NUMERICAL INTEGRATED TRANSFORMER DIFFERENTIALPROTECTION RELAY ANTD 201/ 401 [AN SERIES]

User Manual

ALUMINIUM INDUSTRIES LIMITED
RELAYS DIVISION
THIRUVANANTHAPURAM

ANTD 201/ 401

Numerical Integrated Transformer Differential Protection Relay

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ALUMINIUM INDUSTRIES LIMITED
Relays Division

SAFETY REQUIREMENTS

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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.

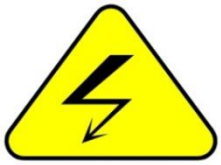
- People handling the equipment should be aware about the relay safety handlet.
- Ensure that the product is in the off condition before working on the conducting or terminal side.
- A qualified person must conduct tests and visual inspections, as necessary, to verify that tools electrical jumpers, shorts,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

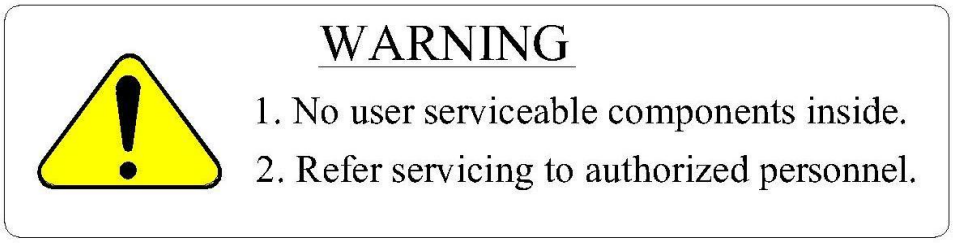
1. FRONT SIDE

Caution: refer to equipment documentation



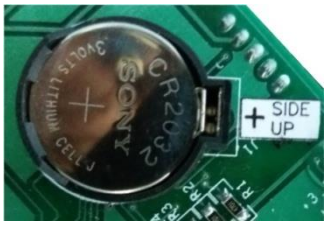
Caution: risk of electric shock

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

4. Contact data

Test voltage across open contact: 1 kV DC for 1 min source.

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

TMADT+TDTA

Static Type.

ATD 12

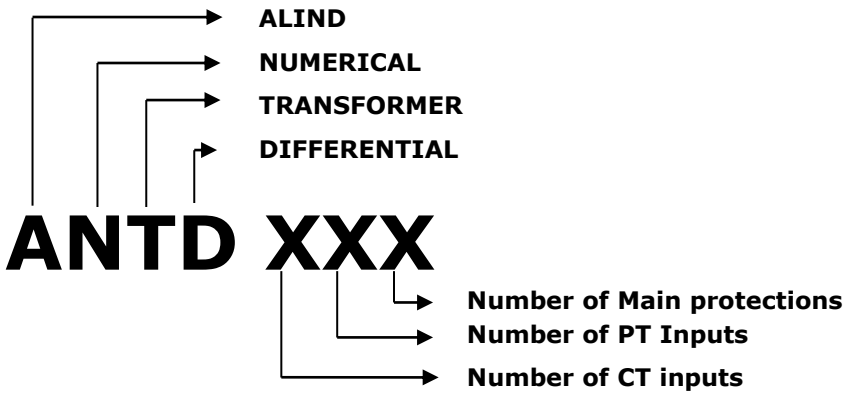
Numerical Integrated transformer differential protection relay

Disturbance & event recorder.

Built in counter facility.

ANTD

The relay is the modified version of our ATD 12 (AN Series) relay. The relay incorporates Instantaneous, IDMT curve, 3 stage definite time over current protection, Post over load protection.



ANTD 201:

The relay conforms to RDSO specification No. TI/SPC/PSI/PROTCT/6071. ANTD 201 (AN Series) relay is a comprehensive Integrated Transformer Differential Protection relay for the protection of conventional 27 KV AC single phase, 50Hz Over Head Equipment (OHE).

ANTD 401:

The relay conforms to RDSO specification No. TI/SPC/PSI/PROTCT/7100(07/2012). ANTD 401 (AN Series) relay is a comprehensive Integrated Transformer Differential Protection relay for the protection of 2x25 KV (AT feeding system) AC single phase, 50Hz Over Head Equipment (OHE).

MAIN FUNCTIONS

Sl No.	PARTICULARS	ANTD 201	ANTD 401
1.	**MAIN PROTECTIONS**		
1.1	Differential	✓	✓
1.2	Relay Fail	✓	✓
2.	**STATUS INPUTS**		
2.1	Trip Circuit Supervision	✓	✓
2.2	Buchholz Trip	✓	✓
2.3	Winding Temperature Trip	✓	✓
2.4	Oil Temperature Trip	✓	✓
2.5	Low Oil Level Trip	✓	✓
2.6	HIS Trip	✓	✓

GENERAL FUNCTIONS

Sl No.	PARTICULARS	ANTD 201	ANTD 401
1.	Password protection	✓	✓
2.	Event Memory	5000	5000
3.	Disturbance recorder waveforms	200	200
4.	50 cycles (45 pre and 5 post fault) of fault waveform	✓	✓
5.	**COMMUNICATION**		
5.1	GUI Interface	Mini USB	Mini USB
5.2	Isolated RS 485 Interface	✓	✓
5.3	Communication Protocol Interface- IEC 60870-5-103	✓	✓
5.4	GPS Time Sync Facility	✓	✓
5.5	Date/time synchronization through PC	✓	✓
6.	**MONITORING**		
6.1	HV Bushing Current	✓	✓
6.2	LV Bushing Current	✓	✓
6.3	Selectable HV CT ratio:5-5000/5A	✓	✓
6.4	Selectable LV CT ratio: 5-5000/5A	✓	✓
6.5	Counters for each element (Differential)	✓	✓
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

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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.

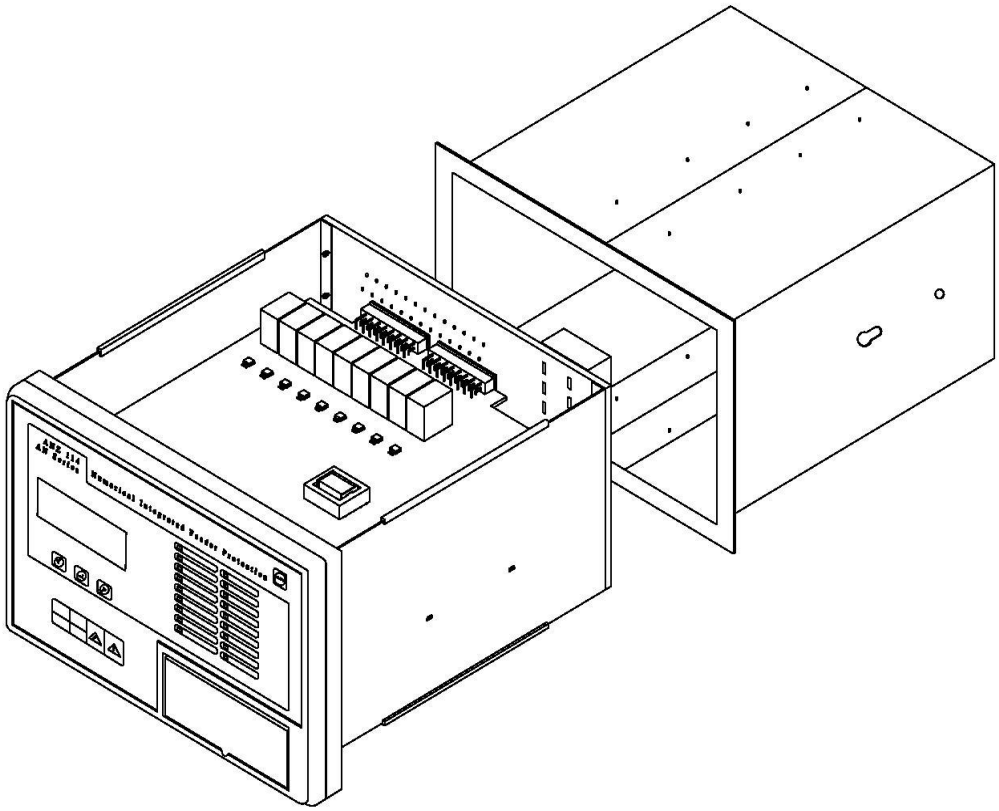
The relay is shipped from factory after detailed testing by our Quality Control Department. However, according to the customer requirement the relay settings/ functions can be verified before commissioning at respective sites with proper testing kits.

STORAGE

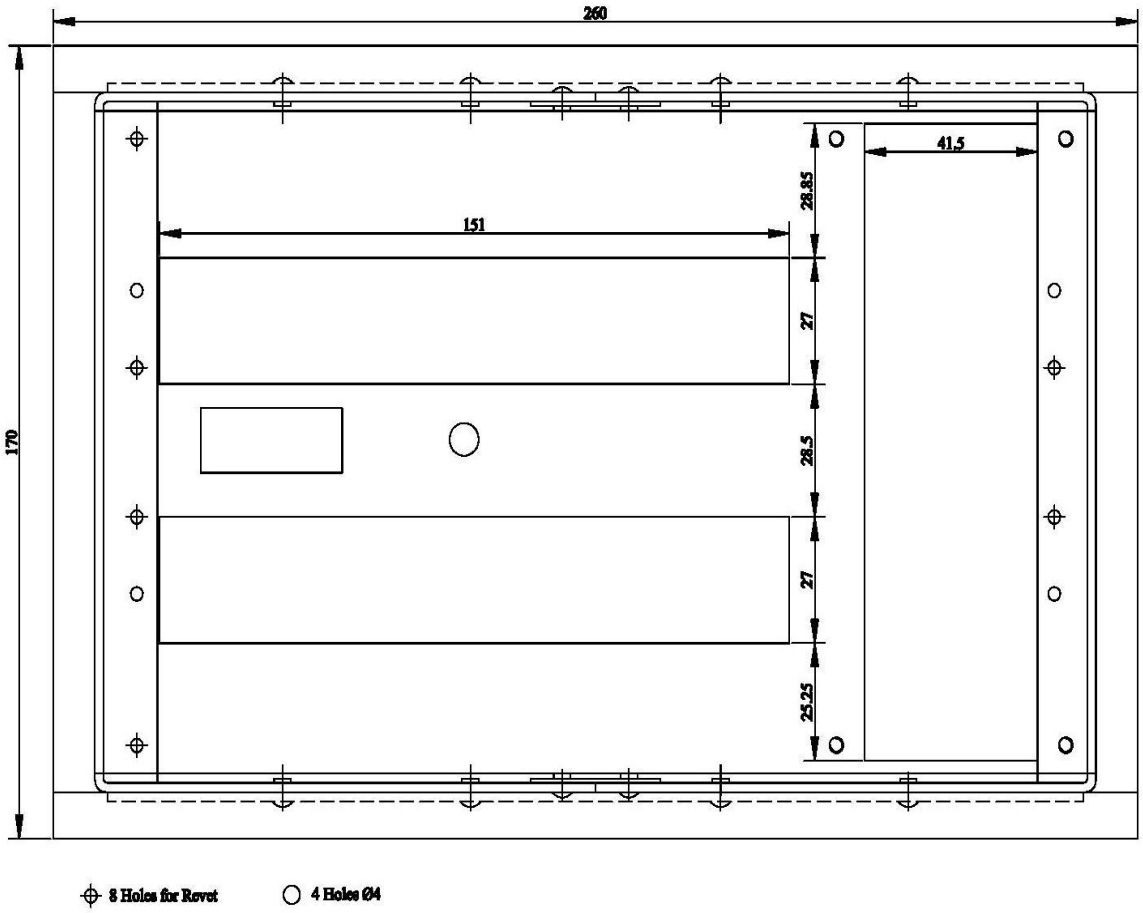
If relays are not to be installed immediately upon receipt they should be stored in a place free from dust and moisture in their original boxes. At most care should be taken while storage.

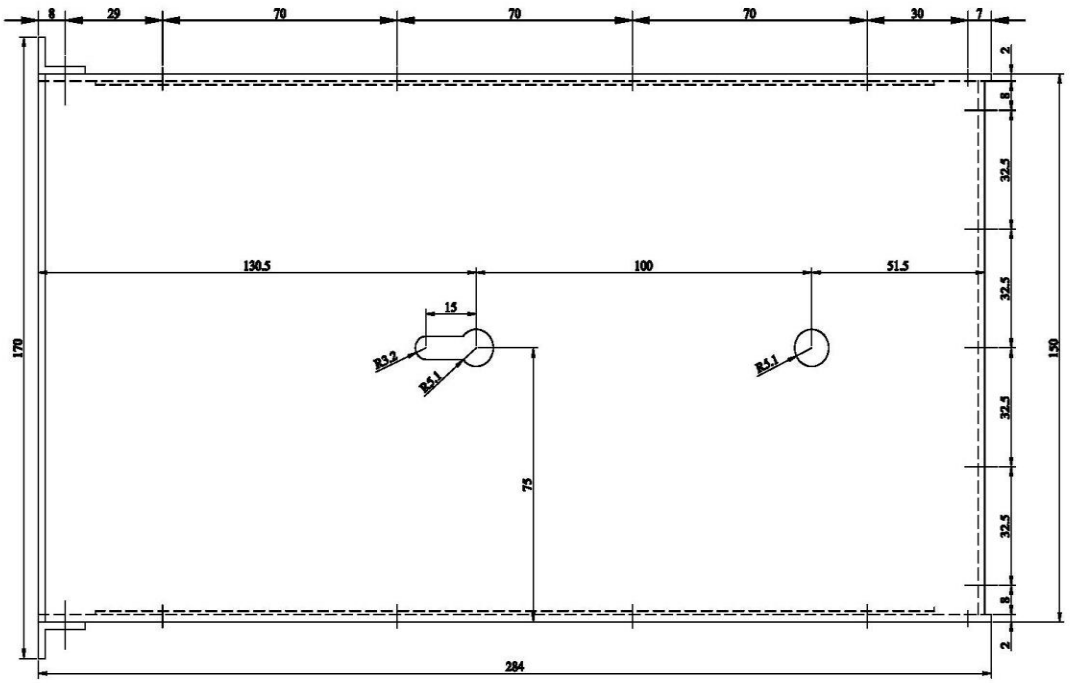
Storage temperature: -25ºC to +70ºC.

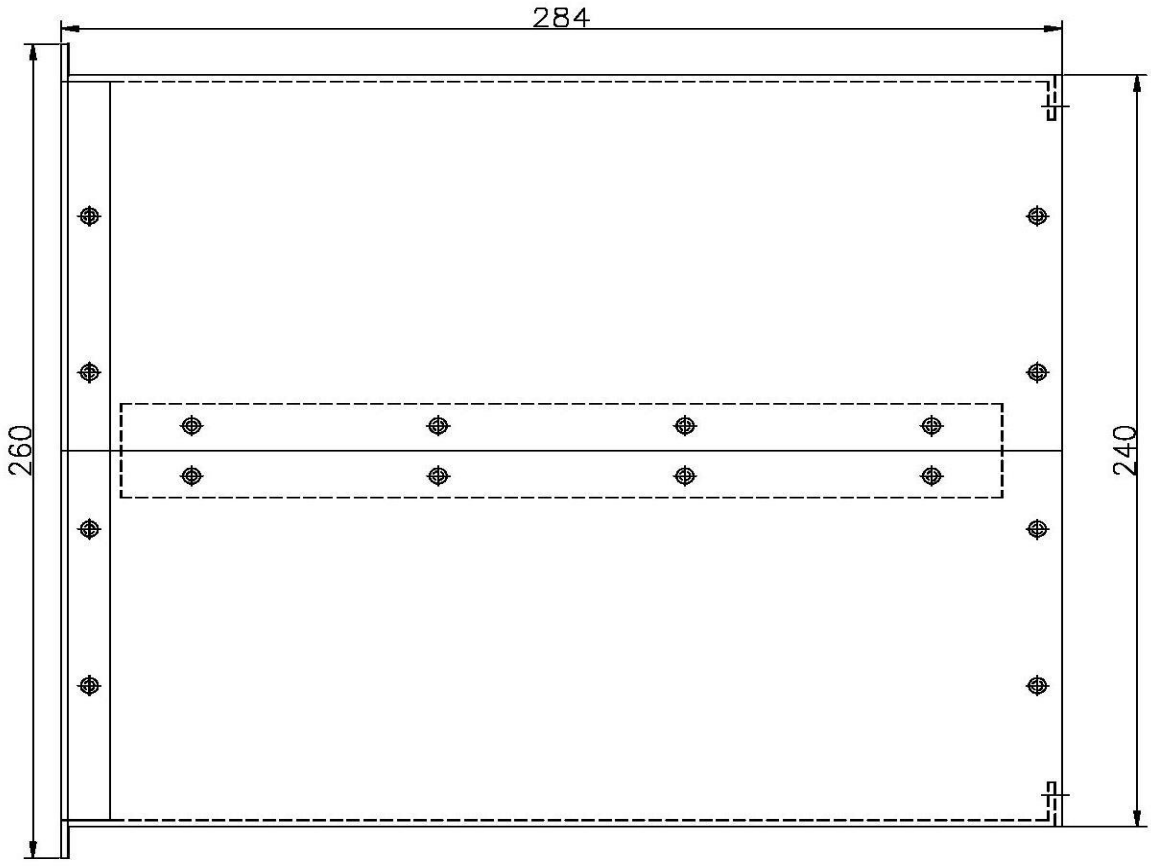
RELAY AND RACK MOUNTING



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
Relays Division

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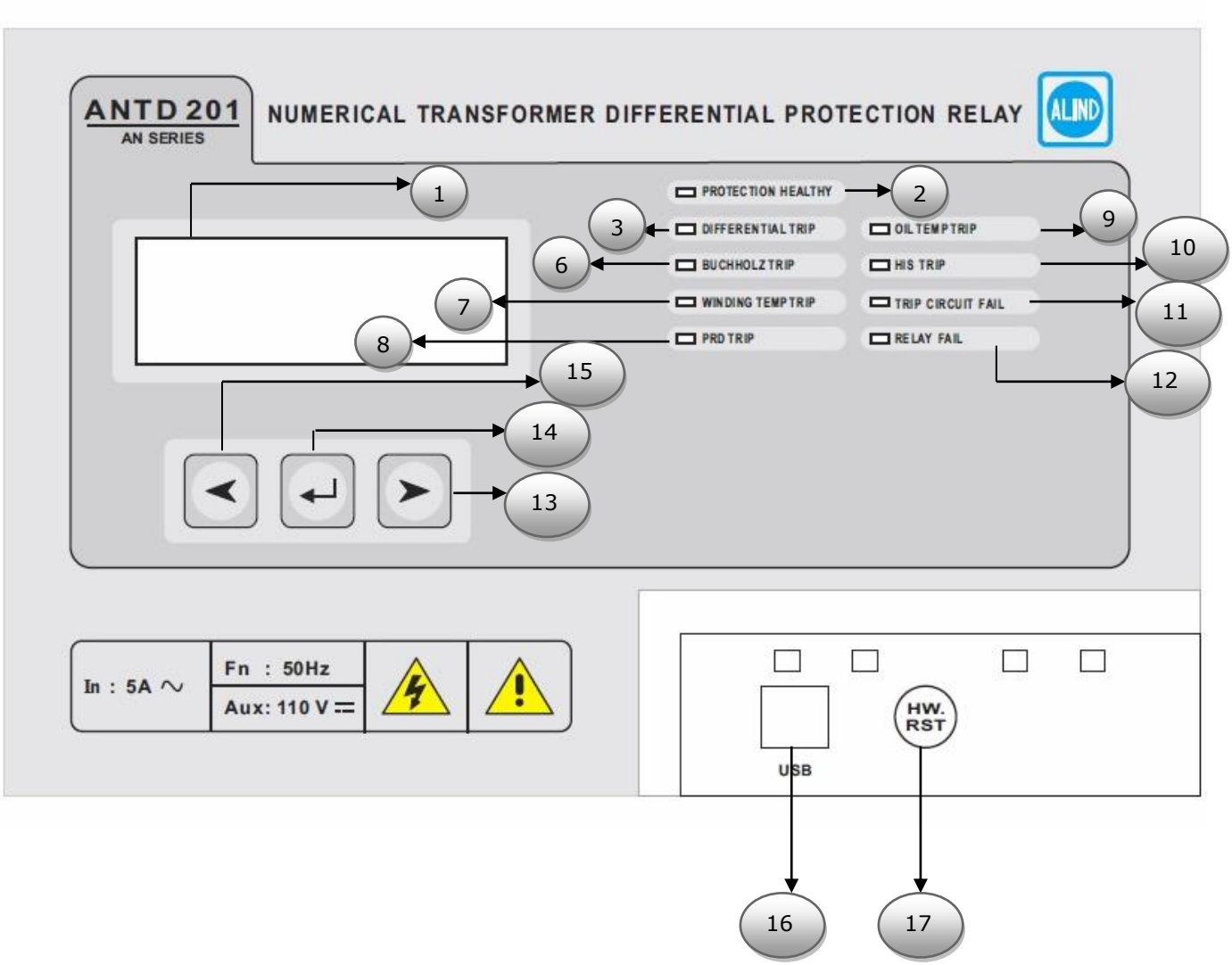
FRONT PANEL INDICATIONS



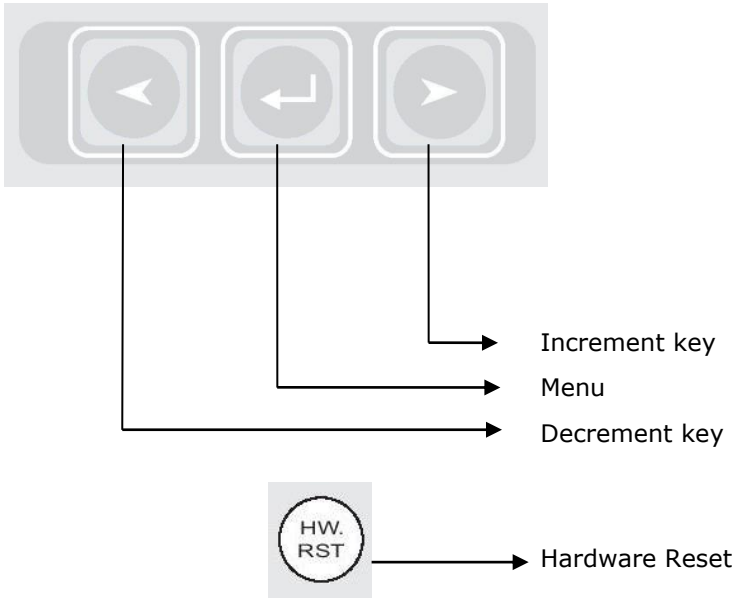
No	Legend	ANTD 201	ANTD 401
1	LCD DISPLAY	✓	✓
2	PROTECTION HEALTHY (Green/Amber)	✓	✓
3	DIFFERENTIAL TRIP (Red)	✓	✓
4	DIFFERENTIAL TRIP - TEASER (Red)		✓
5	DIFFERENTIAL TRIP – MAIN (Red)		✓
6	BUCHHOLZ TRIP (Red)	✓	✓
7	WINDING TEMP TRIP (Red)	✓	✓
8	PRD TRIP (Red)	✓	✓
9	OIL TEMP TRIP (Red)	✓	✓
10	HIS TRIP (Red)	✓	✓
11	TRIP CKT FAIL (Red)	✓	✓
12	RELAY FAIL (Red)	✓	✓
13	**>**	✓	✓
14	↵	✓	✓
15	**<**	✓	✓
16	USB	✓	✓
17	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

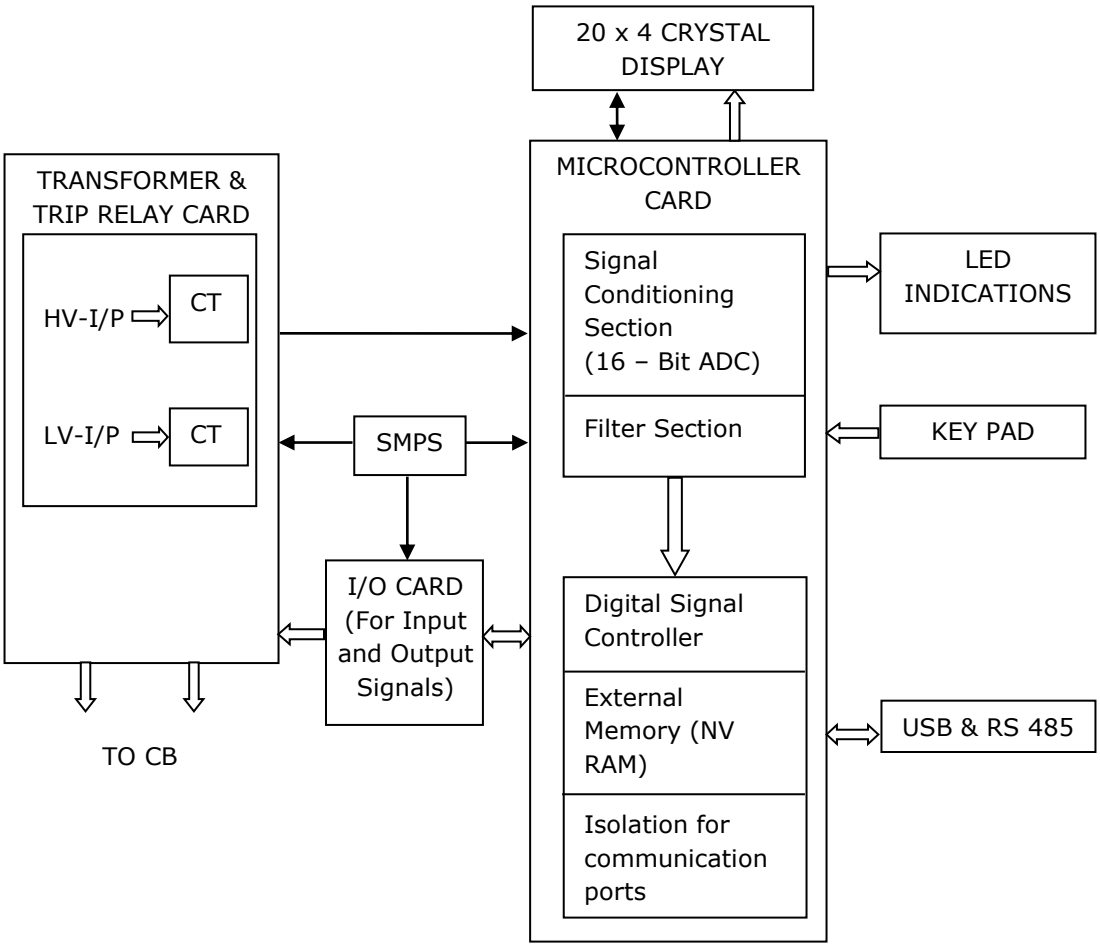
The relay is provided with four switches.



INTERNAL ARCHITECTURE AND BLOCK DIAGRAM

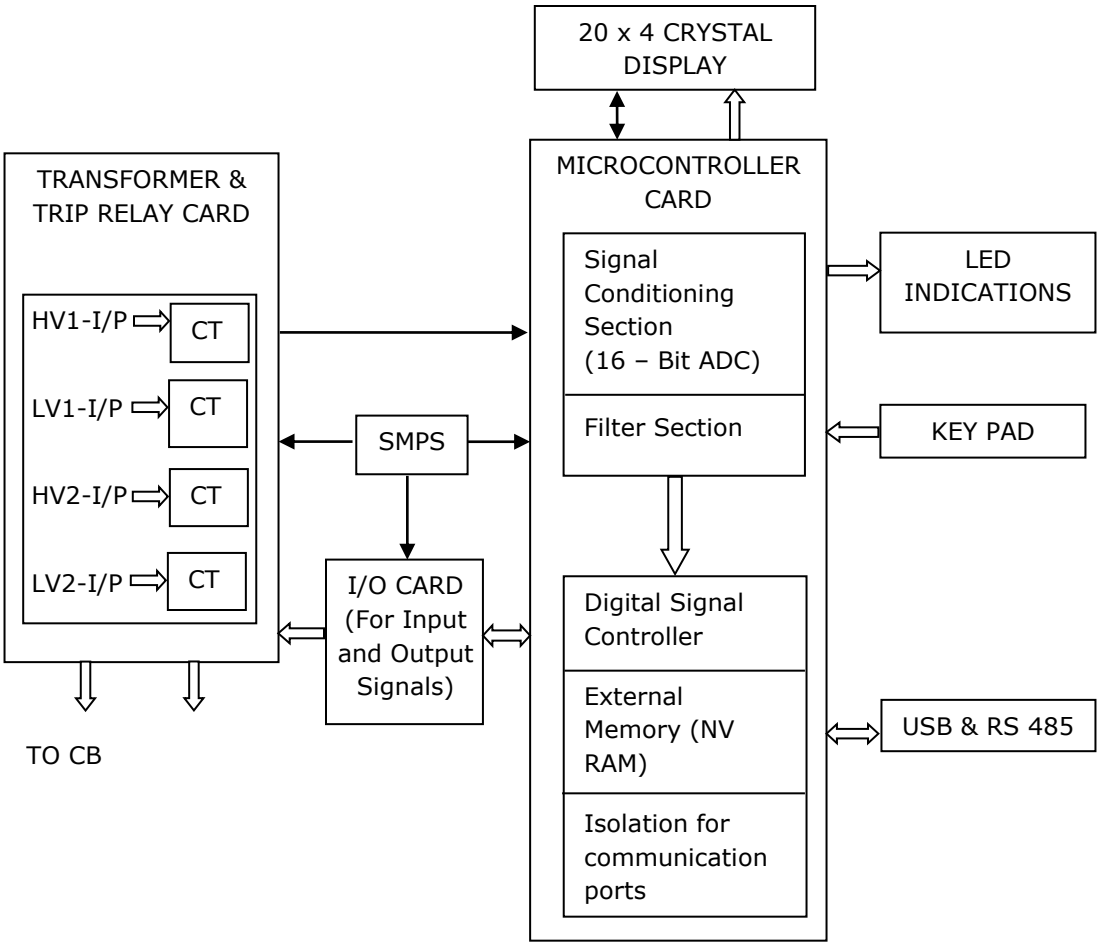
INTERNAL SYSTEM LEVEL ARCHITECTURE- ANTD 201

The internal system level architecture of ANTD 201 relay including card to card architecture in brief is shown below.



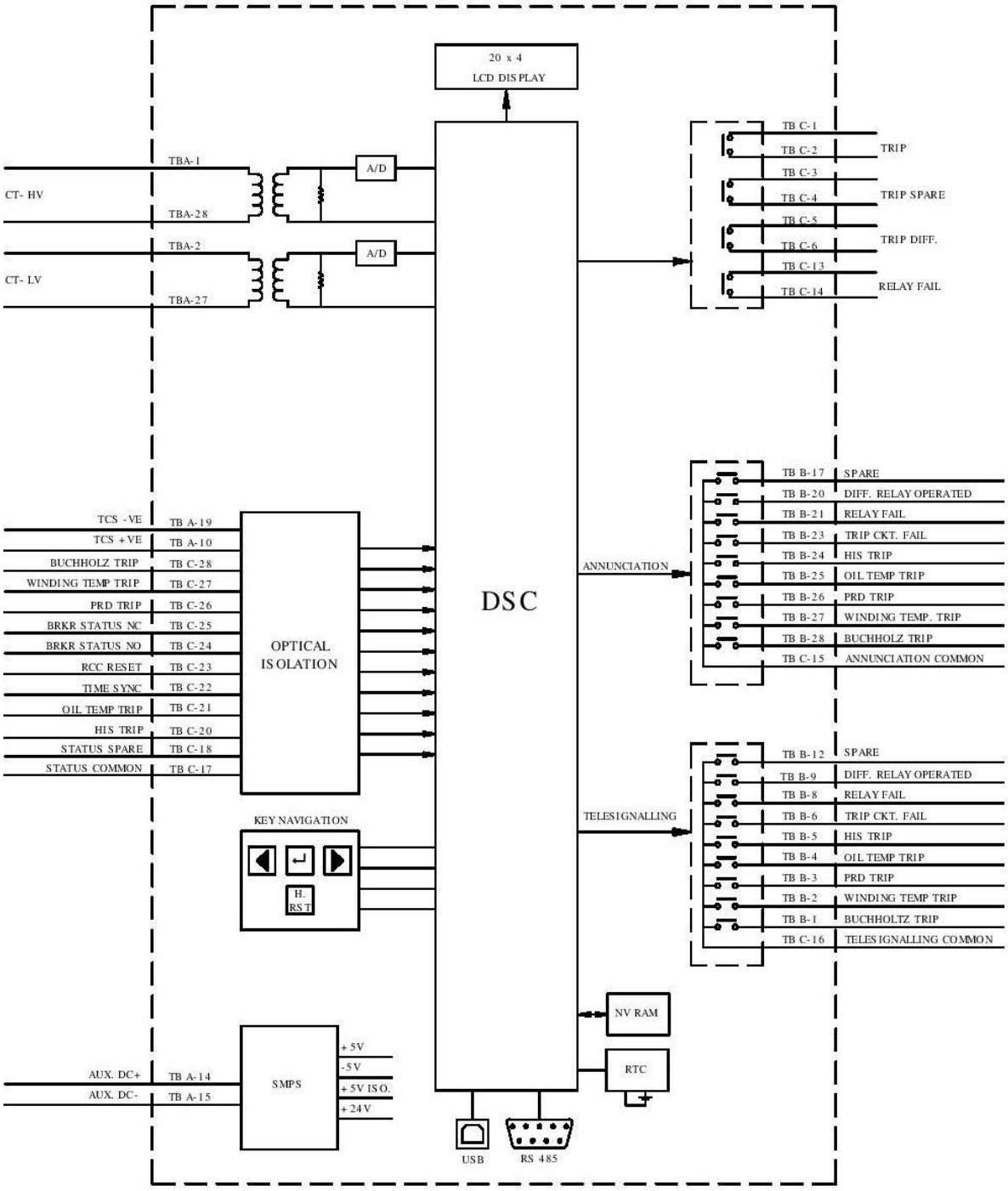
INTERNAL SYSTEM LEVEL ARCHITECTURE- ANTD 401

The internal system level architecture of ANTD 401 relay including card to card architecture in brief is shown below.

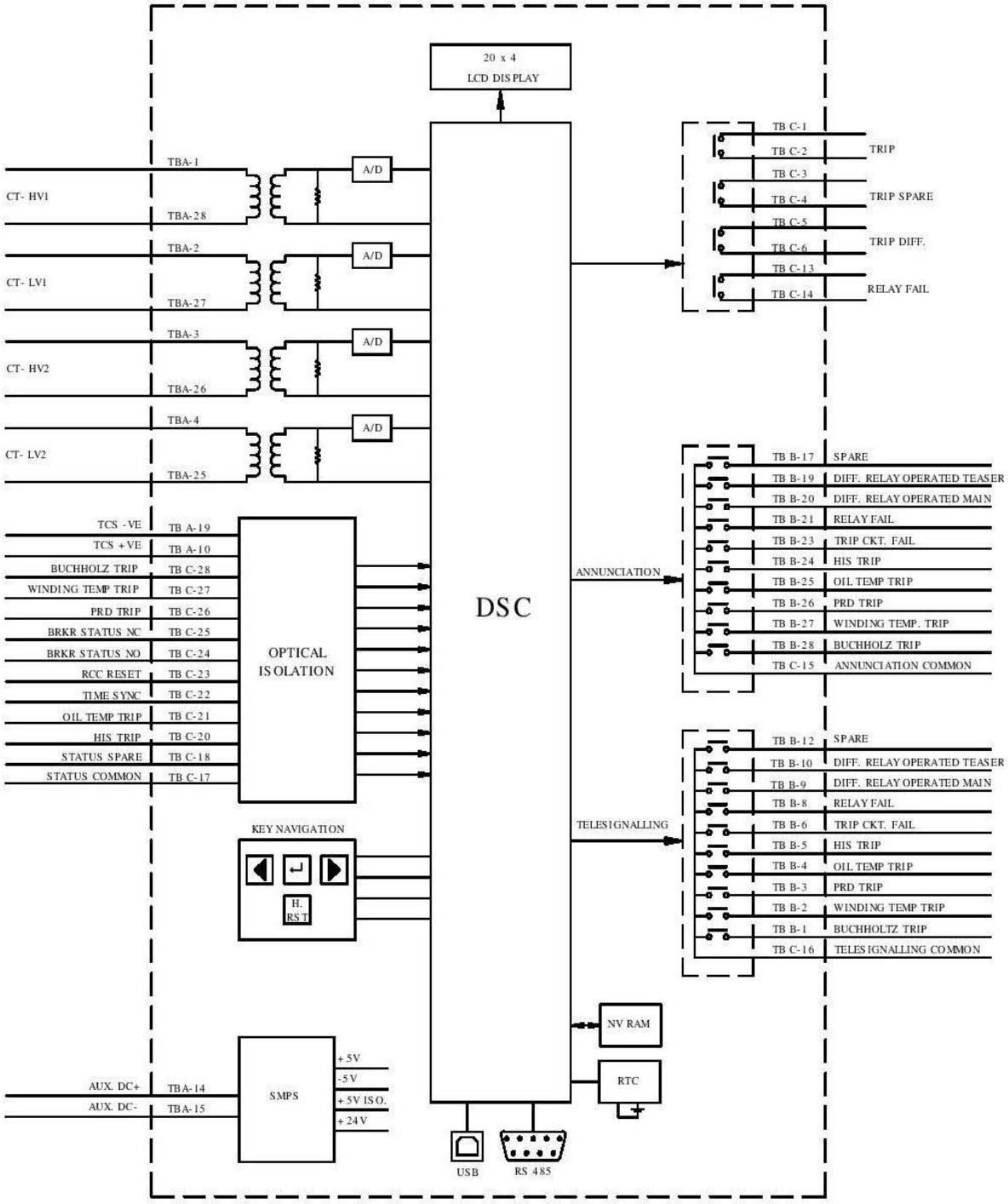


BLOCK DIAGRAM

ANTD 201



ANTD 401


20 x 4
LCD DISPLAY
DSC
A/D
A/D
A/D
A/D
CT- HV1
CT- LV1
CT- HV2
CT- LV2
TBA-1
TBA-28
TBA-2
TBA-27
TBA-3
TBA-26
TBA-4
TBA-25
TCS -VE
TCS +VE
BUCHHOLZ TRIP
WINDING TEMP TRIP
PRD TRIP
BRKR STATUS NC
BRKR STATUS NO
RCC RESET
TIME SYNC
OIL TEMP TRIP
HIS TRIP
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-20
TB C-18
TB C-17
OPTICAL ISOLATION
KEY NAVIGATION
H. RST
AUX. DC+
AUX. DC-
TBA-14
TBA-15
SMPS
+5V
-5V
+5V ISO.
+24V
USB
RS 485
NV RAM
RTC
TB C-1
TB C-2
TB C-3
TB C-4
TB C-5
TB C-6
TB C-13
TB C-14
TRIP
TRIP SPARE
TRIP DIFF.
RELAY FAIL
ANNUNCIATION
TB B-17
TB B-19
TB B-20
TB B-21
TB B-23
TB B-24
TB B-25
TB B-26
TB B-27
TB B-28
TB C-15
SPARE
DIFF. RELAY OPERATED TEASER
DIFF. RELAY OPERATED MAIN
RELAY FAIL
TRIP CKT. FAIL
HIS TRIP
OIL TEMP TRIP
PRD TRIP
WINDING TEMP. TRIP
BUCHHOLZ TRIP
ANNUNCIATION COMMON
TELESIGNALLING
TB B-12
TB B-10
TB B-9
TB B-8
TB B-6
TB B-5
TB B-4
TB B-3
TB B-2
TB B-1
TB C-16
SPARE
DIFF. RELAY OPERATED TEASER
DIFF. RELAY OPERATED MAIN
RELAY FAIL
TRIP CKT. FAIL
HIS TRIP
OIL TEMP TRIP
PRD TRIP
WINDING TEMP TRIP
BUCHHOLTZ TRIP
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 and voltages. Based on this the controller performs different calculations and whenever an abnormal condition occurs it distinguishes the type of fault and issues trip command to the circuit breaker.

2. Data Acquisition

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

The analog signals are then fed to the Analog to Digital Converter which has a 16 bit resolution. The DSP controller will take the 32 samples per cycles of each Current 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 & RS485 communication ports using UI software and SCADA respectively.

7. Event Recorder & Disturbance Recorder

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

Tripping of different protection elements (I, 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.

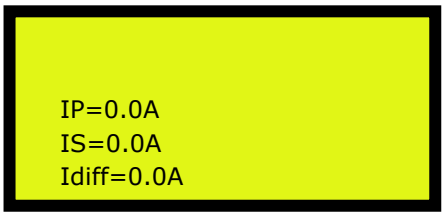
Communication PCB: This PCB is mounted on the front plate of the relay and it consists of USB port and H.RST (Hardware Reset Key).

RELAY SETTINGS AND ALGORITHM

ANTD 201

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

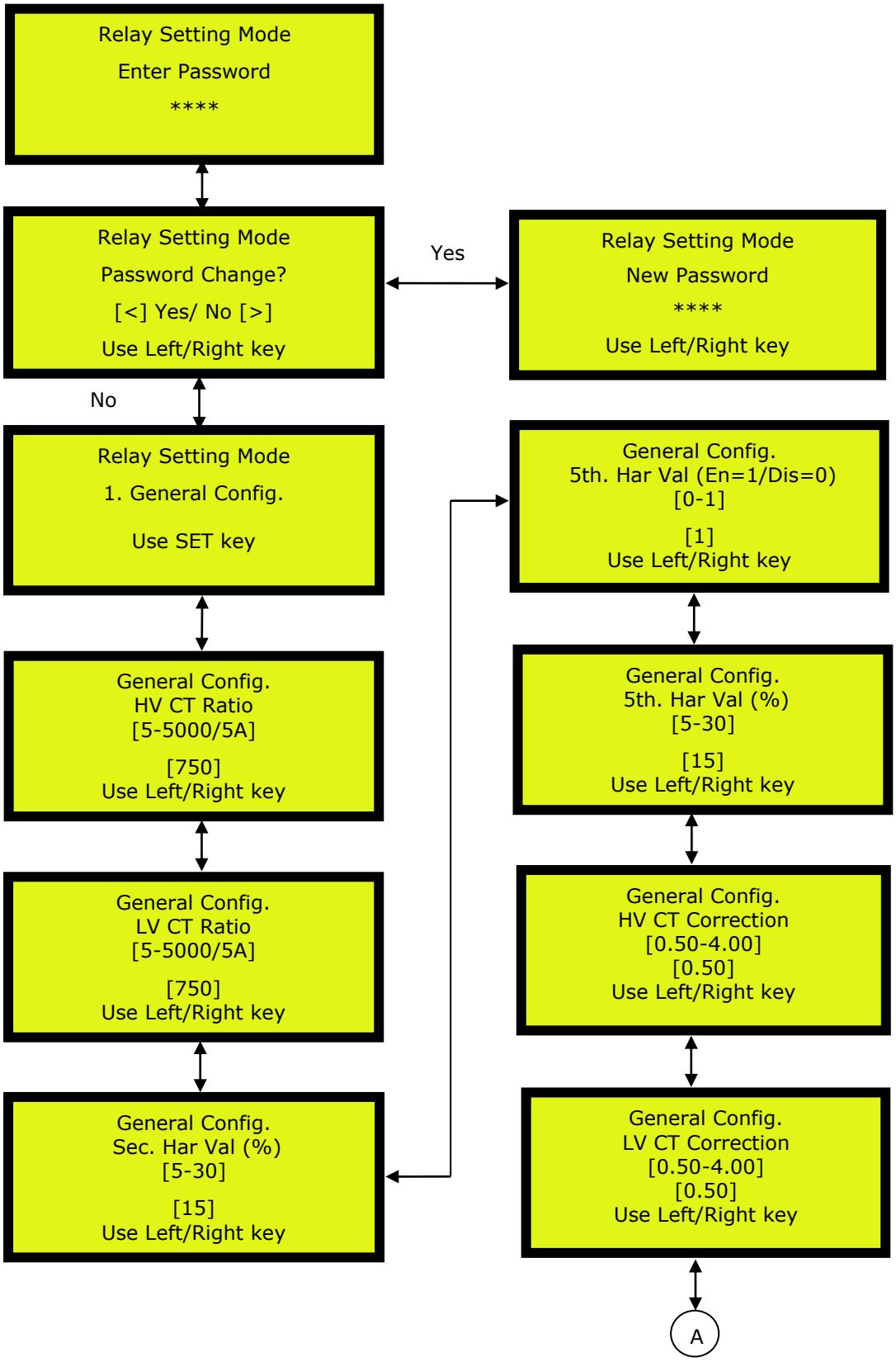
Relay will enter to setting mode.

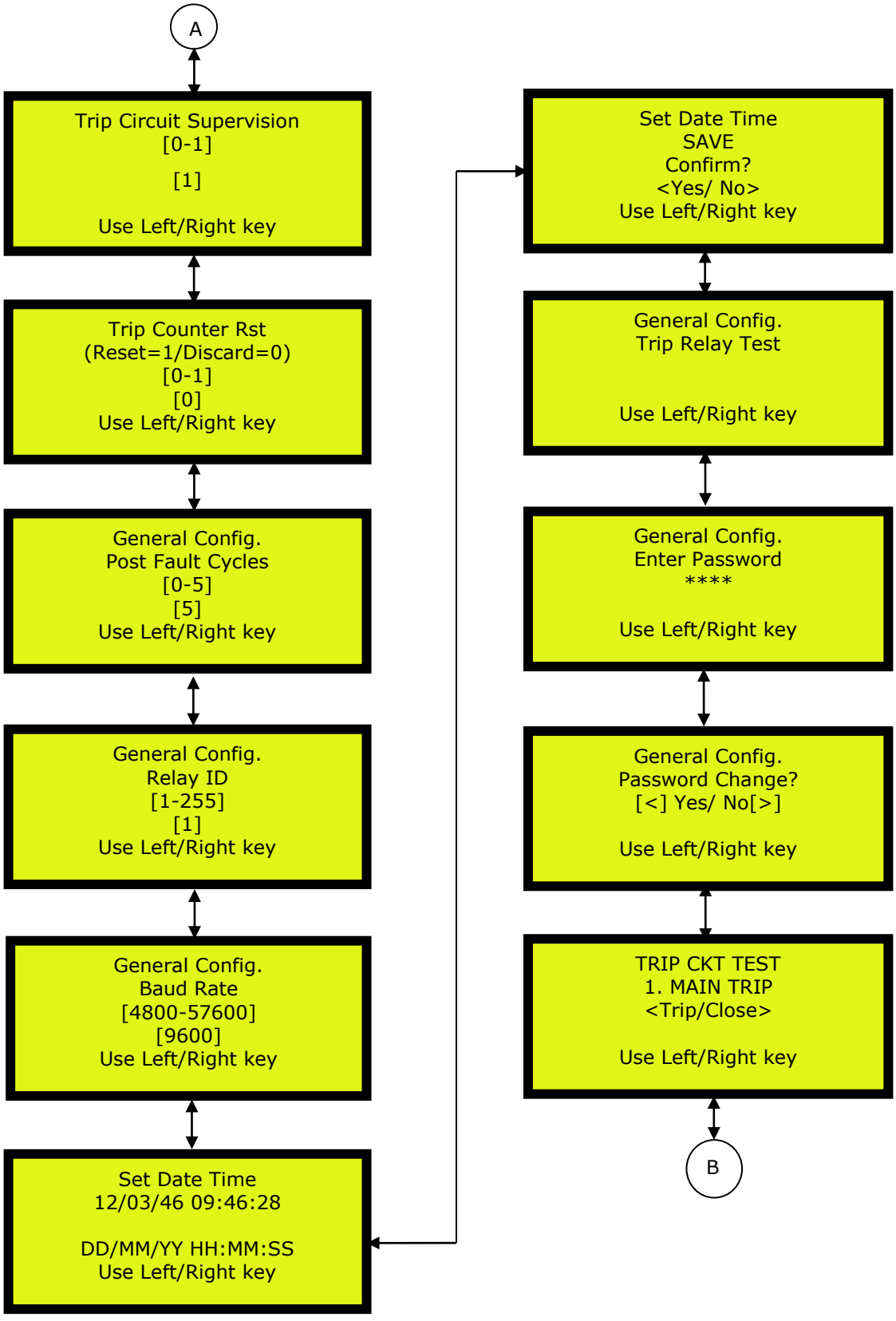
Enter the password and press ↵ key. The default password setting is '1000'

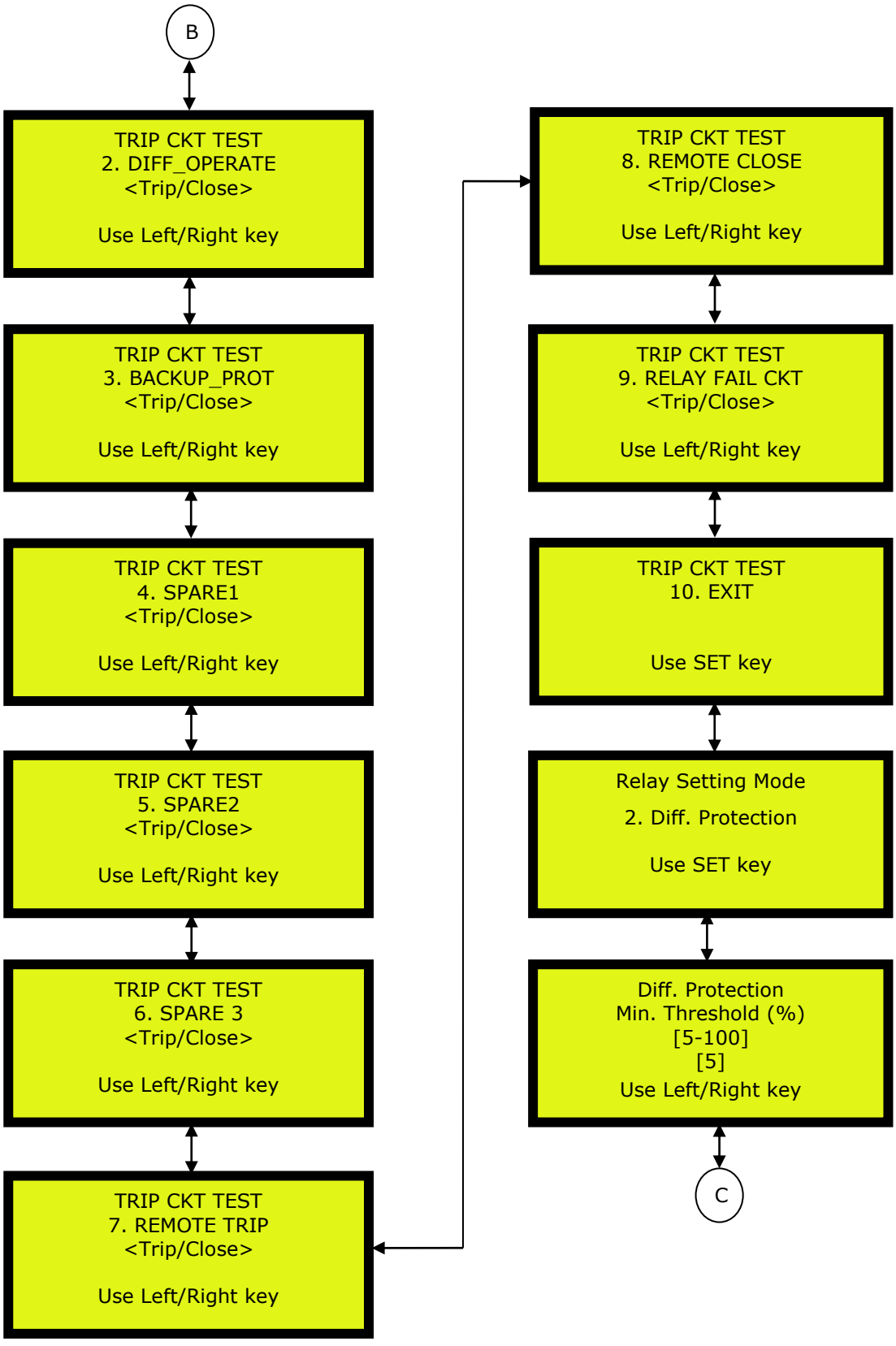
To change settings:

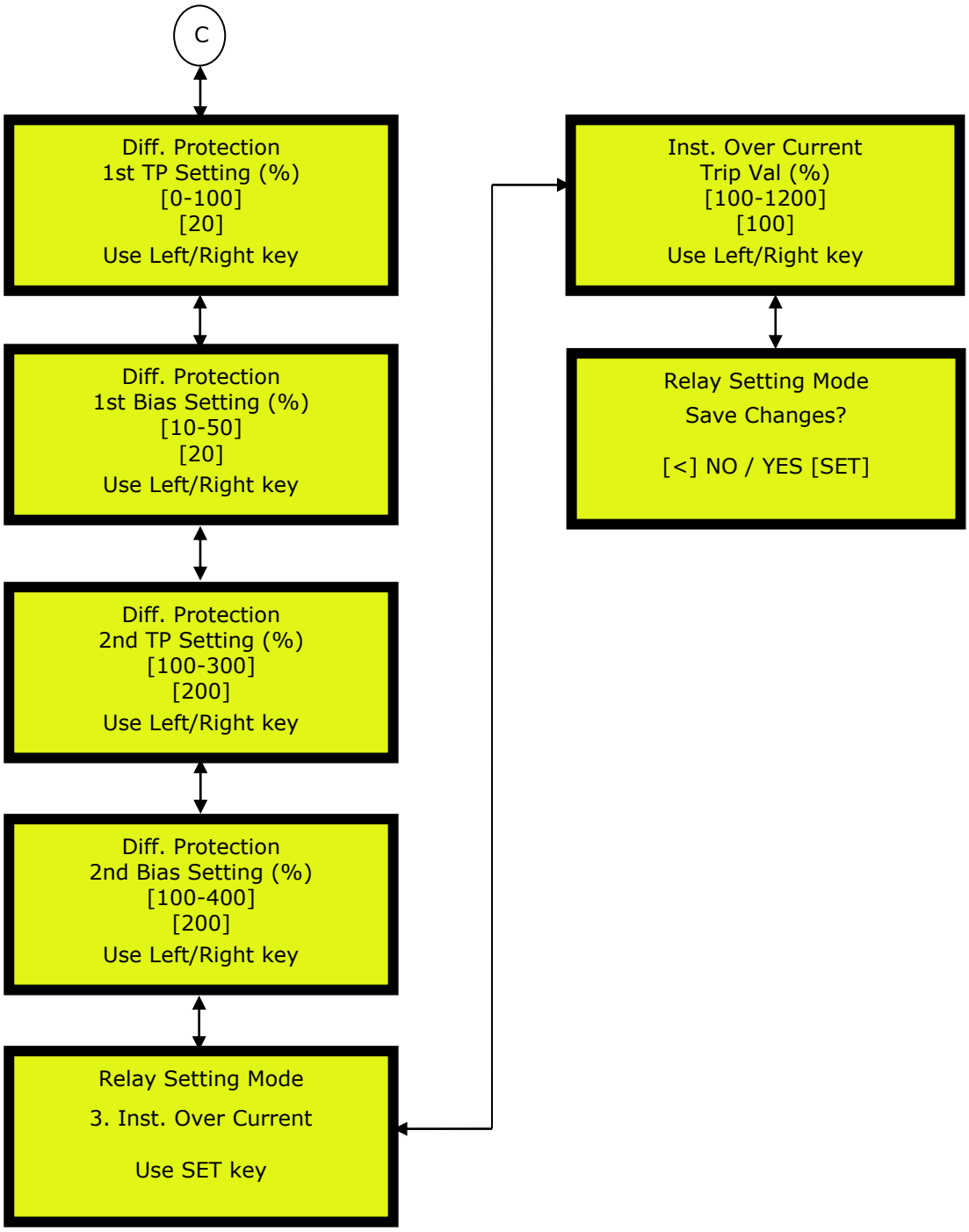
a) Press ↵ to change the settings.
b) Press **Right** key to increment
c) Press **Left** key to decrement
d) Press ↵ to accept change.
e) To coming back to main **MENU** while operating, press **Left** and **Right** key simultaneously.
f) Repeat the process for all settings
g) After completing the settings,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

Relay Settings Algorithm




A
Trip Circuit Supervision
[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
Set Date Time
12/03/46 09:46:28
DD/MM/YY HH:MM:SS
Use Left/Right key
Set Date Time
SAVE
Confirm?
<Yes/ No>
Use Left/Right key
General Config.
Trip Relay Test
Use Left/Right key
General Config.
Enter Password
****
Use Left/Right key
General Config.
Password Change?
[<] Yes/ No[>]
Use Left/Right key
TRIP CKT TEST
1. MAIN TRIP
<Trip/Close>
Use Left/Right key
B

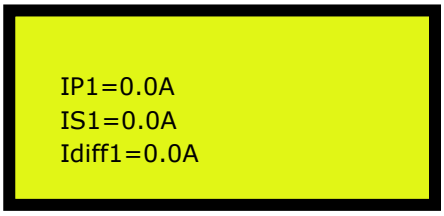

B
TRIP CKT TEST
2. DIFF_OPERATE
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
3. BACKUP_PROT
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
4. SPARE1
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
5. SPARE2
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
6. SPARE 3
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
7. REMOTE TRIP
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
8. REMOTE CLOSE
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
9. RELAY FAIL CKT
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
10. EXIT
Use SET key
Relay Setting Mode
2. Diff. Protection
Use SET key
Diff. Protection
Min. Threshold (%)
[5-100]
[5]
Use Left/Right key
C


C
Diff. Protection
1st TP Setting (%)
[0-100]
[20]
Use Left/Right key
Diff. Protection
1st Bias Setting (%)
[10-50]
[20]
Use Left/Right key
Diff. Protection
2nd TP Setting (%)
[100-300]
[200]
Use Left/Right key
Diff. Protection
2nd Bias Setting (%)
[100-400]
[200]
Use Left/Right key
Relay Setting Mode
3. Inst. Over Current
Use SET key
Inst. Over Current
Trip Val (%)
[100-1200]
[100]
Use Left/Right key
Relay Setting Mode
Save Changes?
[<] NO / YES [SET]

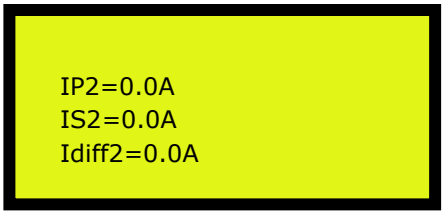
ANTD 401

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

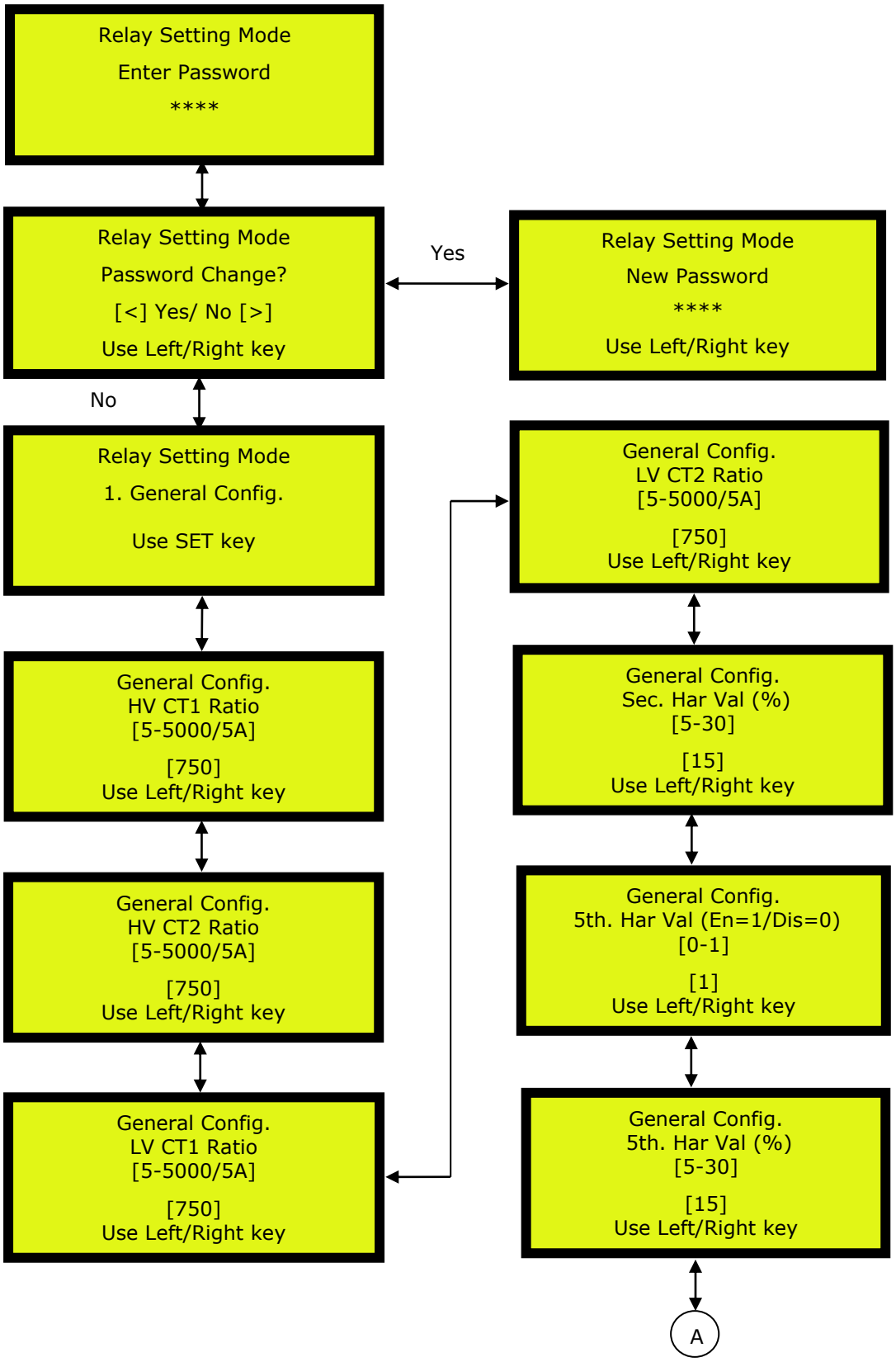
Relay will enter to setting mode.

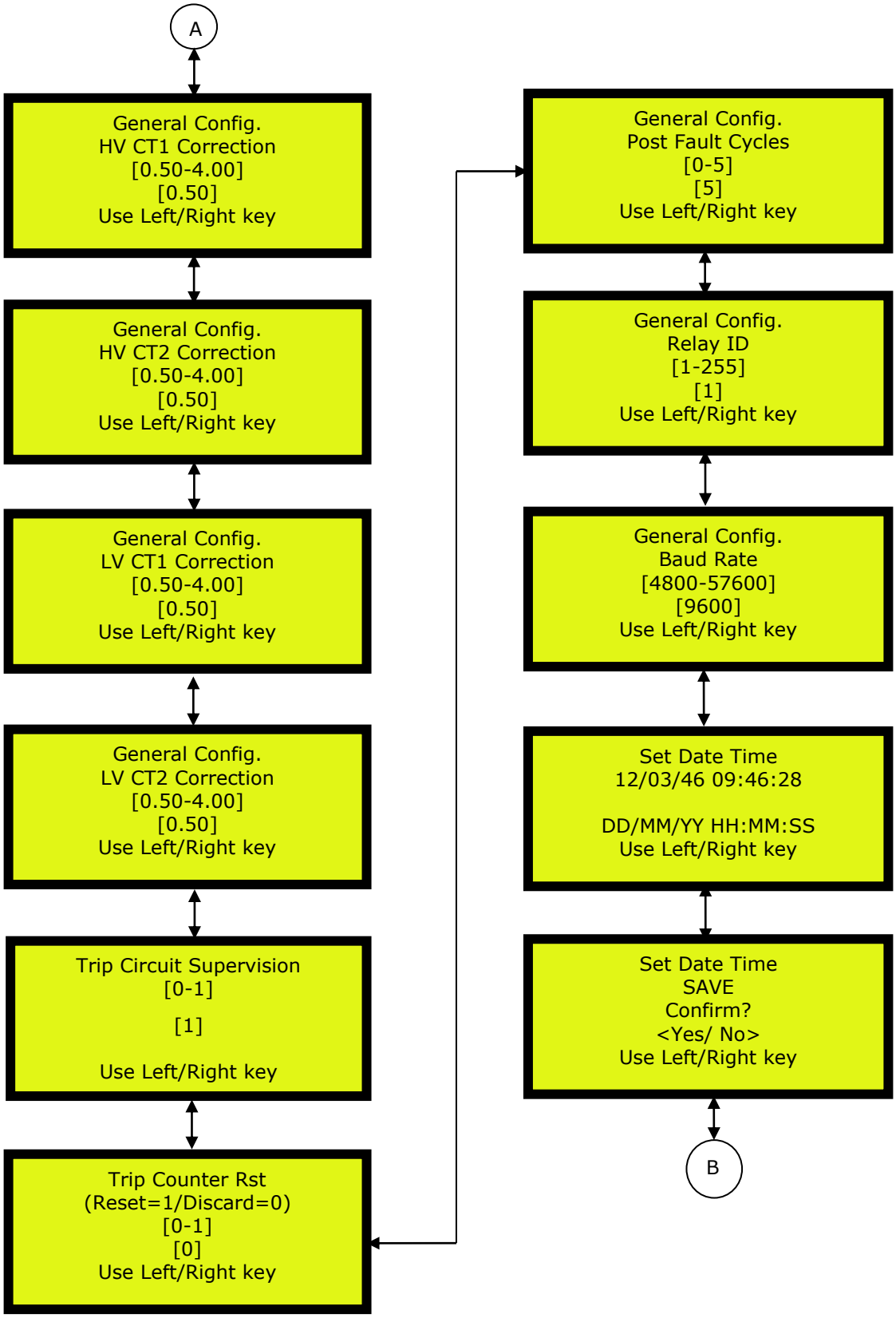
Enter the password and press ↵ key. The default password setting is '1000'

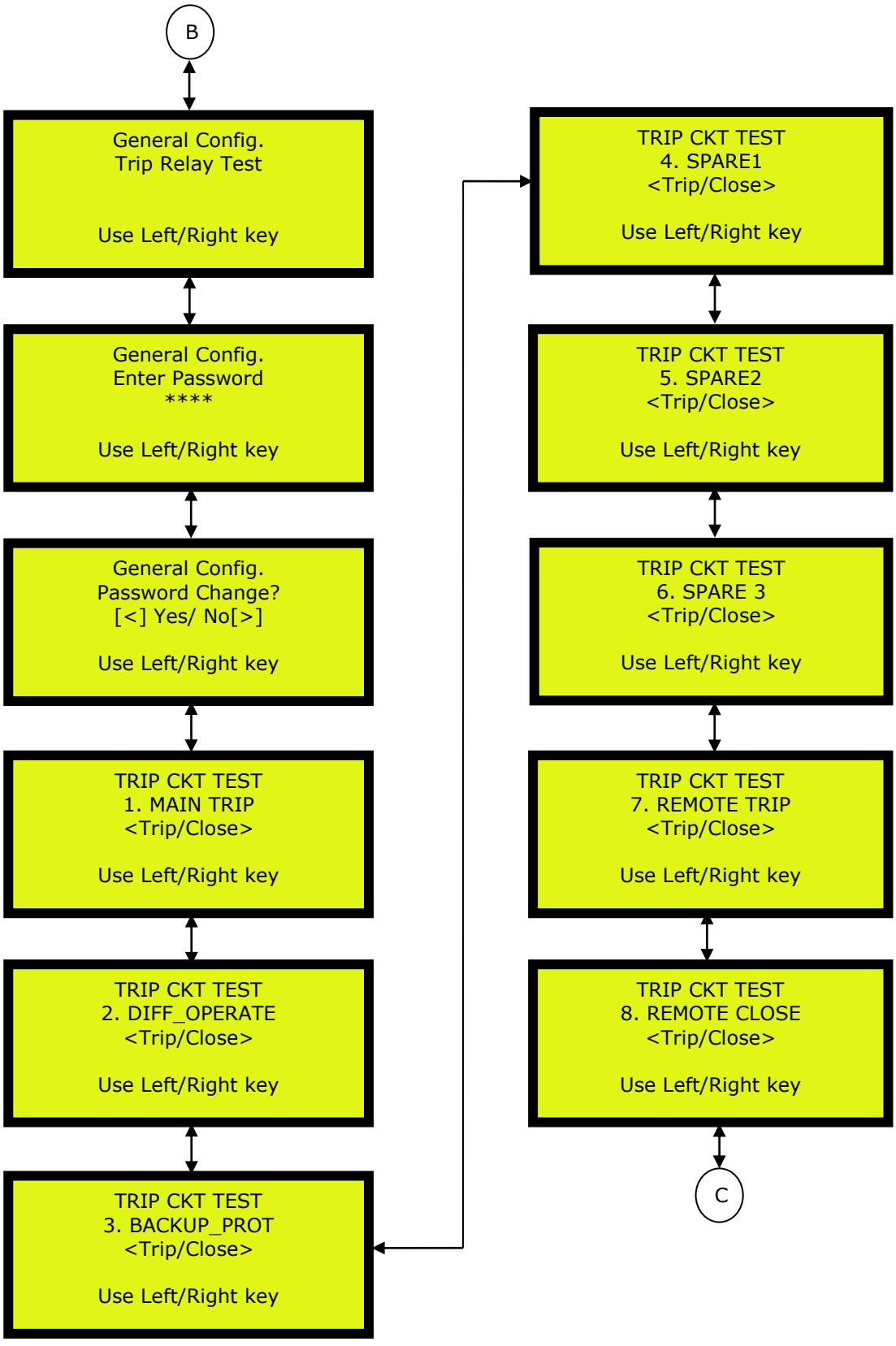
To change settings:

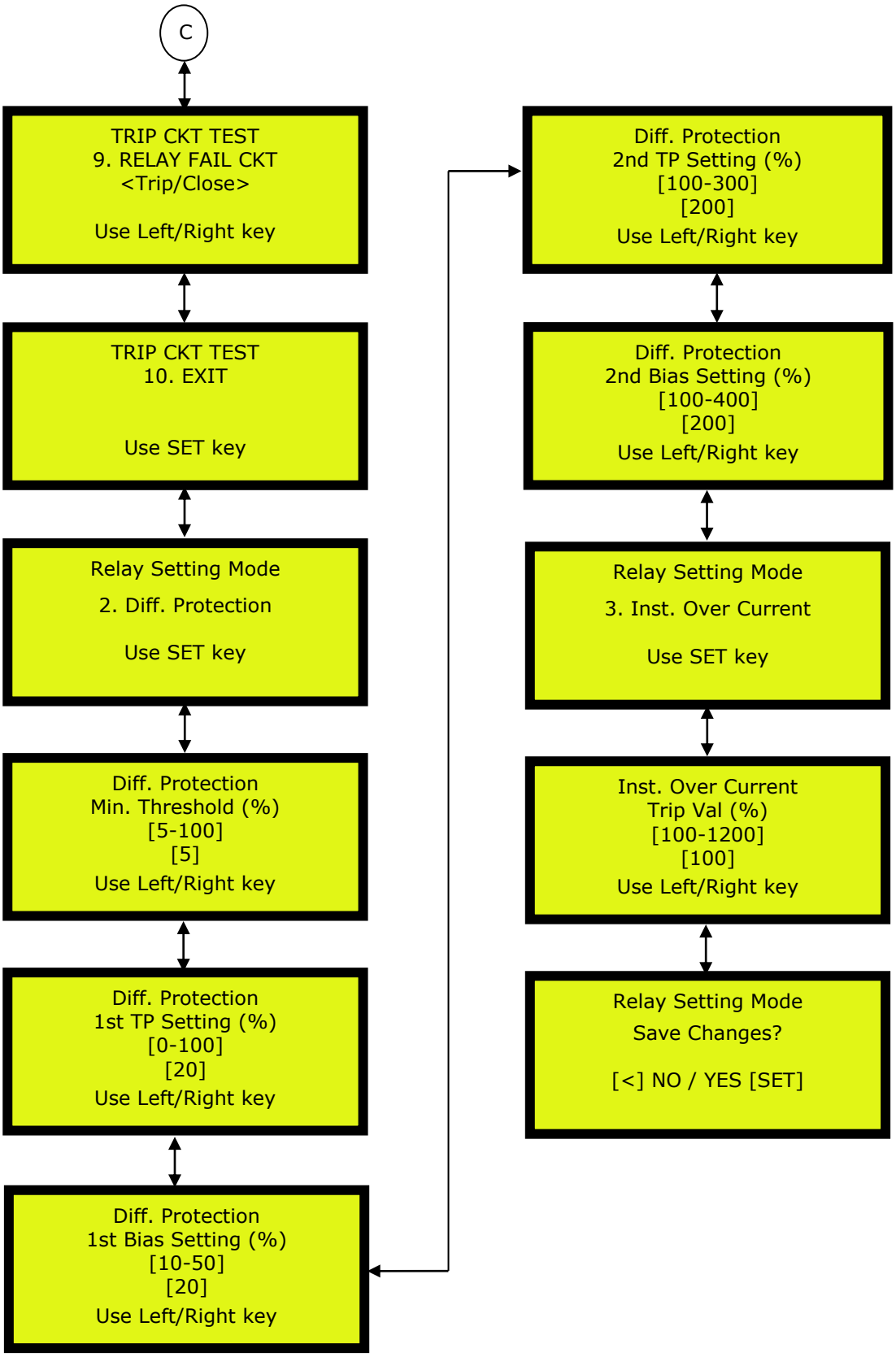
a) Press ↵ to change the settings.
b) Press **Right** key to increment
c) Press **Left** key to decrement
d) Press ↵ to accept change.
e) To coming back to main **MENU** while operating, press **Left** and **Right** key simultaneously.
f) Repeat the process for all settings
g) After completing the settings,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

Relay Settings Algorithm




A
General Config.
HV CT1 Correction
[0.50-4.00]
[0.50]
Use Left/Right key
General Config.
HV CT2 Correction
[0.50-4.00]
[0.50]
Use Left/Right key
General Config.
LV CT1 Correction
[0.50-4.00]
[0.50]
Use Left/Right key
General Config.
LV CT2 Correction
[0.50-4.00]
[0.50]
Use Left/Right key
Trip Circuit Supervision
[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
Set Date Time
12/03/46 09:46:28
DD/MM/YY HH:MM:SS
Use Left/Right key
Set Date Time
SAVE
Confirm?
<Yes/ No>
Use Left/Right key
B


B
General Config.
Trip Relay Test
Use Left/Right key
General Config.
Enter Password
****
Use Left/Right key
General Config.
Password Change?
[<] Yes/ No[>]
Use Left/Right key
TRIP CKT TEST
1. MAIN TRIP
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
2. DIFF_OPERATE
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
3. BACKUP_PROT
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
4. SPARE1
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
5. SPARE2
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
6. SPARE 3
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
7. REMOTE TRIP
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
8. REMOTE CLOSE
<Trip/Close>
Use Left/Right key
C


C
TRIP CKT TEST
9. RELAY FAIL CKT
<Trip/Close>
Use Left/Right key
TRIP CKT TEST
10. EXIT
Use SET key
Relay Setting Mode
2. Diff. Protection
Use SET key
Diff. Protection
Min. Threshold (%)
[5-100]
[5]
Use Left/Right key
Diff. Protection
1st TP Setting (%)
[0-100]
[20]
Use Left/Right key
Diff. Protection
1st Bias Setting (%)
[10-50]
[20]
Use Left/Right key
Diff. Protection
2nd TP Setting (%)
[100-300]
[200]
Use Left/Right key
Diff. Protection
2nd Bias Setting (%)
[100-400]
[200]
Use Left/Right key
Relay Setting Mode
3. Inst. Over Current
Use SET key
Inst. Over Current
Trip Val (%)
[100-1200]
[100]
Use Left/Right key
Relay Setting Mode
Save Changes?
[<] NO / YES [SET]

TECHNICAL DATA & CHARACTERISTIC CURVES

ALUMINIUM INDUSTRIES LIMITED
Relays Division

CONTENTS

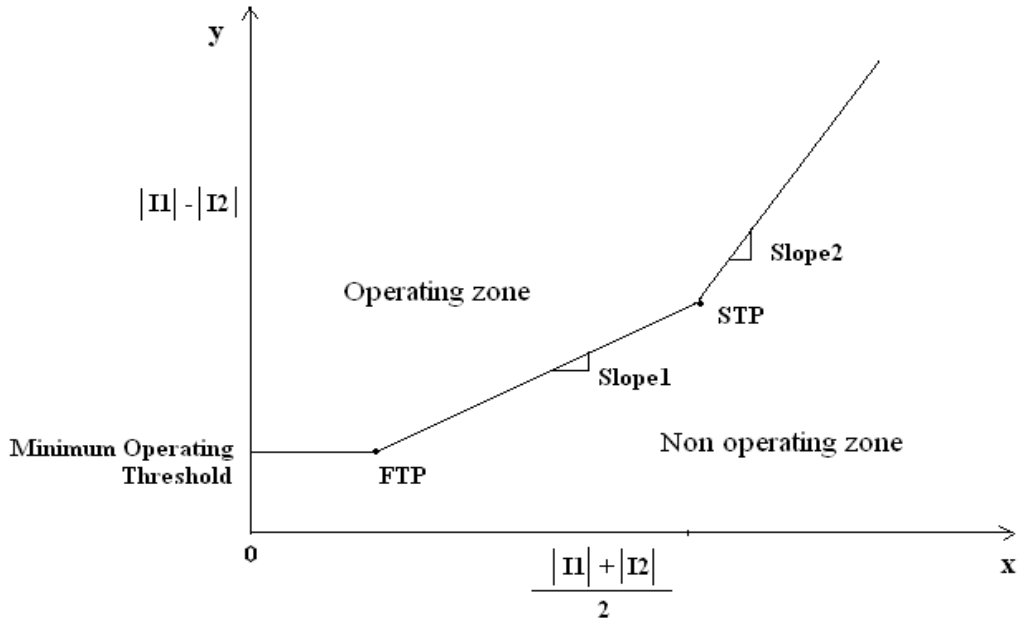
DESCRIPTION OF PROTECTION FUNCTIONS

The basic principle of operation involves the comparison of currents at the terminal of the unit to be protected. The relay measures the HV current (I1) and LV current (I2) of the Transformer through the bushing CTs and calculates the Differential current ΔI (I1- I2) and the bias current ((I1+ I2)/2). The relay is having dual slope characteristics with bias setting. The relay provide trip command when

$$|I1 - I2| \geq S|(I1 + I2)/2|$$

Where S = set bias

Bias Characteristics:



Where FTP – First Turning point

STP – Second Turning point

TECHNICAL SPECIFICATIONS

Sl. No	Specification	REF.	Particulars
1.	**Auxiliary Supply**	V_{DC}	45 to 170 VDC
2.	**Current Input(rated)**	In	5 Amps
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 CT**		3In; 15A
9.	**Thermal Withstand for CT**		40In for 1 sec
10.	**Contact details**		
	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 i) AC 220V, 50-60Hz, Cos Ø=0.4 ii) DC 220V, L/R= 45ms		 5A 0.5A
11.	**Trip Circuit Test**		Yes / No
12.	**Type of communication ports**		USB and RS485
13.	**Overall dimensions** Width Height Depth		 263 mm 173 mm 330 mm
14.	**Weight**		6.9 kg approx.

RELAY SETTINGS

ANTD 201

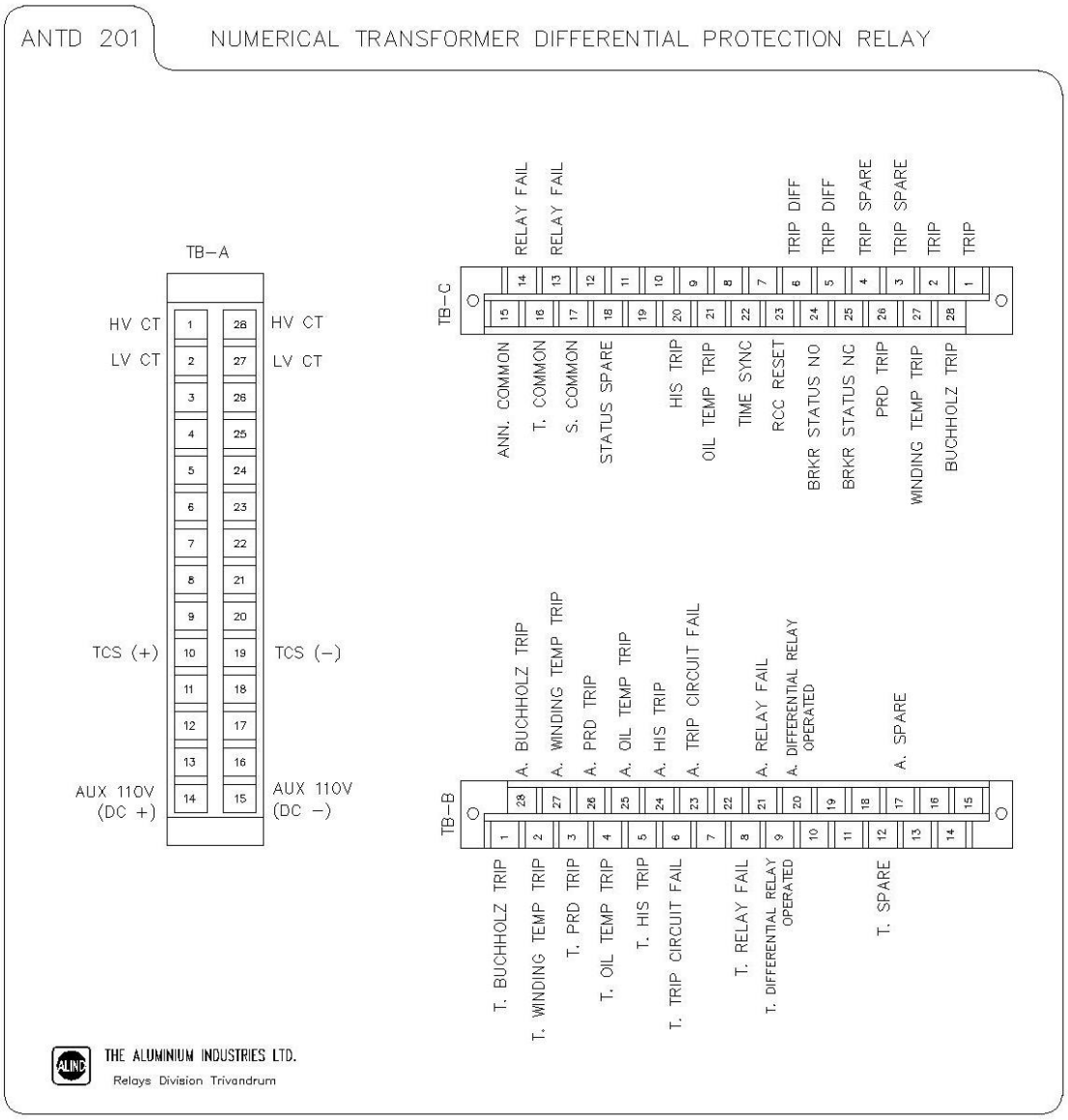
General Settings	Particulars
Password protection (YES/NO)	**0000-9999**
1. General Config.	
HV CT Primary	5-5000 in steps of 5A
LV CT Primary	5-5000 in steps of 5A
Second Harmonics value	5-30% in steps of 1%
Fifth Harmonics (EN/DIS)	
Fifth Harmonics value	5-30% in steps of 1%
HV CT correction factor	0.50-4.00 in steps of 0.01
LV CT correction factor	0.50-4.00 in steps of 0.01
Trip Circuit Supervision (EN/DIS)	
Trip counter reset (Reset/Discard)	
Post fault cycles	0 to 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/YYYY HH:MM:SS
Trip Relay Test	
2. Diff. Protection	
i) Min threshold value	5-100% in steps of 1%
ii) 1st TP setting	0-100% in steps of 1%
iii) 1st Bias setting	10-50% in steps of 1%
iv) 2nd TP setting	100-300% in steps of 10%
v) 2nd Bias setting	100-400% in steps of 100%
3. Instantaneous Over Current Protection	
Trip value	100-1200% in steps of 100%
Operating Time	
i) Differential Protection	30 +/- 10 mSec
ii) Instantaneous OCR Protection	Less than 22 ms

ANTD 401

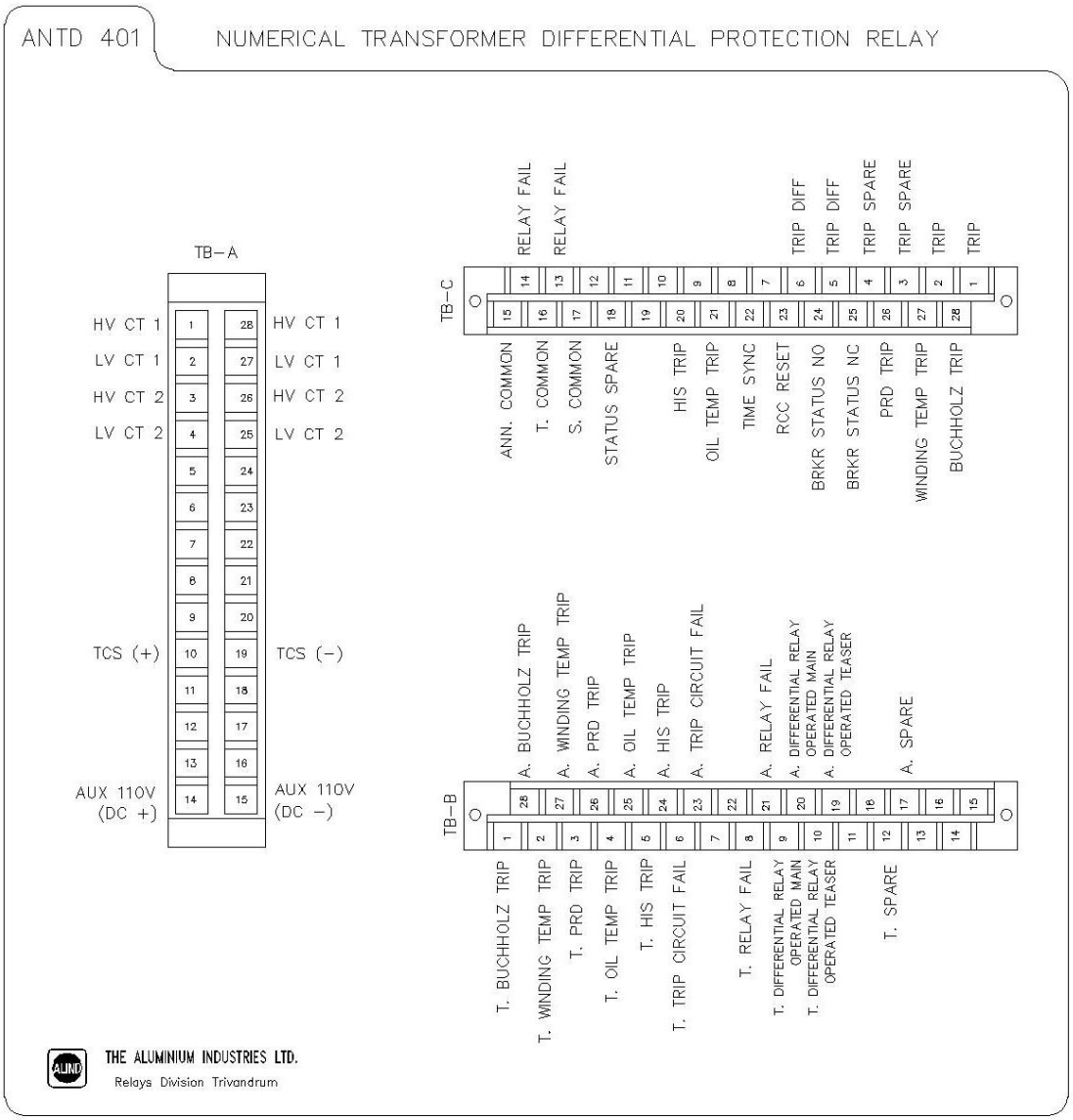
General Settings	Particulars
Password protection (YES/NO)	**0000-9999**
1.General Configuration	
HV CT Ratio	5-5000/5A in steps of 5A
LV CT Ratio	5-5000/5A in steps of 5A
Second Harmonics value	5-30% in steps of 1%
Fifth Harmonics (EN/DIS)	
Fifth Harmonics value	5-30% in steps of 1%
HV CT correction factor	0.50-4.00 in steps of 0.01
LV CT correction factor	0.50-4.00 in steps of 0.01
Trip Circuit Supervision (Enable=1/Disable=0)	
Trip counter reset (Reset=1/Discard=0)	
Post fault cycles	0 to 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/YYYY HH:MM:SS
Trip Relay Test	
2. Diff. Protection	
i) Min threshold value	5-100% in steps of 1%
ii) 1st TP setting	0-100% in steps of 1%
iii) 1st Bias setting	10-50% in steps of 1%
iv) 2nd TP setting	100-300% in steps of 10%
v) 2nd Bias setting	100-400% in steps of 100%
3. Instantaneous Over Current Protection	
Trip value	100-1200% in steps of 100%
Operating Time	
i) Differential Protection	30 +/- 10 mSec
ii) Instantaneous OCR Protection	Less than 22 ms

TB DETAILS

ANTD 201



ANTD 401


ANTD 401
NUMERICAL TRANSFORMER DIFFERENTIAL PROTECTION RELAY
TB–A
HV CT 1
LV CT 1
HV CT 2
LV CT 2
TCS (+)
AUX 110V (DC +)
TCS (–)
AUX 110V (DC –)
TB–C
ANN. COMMON
T. COMMON
S. COMMON
STATUS SPARE
HIS TRIP
OIL TEMP TRIP
TIME SYNC
RCC RESET
BRKR STATUS NO
BRKR STATUS NC
PRD TRIP
WINDING TEMP TRIP
BUCHHOLZ TRIP
RELAY FAIL
RELAY FAIL
TRIP DIFF
TRIP DIFF
TRIP SPARE
TRIP SPARE
TRIP
TRIP
TB–B
T. BUCHHOLZ TRIP
T. WINDING TEMP TRIP
T. PRD TRIP
T. OIL TEMP TRIP
T. HIS TRIP
T. TRIP CIRCUIT FAIL
T. RELAY FAIL
T. DIFFERENTIAL RELAY OPERATED MAIN
T. DIFFERENTIAL RELAY OPERATED TEASER
T. SPARE
A. BUCHHOLZ TRIP
A. WINDING TEMP TRIP
A. PRD TRIP
A. OIL TEMP TRIP
A. HIS TRIP
A. TRIP CIRCUIT FAIL
A. RELAY FAIL
A. DIFFERENTIAL RELAY OPERATED MAIN
A. DIFFERENTIAL RELAY OPERATED TEASER
A. SPARE
THE ALUMINIUM INDUSTRIES LTD.
Relays Division Trivandrum

SETTING GUIDELINES

The biasing and operating current setting of the numerical type differential protection relay should be calculated as follows:

(a) The percentage biased setting should be so chosen that the relay remains inoperative on differential currents resulting from (1) tap changing of traction transformer, (2) mismatch in CT ratios and (3) difference in CT saturation levels under through fault conditions. Percentage mismatches resulting from factors (1) and (2) may be calculated from actual data and an allowance of 7.5 to 15% may be made for factor (3).

(b) The operating current setting may be taken as 40%. If mal operations of the relay are observed on through faults and magnetizing inrush (switching in of power transformer), a higher setting may be considered.

Calculation of ICT multiplication factor setting

This factor is used to neutralize the effect of transformer bushing CTs ratio corresponding to transformer primary and secondary rated current, as the output current (CT secondary) shall be same to avoid the mal function during normal operating condition. The ICT multiplication factor individually for HV & LV shall be calculated by formula given below:

$$\text{ICT multiplication factor} = \frac{5 \times \text{Bushing CT ratio}}{\text{Transformer rated current in Amp}}$$

Bias & operating current setting calculation

Calculate the transformer HV current at lowest tap position i.e. -15%

$$= \frac{\text{Rated transformer MVA} * 1000}{\text{(Rated primary voltage in kV} - 15\% \text{ of rated primary voltage)}} \text{ Amp}$$

$$\text{Current read by relay} = \frac{\text{HV current at lowest tap in amp} * \text{ICT multiplication factor}}{\text{HV bushing CT ratio}}$$

Spill over Current in amp = Current read by relay – 5

$$\text{Percentage differential bias current} = \frac{\text{Spill over current in amp} * 100}{(\text{Current read by relay} + 5) / 2}$$

To allow the relay and CT errors, the % differential current further increased by a factor of 1.25.

The operating current shall be set at 40% of transformer rated current.

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 (Sinusoidal)
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

Under normal working conditions, the 'PROTECTION HEALTHY LED' provided in the front panel of the relay glows green. The same LED turns amber to recognize any fault inside the relay itself.

Following are certain guidelines for the relay to identify the nature of fault and necessary checking procedures to be adopted at site so that relay can be rectified suitably.

Sl. No.	Faults	Checks	Causes
1.	No power ON Indication or No display.	1. Check the auxiliary DC supply to the relay rear terminals TB A-14: +110VDC TB A-15: -110VDC 2. Check the continuity of the output terminal, after disconnecting the wires.	1. Due to power supply failure, the LED turns off. 2. The varistor may short circuit 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.

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

TYPE – ANTD 201

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 **ANTD 201** for communication with a controlling system. The IEC 60870-5 Tele-control Companion Standard TMW Test harness test set can be used as a communication protocol for exchanging information between Control Centre(s) (controlling station) and their substations (controlled station(s)). The information exchanged can be for status messages and commands.

3. LINK LAYER AND PHYSICAL CONNECTION

IEC 60870-5-2 offers a selection of link transmission procedures using a control field and the optional address field. Links between stations may be operated in either an unbalanced or a balanced transmission mode. Appropriate function codes for the control field are specified for both modes of operation. If the links from a central control station (controlling station) to several outstations (controlled stations) share a common physical channel, then these links must be operated in an unbalanced mode to avoid the possibility of more than one outstation attempting to transmit on the channel at the same time. The sequence in which the various outstations are granted access to transmit on the channel is then determined by an application layer procedure in the controlling station. The companion standard specifies whether an unbalanced or a balanced transmission mode is used, together with which link procedures (and corresponding link function codes) are to be used. The companion standard specifies an unambiguous address (number) for each link. Each address may be unique within a specific system, or it may be unique within a group of links sharing a common channel. The latter needs a smaller address field but requires the controlling station to map addresses by channel number.
The protocol uses frames and these frames contain octets that are transmitted as least significant first, without idle time. If transmission have been performed between Master and the Slave the slave will respond to the message with Link status Acknowledgement.

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

4. SYSTEM OR DEVICE CONFIGURATION

A Controlled station definition is used in this companion standard.

4.1 PHYSICAL LAYER

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

4.1.2 ELECTRICAL INTERFACE

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

4.1.3 TRANSMISSION SPEED

Supported Standard transmission speed;

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

4.2 LINK LAYER

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

4.3 APPLICATION LAYER

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

4.4 TRANSMISSION MODE FOR APPLICATION DATA

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

4.5 COMMON ADDRESS OF ASDU

One octet is used in this companion standard.

4.6 INFORMATION OBJECT ADDRESS

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

4.7 CAUSE OF TRANSMISSION

One octet is used in this companion standard.

4.8 LENGTH OF APDU

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

5. PROTOCOL MAPPING

SYSTEM FUNCTIONS IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
End of general interrogation	-	8	255	0	10	GLB
Time synchronization	-	6	255	0	8	GLB
Reset FCB	-	5	176	2	3	According to main FUN
Reset CU	-	5	176	3	4	According to main FUN

STATUS INDICATION IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Protection Healthy/Active	-	1	176	18	1	↑
LED Reset	-	1	176	19	1	↑
Local Parameter Settings (Change)	-	1	176	22	1	↑
Buchholz Trip	X	1	176	27	1,9	↑↓
Oil Temp Trip	X	1	176	28	1,9	↑↓
Winding Temp Trip	X	1	176	29	1,9	↑↓
PRD TRIP	X	1	176	30	1,9	↑↓
HIS Closed	X	1	176	38	1,9	↑↓
CB NC (FDR CB OPEN)	X	1	176	124	1,9	↑↓
CB NO (FDR CB CLOSE)	X	1	176	125	1,9	↑↓
Relay Fail	-	1	176	40	1	↑

SUPERVISION INDICATIONS IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Trip circuit supervision	X	1	176	36	1,9	↑↓

FAULT INDICATION IN (MONITOR DIRECTIONS)

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Start/Pickup Diff: Relay	X	2	178	64	1,9	↑↓
Start/Pickup INST. OCR	X	2	178	65	1,9	↑↓
Differential Relay Operated	-	2	176	69	1	↑↓
INST.OCR Trip	-	2	176	90	1	↑↓

MEASURAND IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Measurand supervision (HV CT)	-	9	176	148	2	↑↓
Measurand supervision (LV CT)	-	9	176	148	2	↑↓

TIME TAGED MEASURAND IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
HV-Fault Current – I	-	4	176	141	1	↑↓
LV-Fault Current – I	-	4	176	142	1	↑↓
Differential Current – I	-	4	176	143	1	↑↓

STANDARD INFORMATION NUMBERS IN CONTROL DIRECTION

SYSTEM FUNCTIONS IN CONTROL DIRECTION

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

GENERAL COMMANDS IN CONTROL DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
RCC RESET(Made as standard)	-	20	176	19	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 ANTD 201

ANTD 201		
FUN	**ACC**	**PARAMETER**
176	**1**	**Ip1**
176	**2**	**Is1**
176	3	x
176	4	x
176	5	x
176	6	x
176	7	x
176	8	x

9. DIGITAL CHANNEL (TAGS) INFORMATION IN ANTD 201

ANTD 201			
TAG POSSITION	**FUN/INF NUMBER**	**SEMANTICS ACCORDING TO TAG POSSITION**	**INPUT/ OUTPUT**
0	**176/84**	**GENERAL PICKUP**	**OUTPUT**
1	**176/68**	**GENERAL TRIP**	**OUTPUT**
2	**176/69**	**DIFFERENTIAL RELAY OPERATED**	**OUTPUT**
3	**176/90**	**INST. OCR TRIP**	**OUTPUT**
4	**176/38**	**HIS TRIP - LOG I/P - 1**	**INPUT**
5	**176/28**	**OIL TEMP TRIP - LOG I/P - 2**	**INPUT**
6	**255/0**	**TIME SYNC - LOG I/P - 3**	**INPUT**
7	**176/19**	**RCC RESET - LOG I/P - 4**	**INPUT**
8	**176/124**	**CB NC (OPEN) - LOG I/P - 5**	**INPUT**
9	**176/125**	**CB NO (CLOSE) - LOG I/P - 6**	**INPUT**
10	**176/30**	**PRD TRIP - LOG I/P - 7**	**INPUT**
11	**176/29**	**WINDING TEMP. TRIP - LOG I/P - 8**	**INPUT**
12	**176/27**	**BUCHHOLZ TRIP - LOG I/P - 9**	**INPUT**
13	**176/36**	**TRIP CIRCUIT FAIL - LOG I/P - 10**	**INPUT**

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

TYPE – ANTD 401

DESIGNED AS PER RDSO SPECIFICATION NO.
TI/SPC/PSI/PROTCT/7100 (07/4012)

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 **ANTD 401** 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	176	2	3	According to main FUN
Reset CU	-	5	176	3	4	According to main FUN
Reset CU/Start/Restart	-	5	176	4	5	According to main FUN

STATUS INDICATION IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Protection Healthy/Active	-	1	176	18	1	↑
LED Reset	-	1	176	19	1	↑
Local Parameter Settings (Change)	-	1	176	22	1	↑
Buchholz Trip	X	1	176	27	1,9	↑↓
Oil Temp Trip	X	1	176	28	1,9	↑↓
Winding Temp Trip	X	1	176	29	1,9	↑↓
PRD TRIP	X	1	176	30	1,9	↑↓
HIS Closed	X	1	176	38	1,9	↑↓
CB NC (FDR CB OPEN)	X	1	176	124	1,9	↑↓
CB NO (FDR CB CLOSE)	X	1	176	125	1,9	↑↓
Relay Fail	-	1	176	40	1	↑

SUPERVISION INDICATIONS IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Trip circuit supervision	X	1	176	36	1,9	↑↓

FAULT INDICATION IN (MONITOR DIRECTIONS)

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Start/Pickup Diff: Relay 1	X	2	178	64	1,9	↑↓
Start/Pickup Diff: Relay 2	X	2	178	65	1,9	↑↓
Start/pickup INST. OCR 1	X	2	178	66	1,9	↑↓
Start/Pickup INST. OCR 2	X	2	178	67	1,9	↑↓
Differential Relay 1 Operated	-	2	176	69	1	↑↓
Differential Relay 2 Operated	-	2	176	70	1	↑↓
INST.OCR 1 Trip	-	2	176	90	1	↑↓
INST.OCR 2 Trip	-	2	176	91	1	↑↓

MEASURAND IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Measurands supervision (HV CT-1)	-	9	176	148	2	↑↓
Measurands supervision (LV CT-1)	-	9	176	148	2	↑↓
Measurands supervision (HV CT-2)	-	9	176	148	2	↑↓
Measurands supervision (LV CT-2)	-	9	176	148	2	↑↓

TIME TAGED MEASURAND IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
HV-1-Fault Current – I	-	4	176	141	1	↑↓
LV-1-Fault Current – I	-	4	176	142	1	↑↓
HV-2-Fault Current – I	-	4	176	143	1	↑↓
LV-1-Fault Current – I	-	4	176	144	1	↑↓
Differential Fault Current 1 – I	-	4	176	146	1	↑↓
Differential Fault Current 2 – I	-	4	176	147	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	176	19	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. The following ranges of TOO are used with the different ASDUs:

7. ANALOG CHANNEL INFORMATION IN ANTD 401

ANTD 401		
FUN	**ACC**	**PARAMETER**
176	**1**	**Ip1**
176	**2**	**Is1**
176	**3**	**Ip2**
176	**4**	**Is2**
176	5	x
176	6	x
176	7	x
176	8	x
176	64	x

8. DIGITAL CHANNEL (TAGS) INFORMATION IN ANTD 401

ANTD 401			
TAG POSSITION	**FUN/INF NUMBER**	**SEMANTICS ACCORDING TO TAG POSSITION**	**INPUT/ OUTPUT**
0	**176/84**	**GENERAL PICKUP**	**OUTPUT**
1	**176/68**	**GENERAL TRIP**	**OUTPUT**
2	**176/69**	**DIFF. RELAY 1 OPERATED**	**OUTPUT**
3	**176/70**	**DIFF. RELAY 2 OPERATED**	**OUTPUT**
4	**176/90**	**INST. OCR 1 - I> TRIP**	**OUTPUT**
5	**176/91**	**INST. OCR 2 - I> TRIP**	**OUTPUT**
6	**176/38**	**HIS TRIP - LOG I/P - 1**	**INPUT**
7	**176/28**	**OIL TEMP TRIP - LOG I/P - 2**	**INPUT**
8	**255/0**	**TIME SYNC - LOG I/P - 3**	**INPUT**
9	**176/19**	**RCC RESET - LOG I/P - 4**	**INPUT**
10	**176/124**	**CB NC (OPEN) - LOG I/P - 5**	**INPUT**
11	**176/125**	**CB NO (CLOSE) - LOG I/P - 6**	**INPUT**
12	**176/30**	**PRD TRIP - LOG I/P - 7**	**INPUT**
13	**176/29**	**WINDING TEMP. TRIP - LOG I/P - 8**	**INPUT**
14	**176/27**	**BUCHHOLZ TRIP - LOG I/P - 9**	**INPUT**
15	**176/36**	**TRIP CIRCUIT FAIL - LOG I/P - 10**	**INPUT**

TEST REPORT

ALUMINIUM INDUSTRIES LIMITED
Relays Division

TEST DETAILS

RELAY CHARACTERISTICS & OPERATING VALUE TEST

Operating Value Test

Pickup setting (%)	Operating Value (A)	Reset Value (A)	Error (%)
20% = 1.00A			
40% = 2.00A			
80% = 4.00A			

Allowable tolerance limit in operating value is ±5%

Relay biased characteristics test

a) Pickup = 30%, First turning point = 50%, first slope = 20%, second turning Point=150%, 2nd slope = 200% & Inst OCR= 600%

I1 (A)	I2 (Measured operating current in A)	I1-I2 (A)	I1+I2/2 (A)	Differential current from graph (A)	Error (%)
0				1.5	
2.75				1.5	
4.35				1.7	

Allowable tolerance limit in operating value is ±5%

Verification of ICT ratio multiplication factor

Pickup setting in %	ICT1 factor	Injected current (A)	Actual current (A)	Current read by relay (A)	Error (%)
60%=3A	1	2	2		
60%=3A	0.8	2	1.6		

Allowable tolerance limit in operating value is ±5%

Pickup setting in %	ICT2 factor	Injected current (A)	Actual current (A)	Current read by relay (A)	Error (%)
60%=3A	1.2	2	2.4		
60%=3A	1	2	2		

OPERATING TIME MEASURING TEST

Set pickup (%)	Injected current (A)	Operating Time (ms)
20% = 1A	2A	
40% = 2A	6A	

Operating time should be within 40 ms.

STATUS VERIFICATION

STATUS	STATUS INPUT	OUTPUT CONTACT VERIFICATION
WINDING TEMP TRIP	Short TB-C 27 &1 7	
PRD TRIP	Short TB- C 26 & 17	
HIS TRIP	Short TB- C 20 & 17	
BUCHHOLZ TRIP	Short TB- C 28 & 17	
OIL TEMP TRIP	Short TB- C 21 & 17	

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