Transformer Differential Protection Relay : A23R

Introduction:

ASHIDA has designed economical & reliable Multifunction A23R Protection & Control System. The simple and compact construction of ADITYA series A23R relay provides integrated Protection, Control and Monitoring functions for Transformer Protection.

A23R Transformer Differential Protection Relay specially designed for Scott-connected / V-Conncted Single-Phase Traction Transformer protection as per RDSO Specifications TI-SPC-PSI-PROTCT-7101.

Functional Overview:

Key Protection & Control Functions:

- Two Independent Settings Groups.
- Differential Protections (87T).
- Harmonic Blocking function.
- Programmable Inputs & Outputs.
- 16 nos. of Programmable & Target LEDs for indications with dual colours.
- Self Supervision of relay.
- Metering function.
- Event Recording (1024 nos.).
- Fault Recording on HMI display (10 nos.).
- Disturbance Recording (10 nos.)
- Fully communicable with IEC standard open protocol IE C60870-5-103, & IEC 61850.
- SCADA communication.
- Single/Dual Ethernet ports (RJ45), RS485 port.

- PC front port communication for convenient relay settings.
- User friendly local operation with key pad.
- Large Liquid crystal display (20X4) with backlight.
- Password Protection.
- Measurement of Current magnitudes.

Software Support:

- Online / Offline Setting Editor.
- Programmable scheme logic Editor.
- Settings upload / download.
- Online Measurement.
- Disturbance analysis.
- Relay assistant for testing relay at site.

Applications:

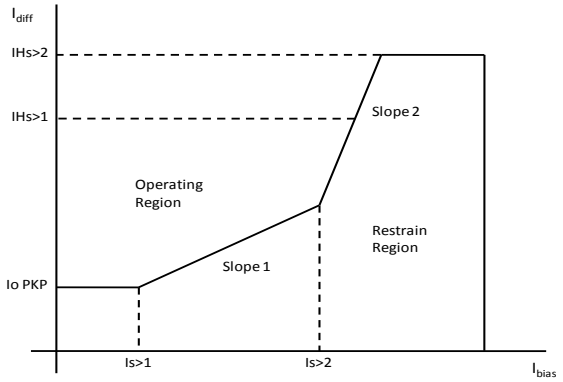
The A23R is second generation Numerical Integrated Transformer Protection Relay for AC Traction Transformer Application. It consist all the necessary protection and monitoring functions required for traction transformer.

The A23R provides protection for AC Traction Transformer Equipment and various electrical network and electrical installation.

Differential Protection Relay:

The A23R-M0 monitors HV and LV current of power transformer through respective CT. The sample current values are processed by DSP controller. It calculates RMS values of IHV and ILV phases. IHV represent HV current and ILV represent LV current. Relay measure amplitude and phase angle.

Normally to match HV and LV CT ratio ICT are needed. In A23R-M0 ICT ratio can be programmed. The relay CPU apply this ICT Scaling factor to measure IHV and ILV current. There are two separate ICT ratio are provided one for HV value and another for LV value. After this Scaling factor relay calculate operating and restraining signal from IHV and ILV. Based on this and setting relay decides to operate or restrain.



Transformer Differential operating characteristics

Once the differential and bias currents are calculated for the Teaser or Main Winding, the following comparisons are made and an operate/restrain signal is obtained:

For the pickup range: 0 ≤ Ibias max ≤ (Is>1)

Idiff ≥ (Io pkp)

For the Slope1 range: (Is>1) ≤ Ibias max ≤ (Is>2)

Idiff ≥ Slope1.Ibias max

For the Slope2 range: Is>2 ≤ Ibias max ≤ (IHs>2)

Idiff ≥ Slope2 * Ibias max + (Slope1 – Slope2) *Is>2

Where;

Idiff and Ibias are calculated current from HV and LV side current.

Operating Current

IDiff = | IHV – ILV |

Restraining Current

Ibias = (IHV + ILV) / 2

Non Restrain Functions:

If the differential current is above the adjustable Is-HS2 setting threshold, bias current is not taken into account and the device will trip regardless. As with High Set 1, second harmonic blocking is not taken into account. The Is-HS2 element resets when the differential current drops below 0.95* HS Non Restrain.

2nd Harmonic Blocking:

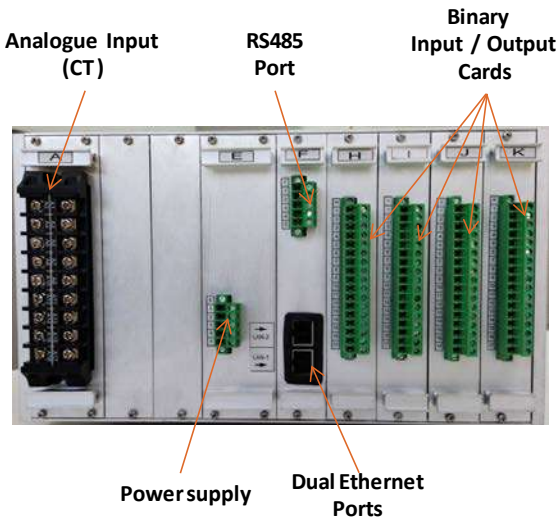
The A23R-M0 relay filters the differential current. The fundamental I(fn) and Second harmonic Components I (2*fn) of the differential current are determined. If the ratio I (2*fn)/I(fn) exceeds a specific adjustable value in at least one measuring system, Differential tripping is Blocked.

5th Harmonic Blocking:

The A23R-M0 relay filters the differential current. The fundamental I (fn) and fifth harmonic Components I (5*fn) of the differential current are determined. If the ratio I (5*fn)/I (fn) exceeds a specific adjustable value in at least one measuring system, Differential tripping is Blocked.

Programmable Inputs, Outputs & Logic:

The relay is provided with tool known as AproLogic, in which user can program their logics as per the requirement. All type of gates such OR/ NOR/ NOT/ NAND/ AND/ XOR/ XNOR/ SR Flip-flop and Counters are available along with Operating and Resetting Timer. For more details please refer to Instruction Manual.



Back side Terminals A23R

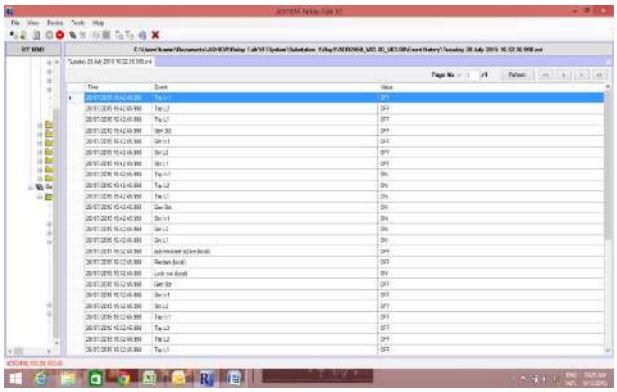
Programmable LEDs and Pushbuttons:

The A23R relay provides total 16 nos. of target and programmable LEDs with dual color indications. The LEDs can be programmed through PC software (RTV2 software).

The A23R also provides the programmable pushbuttons for circuit breaker CLOSE and OPEN from HMI of relay. Pushbuttons can be programmed through HMI or through RTV2 software.

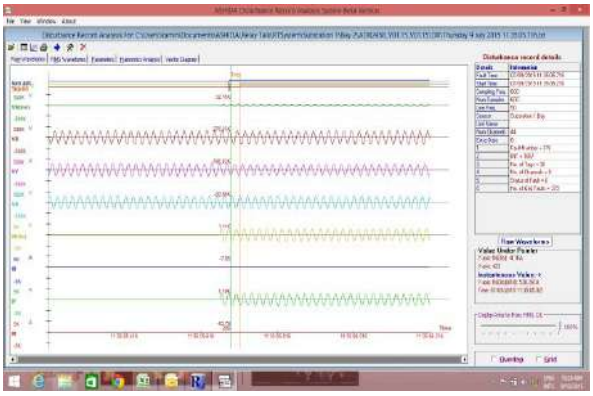
Event recording:

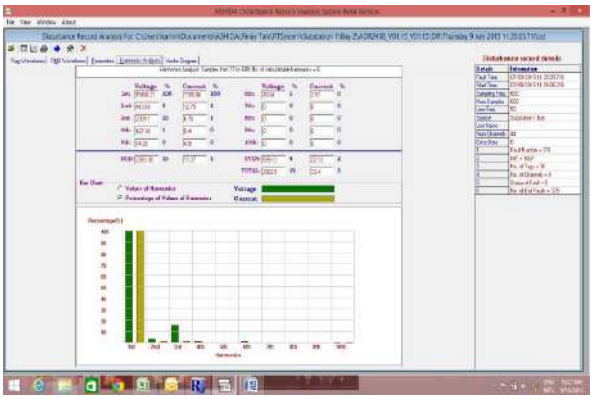
A23R relay provides a feature to record and store 1024 nos. of events (with event time stamping of 1mSec precision) in non-volatile memory through internally by protection and control functions and externally by triggering the digital inputs. And these can be extracted using communication port or can be seen on the LCD. The event can be triggered on time stamp through time synchronization or through internal clock setting.



Disturbance recording:

A23R relay provides built in disturbance recording facility for recoding analogue and digital channels. Relay records 10 nos. of disturbances of 1.5 sec each and stores it in non-volatile memory. Disturbance records can be saved in IEEE COMTRADE format and same can be analyzed in disturbance analysis software.





Fault recording:

A23R relay provides fault recording facility. The fault records can be display either on HMI displayed or in RTV2 software. The relay can record 10 nos. of fault records in non-volatile memory.

Metering:

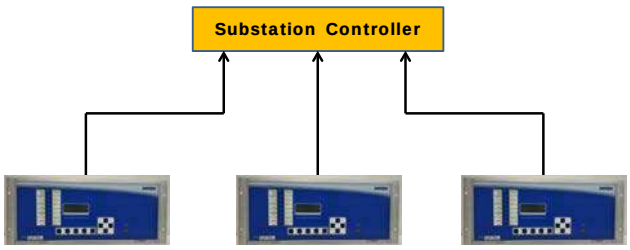
The online metering feature of the A23R relay provides metering of parameters such as all CT's measured current, Bias current, Differential current magnitude on the HMI display or in RTV2 software.

Independent Protection settings groups:

A23R relay provides two independent setting groups which allows the relay to operate on different power system conditions.

IEC 60870-5-103 Protocol:

A23R relay provides internationally standardized protocol for communication via RS485 port of protection relays. IEC 60870-5-103 protocol is used worldwide and supported by relay manufacturers.



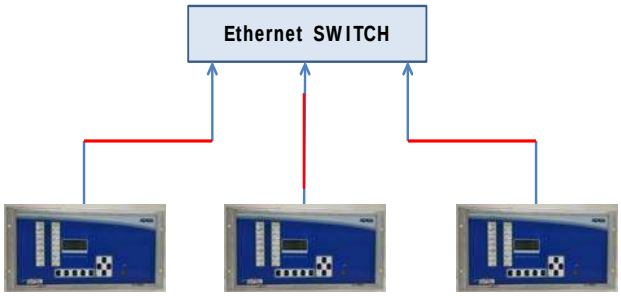
IEC 60870–5–103 star type RS232 copper conductor connection

Ethernate base Protocol:

A23R relay provides IEC61850 internationally standardized protocol for substation automation via Ethernet port of protection relays (Ref ordering information for details)

IEC61850 GOOSE and Interoperability:

A23R support standard GOOSE messaging for relay to relay communication. Any logical (pickup, trip, etc) and physical (Digital Optical Isolated signal such CBNO /NC etc) can be publish via GOOSE configurator. A23R support total 16 simultaneous GOOSE signal which can publish and received by other relays having IEC61850 protocol. Similarly A23R can able subscribed total 16 nos of simultaneous signal published by other relays and can be use for interlocks. The A23R is tested for most of other make relays.



Relay Settings:

Global:

Sr. No	Parameter	Setting / Ranges
1.	Password	0000 to zzzz / ZZZZ
2.	RID	-
3.	SID	-
4.	System Frequency	50Hz / 60Hz
5.	Opto I/P Supply	Read only
6.	Filter Time	0 to 100ms in steps of 1ms
7.	W1 CB Operation	CB Open / CB Close / No Operation
8.	W2 CB Operation	CB Open / CB Close / No Operation
9.	PB-1 Operation	Disabled/ Enabled / Time Enabled
10.	tPB-1 Pulse	0.10 to 50s in steps of 0.01s
11.	PB-2 Operation	Disabled/ Enabled / Time Enabled
12.	tPB-2 Pulse	0.10 to 50s in steps of 0.01s
13.	Config Port	PORT F/ PORT R / PORT 1
14.	Timesync Master	PORT F/ PORT R / PORT 1
15.	Description	Read only
16.	Model no	Read only
17.	Serial No	Read only
18.	Software Version	Read only
19.	Hardware Version	Read only
20.	Virtual Scheme 1	Disabled / Enabled
21.	Virtual Scheme 2	Disabled / Enabled
22.	Language	Read only

Settings Group

Sr. No	Parameter	Setting / Ranges
1.	Factory Defaults	No Operation / All Settings / Setting Group 1 / Setting Group 2
2.	Active Group	G1 / G2
3.	Copy From	G1 / G2
4.	Copy To	No operation / G1 / G2
5.	G1	Disabled / Enabled / Time Enabled
6.	GroupChange Delay	0 to 400.0s in steps of 0.1s
7.	G2	Disabled / Enabled / Time Enabled
8.	GroupChange Delay	0 to 400.0s in steps of 0.1s

PORT F

Sr. No	Parameter	Setting / Ranges
1.	Unit ID	Read only
2.	Baud Rate	Read only
3.	Set Parity	Read only

PORT 1

Sr. No	Parameter	Setting / Ranges
1.	Unit ID	1 to 250 in steps of 1
2.	IP address	Range 0 to 255 in steps of 1
3.	Subnet mask	Range 0 to 255 in steps of 1
4.	Default gateway	Range 0 to 255 in steps of 1
5.	Pri. SNTP	Range 0 to 255 in steps of 1
6.	Sec. SNTP	Range 0 to 255 in steps of 1
7.	Protocol	Disabled / Enabled
8.	Ethernet Mode	Dual / fixed
9.	Operating Mode	Fail over / Switch mode
10.	Primary	LAN1 / LAN 2

PORT R

Sr. No	Parameter	Setting / Ranges
1.	Unit ID	1 to 250 in steps of 1
2.	Baud Rate	9600 / 19200 / 38400 / 57600
3.	Set Parity	None / Even / Odd

Disturbance

Sr. No	Parameter	Setting / Ranges
1.	Post Trigger	5 to 95% in steps of 1%

DATE AND TIME

Sr. No	Parameter	Setting / Ranges
1.	Password	0000 to zzzz / ZZZZ
2.	Local Time Enable	Fixed / Flexible / Disabled
3.	Local Time Offset	-720 to + 720 in steps of 15 Mins
4.	RP Time Zone	UTC / Local
5.	SET Hours	0 to 23 Hrs in steps of 1.
6.	SET Minutes	0 to 59 Mins in steps of 1.
7.	SET Seconds	0 to 59 Sec. in steps of 1.
8.	SET Date	1 to 31 Days in steps of 1.

9.	SET Month	1 to 12 Months in steps of 1.
10.	SET Year	0 to 99 Years in steps of 1.

CB Control

Sr. No	Parameter	Setting / Ranges
1.	Password	0000 to zzzz / ZZZZ
2.	W1 TCS Enable	Disabled / Logic Low / Logic High
3.	W1 TCS Delay	0.1s to 10s in steps of 0.1s
4.	W1 CB Open S'vision	Disabled / Enabled
5.	W1 CB Open Time	50ms to 1000ms in steps of 10ms
6.	W1 CB Open Alarm	Disabled / Enabled
7.	W1 CB Oper. Counter	10 to 50000 in steps of 1
8.	W1 Sigma I	Disabled / Enabled
9.	W1 CB Rated I	1 to 5000A in steps of 1A
10.	W1 M Constant	0.100 to 5.000 in steps of 0.001
11.	W1 CB Control By	Disabled / Local / Remote / Local + Remote
12.	W1 t CB Open Pulse	00.10 to 50.00sec in steps of 0.01s
13.	W1 t CB Close Pulse	00.10 to 50.00sec in steps of 0.01s
14.	W2 TCS Enable	Disabled / Logic Low / Logic High
15.	W2 TCS Delay	0.1s to 10s in steps of 0.1s
16.	W2 CB Open S'vision	Disabled / Enabled
17.	W2 CB Open Time	50ms to 1000ms in steps of 10ms
18.	W2 CB Open Alarm	Disabled / Enabled
19.	W2 CB Oper. Counter	10 to 50000 in steps of 1
20.	W2 Sigma I	Disabled / Enabled
21.	W2 CB Rated I	1 to 5000A in steps of 1A
22.	W2 M Constant	0.100 to 5.000 in steps of 0.001
23.	W2 CB Control By	Disabled / Local / Remote / Local + Remote
24.	W2 t CB Open Pulse	00.10 to 50.00sec in steps of 0.01s
25.	W2 t CB Close Pulse	00.10 to 50.00sec in steps of 0.01s
26.	W2 Invalid DPI Dur H	0.1 to 600s in steps of 0.01s
27.	W2 Invalid DPI Dur I	0.1 to 600s in steps of 0.01s

REPORTING

Sr. No	Parameter	Display value on LCD
1.	Event	Display of all digital events with time stamping
2.	Status	Display Status of Digital Input & Digital Output
3.	Fault Record	Display the Records of fault i.e. parameter value, flag of fault & date and time of Fault
4.	Error Log	Display of error generated by Relay if any, in case of failure of hardware

5.	CB Data	Display of Trip Counter; Breaker Operation Counter; Breaker operating time, Recl Cnt
6.	Alarm Record	Display of latest Alarm Record

SYSTEM CONFIG

CT/VT RATIOS

Sr. No	Parameter	Setting / Ranges
1.	W1 CT Secondary	1A / 5A
2.	W1 CT Primary	10 to 30000A in steps of 1A
3.	W2 CT Secondary	1A / 5A
4.	W2 CT Primary	10 to 30000A in steps of 1A

PROTECTION

Sr. No	Parameter	Setting / Ranges
1.	Password	0000 to zzzz / ZZZZ
2.	Harmonic Blocking	Disabled / Enabled
3.	Equipment Data	Disabled / Enabled
4.	Diff. Protection	Disabled / Enabled

RECORD CONTROL

Sr. No	Parameter	Setting / Ranges
1.	Password	0000 to zzzz / ZZZZ
2.	Clear Events	Yes / No
3.	Clear Faults	Yes / No
4.	Clear Disturbance	Yes / No
5.	Clear Error Record	Yes / No
6.	CB Data	Yes / No

OUTPUT & LED TEST

Sr. No	Parameter	Setting / Ranges
1.	Password	0000 to zzzz / ZZZZ
2.	Test Mode	Disabled/Test Mode/Contacts Blocked
3.	Test Output J	0 = Not Operated, 1 = Operated
4.	Test Output K	0 = Not Operated, 1 = Operated
5.	Test Output L	0 = Not Operated, 1 = Operated
6.	Test Output M	0 = Not Operated, 1 = Operated
7.	Test Apply	No Operation/Apply Test/Remove Test
8.	Test LEDs	No Operation / Apply Test

Group 1 Settings

Harmonic Blocking

Sr. No	Parameter	Settings / Ranges
1.	2ndHrm Diff Block	Disabled / Enabled
2.	2nd Harm Thresh	5% to 70% in steps of 1%
3.	5thHrm Diff Block	0.05 to 99.99 ohm in steps of 0.01 ohm
4.	5th Harm Thresh	0.05 to 99.99 ohm in steps of 0.01 ohm

Equipment Data

Sr. No	Parameter	Settings / Ranges
1.	W1 Scaling factor	0.5 to 12 in steps of 0.01
2.	W2 Scaling factor	0.5 to 12 in steps of 0.01

Diff. Protection

Sr. No	Parameter	Settings / Ranges
1.	Diff. Protection	Disabled / Enabled
2.	I0Pkp	10% to 50% in steps of 1%
3.	Is1	20% to 130% in steps of 1%
4.	K1	10% to 50% in steps of 1%
5.	Is2	100% to 800% in steps of 1%
6.	K2	10% to 50% in steps of 1%
7.	Is-HS1	50% to 3000% in steps of 1%
8.	Is-HS2	50% to 3000% in steps of 1%

ACTIVE GROUP

Sr. No	Parameter	Setting / Ranges
1.	G1/ G2	Read only

Typical Tests Information:

The Relay Confirm to following standard

Sr. No.	Test	Standard
Electromagnetic Compatibility Type Test:		
1.	Damped Oscillatory Wave Test	IEC 60255-26 & IEC 61000-4-18
2.	Electrostatic Discharge Test	IEC 60255-26 & IEC 61000-4-2
3.	Electrical Fast Transient or Burst Requirements	IEC 60255-26 & IEC 61000-4-4
4.	Surge Immunity Test	IEC 60255-26 & IEC 61000-4-5

5.	Immunity to Conducted Disturbances Induces by Radio Frequency Field	IEC 60255-26 & IEC 61000-4-6
6.	Radiated, Radio Frequency, Electromagnetic Field Immunity Test	IEC 60255-26 & IEC 61000-4-3
7.	Power Frequency Immunity Test	IEC 60255-26 & IEC 61000-4-16

Auxiliary Supply Tests		
8.	Effect of DC Voltage Variation	IEC 60255-1 / IEC 60255-26
9.	A.C. Ripples in DC Auxiliary	IEC 60255-26 & IEC 61000-4-17

Insulation Tests:		
10.	High Voltage Test	IEC 60255-27
11.	Impulse Voltage Test	IEC 60255-27
12.	Insulation Resistance	IEC 60255-27

Environmental tests:		
13.	Cold test (Storage & Operational)	IEC 60255-1/ IEC 60068-2-1
14.	Dry heat test (Storage & Operational)	IEC 60255-1/ IEC 60068-2-2
15.	Damp heat steady state test	IEC 60255-1/ IEC 60068-2-78
16.	Damp heat cyclic test	IEC 60255-1/ IEC 60068-2-30
17.	Change of Temperature	IEC 60255-1/ IEC 60068-2-14
18.	Enclosure Protection Test (IP51)	IEC 60529

Mechanical tests		
19.	Vibration Endurance Test	IEC 60255-21-1
20.	Vibration Response Test	IEC 60255-21-1
21.	Bump Test	IEC 60255-21-2
22.	Shock Withstand Test	IEC 60255-21-2
23.	Shock Response Test	IEC 60255-21-2
24.	Seismic Test	IEC 60255-21-3

Accuracy & Functional Performance Tests		
25.	Making & Breaking Capacity Tests of Contacts	IEC 60255 – 1
26.	Mechanical Endurance Tests	IEC 60255 – 1

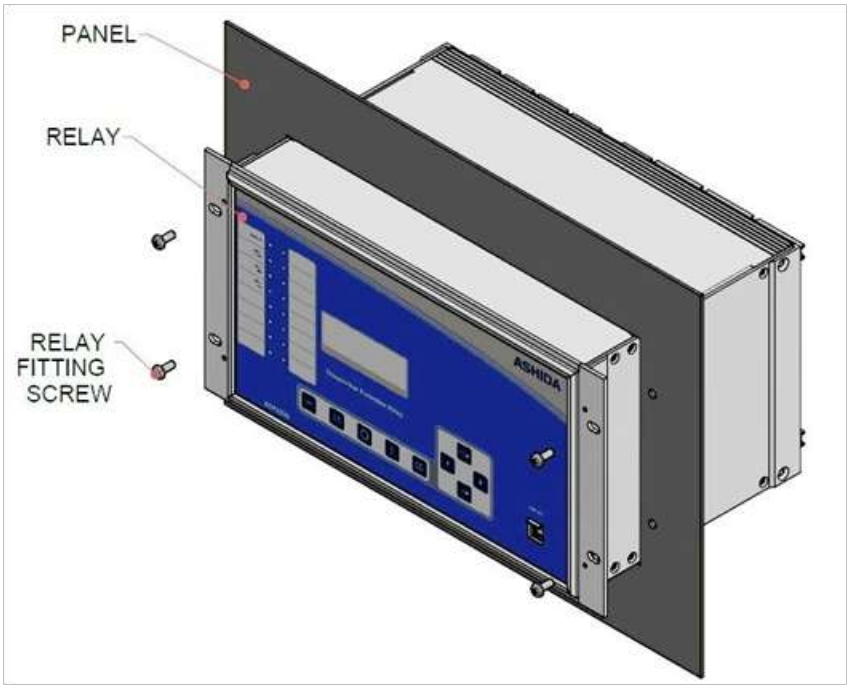
Thermal Withstand Tests		
27.	Over Current Test	IEC 60255-1
28.	Over Voltage Test	IEC 60255-1

*Detailed Type Test Reports are available on request

Drawings Information:

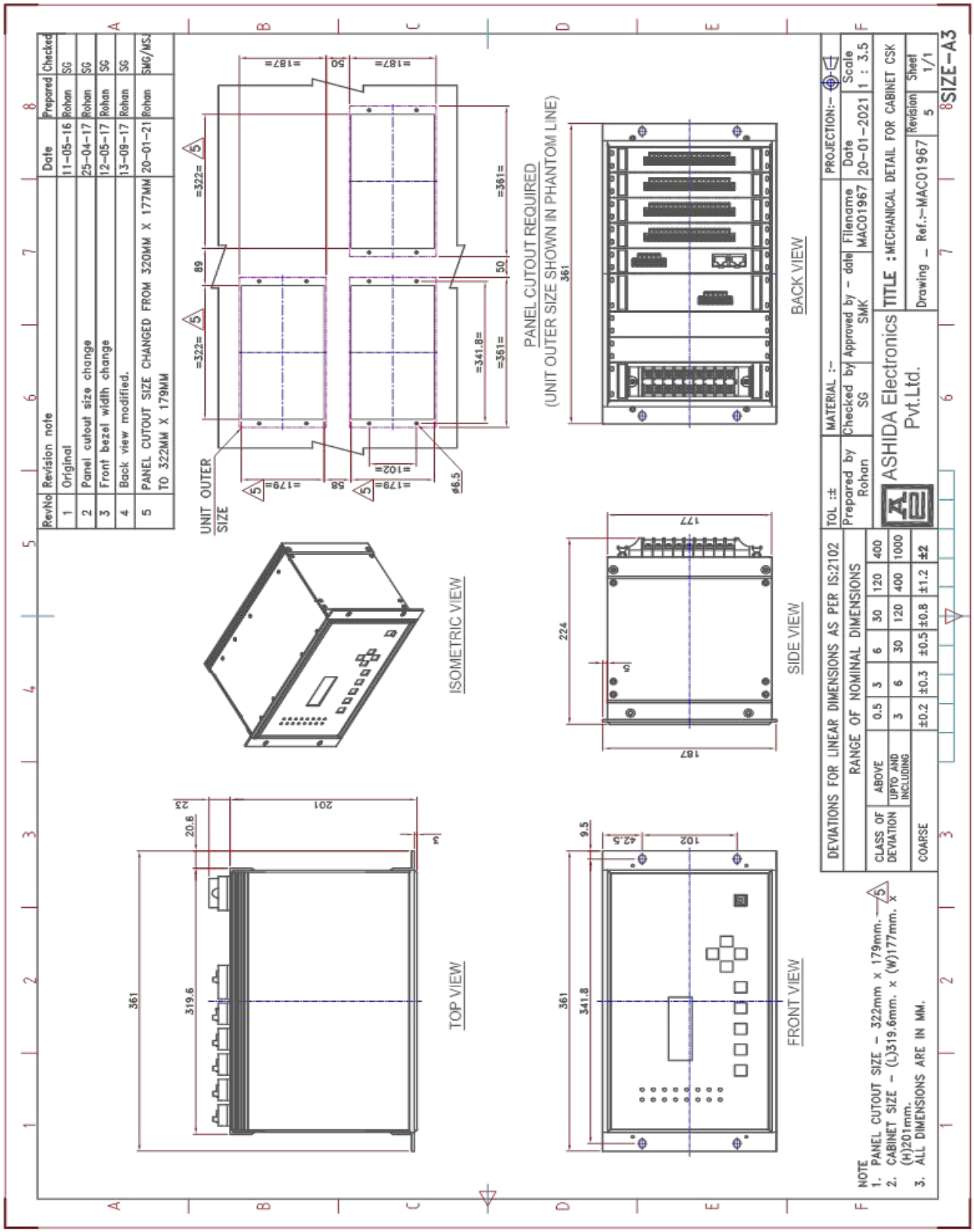
I.	Drawing References	: For Cabinet Type	MAC01967
		: For Back Connections	RLY06802
		: For Typical External Connections	ABD06802

Mounting Information:

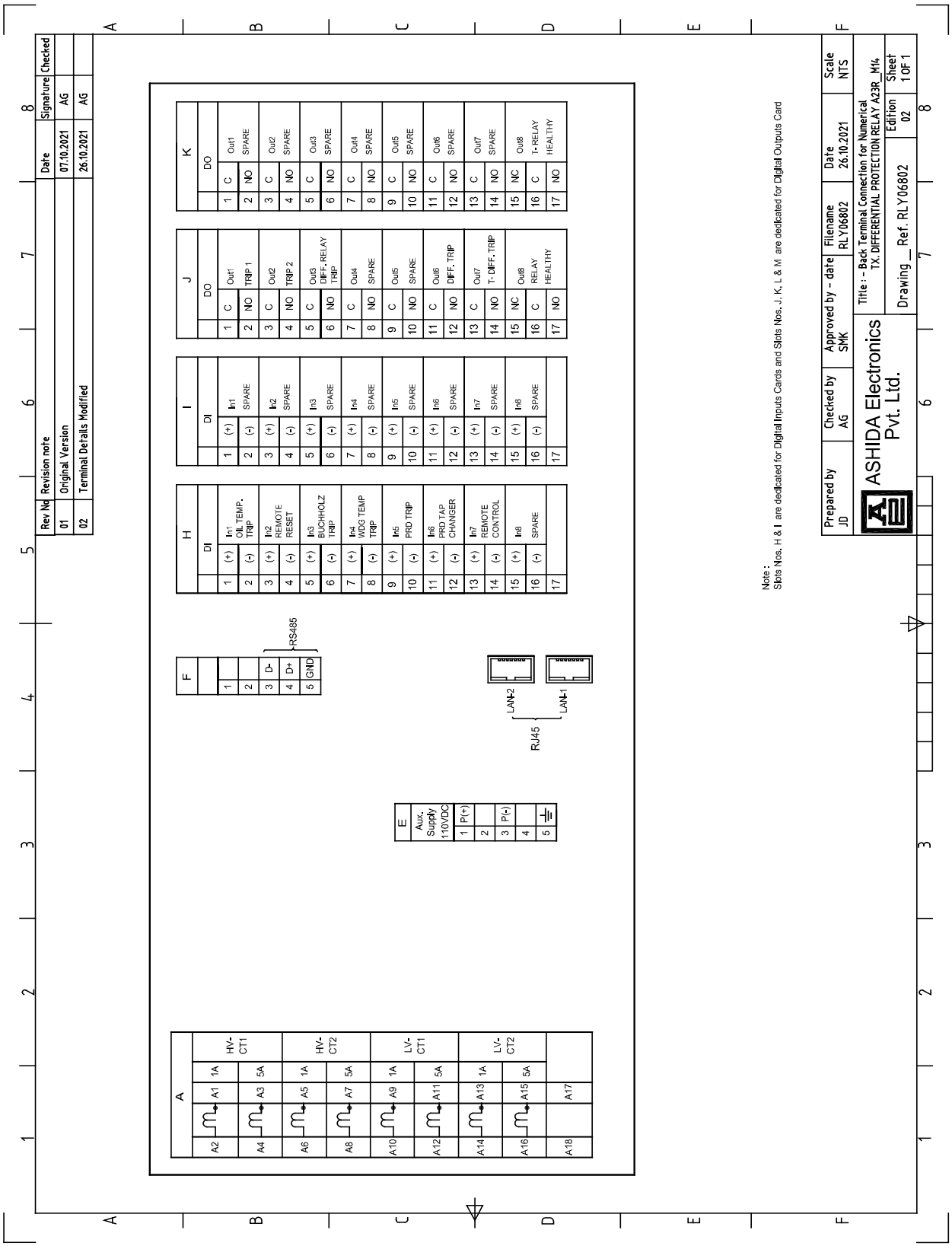


A23R 14” Modular – Rack mounting arrangement

Mechanical Details :

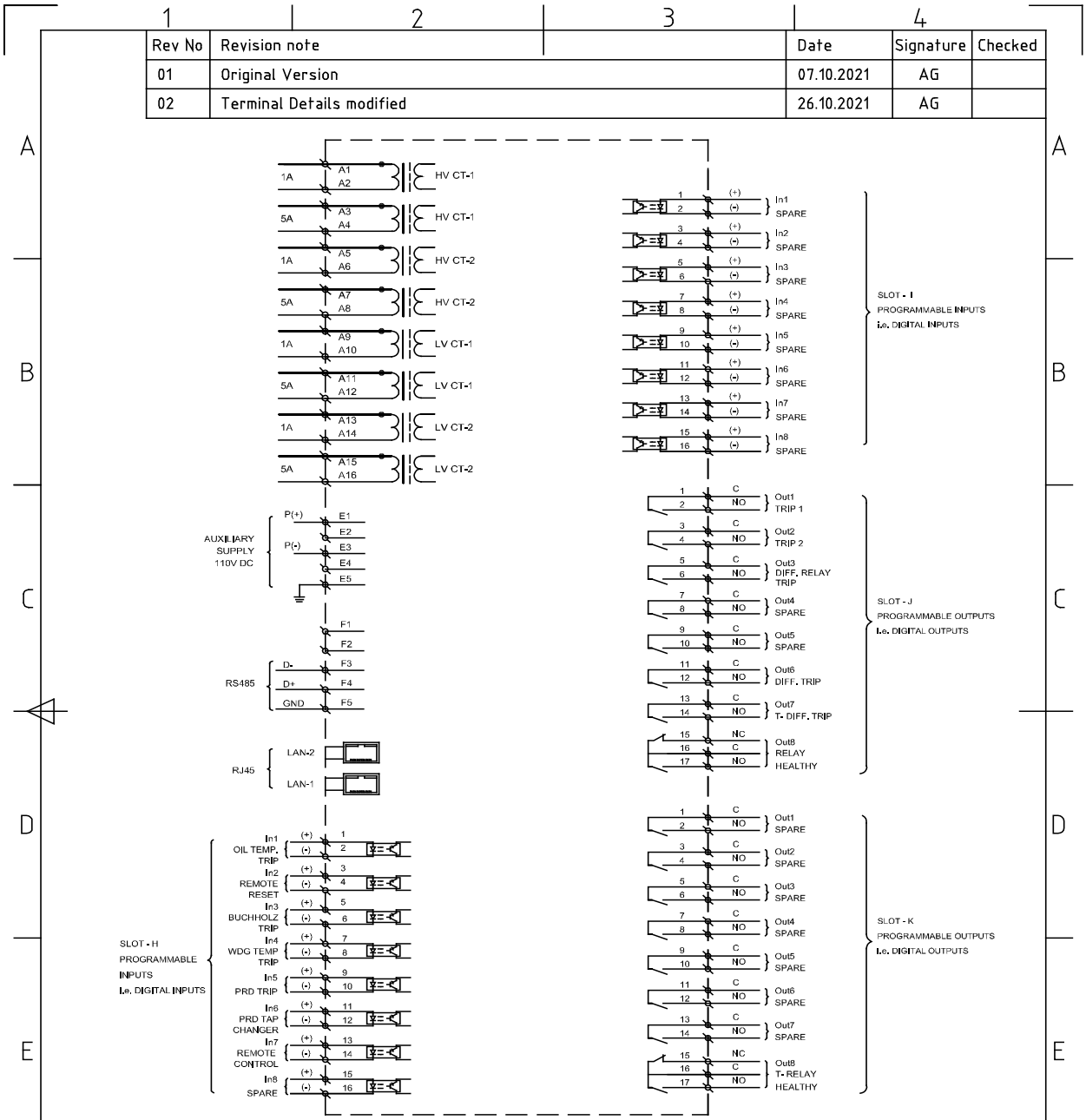


Back Terminal Details :



Electrical Connection Details :

Rev No	Revision note	Date	Signature	Checked
01	Original Version	07.10.2021	AG	
02	Terminal Details modified	26.10.2021	AG	



Note :
Slots Nos. H & I are dedicated for Digital Inputs Cards and Slots Nos. J & K are dedicated for Digital Outputs Card

Perpaed by	Checked by	Approved by – date	Filename	Date	Scale
JD	AG	SMK	ABD06802	26.10.2021	NTS

ASHIDA Electronics Pvt. Ltd.

Title : – BLOCK DIAGRAM FOR NUMERICAL TX. DIFFERENTIAL PROTECTION RELAY A23R__M14

Drawing__ Ref. ABD06802 | Edition 02 | Sheet 1 OF 1

General Specifications:

AC Current Inputs:

1A Nominal

5A Nominal

Thermal Withstand Capacity:

40 X In for 1s

4 X In for Continuous

Burden Rating:

< 0.2VA for 1A Nominal

< 0.2VA for 5A Nominal

System Frequency:

50Hz / 60Hz

Frequency Tracking: 45 – 55Hz for 50Hz and 55 55 – 65Hz for 60Hz

Power Supply:

Range: 110 V DC +15%, -30%

Burden: < 20 Watt

Digital Outputs:

Continuous carry: 5A at 110V DC

Make: 30A for 200 ms at 110V DC

Breaking capacity: 1000 watts @ 110Vdc resistive, 30 watts @ 110Vdc inductive (L/R = 45ms)

Digital Inputs:

Operating range: 77 – 230 Vdc

Communication Ports:

Front Port – USB

Rear Ports – RJ45 (10-100/Base T Copper) & RS485

Operating Temperature:

Operating Temperature: -25^{O}C to +65^{O}C

Storage Temperature: -25^{O}C to +70^{O}C

Humidity: 95% RH

Weight: < 5.5kg Approximate

Ordering Information:

Ordering Information												
	1-4	5	6	7	8	9	10	11	12	13	14	15
Model	A23R	X	X	X	X	X	X	X	X	X	X	X
Example	A23R	M	0	0	2	0	1	1	2	3	2	H
Traction Tx. PROTECTION												
Cabinet Details												
Modular Version		M										
Variant												
2x25			0									
Language												
English				0								
Protocol												
IEC 103 (for all other protocol 103 will native)					0							
IEC 61850					2							
CT / PT												
4CT, CT Selection: 1A/5A						0						
Digital Outputs												
16 DO							1					
32 DO							3					
Digital Inputs												
16 DI								1				
32 DI								3				
DI Setting Threshold												
18VDC									0			
35VDC									1			
77VDC									2			
154VDC									3			
Auxiliary Supply												
24VDC – 230 VDC										2		
110VDC										3		
Cabinet Details												
Modular Version M-14											2	
Communication Ports												
Disable / No Rear Port												0
RS-485 Rear Port												B
10/100 Base-T Ethernet RJ45 Rear Port												C
10/100 Base-T Ethernet RJ45 Rear Port & RS-485 Rear Port												E

DUAL 10/100 Base-T Ethernet RJ45 Rear Port	F
DUAL 10/100 Base-T Ethernet RJ45 Rear Port & RS-485 Rear Port	H
DUAL 10/100 Base-T Ethernet RJ45 Rear Port & RS-485 Rear Port + IRIGB Port	M
DUAL FO Ethernet Rear Port & RS-485 Rear Port	N

ASHIDA

ASHIDA Electronics Pvt. Ltd.
ASHIDA House, Plot No. A-308, Road No. 21,
Wagle Industrial Estate, Thane - 400604, INDIA
Tel : +91 - 22 - 2582 7524/6129 9100
Fax : +91 - 22 - 2580 4262
Email : sales@ashidaelectronics.com
Web : www.ashidaelectronics.com