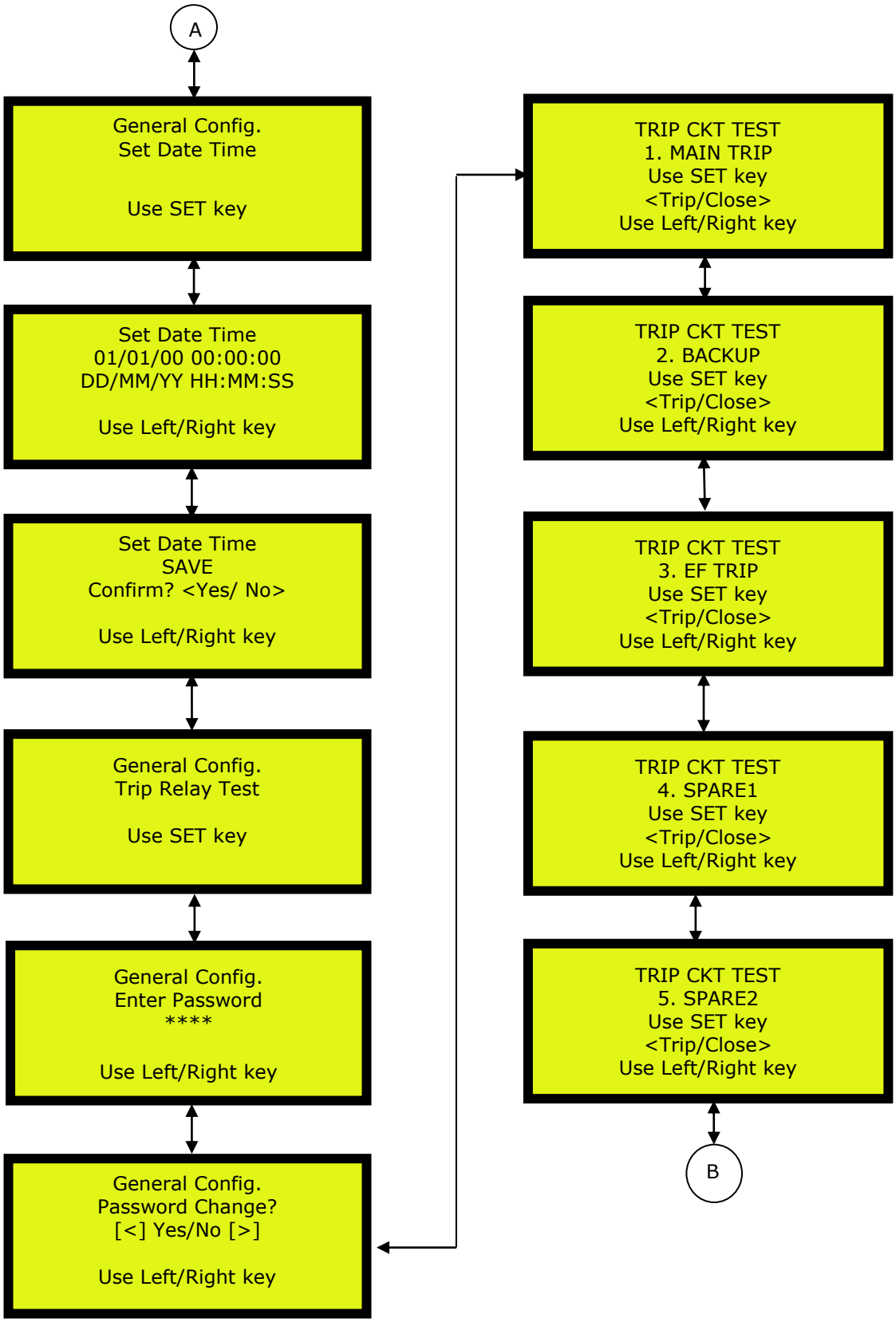

C
OC INST Protection
Trip Val (%)
[160-1600]
[160]
Use Left/Right key
Relay Setting Mode
4. OC Deft. Time
Use SET key
Deft. Time 1
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
Deft. Time 1
Trip Val (%)
[40-320]
[40]
Use Left/Right key
Deft. Time 1
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Deft. Time 1
OL Loop Time (Sec)
[0-300]
[5]
Use Left/Right key
Deft. Time 2
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
Deft. Time 2
Trip Val (%)
[40-320]
[40]
Use Left/Right key
Deft. Time 2
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Deft. Time 2
OL Loop Time (Sec)
[0-300]
[5]
Use Left/Right key
Deft. Time 3
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
D

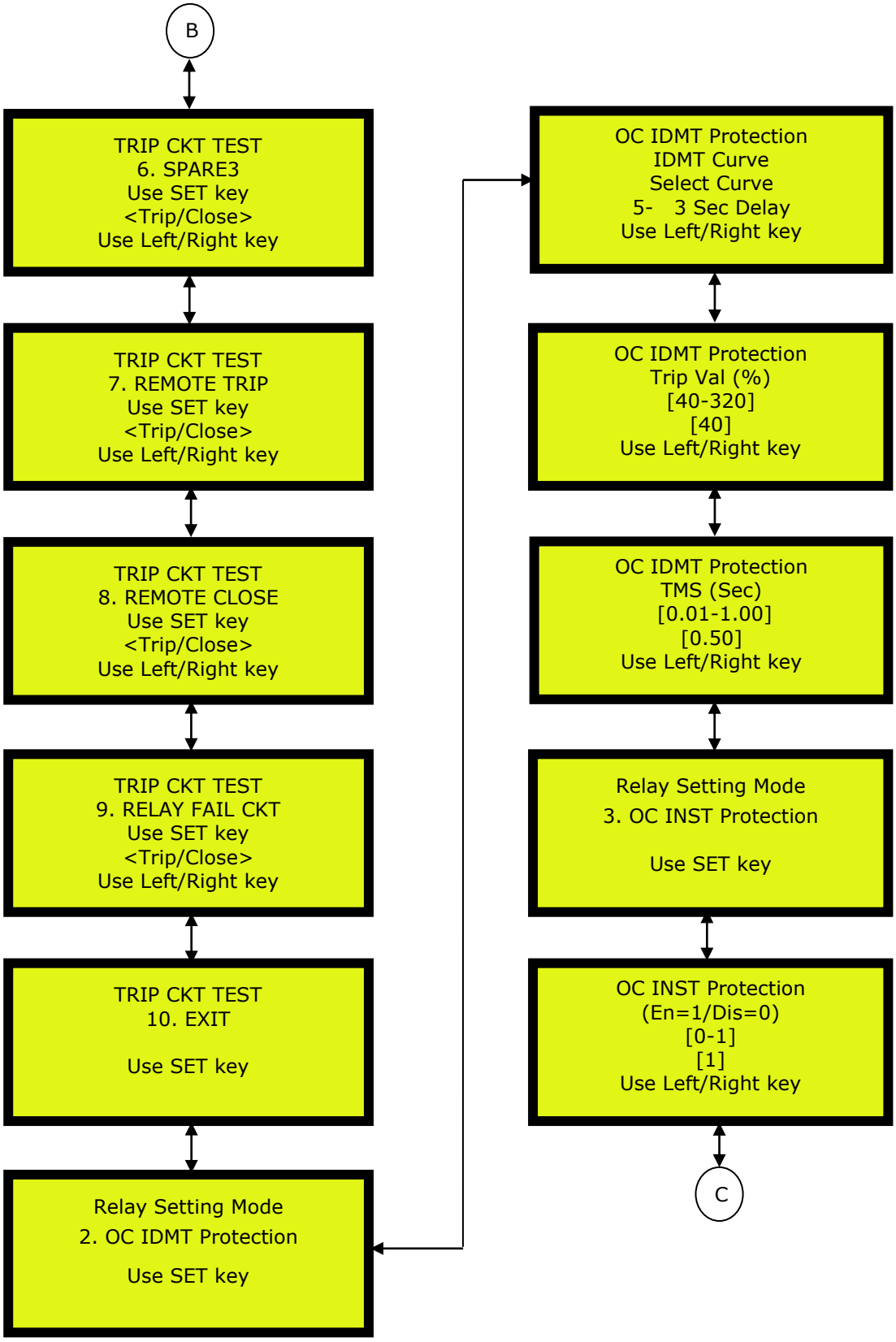

D
Deft. Time 3
Trip Val (%)
[40-320]
[40]
Use Left/Right key
Deft. Time 3
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Deft. Time 3
OL Loop Time (Sec)
[0-300]
[5]
Use Left/Right key
Relay Setting Mode
5. Post Overload
Use SET key
Post Overload
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
Post Overload
Trip Val (%)
[50-280]
[50]
Use Left/Right key
Post Overload
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Post Overload
Reset Time (Min)
[5-180]
[5]
Use Left/Right key
Relay Setting Mode
6. REF Prot.
Use SET key
REF Prot.
Trip Val (%)
[2-100]
[2]
Use Left/Right key
Relay Setting Mode
7. LBB
Use SET key
E

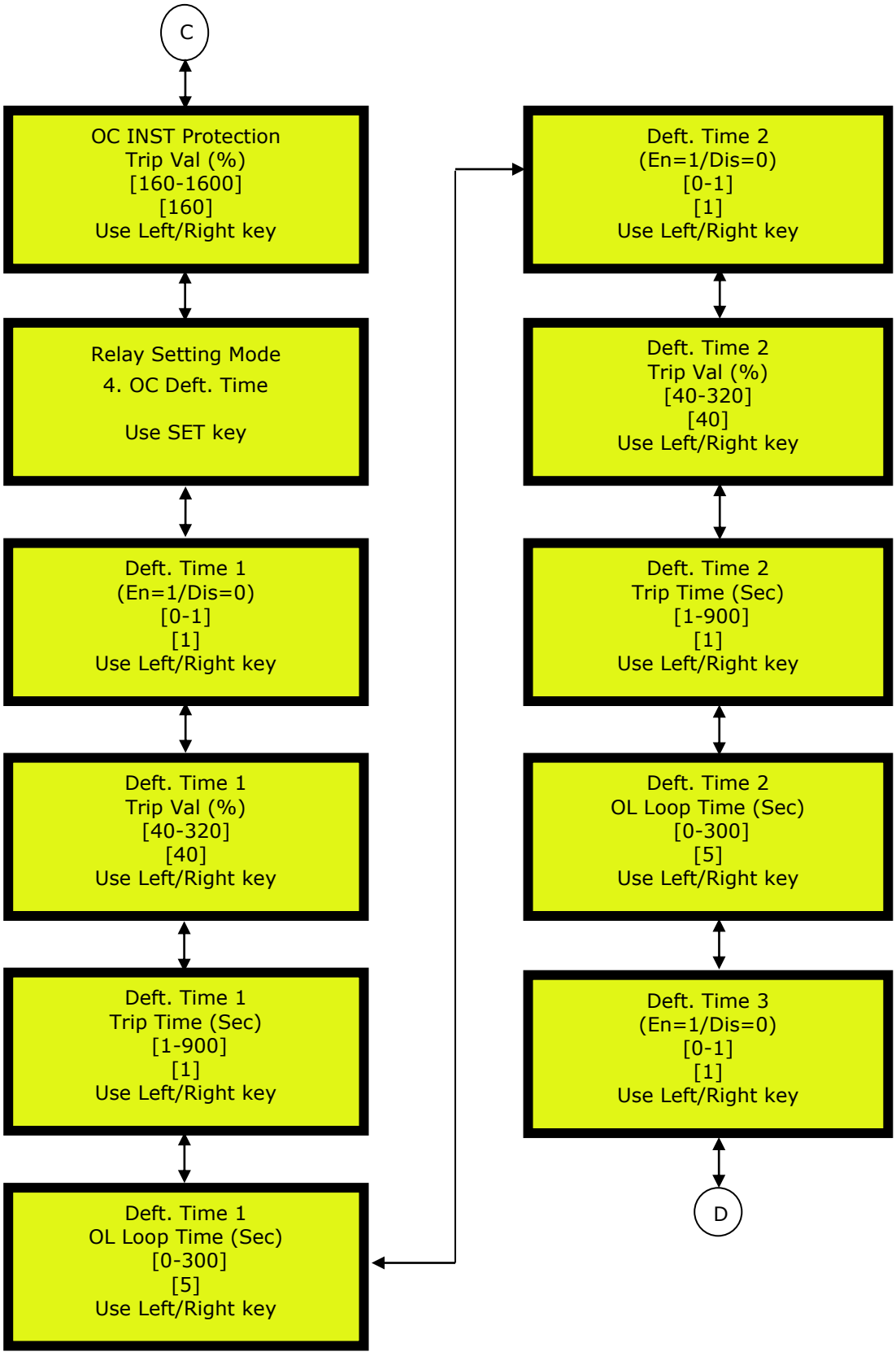

E
LBB
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
LBB
Trip Time (mSec)
[5-5000]
[200]
Use Left/Right key
Relay Setting Mode
Save Changes?
[<] NO / YES [SET]
Use Left/Right key

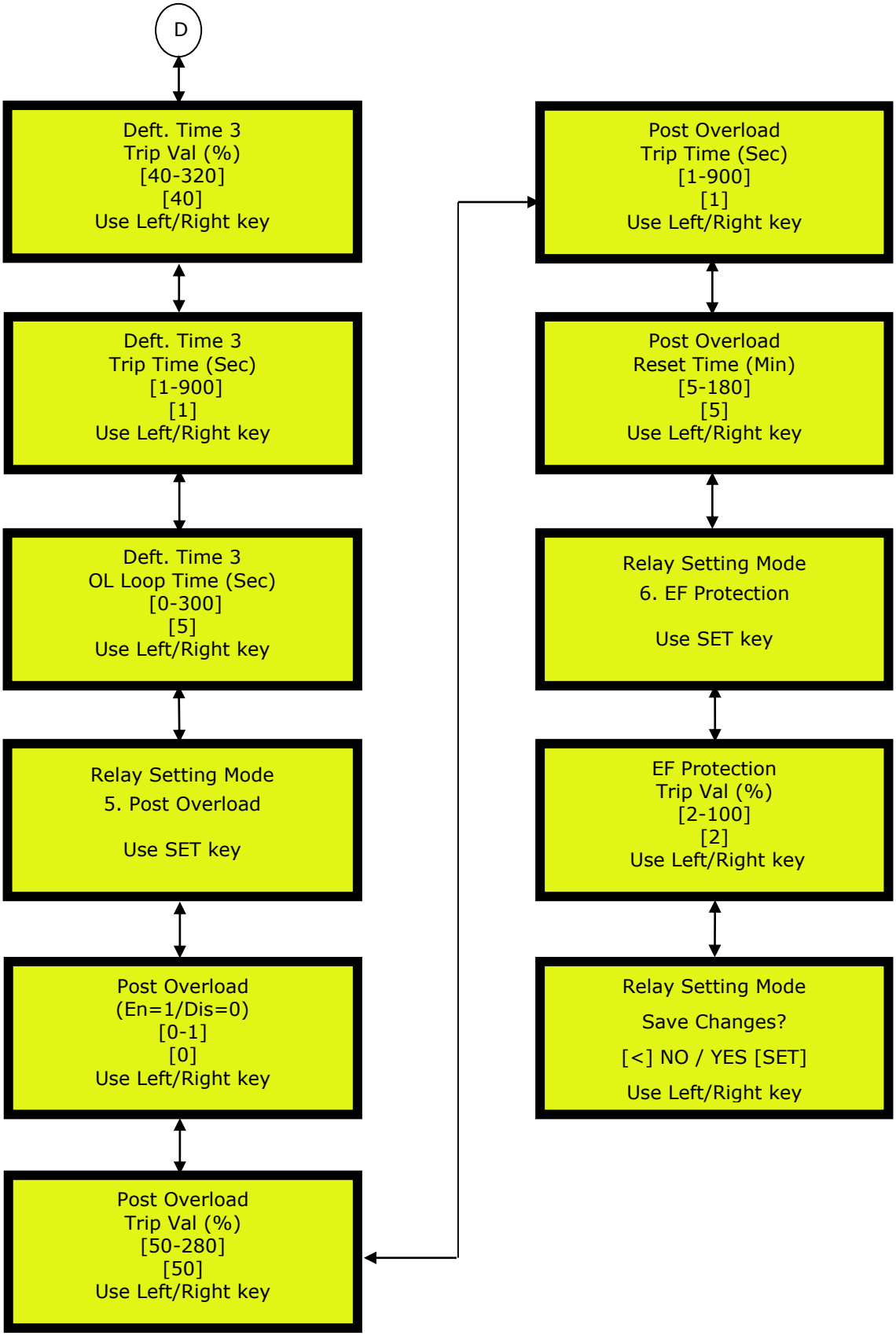
ANTP 402


Relay Setting Mode
Enter Password
****
Relay Setting Mode
Password Change?
[<] Yes/ No [>]
Use Left/Right key
Yes
Relay Setting Mode
New Password
****
No
Relay Setting Mode
1. General Config.
Use SET key
General Config.
Line CT Primary
[5-5000]
[750]
Use Left/Right key
General Config.
Earth CT Primary
[5-5000]
[750]
Use Left/Right key
Trip Ckt Supervision
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
Trip Counter Rst
(Reset=1/Discard=0)
[0-1]
[0]
Use Left/Right key
General Config.
Post Fault Cycles
[0-5]
[5]
Use Left/Right key
General Config.
Relay ID
[1-255]
[1]
Use Left/Right key
General Config.
Baud Rate
[4800-57600]
[9600]
Use Left/Right key
A

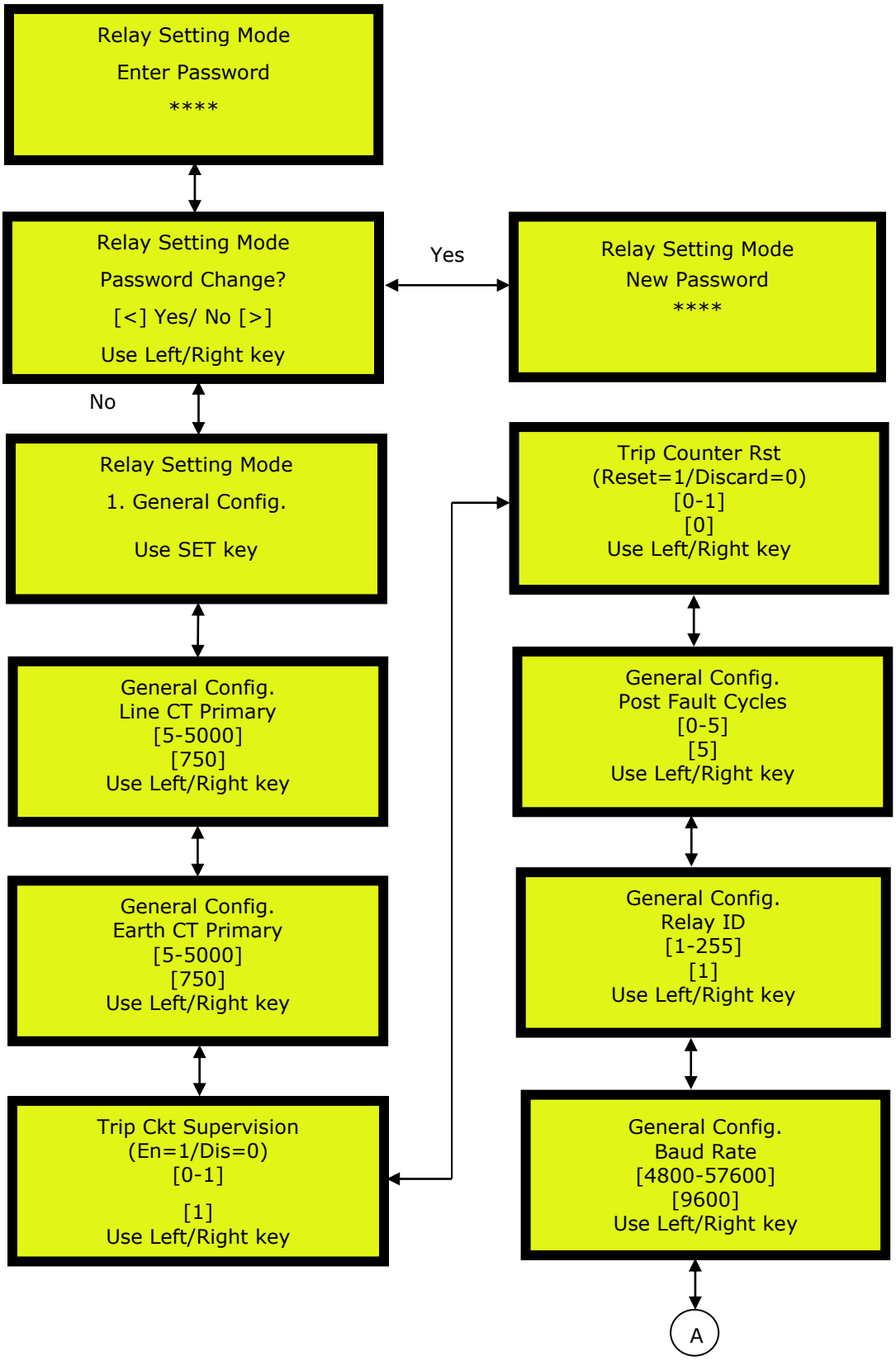

A
General Config.
Set Date Time
Use SET key
Set Date Time
01/01/00 00:00:00
DD/MM/YY HH:MM:SS
Use Left/Right key
Set Date Time
SAVE
Confirm? <Yes/ No>
Use Left/Right key
General Config.
Trip Relay Test
Use SET key
General Config.
Enter Password
****
Use Left/Right key
General Config.
Password Change?
[<] Yes/No [>]
Use Left/Right key
TRIP CKT TEST
1. MAIN TRIP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
2. BACKUP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
3. EF TRIP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
4. SPARE1
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
5. SPARE2
Use SET key
<Trip/Close>
Use Left/Right key
B

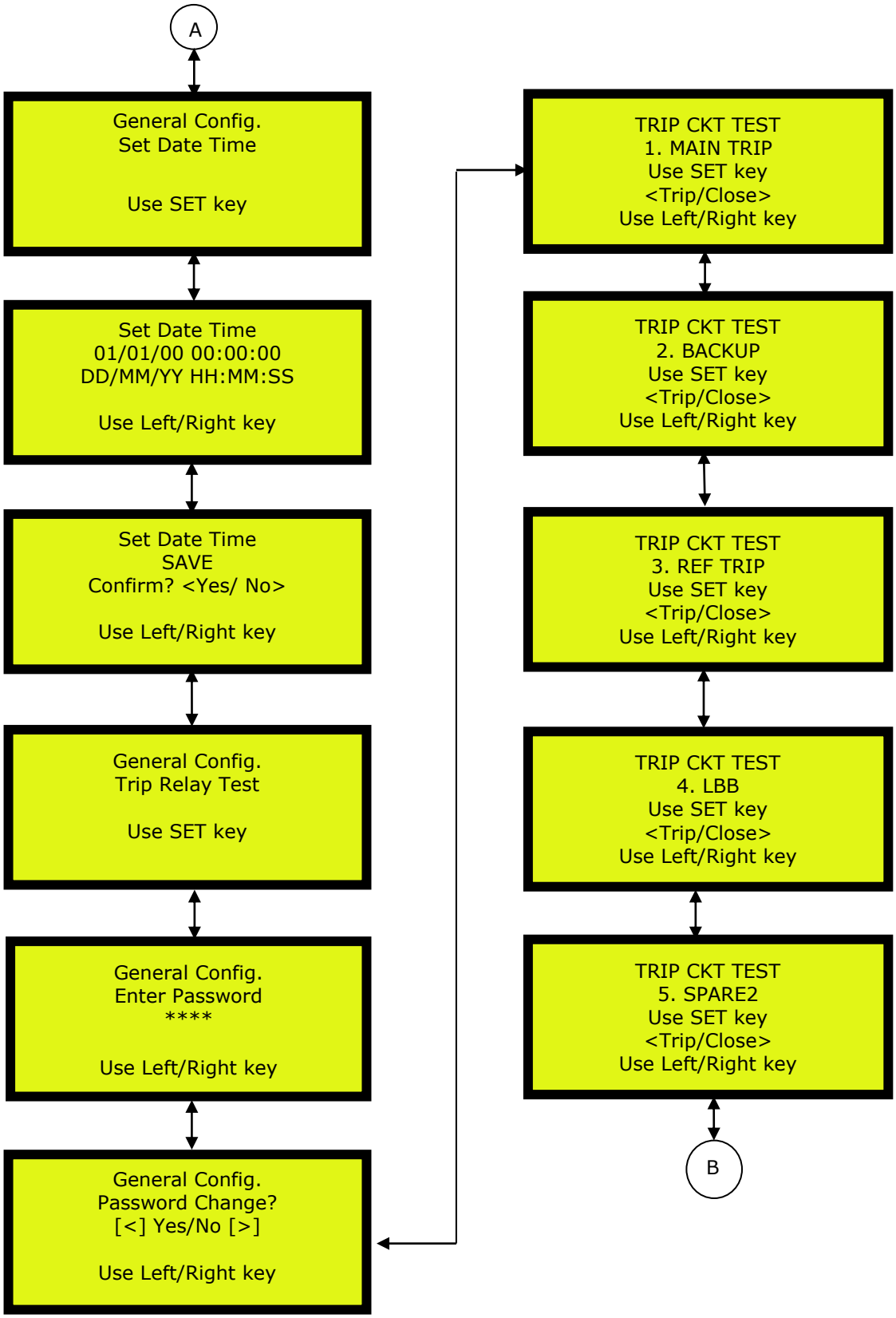

B
TRIP CKT TEST
6. SPARE3
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
7. REMOTE TRIP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
8. REMOTE CLOSE
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
9. RELAY FAIL CKT
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
10. EXIT
Use SET key
Relay Setting Mode
2. OC IDMT Protection
Use SET key
OC IDMT Protection
IDMT Curve
Select Curve
5- 3 Sec Delay
Use Left/Right key
OC IDMT Protection
Trip Val (%)
[40-320]
[40]
Use Left/Right key
OC IDMT Protection
TMS (Sec)
[0.01-1.00]
[0.50]
Use Left/Right key
Relay Setting Mode
3. OC INST Protection
Use SET key
OC INST Protection
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
C

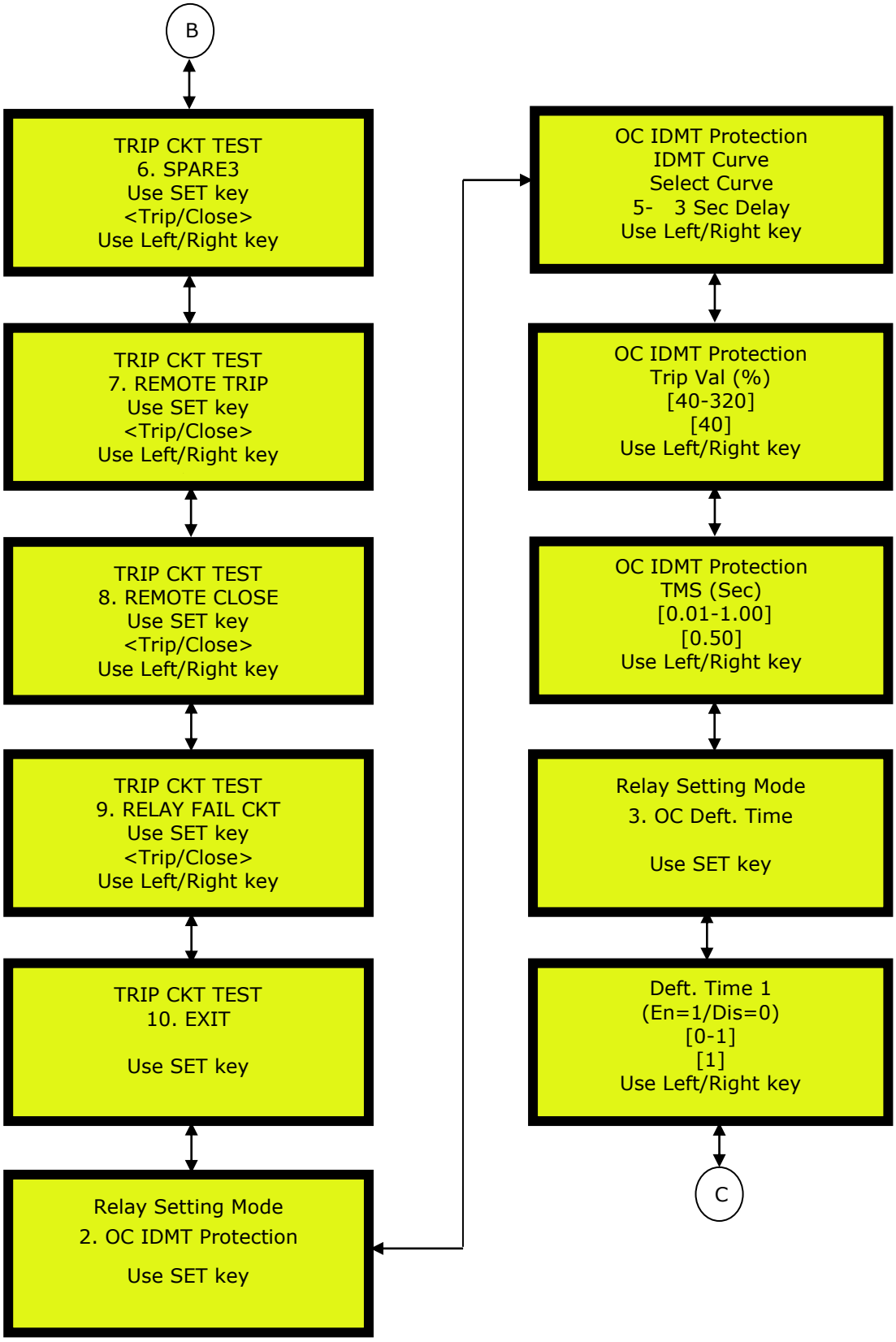

C
OC INST Protection
Trip Val (%)
[160-1600]
[160]
Use Left/Right key
Relay Setting Mode
4. OC Deft. Time
Use SET key
Deft. Time 1
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
Deft. Time 1
Trip Val (%)
[40-320]
[40]
Use Left/Right key
Deft. Time 1
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Deft. Time 1
OL Loop Time (Sec)
[0-300]
[5]
Use Left/Right key
Deft. Time 2
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
Deft. Time 2
Trip Val (%)
[40-320]
[40]
Use Left/Right key
Deft. Time 2
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Deft. Time 2
OL Loop Time (Sec)
[0-300]
[5]
Use Left/Right key
Deft. Time 3
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
D

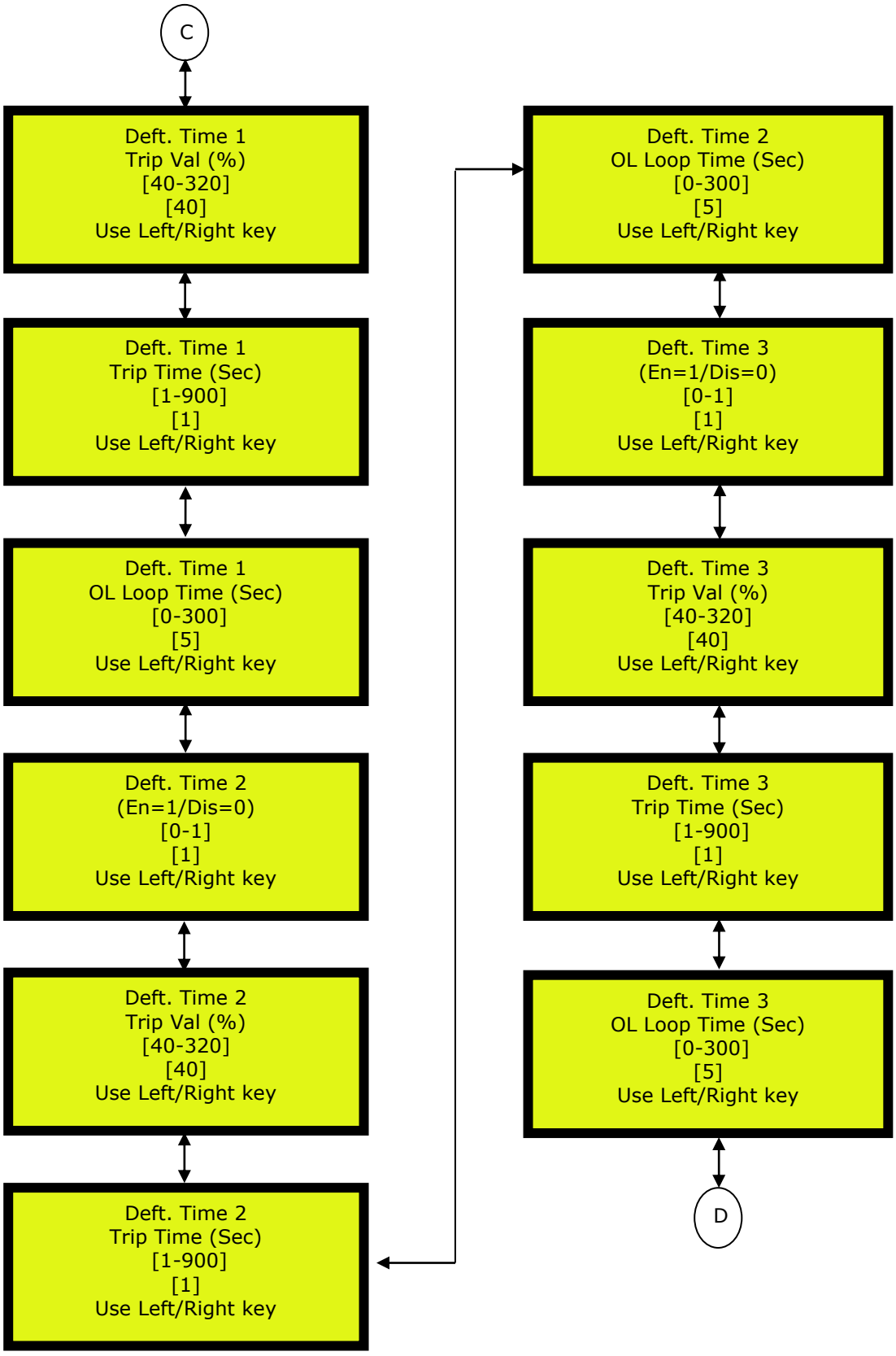

D
Deft. Time 3
Trip Val (%)
[40-320]
[40]
Use Left/Right key
Deft. Time 3
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Deft. Time 3
OL Loop Time (Sec)
[0-300]
[5]
Use Left/Right key
Relay Setting Mode
5. Post Overload
Use SET key
Post Overload
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
Post Overload
Trip Val (%)
[50-280]
[50]
Use Left/Right key
Post Overload
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Post Overload
Reset Time (Min)
[5-180]
[5]
Use Left/Right key
Relay Setting Mode
6. EF Protection
Use SET key
EF Protection
Trip Val (%)
[2-100]
[2]
Use Left/Right key
Relay Setting Mode
Save Changes?
[<] NO / YES [SET]
Use Left/Right key

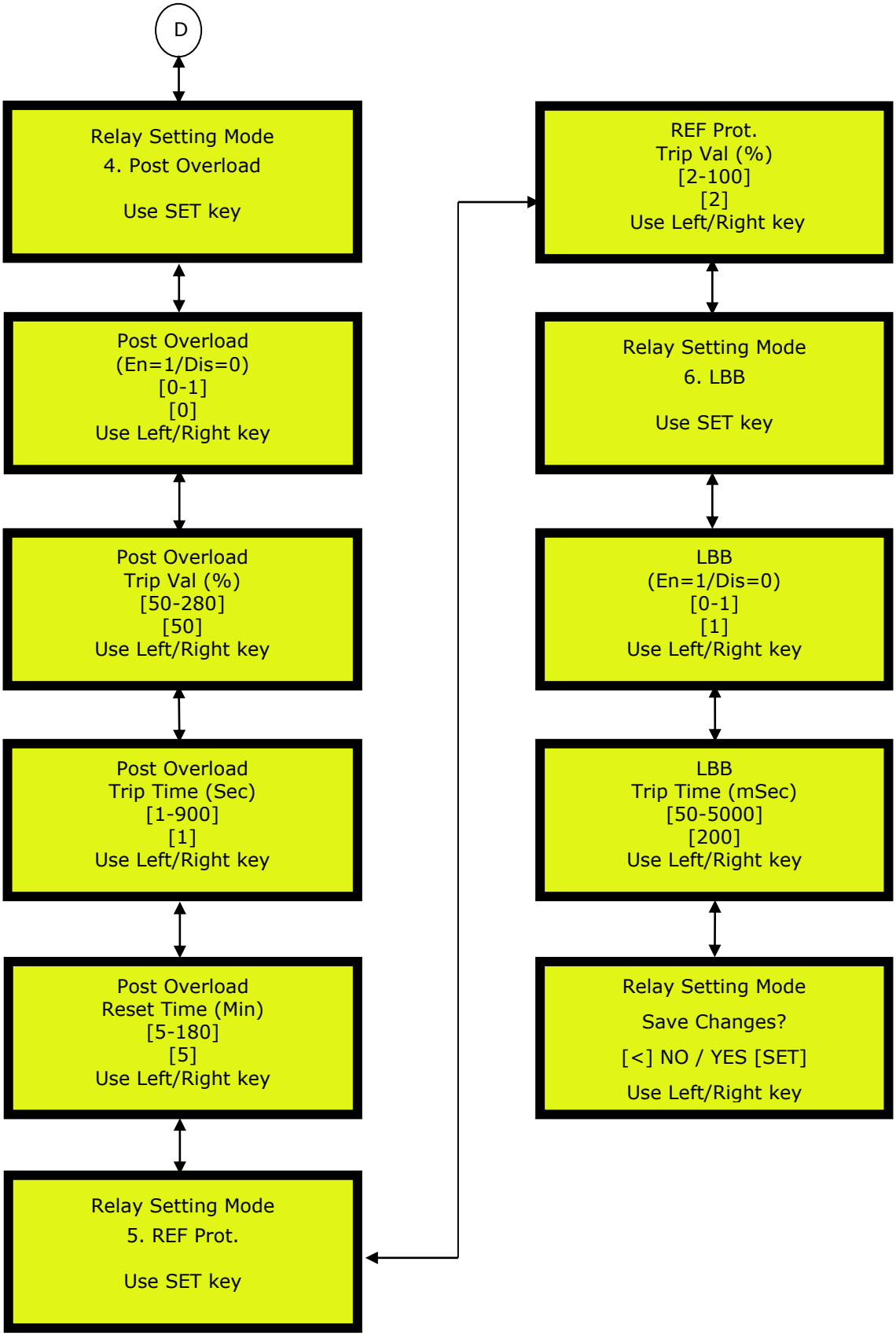
ANTP 302


Relay Setting Mode
Enter Password
****
Relay Setting Mode
Password Change?
[<] Yes/ No [>]
Use Left/Right key
Yes
Relay Setting Mode
New Password
****
No
Relay Setting Mode
1. General Config.
Use SET key
General Config.
Line CT Primary
[5-5000]
[750]
Use Left/Right key
General Config.
Earth CT Primary
[5-5000]
[750]
Use Left/Right key
Trip Ckt Supervision
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
Trip Counter Rst
(Reset=1/Discard=0)
[0-1]
[0]
Use Left/Right key
General Config.
Post Fault Cycles
[0-5]
[5]
Use Left/Right key
General Config.
Relay ID
[1-255]
[1]
Use Left/Right key
General Config.
Baud Rate
[4800-57600]
[9600]
Use Left/Right key
A


A
General Config.
Set Date Time
Use SET key
Set Date Time
01/01/00 00:00:00
DD/MM/YY HH:MM:SS
Use Left/Right key
Set Date Time
SAVE
Confirm? <Yes/ No>
Use Left/Right key
General Config.
Trip Relay Test
Use SET 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
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
2. BACKUP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
3. REF TRIP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
4. LBB
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
5. SPARE2
Use SET key
<Trip/Close>
Use Left/Right key
B


B
TRIP CKT TEST
6. SPARE3
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
7. REMOTE TRIP
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
8. REMOTE CLOSE
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
9. RELAY FAIL CKT
Use SET key
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
10. EXIT
Use SET key
Relay Setting Mode
2. OC IDMT Protection
Use SET key
OC IDMT Protection
IDMT Curve
Select Curve
5- 3 Sec Delay
Use Left/Right key
OC IDMT Protection
Trip Val (%)
[40-320]
[40]
Use Left/Right key
OC IDMT Protection
TMS (Sec)
[0.01-1.00]
[0.50]
Use Left/Right key
Relay Setting Mode
3. OC Deft. Time
Use SET key
Deft. Time 1
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
C


C
Deft. Time 1
Trip Val (%)
[40-320]
[40]
Use Left/Right key
Deft. Time 1
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Deft. Time 1
OL Loop Time (Sec)
[0-300]
[5]
Use Left/Right key
Deft. Time 2
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
Deft. Time 2
Trip Val (%)
[40-320]
[40]
Use Left/Right key
Deft. Time 2
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Deft. Time 2
OL Loop Time (Sec)
[0-300]
[5]
Use Left/Right key
Deft. Time 3
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
Deft. Time 3
Trip Val (%)
[40-320]
[40]
Use Left/Right key
Deft. Time 3
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Deft. Time 3
OL Loop Time (Sec)
[0-300]
[5]
Use Left/Right key
D


D
Relay Setting Mode
4. Post Overload
Use SET key
Post Overload
(En=1/Dis=0)
[0-1]
[0]
Use Left/Right key
Post Overload
Trip Val (%)
[50-280]
[50]
Use Left/Right key
Post Overload
Trip Time (Sec)
[1-900]
[1]
Use Left/Right key
Post Overload
Reset Time (Min)
[5-180]
[5]
Use Left/Right key
Relay Setting Mode
5. REF Prot.
Use SET key
REF Prot.
Trip Val (%)
[2-100]
[2]
Use Left/Right key
Relay Setting Mode
6. LBB
Use SET key
LBB
(En=1/Dis=0)
[0-1]
[1]
Use Left/Right key
LBB
Trip Time (mSec)
[50-5000]
[200]
Use Left/Right key
Relay Setting Mode
Save Changes?
[<] NO / YES [SET]
Use Left/Right key

TECHNICAL DATA & CHARACTERISTIC CURVES

ALUMINIUM INDUSTRIES LIMITED
Relays Division

CONTENTS

DESCRIPTION OF PROTECTION FUNCTIONS

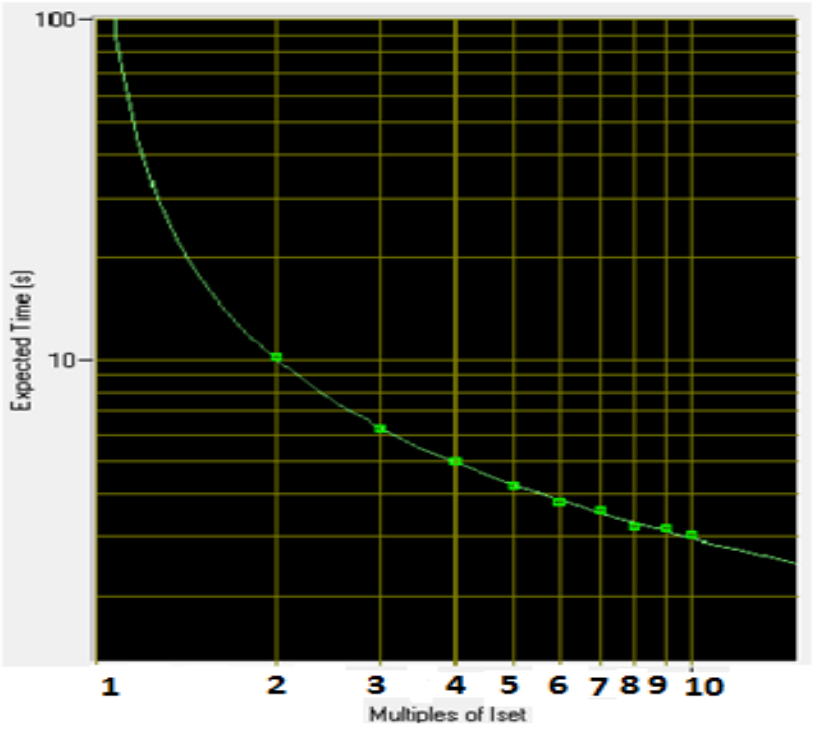
1. Instantaneous Over Current Protection

In instantaneous over current protection, relay operates without intentional time delay. It provides protection for fault between HV CT & transformer bushing CT or Transformer HV bushing fault. Its operating time is around 20ms.

2. IDMT Over Current Protection

The IDMT element use standard inverse of characteristics (3 sec Delay Curve). It's graphical representation as shown in Figure.

3 sec Delay Curve



t=3k/log[PSM]
Where,
k= Time Multiplier Setting (TMS)
t = Operating time in second
TMS = Time multiplier setting
PSM=Fault Current/Plug Setting

3. Definite Time Over Current Protection

This element gives protection during over load condition. This helps to utilize the maximum capacity of transformer.

4. Restricted Earth Fault Protection

Relay consists of separate input for monitoring unbalance current. This input is to be connected to the parallel connection of both phases CT. During normal load condition and during through fault current this current is zero, but during winding fault of transformer this create unbalance and trip instantly.

TECHNICAL SPECIFICATIONS

Sl. No	Specification	REF.	Particulars
1.	**Auxiliary Supply**	V_{DC}	45 to 260VDC
2.	**Current Input (rated)**	I	5A AC
3.	**Frequency**	Fn	50 Hz
4.	**VA Burden on CT**		Less than 0.5 VA
5.	**VA burden on Aux**		Less than 15 Watts(energized) Less than 10 watts(de-energized)
6.	**Operating Temp Range**		-10°C to + 60 °C
7.	**Max. & Minimum relative humidity**		100% & 22%
8.	**Continuous Current Carry Capacity of C**		3In; 15A
9.	**Thermal Withstand for CT**		40In for 1 sec
10.	**Contact details**		
11.	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 Ø=0.4 i) DC 220V, L/R= 45ms		 5A 0.5A
12.	**Type of communication ports**		USB and RS 485
13.	**Overall dimensions** Width Height Depth		 263 mm 173 mm 330 mm
14.	**Weight**		6.9 kg approx.

RELAY SETTINGS

ANTP 202 HV/LV & ANTP 402

Settings	Particulars
Password protection (YES/NO)	**0000-9999**
1. General config.	
Line CT Primary	5-5000 in steps of 5A
Earth CT Primary	5 -5000 in steps of 5A
Trip Ckt Supervision	Enable/Disable
Trip Counter Reset	Reset=1/Discard=0
Post fault cycles	0-5 in steps of 1
Relay ID	1-255 in steps of 1
Baud Rate	4800-57600 in steps of 200
Set Date Time	(Yes/No)DD/MM/YY HH:MM:SS
Trip Relay Test	
2. OC IDMT Protection	
IDMT Curve	1- Normal Inverse
	2- Extremely Inverse
	3- Very Inverse
	4- Restricted Inverse
	5- 3 Sec Delay
	6- 1.3 Sec Delay
	7- Long Time Delay
Trip Val (%)	40-320 in steps of 1%
TMS	0.01-1.00 in steps of 0.01 sec
3. OC INST Protection	
OC INST Protection	EN/DIS
Trip Val (%)	160-1600 in steps of 1%
4. OC Deft. Time	

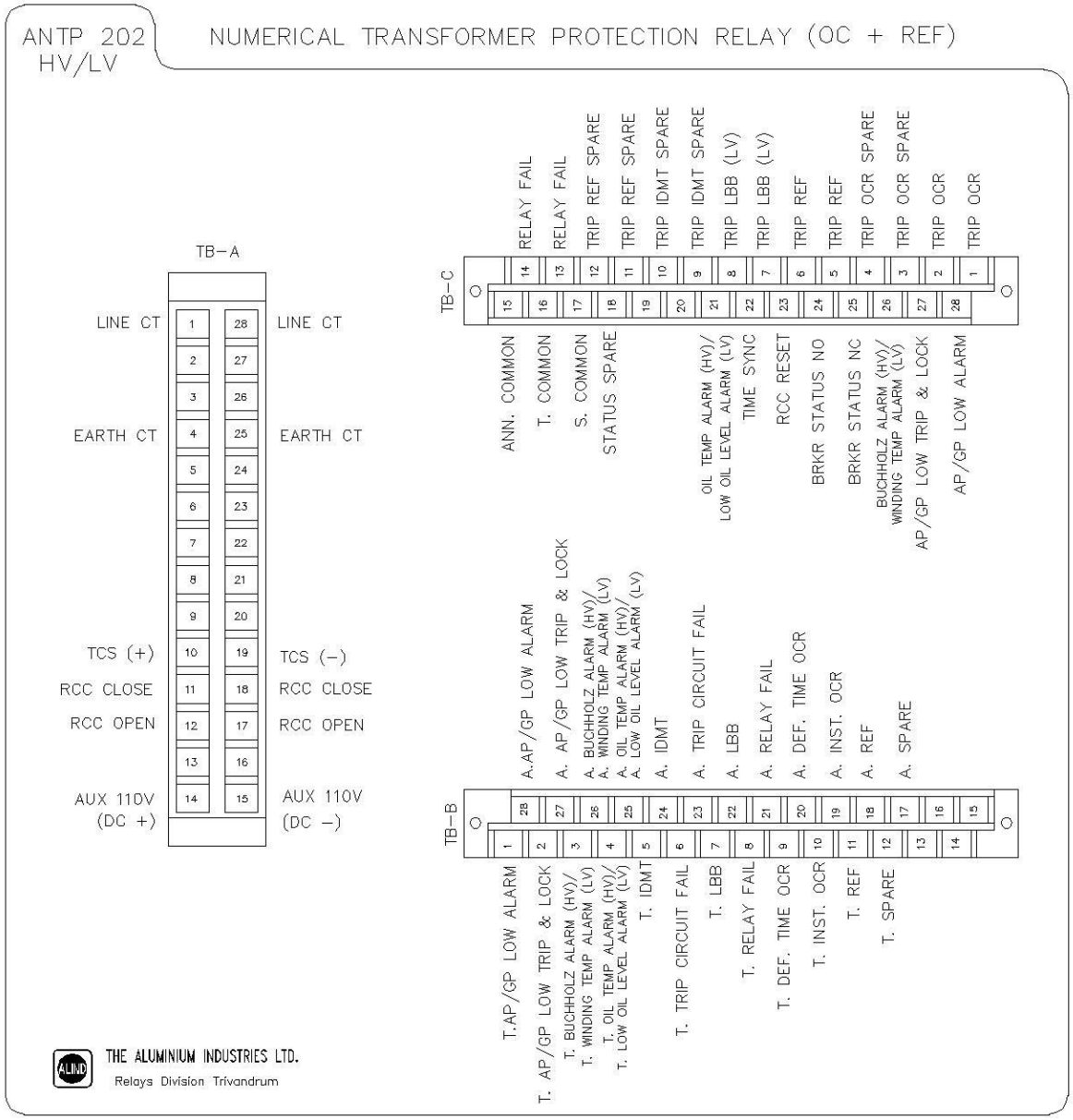
Deft. Time 1	EN/DIS
Trip Val (%)	40-320 in steps of 1%
Trip Time(Sec)	1-900 in steps of 1 Sec
OL Loop Time(Sec)	0-300 in steps of 1 Sec
Deft. Time 2	EN/DIS
Trip Val (%)	40-320 in steps of 1%
Trip Time(Sec)	1-900 in steps of 1 Sec
OL Loop Time(Sec)	0-300 in steps of 1 Sec
Deft. Time 3	
Trip Val (%)	40-320 in steps of 1%
Trip Time(Sec)	1-900 in steps of 1 Sec
OL Loop Time(Sec)	0-300 in steps of 1 Sec
5. Post Over load Protection	
Post Overload	EN/DIS
Trip Val (%)	50-280 in steps of 1%
Trip Time(Sec)	1-900 in steps of 1 Sec
Reset Time(Min)	5-180 in steps of 1 Min
6. REF Prot.	
Trip Val (%)	2-100 in steps of 1 %
7. LBB	
LBB	EN/DIS
Trip Time	50-5000 in steps of 1mSec
Operating Time	
i) IDMT OCR Protection	Depends on curve & TMS setting
ii) Instantaneous OCR Protection	Less than 22 ms
iii) Definite OCR Protection	30 +/- 10 msec
iv) Earth Fault Protection	Less than 20 ms
v) LBB	Depends on Time setting

ANTP 302

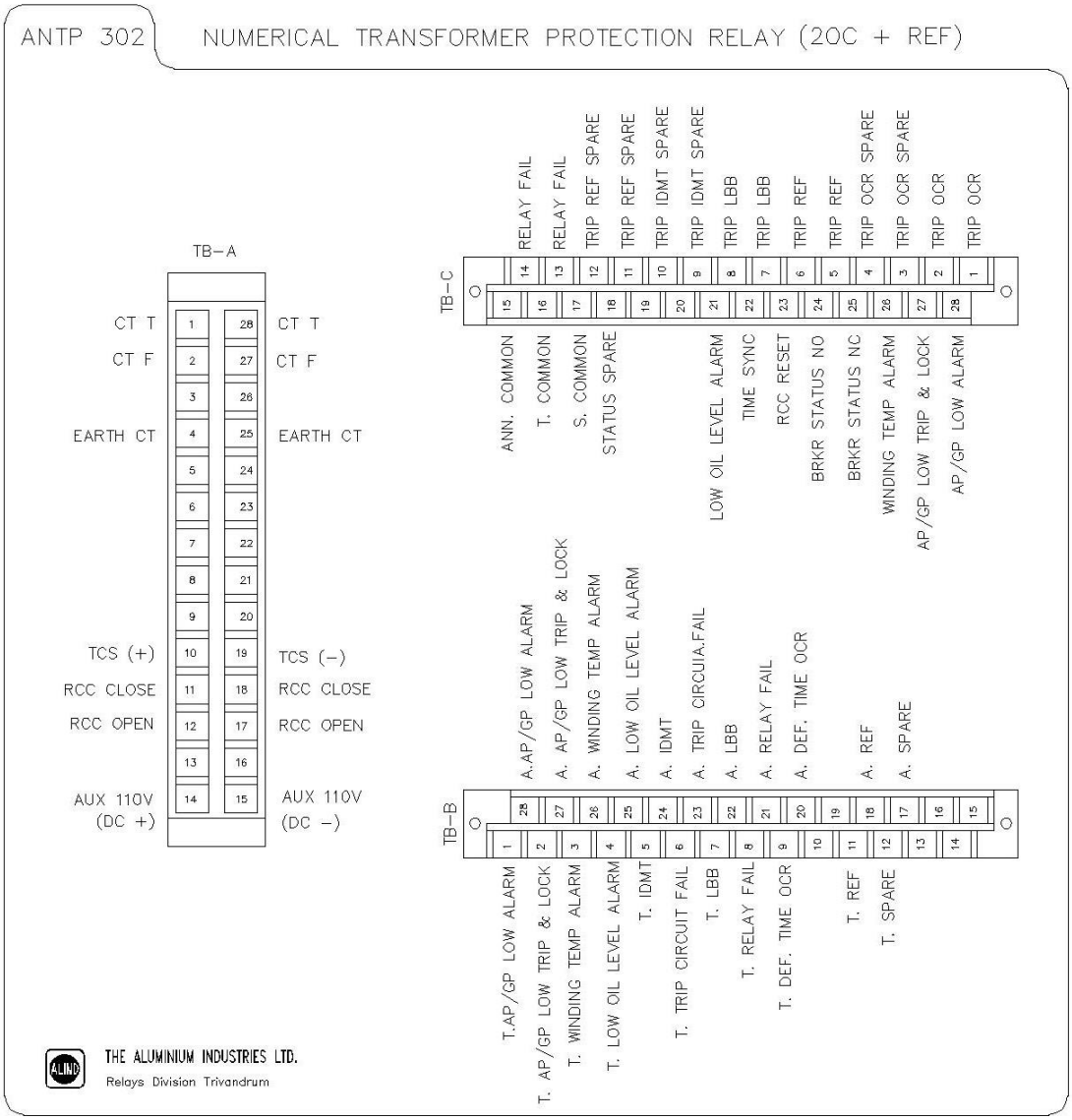
Settings	Particulars
Password protection (YES/NO)	**0000-9999**
1. General config.	
Line CT Primary	5-5000A in steps of 5A
Earth CT Primary	5 -5000A in steps of 5A
Trip Ckt Supervision	Enable/Disable
Trip Counter Rst	Reset/Discard
Post Fault cycles	0-5 in steps of 1
Relay ID	1 to 255 in steps of 1
Baud Rate	4800-57600 in steps of 200
Set Date Time	(Yes/No)DD/MM/YY HH:MM:SS
Trip Relay Test	
2. OC IDMT Protection	
IDMT Curve	1- Normal Inverse
	2- Extremely Inverse
	3- Very Inverse
	4- Restricted Inverse
	5- 3 Sec Delay
	6- 1.3 Sec Delay
	7- Long Time Delay
Trip Val (%)	40-320 in steps of 1%
TMS(Sec)	0.01-1.00 in steps of 0.01
3. OC Deft. Time	
1. Deft. Time 1 (EN/DIS)	
Trip Val (%)	40-320 in steps of 1%
Trip Time(Sec)	1-900 in steps of 1 Sec
OL Loop Time(Sec)	0-300 in steps of 1 Sec
2. Deft. Time 2 (EN/DIS)	
Trip Val (%)	40-320 in steps of 1%
Trip Time(Sec)	1-900 in steps of 1 Sec
OL Loop Time(Sec)	0-300 in steps of 1 Sec
3. Deft. Time 3 (EN/DIS)	
Trip Val (%)	40-320 in steps of 1%
Trip Time(Sec)	1-900 in steps of 1 Sec
OL Loop Time(Sec)	0-300 in steps of 1 Sec
4. Post Over load Protection (EN/DIS)	
Trip Val (%)	50-280 in steps of 1%
Trip Time (Sec)	1-900 in steps of 1 Sec
Reset Time (Min)	5-180 in steps of 1 Min
5. REF Prot.	
Trip Val (%)	2-100 in steps of 1 %
6. LBB(EN/DIS)	
Trip Time(mSec)	50-5000 in steps of 1mSec
Operating Time	
i) IDMT OCR Protection	Depends on curve & TMS setting
ii) Definite OCR Protection	30 +/- 10 mSec
iii) Earth Fault Protection	Less than 22 ms

TB DETAILS

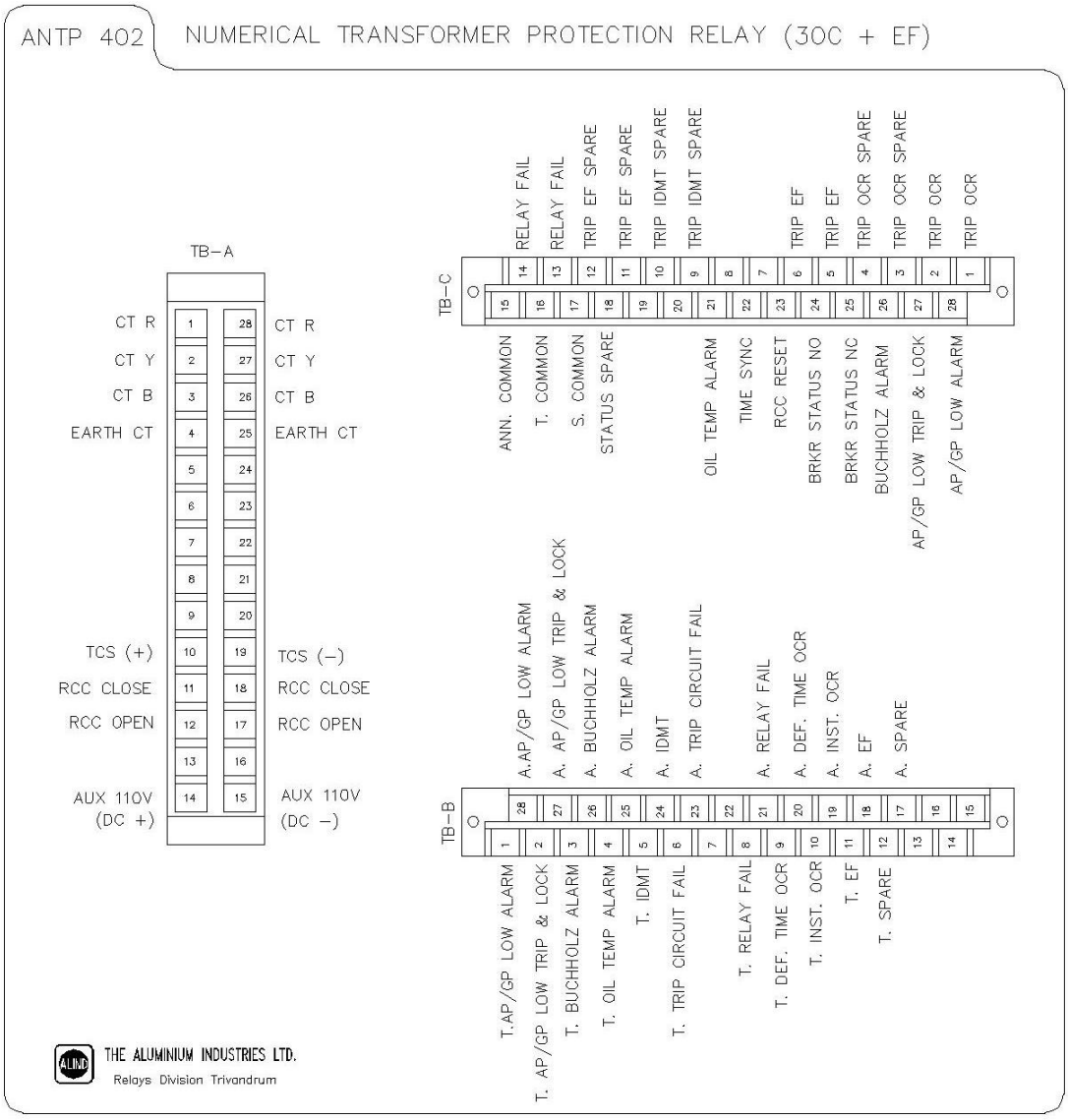
ANTP 202 HV/LV



ANTP 302


ANTP 302
NUMERICAL TRANSFORMER PROTECTION RELAY (2OC + REF)
TB-A
CT T
CT F
EARTH CT
TCS (+)
RCC CLOSE
RCC OPEN
AUX 110V (DC +)
CT T
CT F
EARTH CT
TCS (-)
RCC CLOSE
RCC OPEN
AUX 110V (DC -)
TB-C
RELAY FAIL
RELAY FAIL
TRIP REF SPARE
TRIP REF SPARE
TRIP IDMT SPARE
TRIP IDMT SPARE
TRIP LBB
TRIP LBB
TRIP REF
TRIP REF
TRIP OCR SPARE
TRIP OCR SPARE
TRIP OCR
TRIP OCR
ANN. COMMON
T. COMMON
S. COMMON
STATUS SPARE
LOW OIL LEVEL ALARM
TIME SYNC
RCC RESET
BRKR STATUS NO
BRKR STATUS NC
WINDING TEMP ALARM
AP/GP LOW TRIP & LOCK
AP/GP LOW ALARM
TB-B
A.AP/GP LOW ALARM
A. AP/GP LOW TRIP & LOCK
A. WINDING TEMP ALARM
A. LOW OIL LEVEL ALARM
A. IDMT
A. TRIP CIRCUIA.FAIL
A. LBB
A. RELAY FAIL
A. DEF. TIME OCR
A. REF
A. SPARE
T.AP/GP LOW ALARM
T. AP/GP LOW TRIP & LOCK
T. WINDING TEMP ALARM
T. LOW OIL LEVEL ALARM
T. IDMT
T. TRIP CIRCUIT FAIL
T. LBB
T. RELAY FAIL
T. DEF. TIME OCR
T. REF
T. SPARE
THE ALUMINIUM INDUSTRIES LTD.
Relays Division Trivandrum

ANTP 402


ANTP 402
NUMERICAL TRANSFORMER PROTECTION RELAY (3OC + EF)
TB–A
CT R
CT Y
CT B
EARTH CT
TCS (+)
RCC CLOSE
RCC OPEN
AUX 110V (DC +)
CT R
CT Y
CT B
EARTH CT
TCS (–)
RCC CLOSE
RCC OPEN
AUX 110V (DC –)
TB–C
RELAY FAIL
RELAY FAIL
TRIP EF SPARE
TRIP EF SPARE
TRIP IDMT SPARE
TRIP IDMT SPARE
TRIP EF
TRIP EF
TRIP OCR SPARE
TRIP OCR SPARE
TRIP OCR
TRIP OCR
ANN. COMMON
T. COMMON
S. COMMON
STATUS SPARE
OIL TEMP ALARM
TIME SYNC
RCC RESET
BRKR STATUS NO
BRKR STATUS NC
BUCHHOLZ ALARM
AP/GP LOW TRIP & LOCK
AP/GP LOW ALARM
TB–B
A.AP/GP LOW ALARM
A. AP/GP LOW TRIP & LOCK
A. BUCHHOLZ ALARM
A. OIL TEMP ALARM
A. IDMT
A. TRIP CIRCUIT FAIL
A. RELAY FAIL
A. DEF. TIME OCR
A. INST. OCR
A. EF
A. SPARE
T.AP/GP LOW ALARM
T. AP/GP LOW TRIP & LOCK
T. BUCHHOLZ ALARM
T. OIL TEMP ALARM
T. IDMT
T. TRIP CIRCUIT FAIL
T. RELAY FAIL
T. DEF. TIME OCR
T. INST. OCR
T. EF
T. SPARE
THE ALUMINIUM INDUSTRIES LTD.
Relays Division Trivandrum

RELAY CONFORMING STANDARDS

The relay conforms to the following standards:

Sl No.	Standards	Description
I.	IEC 60255-151	Functional Requirements for Over/Under Current Protection.
II.	IEC 60255-5	Insulation coordination of measuring relays and protection equipment- requirements and tests.
III.	IEC 60255-1	Measuring relays and protection equipment- Common requirements.
IV.	IEC 60255-21-1	Vibration Tests (Sinusodial)
V.	IEC 60255-21-2	Shock and Bump Tests
VI.	IEC 60255-21-3	Seismic Tests
VII.	IEC 60255-27	Product Safety Requirement.
VIII.	IEC 60255-26	Electromagnetic Compatibility Requirement.
IX.	IEC 60529	Degrees of Protection provided by enclosures (IP Code)
X.	IEC 61810-2	Reliability.
XI.	IS 2705 (Part II, III&IV)	Protective current transformers.
XII.	IS 3231 (Part 1 to 3)	Electrical relays for power system protection.
XIII.	IS 8686	Static protective relays.
XIV.	IEC 60068-2	Environmental tests.
XV.	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 have 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.	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.
4.	Relay operating but output relay contact not making	1. Check CT/PT card. 2. Check output relay coil's continuity	1. Card not inserted properly.

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

TYPE – ANTP 202

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 **ANTP 202** 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. SYSTEMS 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	160	2	3	According to main FUN
Reset CU	-	5	160	3	4	According to main FUN
Reset CU/Start/Restart	-	5	160	4	5	According to main FUN

STATUS INDICATION IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Protection Healthy/Active	-	1	160	18	1	↑
LED Reset	-	1	160	19	1	↑
Local Parameter Settings (Change)	-	1	160	22	1	↑
Buchholz alarm/Winding temp alarm	X	1	160	27	1,9	↑↓
Oil Temp Alarm/Low Oil Alarm	X	1	160	28	1,9	↑↓
AP/GP Low Alarm	X	1	160	29	1,9	↑↓
AP/GP Trip & Lock	X	1	160	30	1,9	↑↓
CB NC (FDR CB OPEN)	X	1	160	124	1,9	↑↓
CB NO (FDR CB CLOSE)	X	1	160	125	1,9	↑↓
Relay Fail	-	1	160	40	1	↑

SUPERVISION INDICATIONS IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Trip circuit supervision	X	1	160	36	1,9	↑↓
Spare	X	1	160	26	1,9	↑↓

FAULT INDICATION IN (MONITOR DIRECTIONS)

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Breaker Failure (LBB)	X	2	160	85	1, 9	↑↓
General Start/Pickup Trip IDMT	X	2	168	63	1,9	↑↓
Start/Pickup Trip I> (INST.OCR)	X	2	168	64	1,9	↑↓
Start/Pickup Trip I>> (OCR Stage1)	X	2	168	65	1,9	↑↓
Start/Pickup Trip I>>> (OCR Stage2	X	2	168	66	1,9	↑↓
Start/Pickup Trip I >>>> (OCR stage 3)	X	2	168	62	1,9	↑↓
Start/Pickup Trip IN> (REF/EF)	X	2	168	55	1,9	↑↓
Start/Pickup Post Overload	X	2	168	82	1,9	↑↓
General Trip IDMT (OC HV Operated)	-	2	160	69	1	↑
Trip I> (INST.OCR)	-	2	160	90	1	↑
Trip I>> (DEF.OCR Stage1)	-	2	160	91	1	↑
Trip I>>> (DEF.OCR Stage2)	-	2	160	104	1	↑
Trip I >>>> (DEF. OCR stage 3)	-	2	160	105	1	↑
Trip IN> (REF/EF Operated)	-	2	160	93	1	↑
Post Overload Trip	-	2	160	106	1	↑

MEASURAND IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Measurand supervision I	-	9	160	148	2	↑↓
Measurand supervision Earth CT	-	9	160	148	2	↑↓

TIME TAGED MEASURAND IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Line Fault Current – I	-	4	160	141	1	↑↓
Fault REF – I	-	4	160	145	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 RESET	-	20	160	19	20	↑ (PULSE)
CB Open	-	20	160	120	20	↑ (PULSE)
CB Close	-	20	160	121	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 ANTP 202

ANTP 202		
FUN	ACC	PARAMETER
160	**1**	**I**
160	2	x
160	3	x
160	**4**	**Ie**
160	5	x
160	6	x
160	7	x
160	8	x

9. DIGITAL CHANNEL (TAGS) INFORMATION IN ANTP 202

ANTP 202			
TAG POSSITION	FUN/INF NUMBER	SEMANTICS ACCORDING TO TAG POSSITION	INPUT/ OUTPUT
0	160/84	GENERAL PICKUP	OUTPUT
1	160/68	GENERAL TRIP	OUTPUT
2	160/69	IDMT OVER CURRENT OPERATED	OUTPUT
3	160/90	INST.OCR TRIP - I>	OUTPUT
4	160/91	TRIP I>>	OUTPUT
5	160/104	TRIP I>>>	OUTPUT
6	160/105	TRIP I>>>>	OUTPUT
7	160/93	TRIP IN> REF	OUTPUT
8	160/106	POST OVERLOAD TRIP	OUTPUT
9	160/85	LBB	OUTPUT
10	160/28	OIL TEMP/LOW OIL ALARM -LOG I/P - 1	INPUT
11	255/0	TIME SYNC - LOG I/P - 2	INPUT
12	160/19	RCC RESET - LOG I/P - 3	INPUT
13	160/124	CB NC (OPEN) - LOG I/P - 4	INPUT
14	160/125	CB NO (CLOSE) - LOG I/P - 5	INPUT
15	160/27	BUCHHOLTZ/WIND. TEMP ALARM - LOG I/P - 6	INPUT
16	160/30	AP/GP LOW TRIP & LOCK - LOG I/P - 7	INPUT
17	160/29	AP/GP LOW ALARM - LOG I/P - 8	INPUT
18	160/36	TRIP CIRCUIT FAIL - LOG I/P - 9	INPUT

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

TYPE – ANTP 302

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 **ANTP 302** 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.
253 Maximum length of APDU 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	160	2	3	According to main FUN
Reset CU	-	5	160	3	4	According to main FUN
Reset CU/Start/Restart	-	5	160	4	5	According to main FUN

STATUS INDICATION IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Protection Healthy/Active	-	1	160	18	1,9	↑↓
LED Reset	-	1	160	19	1,9	↑↓
Local Parameter Settings (Change)	-	1	160	22	1,9	↑↓
Buchholz alarm/Winding temp alarm	X	1	160	27	1,9	↑↓
Oil Temp Alarm/Low Oil Alarm	X	1	160	28	1,9	↑↓
AP/GP Low Alarm	X	1	160	29	1,9	↑↓
AP/GP Trip & Lock	X	1	160	30	1,9	↑↓
CB NC (FDR CB OPEN)	X	1	160	124	1,9	↑↓
CB NO (FDR CB CLOSE)	X	1	160	125	1,9	↑↓
Relay Fail	-	1	160	40	1,9	↑↓

SUPERVISION INDICATIONS IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Trip circuit supervision	X	1	160	36	1,9	↑↓
Spare	X	1	160	26	1,9	↑↓

FAULT INDICATION IN (MONITOR DIRECTIONS)

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Breaker Failure (LBB)	X	2	160	85	1,9	↑↓
General Start/Pickup Trip IDMT-T	X	2	168	84	1,9	↑↓
Start/Pickup Trip I>> (OCR Stage1) – T	X	2	168	74	1,9	↑↓
Start/Pickup Trip I>>> (OCR Stage2) – T	X	2	168	75	1,9	↑↓
Start/Pickup Trip I >>>> (OCR stage 3)- T	X	2	168	81	1,9	↑↓
Start/Pickup Trip IN> (REF/EF)	X	2	168	55		
Start/Pickup Post Overload - T	X	2	168	82	1,9	↑↓
General Start/Pickup Trip IDMT-F	X	2	167	62	1,9	↑↓
Start/Pickup Trip I>> (OCR Stage1) – F	X	2	167	64	1,9	↑↓
Start/Pickup Trip I>>> (OCR Stage2) - F	X	2	167	65	1,9	↑↓
Start/Pickup Trip I >>>> (OCR stage 3)- F	X	2	167	66	1,9	↑↓
Start/Pickup Post Overload – F	X	2	167	67	1,9	↑↓
General Trip IDMT (OC HV Operated)-T	-	2	160	69	1	↑↓
Trip I>> (DEF.OCR Stage1)-T	-	2	160	91	1	↑↓
Trip I>>> (DEF.OCR Stage2)-T	-	2	160	104	1	↑↓
Trip I >>>> (DEF. OCR stage 3)-T	-	2	160	105	1	↑↓
Trip IN> (REF/EF Operated)-T	-	2	160	93	1	↑↓
Post Overload Trip-T	-	2	160	106	1	↑↓
General Trip IDMT (OC HV Operated)-F	-	2	167	69	1	↑↓
Trip I>> (INST.OCR)-F	-	2	167	91	1	↑↓
Trip I>>> (DEF.OCR Stage2)-F	-	2	167	104	1	↑↓
Trip I >>>> (DEF. OCR stage 3)-F	-	2	167	105	1	↑↓
Post Overload Trip-F	-	2	167	106	1	↑↓

MEASURAND IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Measurand supervision I - t	-	9	160	148	2	↑↓
Measurand supervision I - m	-	9	160	148	2	↑↓
Measurand supervision I –Ie	-	9	160	148	2	↑↓

TIME TAGED MEASURAND IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Teaser Fault Current – I	-	4	160	141	1	↑↓
Main Fault Current – I	-	4	160	142	1	↑↓
Earth Fault Current – Ie	-	4	160	145	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 RESET	-	20	160	19	20	↑ (PULSE)
CB Open	-	20	160	120	20	↑(PULSE)
CB Close	-	20	160	121	20	↑(PULSE)

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• 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. The following ranges of TOO are used with the different ASDUs:

7. ANALOG CHANNEL INFORMATION IN ANTP 302

ANTP 302		
FUN	ACC	PARAMETER
160	1	I-t
160	2	I-m
160	3	x
160	4	I-e
160	5	x
160	6	x
160	7	x
160	8	x

8. DIGITAL CHANNEL (TAGS) INFORMATION IN ANTP 302

ANTP 302			
TAG POSSITION	FUN/INF NUMBER	SEMANTICS ACCORDING TO TAG POSSITION	INPUT/ OUTPUT
0	160/84	GENERAL PICKUP	OUTPUT
1	160/68	GENERAL TRIP	OUTPUT
2	160/69	IDMT - T - TRIP	OUTPUT
3	160/91	DEF. OCR STAGE 1 - T - I>> TRIP	OUTPUT
4	160/104	DEF. OCR STAGE 2 - T- I>>> TRIP	OUTPUT
5	160/105	DEF. OCR STAGE 3 - T- I>>>> TRIP	OUTPUT
6	160/93	REF/EF - IN - T – TRIP	OUTPUT
7	160/106	POST OVERLOAD - T - TRIP	OUTPUT
8	167/68	IDMT -M- TRIP	OUTPUT
9	167/91	DEF. OCR STAGE 1 - M - I>> TRIP	OUTPUT
10	167/104	DEF. OCR STAGE 2 - M- I>>> TRIP	OUTPUT
11	167/105	DEF. OCR STAGE 3 - M - I>>>> TRIP	OUTPUT
12	167/106	POST OVERLOAD – M- TRIP	OUTPUT
13	160/85	BREAKER FAILURE	OUTPUT
14	160/28	OIL TEMP/LOW OIL ALARM -LOG I/P - 1	INPUT
15	255/0	TIME SYNC - LOG I/P – 2	INPUT
16	160/19	RCC RESET - LOG I/P – 3	INPUT
17	160/124	CB NC (OPEN) - LOG I/P - 4	INPUT
18	160/125	CB NO (CLOSE) - LOG I/P – 5	INPUT
19	160/27	BUCHHOLTZ/WIND. TEMP ALARM - LOG I/P - 6	INPUT
20	160/30	AP/GP LOW TRIP & LOCK - LOG I/P - 7	INPUT
21	160/29	AP/GP LOW ALARM - LOG I/P - 8	INPUT
22	160/36	TRIP CIRCUIT FAIL - LOG I/P - 9	INPUT

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

TYPE – ANTP 402

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 **ANTP 402** 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.
253 Maximum length of APDU 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	160	2	3	According to main FUN
Reset CU	-	5	160	3	4	According to main FUN
Reset CU/Start/Restart	-	5	160	4	5	According to main FUN

STATUS INDICATION IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Protection Healthy/Active	-	1	160	18	1	↑
LED Reset	-	1	160	19	1	↑
Local Parameter Settings (Change)	-	1	160	22	1	↑
Buchholz alarm	X	1	160	27	1,9	↑↓
Oil Temp Alarm	X	1	160	28	1,9	↑↓
AP/GP Low Alarm	X	1	160	29	1,9	↑↓
AP/GP Trip & Lock	X	1	160	30	1,9	↑↓
CB NC (FDR CB OPEN)	X	1	160	124	1,9	↑↓
CB NO (FDR CB CLOSE)	X	1	160	125	1,9	↑↓
Relay Fail	-	1	160	40	1	↑

SUPERVISION INDICATIONS IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Trip circuit supervision	X	1	160	36	1,9	↑↓
Spare	X	1	160	26	1,9	↑↓

FAULT INDICATION IN (MONITOR DIRECTIONS)

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
General Start/Pickup Trip IDMT- R	X	2	168	84	1,9	↑↓
Start/Pickup Trip I> (INST.OCR) - R	X	2	168	73	1,9	↑↓
Start/Pickup Trip I>> (OCR Stage1) - R	X	2	168	74	1,9	↑↓
Start/Pickup Trip I>>> (OCR Stage2) - R	X	2	168	75	1,9	↑↓
Start/Pickup Trip I >>>> (OCR stage 3)- R	X	2	168	81	1,9	↑↓
Start/Pickup Post Overload - R	X	2	168	82	1,9	↑↓
General Start/Pickup Trip IDMT- Y	X	2	167	62	1,9	↑↓
Start/Pickup Trip I> (INST.OCR) - Y	X	2	167	63	1,9	↑↓
Start/Pickup Trip I>> (OCR Stage1) - Y	X	2	167	64	1,9	↑↓
Start/Pickup Trip I>>> (OCR Stage2) - Y	X	2	167	65	1,9	↑↓
Start/Pickup Trip I >>>> (OCR stage 3)- Y	X	2	167	66	1,9	↑↓
Start/Pickup Post Overload - Y	X	2	167	67	1,9	↑↓
General Start/Pickup Trip IDMT- B	X	2	164	62	1,9	↑↓
Start/Pickup Trip I> (INST.OCR) - B	X	2	164	63	1,9	↑↓
Start/Pickup Trip I>> (OCR Stage1) - B	X	2	164	64	1,9	↑↓
Start/Pickup Trip I>>> (OCR Stage2) - B	X	2	164	65	1,9	↑↓
Start/Pickup Trip I >>>> (OCR stage 3)- B	X	2	164	66	1,9	↑↓
Start/Pickup Post Overload - B	X	2	164	96	1,9	↑↓
Start/Pickup Trip IN> (REF/EF)	X	2	168	55	1,9	↑↓
General Trip IDMT (OC HV Operated)-R	-	2	160	69		↑↓
Trip I> (INST.OCR) -R	-	2	160	90	1	↑↓
Trip I>> (DEF.OCR Stage1)-R	-	2	160	91	1	↑↓
Trip I>>> (DEF.OCR Stage2)-R	-	2	160	104	1	↑↓
Trip I >>>> (DEF. OCR stage 3)-R	-	2	160	105	1	↑↓
Trip IN> (REF/EF Operated)	-	2	160	93	1	↑↓
Post Overload Trip-R	-	2	160	106	1	↑↓
General Trip IDMT (OC HV Operated)-Y	-	2	167	69	1	↑↓
Trip I> (INST.OCR)-Y	-	2	167	90	1	↑↓

Trip I>> (DEF.OCR Stage1)-Y	-	2	167	91	1	↑↓
Trip I>>> (DEF.OCR Stage2)-Y	-	2	167	104	1	↑↓
Trip I >>>> (DEF. OCR stage 3)-Y	-	2	167	105	1	↑↓
Post Overload Trip-Y	-	2	167	106	1	↑↓
General Trip IDMT (OC HV Operated)-B	-	2	164	69	1	↑↓
Trip I> (INST.OCR)-B	-	2	164	90	1	↑↓
Trip I>> (DEF.OCR Stage1)-B	-	2	164	91	1	↑↓
Trip I>>> (DEF.OCR Stage2)-B	-	2	164	104	1	↑↓
Trip I >>>> (DEF. OCR stage 3)-B	-	2	164	105	1	↑↓
Post Overload Trip-B	-	2	164	106	1	↑↓

MEASURAND IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Measurand supervision I-R	-	9	160	148	2	↑↓
Measurand supervision I -Y	-	9	160	148	2	↑↓
Measurand supervision I –B	-	9	160	148	2	↑↓
Measurand supervision I –Ie	-	9	160	148	2	↑↓

TIME TAGED MEASURAND IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
R-PH. Fault Current – I	-	4	160	141	1	↑↓
Y-PH. Fault Current – I	-	4	160	142	1	↑↓
B-PH. Fault Current – I	-	4	160	143	1	↑↓
Earth Fault Current – Ie	-	4	160	145	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	160	19	20	↑ (PULSE)
CB Open	-	20	160	120	20	↑↓ (PULSE)
CB Close	-	20	160	121	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 ANTP 402

ANTP 402		
FUN	**ACC**	**PARAMETER**
160	**1**	**It**
160	**2**	**If**
160	**3**	**Ib**
160	**4**	**Ie**
160	5	x
160	6	x
160	7	x
160	8	x

9. DIGITAL CHANNEL (TAGS) INFORMATION IN ANTP 402

ANTP 402			
TAG POSSITION	FUN/INF NUMBER	SEMANTICS ACCORDING TO TAG POSSITION	INPUT/ OUTPUT
0	160/84	GENERAL PICKUP	OUTPUT
1	160/68	GENERAL TRIP	OUTPUT
2	160/69	IDMT - R - PH - TRIP	OUTPUT
3	160/90	INST. OCR - R - PH - I> TRIP	OUTPUT
4	160/91	DEF. OCR STAGE 1 - R - PH - I>> TRIP	OUTPUT
5	160/104	DEF. OCR STAGE 2 - R - PH - I>>> TRIP	OUTPUT
6	160/105	DEF. OCR STAGE 3 - R - PH - I>>>> TRIP	OUTPUT
7	160/106	POST OVERLOAD - R - PH - TRIP	OUTPUT
8	167/69	IDMT - Y - PH - TRIP	OUTPUT
9	167/90	INST. OCR - Y - PH - I> TRIP	OUTPUT
10	167/91	DEF. OCR STAGE 1 - Y - PH - I>> TRIP	OUTPUT
11	167/104	DEF. OCR STAGE 2 - Y - PH - I>>> TRIP	OUTPUT
12	167/105	DEF. OCR STAGE 3 - Y - PH - I>>>> TRIP	OUTPUT
13	167/106	POST OVERLOAD - Y - PH - TRIP	OUTPUT
14	164/69	IDMT - B - PH - TRIP	INPUT
15	164/90	INST. OCR - B - PH - I> TRIP	INPUT
16	164/91	DEF. OCR STAGE 1 - B - PH - I>> TRIP	INPUT
17	164/104	DEF. OCR STAGE 2 - B - PH - I>>> TRIP	INPUT
18	164/105	DEF. OCR STAGE 3 - B - PH - I>>>> TRIP	INPUT
19	164/106	POST OVERLOAD - B - PH - TRIP	INPUT
20	160/93	REF/EF - IN - TRIP	INPUT
21	160/28	OIL TEMP/LOW OIL ALARM -LOG I/P - 1	INPUT
22	255/0	TIME SYNC - LOG I/P - 2	INPUT
23	160/19	RCC RESET - LOG I/P - 3	INPUT
24	160/124	CB NC (OPEN) - LOG I/P - 4	INPUT
25	160/125	CB NO (CLOSE) - LOG I/P - 5	INPUT
26	160/27	BUCHHOLTZ/WIND. TEMP ALARM - LOG I/P - 6	INPUT
27	160/30	AP/GP LOW TRIP & LOCK - LOG I/P - 7	INPUT
28	160/29	AP/GP LOW ALARM - LOG I/P - 8	INPUT
29	160/36	TRIP CIRCUIT FAIL - LOG I/P - 9	INPUT

TEST REPORT

ALUMINIUM INDUSTRIES LIMITED
Relays Division

TEST DETAILS

Relay characteristics & Operating Value Test

Operating Value Test for IDMT

Pickup setting (%)	Operating Value (A)	Drop off value (A)	Drop off / Pick up (%)
40% = 2.00A			
120% = 6.00A			
200% = 10.0A			

Allowable tolerance limit in operating value is ±5%

Operating Value Test for Inst OCR element

Relay Setting (%)	Operating Value (A)	Drop off value (A)	Drop off /Pick up (%)
160% = 8A			
260% = 13A			
300% = 15A			

Allowable tolerance limit in operating value is ±5%

Operating Value Test for Restricted Earth Fault (REF)

REF Setting (%)	Operating Value (A)	Drop off value (A)	Drop off / Pick up (%)
5% = 0.25A			
20% = 1.00A			
100%= 5.00A			

Allowable tolerance limit in operating value is ±5%

Operating Value Test for Definite time stage 1 OCR

OCR1 Setting (%)	Operating Value (A)	Error (%)
40% = 2.00A		
120% = 6.00A		
200% = 10.0A		

Allowable tolerance limit in operating value is ±5%

Operating Value Test for Definite time stage 2 OCR

OCR2 Setting (%)	Operating Value (A)	Error (%)
80% = 4.00A		
160% = 8.00A		
200% = 10.00A		

Allowable tolerance limit in operating value is ±5%

Operating Value Test for Definite time stage 3 OCR

OCR3 Setting (%)	Operating Value (A)	Error (%)
100% = 5.00A		
150% = 7.50A		
200% = 10.00A		

Allowable tolerance limit in operating value is ±5%

Operating Time Measuring Test

IDMT PROTECTION

PSM (%)	TMS	I (I/Ip>) (A)	Expected Time from curve (Sec)	Observed Time (Sec)
60%	0.5	4.5A(1.5N)	8.52	
60%	0.5	12A(4N)	2.49	
60%	0.1	12A(4N)	0.50	
60%	0.03	6A(2N)	0.30	
60%	0.01	6A(2N)	0.10	

Allowable tolerance limit in operating value is ±5%

Over Load (OCR) Operating Time Test

Definite Time OCR1

OCR Setting (%)	Set Time (sec)	Injected current (A)	Observed Time (Sec)
80%	1	8A	
80%	10	8A	
100%	60	8A	

Allowable tolerance limit in operating time is ±5%

Definite Time OCR2

OCR Setting (%)	Set Time (sec)	Injected current (A)	Observed Time (Sec)
140%	1	8A	
100%	20	8A	
150%	50	9A	

Allowable tolerance limit in operating time is ±5%

Definite Time OCR3

OCR Setting (%)	Set Time (sec)	Injected current (A)	Observed Time (Sec)
100%	1	8A	
200%	30	15A	
150%	120	10A	

Allowable tolerance limit in operating time is ±5%

Inst. Current Operating Time Test

Relay Setting (%)	Injected Current (A)	Time (ms)
160% = 8A	15A	

Operating time should be within 22 ms

REF Operating Time Test

Relay Setting (%)	Injected Current (A)	Time (ms)
30%	7.5A	
60%	15A	

Operating time should be within 30 ms

Local Breaker Backup (LBB) Trip

Inst. OCR Setting (%)	Injected current (A)	LBB time setting (ms)	Breaker status	LBB Status	LBB + Inst OCR time (ms)
200%	12A	200ms	Not operated	Operated	
			Operated	Not operated	
160%	15A	500ms	Not operated	Operated	
			Operated	Not operated	

Allowable tolerance limit in operating time is ±5%

STATUS VERIFICATION

STATUS	STATUS INPUT	OUTPUT CONTACT VERIFICATION
AP/GP LOW ALARM	Short TB-C 28 & 17	
AP/GP TRIP & LOCK	Short TB- C 27 & 17	
BUCHHOLZ/WINDING TEMP ALARM	Short TB- C 26 & 17	
OIL TEMP/LOW OIL LEVEL ALARM	Short TB- C 21 & 17	

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