DATAKOM

DPR-400

PROTECTION RELAY

DESCRIPTION

DPR-400 is a state of the art, color screen, directional network analyzer and protection relay in 144x144mm standard panel dimensions. Thanks to its low depth, it saves space in the panel. The device combines high precision, ease of use and versatility with a reliable and cost-effective design.

The DPR-400 features dual current measurement circuits, making it a class 0.5% accuracy analyzer, and a protection relay capable of measuring 50xIn.

The DPR-400 offers various protection curves to provide precise protection. Multiple protection curves can be activated simultaneously.

The DPR-400 displays multiple measurements on its 4.3” screen. The large display offers ease of use and provides abundant information.

The device can connect to various Scada systems easily via USB, isolated RS-485 and Ethernet ports for remote monitoring.

Modbus and IEC60870-5-103 protocols are supported through RS-485 port.

Modbus TCP/IP and IEC61850 protocols are supported over the Ethernet port.

Parameter configuration is done using the buttons on the front panel or with the free PC software. The program connects via USB, RS-485 or optionally over the Internet. Additionally, firmware updates are performed through the USB port.

Two of the relay outputs of the device have connection monitoring capability. These outputs continually check the integrity of the load circuit, and raise an alarm if the circuit opens.

DPR-400 stores up to 7 oscillographic records in COMTRADE format in its 1MB internal memory.

The device meets the security, EMC, vibration, and environmental standards for industrial products.

FEATURES

- 4.3” color graphic display, 480x272 pixels
- Accurate power analyzer (%0.5)
- 4 quadrant energy counters
- Multiple protection curves
- Self-test, internal failure monitoring
- Cold reclosure
- Configurable digital outputs
- Configurable relay outputs
- 3 independent adjustment sets
- Multiple languages
- All parameters front panel adjustable
- 3 level password protection
- Free PC program for setup
- Setup through USB, RS-485, and Ethernet
- 14 x configurable front panel leds
- Manual & Scada driven closing and opening
- Firmware upgrade through USB
- IP65 protection (with optional gasket)
- Low panel depth, only 55mm
- Trip counter, service warning

PROTECTION CURVES

- IEC Normal, Very, Extreme Inverse
- UK Long Term Inverse,
- IEEE Medium, Very, Extreme Inverse
- US Normal Inverse, Short Time Inverse

PROTECTION FUNCTIONS

ANSI CODE	DESCRIPTION
27	Under Voltage (Ph-Ph / Ph-N)
46	Negative Sequence Overcurrent
46BC	Broken Conductor
47	Negative Sequence Over Voltage
49RMS	Thermal Overload
50,51	Overcurrent
50N/51N	Ground Overcurrent
50BF	Breaker Failure
59	Over Voltage (Ph-Ph / Ph-N)
67	Directional Overcurrent
74CT	CT Supervision
79	Reclosure
81O	High Frequency
81U	Under Frequency
CLP	Cold Load Pickup

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ABOUT THIS DOCUMENT

This document describes the minimum requirements and necessary steps for the successful installation of the DPR-400 family units.

Follow the advice given in the document carefully. These are often good practices for the installation of the units which reduce future issues.

For all technical queries please contact Datakom at the e-mail address below:

technical.support@datakom.com.tr

QUERRIES

If additional information to this manual is required, please contact the manufacturer directly at the e-mail address below:

technical.support@datakom.com.tr

Please provide the following information in order to receive answers to any question:

- Device model name (see the back panel of the unit),
- Complete serial number (see the back panel of the unit),
- Firmware version (read from the display screen),
- Measuring-circuit voltage and power supply voltage,
- Precise description of the query.

RELATED DOCUMENTS

FILENAME	DESCRIPTION
Rainbow Installation	Rainbow Plus Installation Guide
Rainbow Usage	Rainbow Plus Usage Guide
Rainbow Scada Installation	Rainbow Scada Installation Guide
Rainbow Scada Usage	Rainbow Scada Usage Guide

REVISION HISTORY

REVISION	DATE	AUTHOR	DESCRIPTION
01	06.06.2020	MH	First Edition

TERMINOLOGY

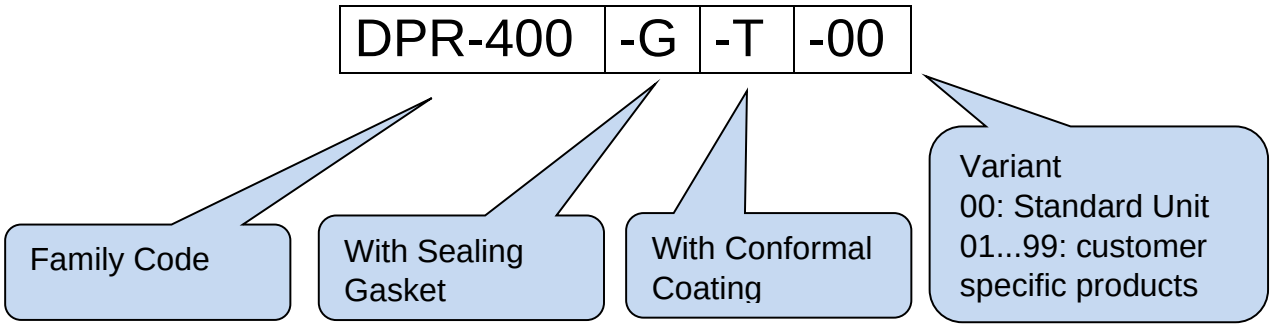
CAUTION: Potential risk of injury or death.

WARNING: Potential risk of malfunction or material damage.

ATTENTION: Useful hints for the understanding of device operation.

ORDERING CODES

The DPR-400 family units are available in various options and peripheral features. Please use below information for ordering the correct version.



SPARE PARTS

Screw type bracket
Stock Code=J10P01 (per unit)

Self-Retaining type bracket
Stock Code=K16P01 (per unit)

Sealing Gasket, Stock Code= K63P01

SAFETY NOTICE

Failure to follow below instructions will result in death or serious injury.

- **Electrical equipment should only be installed by a qualified specialist. No responsibility is assured by the manufacturer or any of its subsidiaries for any consequences resulting from the non-compliance to these instructions.**
- **Check the unit for cracks and damages due to transportation. Do not install damaged equipment.**

- **Do not open the unit. There are no serviceable parts inside.**
- **Fuses must be connected to the power supply and phase voltage inputs, in close proximity of the unit.**

- **Fuses must be of fast type (FF) with a maximum rating of 6A.**

- **Disconnect all power before working on the equipment.**

- **When the unit is connected to the network, do not touch the terminals.**
- **Short circuit terminals of unused current transformers.**

- **Any electrical parameter applied to the device must be in the range specified in the user manual. Although the unit is designed with a wide safety margin, over-range parameters may reduce lifetime, alter operation precision or even damage the unit.**

- **Do not try to clean the device with solvent or the like. Only clean with a damp cloth.**
- **Verify correct terminal connections before applying power.**
- **Only for front panel mounting.**

TABLE OF CONTENTS

1. INSTALLATION INSTRUCTIONS

Before installation:

- Read the user manual carefully, determine the correct connection diagram.
- Remove all connectors and mounting brackets from the unit, then pass the unit through the mounting opening.
- Put mounting brackets and tighten. Do not tighten too much, this may break the enclosure.
- Make electrical connections with plugs removed from sockets, then place plugs to their sockets.
- Be sure that adequate cooling is provided.
- Be sure that the temperature of the environment will not exceed the maximum operating temperature in any case.
- Be sure that no water will contact the device.

Below conditions may damage the device:

- Incorrect connections.
- Incorrect power supply voltage.
- Voltage at measuring terminals beyond specified range.
- Voltage applied to digital inputs over specified range.
- Current at measuring terminals beyond specified range.
- Overload or short circuit at relay outputs.
- Connecting or removing data terminals while the unit is powered up.
- High voltage applied to communication ports.
- Ground potential differences at non-isolated communication ports.
- Excessive vibration, direct installation on vibrating parts.

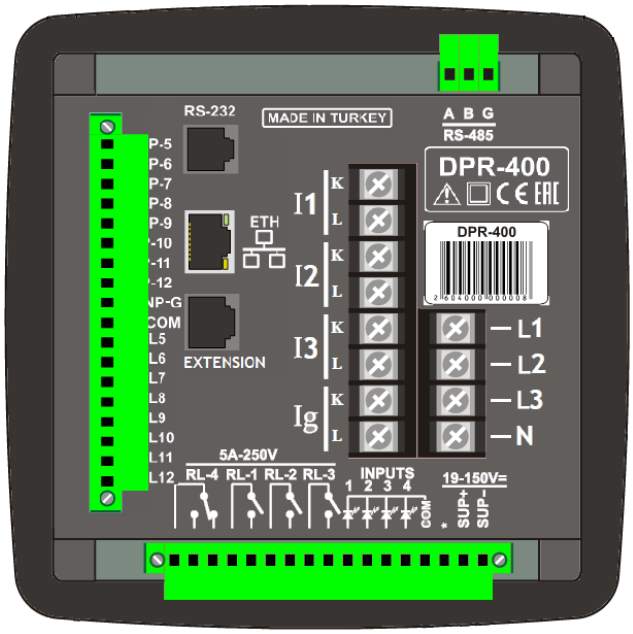
Below conditions may cause abnormal operation:

- Power supply voltage below minimum acceptable level.
- Frequency outside specified limits.
- Phase order fault.
- Faulty current transformer input.
- Incorrect current transformer polarity.
- Missing grounding.

2. MOUNTING

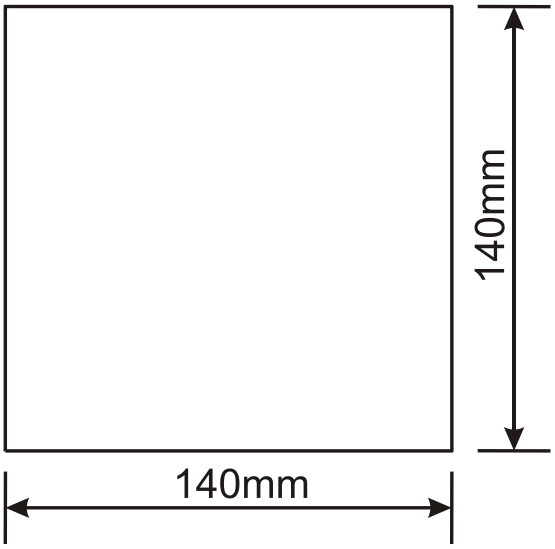
2.1. DIMENSIONS

Dimensions: 164x164x69mm (6.5”x6.5”x2.7”)
Panel Cutout: 140x140mm minimum (5.52”x5.52”)
Weight: - 630gr (approx.)

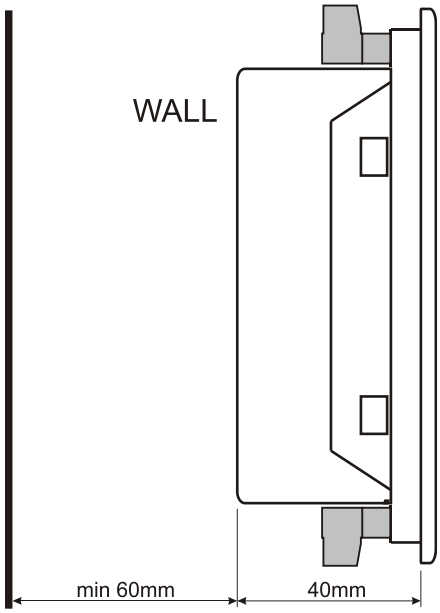


Mount the unit on a flat, vertical surface. Before mounting, remove the mounting brackets and connectors from the unit, then pass the unit through the mounting opening.

Place and tighten mounting brackets.



Panel Cutout



Required Panel Depth

The unit is designed for panel mounting. The user should not be able to access parts of the unit other than the front panel during normal operation.

Two different types of brackets are provided:

Screw type bracket

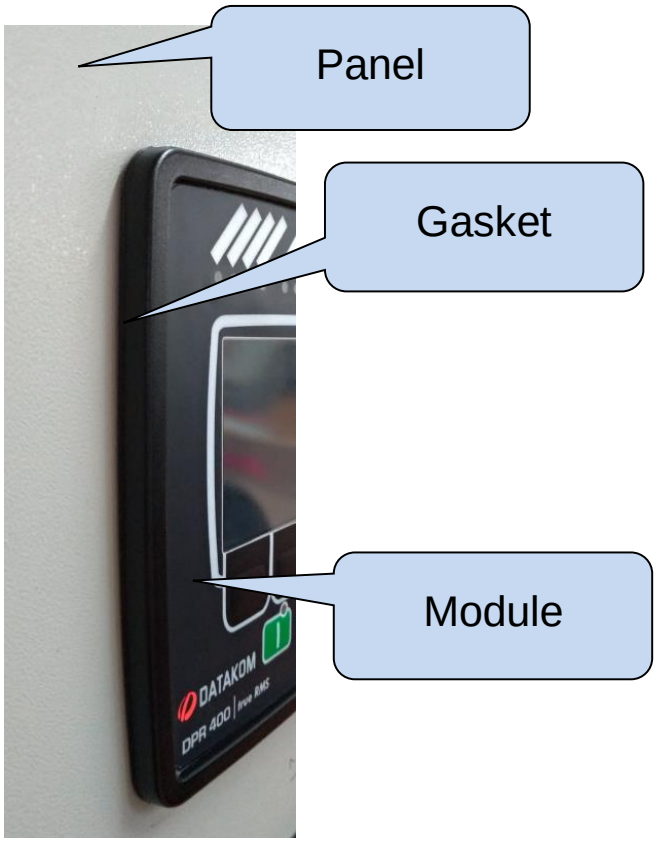
Self-retaining type bracket

Installation of screw type bracket

Installation of self-retaining type bracket

Do not tighten too much, this may break the unit.

2.2. SEALING GASKET



The rubber gasket (sold separately) provides a watertight means of mounting the module to the panel. With the gasket, IEC 60529-IP65 protection is provided. A short definition of IP protection levels is given below:

1st Digit

0 Not protected
1 Protected against solid foreign objects of 50 mm diameter and greater
2 Protected against solid foreign objects of 12.5 mm diameter and greater
3 Protected against solid foreign objects of 2.5 mm diameter and greater
4 Protected against solid foreign objects of 1.0 mm diameter and greater
5 Protected from the amount of dust that would interfere with normal operation
6 Dust tight

2nd Digit

0 Not protected
1 Protected against vertically falling water drops
2 Protected against vertically falling water drops when enclosure is tilted up to 15 °
3 Protected against water sprayed at an angle up to 60 ° on either side of the vertical
4 Protected against water splashed against the component from any direction
5 Protected against water projected in jets from any direction
6 Protected against water projected in powerful jets from any direction
7 Protected against temporary immersion in water
8 Protected against continuous immersion in water, or as specified by user

2.3. ELECTRICAL INSTALLATION

Do not install the unit close to high electromagnetic noise emitting devices like contactors, high current busbars, switch mode power supplies, etc.

Although the unit is protected against electromagnetic disturbance, excessive disturbance can affect the operation, measurement precision and data communication quality.

- **ALWAYS remove plug connectors when inserting wires with a screwdriver.**
- **Fuses must be connected to the power supply and phase voltage inputs, in close proximity to the unit.**
- **Fuses must be of fast type with a maximum rating of 6A.**
- **Use cables of appropriate temperature range.**
- **Use adequate cable section, at least 0.75mm^2 (AWG18).**
- **Follow national rules for electrical installation.**
- **Current transformers must have 1A or 5A output.**
- **For current transformer inputs, use at least 1.5mm^2 section (AWG15) cable.**
- **The current transformer cable length should not exceed 1.5 meters. If a longer cable is used, increase the cable section proportionally.**

For the correct storage of event records, adjust the real time clock through the programming menu.

3. TERMINAL TECHNICAL SPECIFICATIONS

3.1. BATTERY VOLTAGE INPUT

Power Supply Voltage:	19 - 150VDC
Reverse Voltage:	Protected
Maximum Input Current:	200mA @ 24VDC. (All options included, relays engaged.) 50mA @ 110VDC. (All options included, relays engaged.)
Typical operating current:	150mA @ 24VDC. (Options not included, relays engaged.) 40mA @ 110VDC. (Options not included, relays engaged.)

3.2. AC VOLTAGE INPUTS

Measurement method:	True RMS
Sampling rate:	8192 Hz
Input voltage range:	0 - 100 VAC (phase-neutral)
Measurement range:	5 - 100VAC Ph-N (10 - 170VAC Ph-Ph)
Input impedance:	5.0 M-ohms
Display resolution:	0.1VAC
Accuracy:	0.5% + 1 digit @ 100VAC Ph-N (±0.6VAC Ph-N) 0.5% + 1 digit @ 170VAC Ph-Ph (±1.0VAC Ph-Ph)
Withstanding:	1300V-AC continuous

Frequency range:	30 - 100 Hz
Frequency display resolution:	0.01 Hz
Frequency accuracy:	0.5% + 1 digit

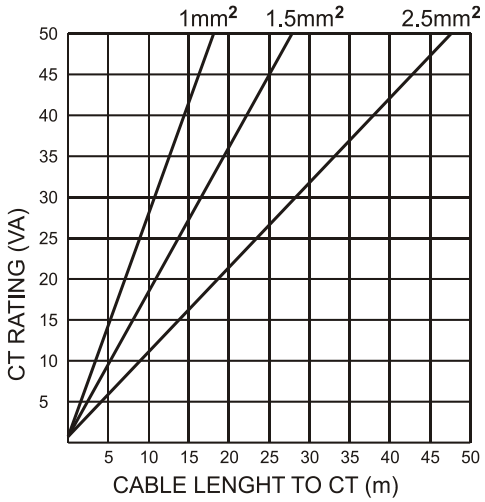
3.3. AC CURRENT INPUTS

Structure:	Isolated, integrated current transformers
Measurement Method:	True RMS
Sampling Rate:	8192 Hz
CT Secondary Rating:	1 or 5A
CT Range:	5/5 - 30000/5A minimum
Measurement Range:	Measurement inputs: 0.01 - 6A AC Protection inputs: 0.1 – 250 A AC
Display resolution:	0.1A
Accuracy:	0.5% + 1 digit
Isolation:	1000VAC/1minute from all other terminals.
Maximum Current:	20A continuous
Withstanding:	500A for 1sec

SELECTING THE CT RATING AND CABLE SECTION:

The load on a CT must be kept minimum in order to minimize phase shift effect of the current transformer. Phase shift in a CT will cause erroneous power and power factor readings, although the amp readings are correct.

It is advised CT rating to be selected following this table for the best measurement accuracy.



SELECTING THE CT ACCURACY CLASS:

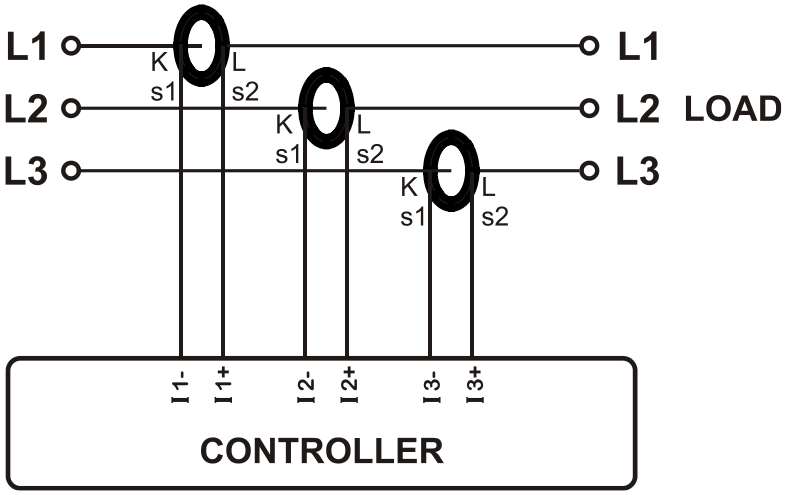
The CT accuracy class should be selected in accordance with the required measurement precision. The accuracy class of the controller is 0.5%. Thus 0.5% class CTs are advised for the best result.

CONNECTING THE CTs:

Be sure to connect each CT to the related phase input with the correct polarity. Mixing CTs between phases will cause faulty power and power factor readings.

Many combinations of incorrect CT connections are possible, so check both the order of the CTs and their polarity. Reactive power measurement is affected by incorrect CT connections in a similar was as active power measurement.

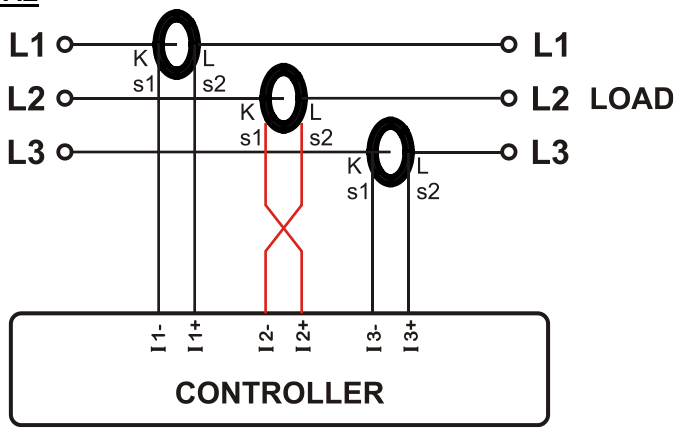
CORRECT CT CONNECTIONS



Suppose that each phase of the utility mains are loaded with 100 kW. The power factor (PF) for the load is as follows:

	kW	kVAr	kVA	pf
Phase L1	100.0	0.0	100	1.00
Phase L2	100.0	0.0	100	1.00
Phase L3	100.0	0.0	100	1.00
Total	**300.0**	**0.0**	**300**	**1.00**

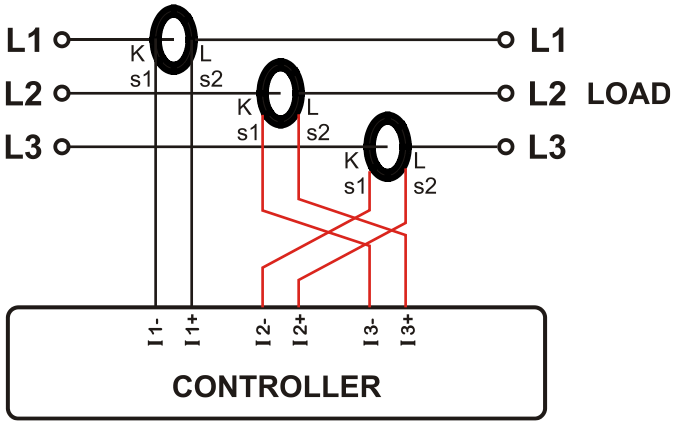
EFFECT OF POLARITY REVERSAL



The utility mains is still loaded with 100 kW on each phase. The load power factor (PF) on Phase L2 will show -1.00 due to reverse CT polarity.
As a result, total load power displayed will be 100 kW.
Measured values are as follows:

	kW	kVAr	kVA	pf
Phase L1	100.0	0.0	100	1.00
Phase L2	-100.0	0.0	100	-1.00
Phase L3	100.0	0.0	100	1.00
Total	**100.0**	**0.0**	**300**	**0.33**

EFFECT OF PHASE SWAPPING



The utility mains is still loaded with 100 kW on each phase. PF in phases L2 and L3 will show -0.50 due to phase shift between voltages and currents which is caused by CT swapping. As a result, the total power displayed will be 0 kW. Measured values are as follows:

	kW	kVAr	kVA	pf
Phase L1	100.0	0.0	100	1.00
Phase L2	-50.0	86.6	100	-0.50
Phase L3	-50.0	-86.6	100	-0.50
Total	**0.0**	**0.0**	**300**	**0.0**

3.4. DIGITAL INPUTS

Number of Inputs:	4 inputs, all configurable. (16 additional inputs optional)
Input Type:	Optically isolated, digital input
Function Selection:	From list
Contact Type:	Normally open or normally closed (programmable)
Minimum Sensing Duration:	100ms
Active Signal Level:	19-140V-DC
Isolation:	1000VAC, 1 minute
Noise Filtering:	Yes

3.5. RELAY OUTPUTS

Number of Relays:	4 relays, all configurable. (16 additional relays optional)
Structure:	Relay output, normally open contact, single common terminal free contact output.
Circuit Monitoring:	RL-2 and RL-3 outputs only
Max. Switching Current:	5A @250VAC
Max. Switching Voltage:	250VAC
Max. Switching Power:	1250VA

3.6. RS-485 PORT

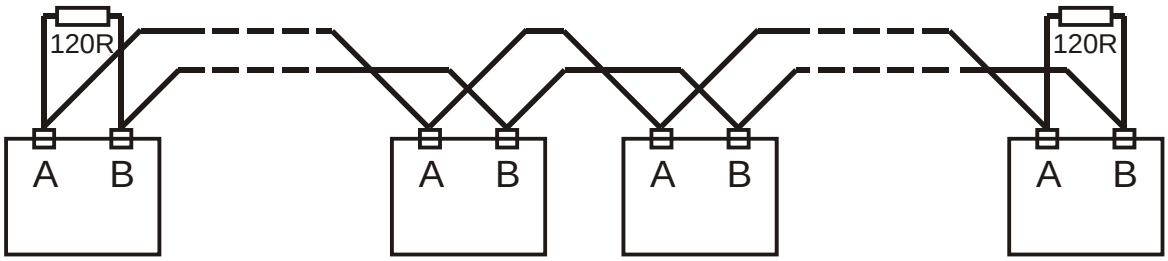
Structure:	RS-485, isolated.
Connection:	3 wires (A-B-GND). Half duplex.
Baud rate:	2400-115200 baud, selectable.
Data type:	8-bit data, no parity, 1 bit stop
Termination	External 120 ohms required.
Common mode voltage:	-0.5 VDC to +7VDC, internally clamped by transient suppressors.
Max. Distance:	1200m @ 9600 baud (with 120-ohm balanced cable) 200m @ 115200 baud (with 120-ohm balanced cable)
Isolation:	500VAC, 1 minute
Supported protocols:	IEC60870-5-103, Modbus RTU

The Modbus register list is available at Datakom technical support.

The RS-485 port provides an effective solution for distant PC connection to enable programming and monitoring via SCADA software.

RS-485 LINE STRUCTURE

Up to 32 controllers can be connected in parallel in a single RS-485 line. A repeater is required in order to connect more controllers.



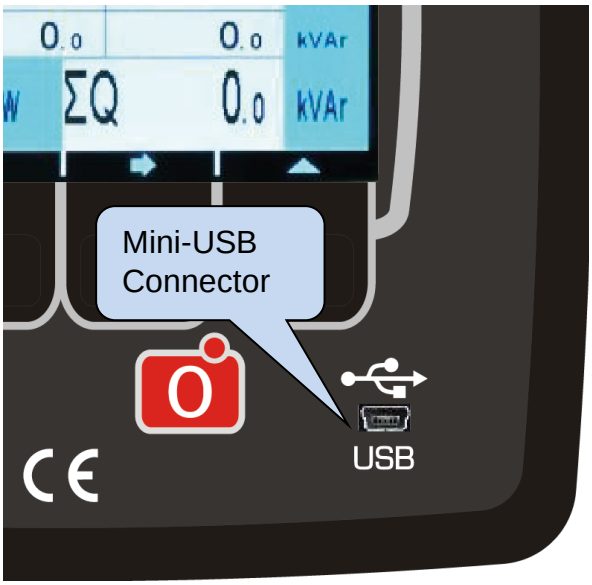
The line must be terminated by 120 ohms on each end.

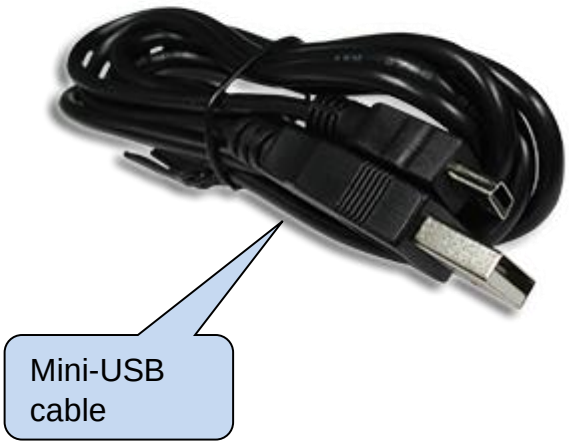
The cable shield must be grounded at one end only.

There is no termination resistor in the controller.

120 ohm termination resistors must be installed at each end of the line.

3.7. USB PORT





Description:	USB 2.0, non-isolated, HID mode
Data transfer rate:	1.5/12 Mbit/s, auto detecting
Connector:	Mini-USB (camera cable)
Cable length:	Max. 6 meters
Function:	FAT32(Comtrade), Modbus, FAT32 for firmware update (only boot loader mode)

The USB port is designed to provide PC connection with the controller. Programming and monitoring can be done via RainbowPlus program.

The RainbowPlus program is available for free on **www.datakom.com.tr**.

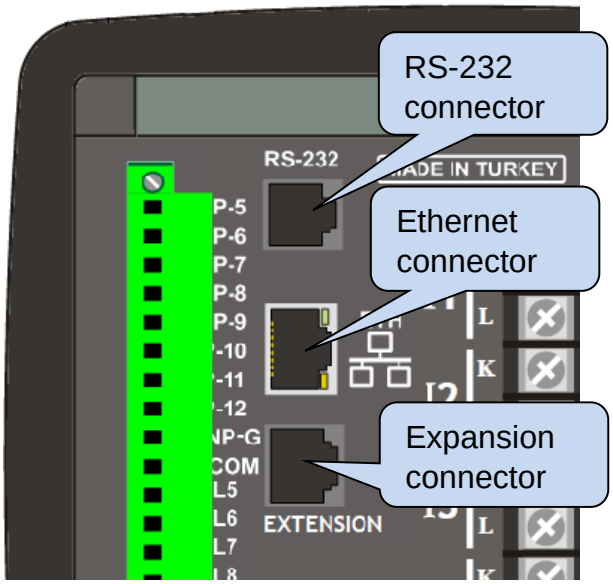
The connector type is Mini-USB. The cable type is the commonly available camera cable.

Please refer to the RainbowPlus user manual for more detailed information about monitoring, programming, and control.

The USB connection may power-up the device. An extra power supply is not required for testing.

The RS-485 inputs are inactive while the device is supplied via USB.

3.8. ETHERNET PORT (OPTIONAL)



Description:	IEEE802.3 compliant, 10/100 Base-TX RJ45 ethernet port with indicating LEDs
Data transfer rate:	10/100 Mbit/s, auto detecting
Connector:	RJ45
Cable type:	CAT5 or CAT6
Isolation:	1500 VAC, 1 minute
Max. distance:	30m
Function:	IEC 61850, Modbus TCP_IP

LED FUNCTIONS:

GREEN: This LED turns on when the Ethernet link is established (connectors inserted).

YELLOW: This LED blinks while incoming or outgoing data transfer occurs. Periodic blinking will witness data flow.

3.9. RS-232 PORT (OPTIONAL)

RS-232 port is used to connect the separately sold modem unit. The connection cable is supplied with the modem.

Description:	RS-232, non-isolated.
Function:	External DKG-090 GSM modem
Data transfer rate:	2400-115200 baud, selectable.
Data type:	8 bit data, no parity, 1 bit stop

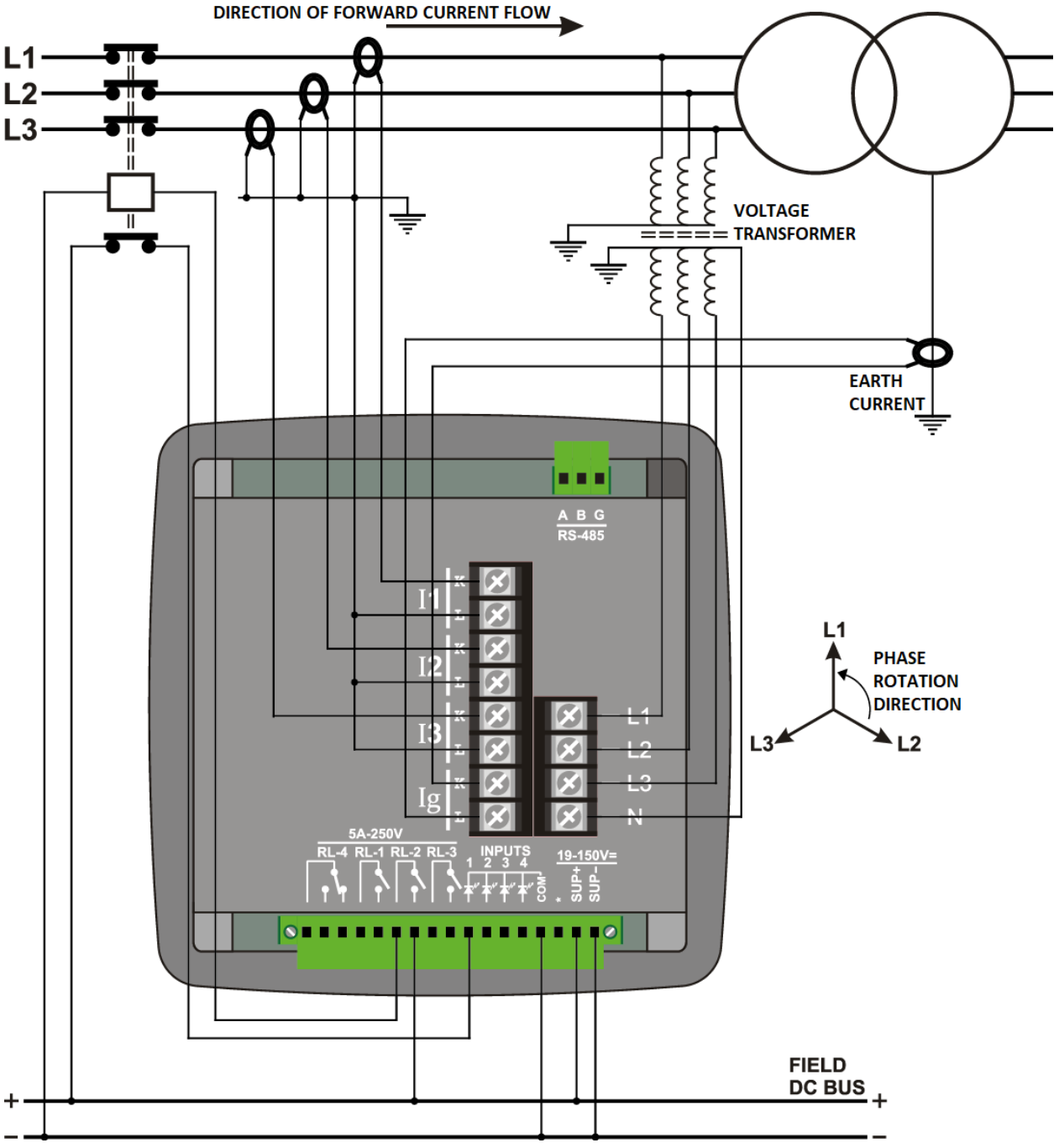
3.10. EXPANSION PORT (OPTIONAL)

The expansion port is used to connect to the external input / output expansion modules. The connection cable is supplied with the external module.

Digital inputs can be extended using extension module, each one providing 8 inputs. Digital inputs are programmable through the main controller.

Digital outputs can be extended using extension module, each one providing 8 outputs. They have programmable functions through the main controller.

4. CONNECTION DIAGRAM



5. TERMINAL DESCRIPTIONS

Terminal	Function	Technical Data	Description
1	I1_K	Current Transformer Inputs, In=5A-AC, Imax=50xIn	Connect the Current Transformer to these terminals. Be sure to connect CTs to the correct inputs in the correct polarity. The CT primary value must be the same for each of the 3 phases. CT Secondary current must be 1 or 5 Amps. (example: 200/5 A).
2	I1_L		
3	I2_K		
4	I2_L		
5	I3_K		
6	I3_L		
7	Ig_K		
8	Ig_L		

Terminal	Function	Technical Data	Description
9	NEUTRAL	Phase inputs, 0-100V-AC	Connect voltage measurement terminals to these terminals.
10	PHASE-L1		
11	PHASE-L2		
12	PHASE-L3		

Terminal	Function	Technical Data	Description
21-22	RL-1	Relay Output, NO, 5A/250VAC	Relay function can be configured via the input/output matrix. Factory preset is "**CB Rly**".
23-24	RL-2	Relay Output, NO, 5A/250VAC	Relay function can be configured via the input/output matrix. Factory preset is "**CBfail 1**".
25-26	RL- 3	Relay Output, NO, 5A/250VAC	Relay function can be configured via the input/output matrix. Factory preset is "**CBfail 2**" .
27-28-29	RL- 4	Relay Output, NO-NC, 5A/250VAC	Relay function can be configured via the input/output matrix. Factory preset is "**Reclose**".

Terminal	Function	Technical Data	Description
30	**DIGITAL INPUT 1**	Digital inputs are optically isolated from other terminals. **Active Level:** +19VDC to +140VDC	Digital input function can be configured via the input/output matrix. Factory preset is "**Relay-1**". RL-1 follows this input.
31	**DIGITAL INPUT 2**		Digital input function can be configured via the input/output matrix. Factory preset is "**MC**" (breaker closed contact info for mimic diagram).
32	**DIGITAL INPUT 3**		Digital input function can be configured via the input/output matrix. Factory preset is "**MO**" (breaker open contact info for mimic diagram).
33	**DIGITAL INPUT 4**		Digital input function can be configured via the input / output matrix. Factory preset is "**ML**" (load break switch info for mimic diagram).
34	**INPUT GROUND**	Digital inputs 0Vdc.	

Terminal	Function	Technical Data	Description
35	**RS-485-GROUND**	Grounding terminal	Connect the shield of the RS-485 cable to this terminal.
36	**RS-485 B**	Digital communication port	Connect the A-B terminals of the RS-485 data line to these inputs.
37	**RS-485 A**		

Terminal	Function	Technical Data	Description
38	**SUPPLY POSITIVE**	19VDC - 150VDC Power supply inputs are isolated from other terminals.	Supply input positive terminal
39	**SUPPLY NEGATIVE**		Supply input negative terminal

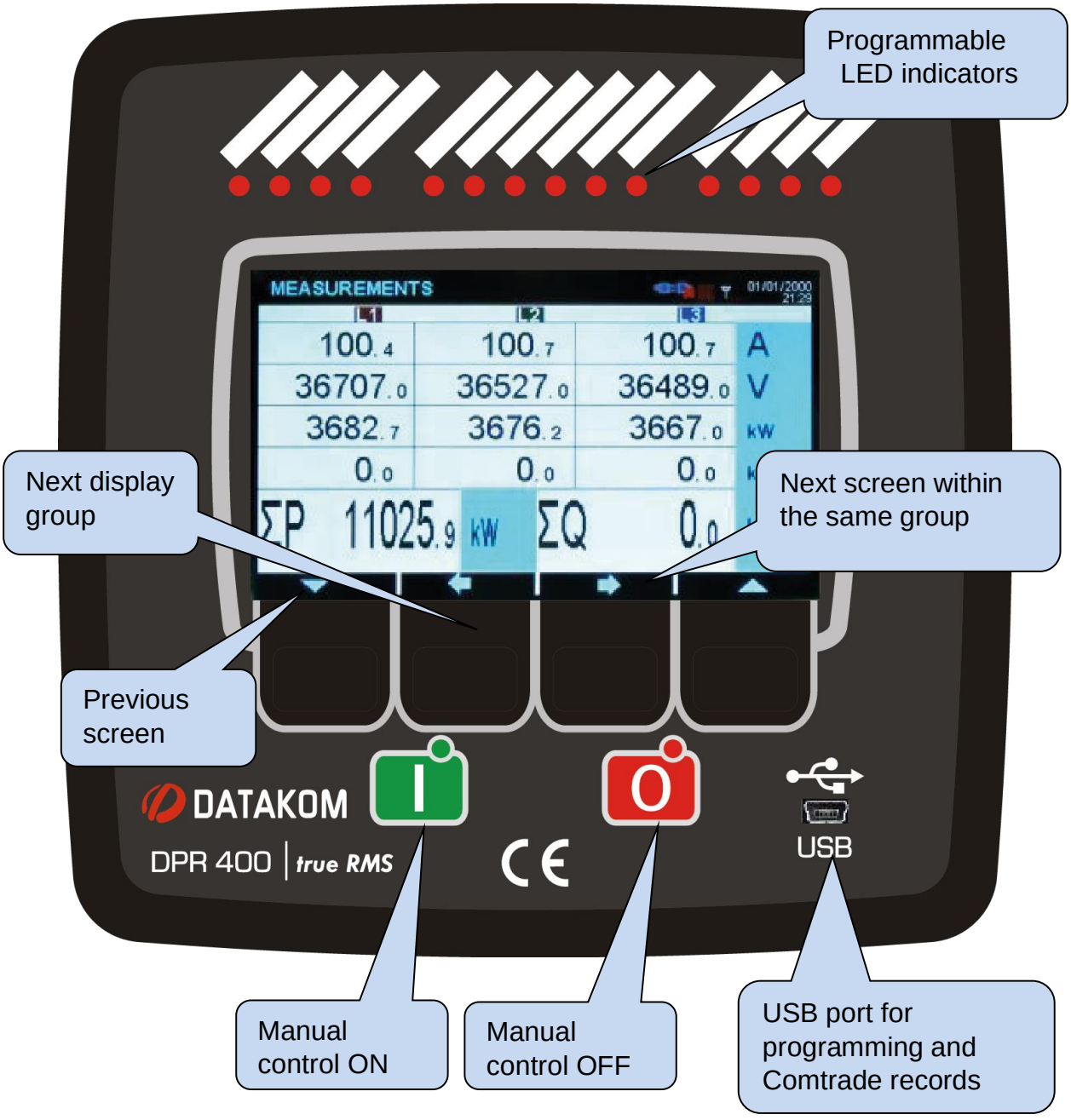
6. TECHNICAL SPECIFICATIONS

Power Supply Input: 19 – 150VDC
Power Consumption: < 10 VA
Nominal Frequency: 50/60 Hz
Phase Current Transformer Secondary: 1A/5A
Ground Current Secondary: 1A/5A
Protection Inputs:
Current: 0.1 – 250.0 A AC
Voltage: 5 - 100 V AC (Ph-N)
10 – 170 V AC (Ph-Ph)
Measuring Inputs:
Current: 0.01 – 6.0 A AC
Voltage: 5 - 100 V AC (Ph-N)
10 - 170 V AC (Ph-Ph)
Withstanding:
Current Inputs: 100xIn 1 second duration.
Voltage Inputs: 1300 V AC (continuous)
Burden:
Current Inputs: < 0.5 VA per phase @ In
Voltage Inputs: < 0.02VA per phase @ 100V (Ph-N)
Analyzer Measurement Accuracy:
Voltage: % 0.5 + 1 digit
Current: % 0.5 + 1 digit
Frequency: % 0.2 + 1 digit
Power (kW,kVAr)**:** %1.0 + 2 digit
Cos: % 0.5 + 1 digit
Measurement Range:
CT Range: 5**/**5A to 30000**/**5A
VT Range: 1.0/1 to 50000.0/1
kW Range: 1.0 kW to 5000 MW
Relay Outputs: 5A @ 250VAC
Digital Inputs:
Active Level: 19 - 140V DC or AC
Min pulse: 100ms.
Isolation: 1000V AC, 1 minute
Serial Port:
Signal Type: RS-485
Communication: Modbus RTU, 60870-5-103
Data Transfer Rate: 2400-115200baud, configurable
Isolation: 500V AC, 1 minute
Operating Environment Temperature: -20°C to +70 °C
Maximum Relative Humidity: %95 non-condensing
Altitude: 2000m. max.
Protection Rating: IP 65 (Front panel, with sealing gasket), IP 30 (Back panel)
Enclosure: Flame retardant, ROHS compliant, high temperature non-flammable ABS/PC (UL94-V0)
Mounting: Panel mounted with rear retaining plastic brackets.
Dimensions: 164x164x69mm (WxHxD)
Panel Cutout Dimensions: 140x140mm
Weight: 630 gr

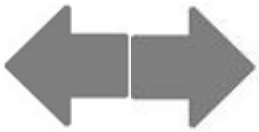
EU Directives:	**Reference Standards:**	**OTHER STANDARDS:**
2014/35/EC (LVD)	EN 61010 (safety)	EN60255 Electrical Relays
2014/30/EC (EMC)	EN 61326 (EMC)	EN60068 Environmental Conditions
		EN60529 Protection Levels

7. DESCRIPTION OF CONTROLS

7.1. FRONT PANEL FUNCTIONALITY



7.2. PUSHBUTTON FUNCTIONS

BUTTON	FUNCTION
MANUAL	Hold pressed for 1 second: Manual control mode is activated. If manual control is password protected, the password must be entered first
	Move to previous display group.
	Move to next display group. Removes alarms if an alarm is displayed on screen. Hold pressed for 1 second: Reset all alarms.
	Move to next screen within the group. Increase selected value in Programming mode. Hold pressed for 5 seconds: The current screen is assigned as main opening screen.
	Decrease selected value in Programming mode.
	Hold pressed together for 5 seconds: Enter Programming mode.
	Return to previous menu discarding changes, cancel or exit.
	Approve changes, set, or accept.
	Breaker ON
	Breaker OFF

7.3. MEASURED PARAMETERS

The controller measures multiple analog parameters with high accuracy.

List of measured parameters is given below:

L1-N voltage
L2-N voltage
L3-N voltage
L1-L2 voltage
L2-L3 voltage
L3-L1 voltage
L1 current
L2 current
L3 current
Ground current
L1 current (coarse measurement, using protection circuit)
L2 current (coarse measurement, using protection circuit)
L3 current (coarse measurement, using protection circuit)
Ground current (coarse measurement, using protection circuit)
Ground current
Frequency (Hz)
Total active power
Total reactive power
L1 active power (kW)
L2 active power (kW)
L3 active power (kW)
L1 reactive power (kVAr)
L2 reactive power (kVAr)
L3 reactive power (kVAr)

8. DISPLAY SYMBOLS

SYMBOL	DESCRIPTION
Ver	Firmware version
U12	Phase 1 - Phase 2 AC RMS Voltage
U23	Phase 2 - Phase 3 AC RMS Voltage
U31	Phase 3 - Phase 1 AC RMS Voltage
FRQ	Frequency
V1	Phase 1 - Neutral AC RMS Voltage
V2	Phase 2 - Neutral AC RMS Voltage
V3	Phase 3 - Neutral AC RMS Voltage
I1	Phase 1 AC RMS Current
I2	Phase 2 AC RMS Current
I3	Phase 3 AC RMS Current
Ig	Ground Current
i1	Phase 1 AC RMS Current (Coarse measurement for protection)
i2	Phase 2 AC RMS Current (Coarse measurement for protection)
i3	Phase 3 AC RMS Current (Coarse measurement for protection)
iG	Ground Current (Coarse measurement for protection)
P1	Phase 1 Active Power (kW)
P2	Phase 2 Active Power (kW)
P3	Phase 3 Active Power (kW)
∑P	Total Active Power (kW)
Q1	Phase 1 Reactive Power (kVar)
Q2	Phase 2 Reactive Power (kVar)
Q3	Phase 3 Reactive Power (kVar)
∑Q	Total Reactive Power (kVar)

8.1. AUTOMATIC DISPLAY SCROLL

The controller measures many electrical parameters. The viewing of these parameters are organized into DISPLAY GROUPS and their sub categories.

Moving between different display groups is done by and buttons.

Each time is pressed, the next parameter group screen is displayed. The group display goes back to the first screen after pressing this button in the last screen.

Each time is pressed, the previous parameter groups screen is displayed. The group display goes back to the last screen after pressing this button in the first screen.

Moving within the same display group is done using the button.

Each time is pressed, the next screen within the same group is displayed. Pressing this button in the last screen will move back to the first screen.

Parameter groups are listed below:

Mimic Diagram: Screens showing protection status.

Measurement Screens: Voltage, current, kW, kVAr values

Information Screens: Date & time, firmware revision, controller ID, configured values, etc...

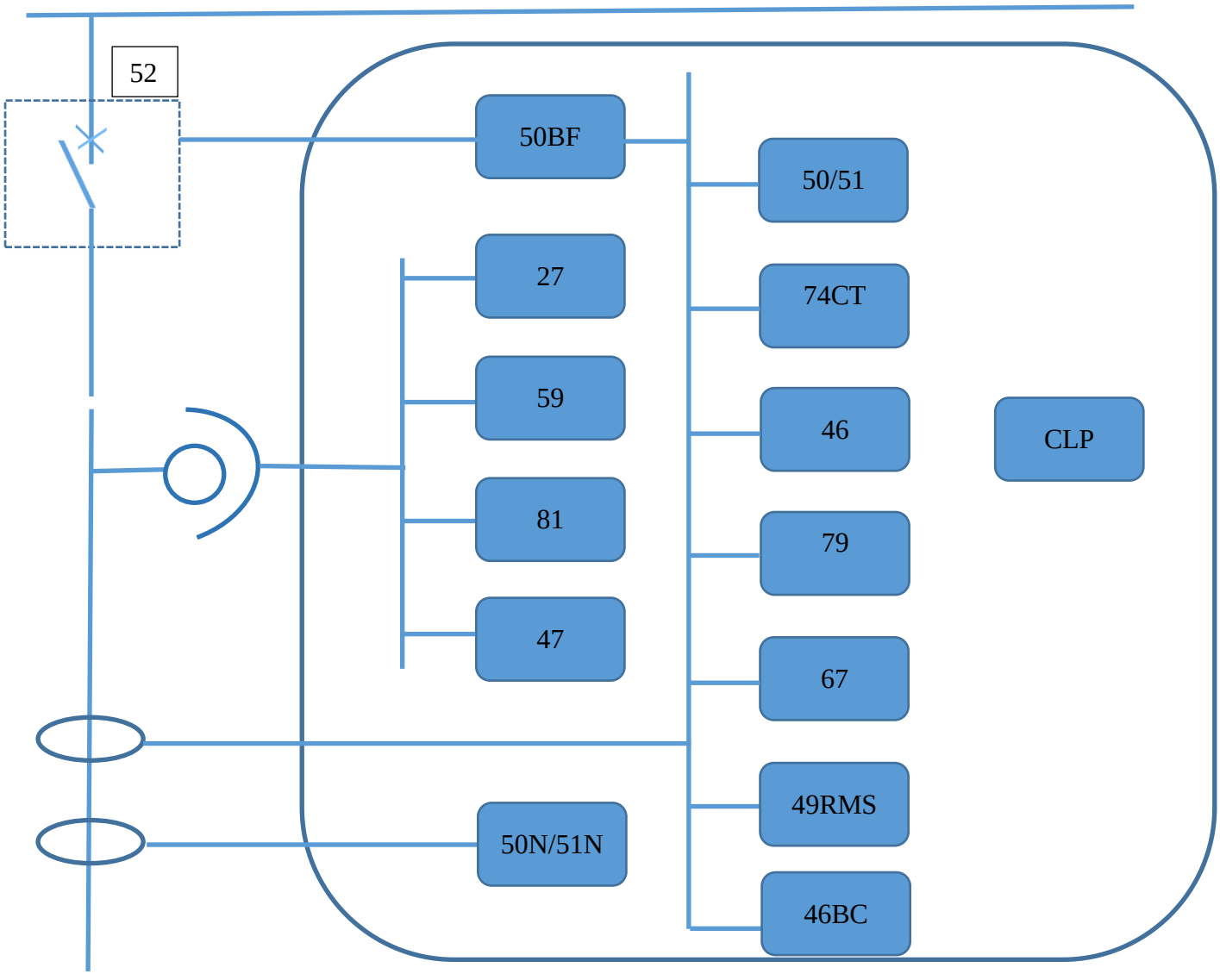
Ethernet Screens: Ethernet communication related screens.

9. PROTECTION FUNCTIONS

9.1. GENERAL FEATURES

DPR-400 offers overcurrent protection relay functionality in order to protect and manage transmission lines. Supported ANSI protection functions are listed below:

- Overcurrent protection (ANSI 50/51)
- Negative Sequence Overcurrent (ANSI 46)
- Directional Overcurrent (ANSI 67)
- Broken Conductor (ANSI 46BC)
- Breaker Failure (ANSI 50BF)
- Ground Overcurrent (ANSI 50N/51N)
- CT Supervision (ANSI 74CT)
- Reclosure (ANSI 79)
- Cold Load Pickup (CLP 50/51)
- Thermal Overload (ANSI 49RMS)
- Under / High Voltage Protection (ANSI 27/59)
- Under / High Frequency Protection (ANSI 81U / 81O)
- Negative Sequence Over Voltage (ANSI 47)



9.2. TIME CALCULATION FOR CURVES

The DPR-400 controller offers constant time and 12 different variable time curves for protection functions.

Current / time curves are usually calculated using the equation below:

$$t(I) = T * \left[\frac{\beta}{\left(\frac{I}{Is}\right)^{\propto} - 1} + L \right] + C$$

Here:

t(I) = Trip time as a function of input current I

I = Instantaneous secondary current value of the phase

Is = Fault threshold for secondary current

T = Time coefficient (TD for IEEE, TMS for IEC)

β = Constant for the given curve

α = Constant for the given curve

L = Constant for IEEE, 0 for IEC

C = Constant additional delay

CURVE	STANDARD	β	α	L
Constant Time	DT	$IfI > Is; set = T$		
Standard Inverse	IEC	0.14	0.02	0
Very Inverse	IEC	13.5	1	0
Extremely Inverse	IEC	80	2	0
Long Time Inverse	UK	120	1	0
RI (electromechanical)	RI	$t = K * \left(\frac{1}{0.339 - \left(\frac{0.236}{\frac{I}{Is}}\right)} \right)$,K between 0.1-10		
Moderately Inverse	IEEE	0.0515	0.02	0.114
Very Inverse	IEEE	19.61	2	0.491
Extremely Inverse	IEEE	28.2	2	0.1217
Inverse	US	5.95	2	0.18
Short Time Inverse	US	0.16758	0.02	0.11858
IDG	IDG	$t = 5.8 - 1.35 * log_e\left(\frac{I}{Is}\right)$		
Rectifier	UK	45900	5.6	0

The DPR-400 offers the following parameters to configure protection functions:

PARAMETER	DESCRIPTION	VALID CURVES
Status	Protection is activated or deactivated.	All
Function	Protection curve	All
Direct.	Direction setting for directional protection	All
Set Val	(Is) Fault threshold for current	All
Time Dly	(T) Constant time protection time	DT
TMS	(T) Time multiplier for IEC curves	IEC-S, IEC-V, IEC-E, UK-LT, UK-RC
Time Dial	(T) Time multiplier for IEEE curves	IEEE-M, IEEE-V, IEEE-E, US, US-ST
K	(K) Time multiplier for RI (electromechanical) curve	RI
DT Adder	(C) Additional delay time	All except RI and IDG
Reset Ch	Timer reset function if fault is dismissed	IEEE-M, IEEE-V, IEEE-E, US, US-ST
Reset Time	Timer reset delay if fault is dismissed	All

Table 9.1

9.3. OVERCURRENT PROTECTION (ANSI 50/51)

If any of the phase currents exceeds the configured threshold value, the function begins calculating the trip time using the given parameters. This output trips the breaker at the end of the configured time, according to constant time (DT) or variable inverse time (IDMT).

There are 4 levels of configuration parameters for overcurrent. This allows for configuring different trip timers for different input currents. For example, level 1 (I>) can be used for overcurrent protection, while level 2 (I>>) can be used for short circuit protection with sudden trip (constant time (DT) and trip timer set to 0).

The controller allows directional protection for overcurrent. It can be used for single directional protection, or level 1 (I>) protection may be programmed for forward directional protection while level 2 (I>>) can be configured for reverse directional protection.

9.4. NEGATIVE SEQUENCE OVERCURRENT PROTECTION (ANSI 46)

The controller continuously measures the negative sequence current component and provides 4 levels of optionally directional protection. Constant time (DT) and variable time (IDMT) protection curves identical to the overcurrent protection are available.

Negative component protection provides protection from unbalanced loading. In particular, generators can handle only a certain amount of unbalanced loading. Generators must be broken from the circuit in case of an extreme unbalance. In case of unbalance, the symmetry of stator currents is broken and a negative current component in the opposite direction begins to flow. These negative current components cause extra heating along with mechanical problems such as rotor vibrations.

There are 4 levels of configuration parameters for negative component overcurrent. This allows for configuring different trip timers for different input currents. For example, level 1 (I2>) protection may be programmed for negative component overcurrent, while level 2 (I2>>) can be used for short circuit protection with sudden trip (constant time (DT) and trip timer set to 0).

The controller allows directional protection for negative component overcurrent. It can be used for single directional protection, or level 1 (I2>) protection can be programmed for forward directional protection while level 2 (I2>>) can be configured for reverse directional protection.

9.5. DIRECTIONAL OVERCURRENT PROTECTION (ANSI 67)

If the voltage and current of one phase are in the same direction, the current is flowing from the source to the load, which means it is forward directional. If the voltage and current of one phase are in opposite directions, the current is flowing from the load to the source, which means it is reverse directional. Protections can be configured directionless or for either of these directions.

As explained in the “OVERCURRENT PROTECTION (ANSI 50/51)” section, protections can be configured as directional. In addition, different levels of protection can be configured for forward and reverse directions.

9.6. BROKEN CONDUCTOR (ANSI 46BC)

Broken conductor can be recognized basically from the unbalance in the forward and reverse directional components of current (I2/I1). Here, I2 is the reverse directional current component and I1 is the forward directional component of the current. If one of the phase wires is broken, which means its current value is 0, the I2/I1 ratio becomes 50%. This protection can also be used for unbalanced loading protection purposes.

Two fundamental values determine the configuration of this protection:

1. Current threshold value (% I2/I1)
2. Trip timer (sec)

9.7. CT SUPERVISION (ANSI 74CT)

The CT supervision feature operates on detection of derived zero sequence current, in the absence of corresponding derived zero sequence voltage that would normally accompany it.

9.8. GROUND OVERCURRENT PROTECTION (ANSI 50N/51N)

If the ground current exceeds the configured threshold, this function begins calculating the trip timer for the given parameters. This output trips the breaker at the end of the configured timer. This protection can be configured as constant time (DT) or variable time (IDMT).

There are 2 levels of configuration parameters for ground overcurrent. This allows for configuring different trip timers for different input currents. For example, level 1 (IN>) can be used for overcurrent protection while level 2 (IN>>) can be used for short circuit protection with sudden trip (constant time (DT) and trip timer set to 0).

9.9. NEGATIVE SEQUENCE OVER VOLTAGE (ANSI 47)

This function operates on the negative components of the 3 phase voltage vectors has only one threshold and uses the constant time trip characteristic curve.

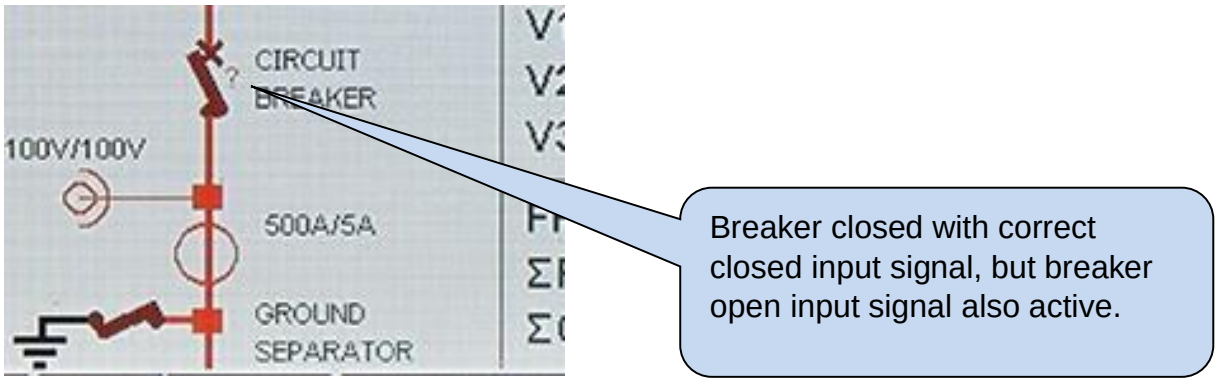
9.10. BREAKER FAILURE (ANSI 50BF)

If the breaker fails to open at the end of the configured timer when the open command was sent, this means that the breaker has failed to perform its function, and is malfunctioning. In this situation, breaker failure status occurs. A digital output may be configured as breaker failure output.

- **Breaker Monitoring:**

Digital inputs can be configured to read the open and closed contacts of the breaker. If breaker contact information is assigned to digital inputs, abnormal situations will be displayed on the device's protection screen (MIMIC DIAGRAM) with the following symbols:

SYMBOL	DESCRIPTION
?	Breaker closed with correct closed input signal, but breaker open input signal also active.
??	Breaker open with correct open input signal, but breaker closed input signal also active.
X	Opposite breaker position and input position. Input reads closed while breaker is open, or input reads open while the breaker is closed.
	No symbol means breaker position and input values are correctly corresponding, or inputs are not configured to read breaker position.



9.11. AUTOMATIC RECLOSURE (ANSI 79)

After a successful breaker trip, the system can be asked to try a reclosure if the fault cause is removed. Up to 4 reclosure trials at different times can be done and the number of trials can be configured. In addition, a no-fault timer after which the reclosure is counted as successful can be configured.

Automatic reclosure can be assigned to any output.

9.12. COLD LOAD PICKUP (CLP 50/51)

Cold load pickup operation is used to prevent unwanted conditions while energizing after long duration power losses. Temporary pulse currents which exceed protection threshold values may be formed when restoring power, depending on the characteristics of the network's load. These current transients may be due to the following reasons:

- Pulse magnetization currents of transformers
- Starting currents of asynchronous motors
- Collective activation of air conditioning of heating loads

Protections should normally be configured so as not to trip the breaker in similar transient situations. However, configuring the protection functions to consider such transient current fluctuations will not always be possible as it will require setting very high values or very long timers. Instead, cold load pickup will temporarily inhibit protection threshold values to prevent faulty breaker trips.

9.13. THERMAL OVERLOAD (ANSI 49RMS)

On the field, long term loads which are not high enough to trip cause faults and heating in the wires. The amount of heating can be calculated using formulas which are determined by network characteristics, current flow, and time. According to the IEC 60255-8 standard, this thermal loading can be calculated as follows:

$$t = T_e * log_e \left[\frac{\left| I^2 - \left(k * I_{flc}\right)^2 \right|}{\left| I^2 - {I_p}^2 \right|} \right]$$

Here;

t → Time remaining for protection at given current value
Te → Thermal constant coefficient, entered as a parameter
I → Maximum phase current
Iflc → Current threshold, entered as a parameter
K → 1.05 constant, continuous operation permitted up to 105% of Iflc
Ip → Stable current value before going into overload

9.14. UNDER VOLTAGE PROTECTION (ANSI 27)

The controller offers 2 levels of under voltage protection. These protections can be configured as phase-phase as well as phase-neutral. In addition, protection may be desired if any or all of the three phases are below the threshold value. Voltage protections can be disabled if breaker is open or the voltage and current values of one phase are simultaneously zero. Protections can be configured as constant timer or variable timer.

9.15. HIGH VOLTAGE PROTECTION (ANSI 59)

The controller offers 2 levels of high voltage protection. These protections can be configured as phase-phase as well as phase-neutral. In addition, protection may be desired if any or all of the three phases are above the threshold value. Protections can be configured as constant timer or variable timer.

9.16. UNDER FREQUENCY PROTECTION (ANSI 81U)

The controller offers 2 levels of under frequency protection. Frequency protections can be disabled if the breaker is open or the voltage and current of one phase are simultaneously equal to zero. Protections can be configured as constant timer or variable timer.

9.17. HIGH FREQUENCY PROTECTION (ANSI 81O)

The controller offers 2 levels of high frequency protection. Protections can be configured as constant timer or variable timer.

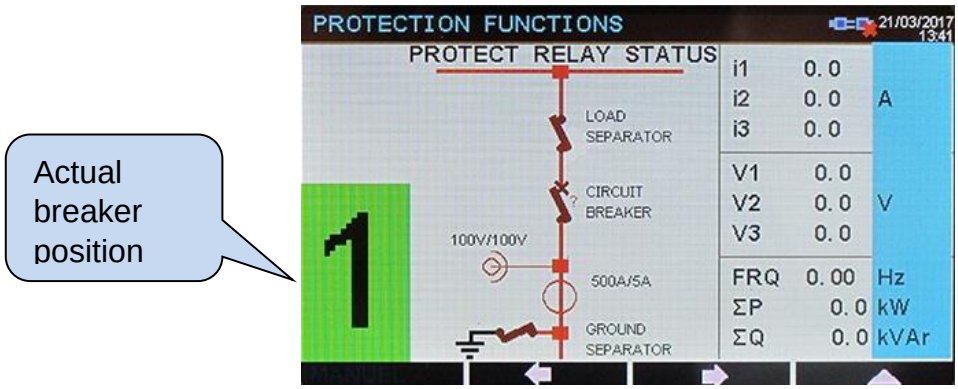
10. MIMIC DIAGRAM

The controller offers a mimic diagram screen which displays the breaker position. This screen is the factory default upon the device being powered on. In addition, the device shows this screen if no keys have been pressed for 1 minute.

On the mimic diagram screen, the current, phase-neutral voltage, frequency, total active and reactive power values of the phases of the protection circuit are displayed.

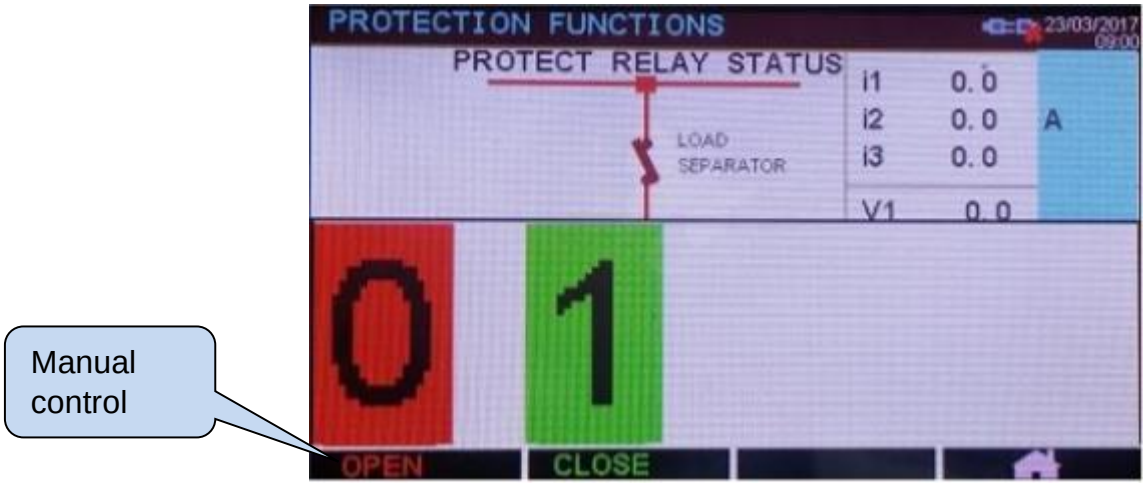
If digital inputs have been configured to breaker open and closed contact, this screen displays the related error symbols. For detailed information about the symbols, refer to "**BREAKER FAILURE (ANSI 50BF)"** section.

In addition, the mimic diagram screen displays the current and voltage transformer ratios along with the load and ground breaker status if assigned to digital inputs.



Mimic Diagram Display

ON & OFF buttons allow manual open and close. If so desired, pressing the button discards, changes and exits.



Manual Control Display

11. PROGRAMMING

Programming mode is used to configure timers, operation limits and parameters.

While every program parameter can be changed from the front panel of the controller, they can also be changed using the free "**RainbowPlus**" PC software.

Parameter changes are automatically saved to non volatile memory and are effective immediately.

Entering program mode does not affect device operation.

11.1. ENTERING PROGRAM MODE

To enter program mode, press and hold the ⬅ and ➡ buttons for 5 seconds. Upon entering the program mode, the following password prompt is displayed:

The 4-digit password must be entered using the ⬆, ⬇ and ↵ buttons.

⬆ and ⬇ buttons change the digit value. ↵ button moves to the next digit.

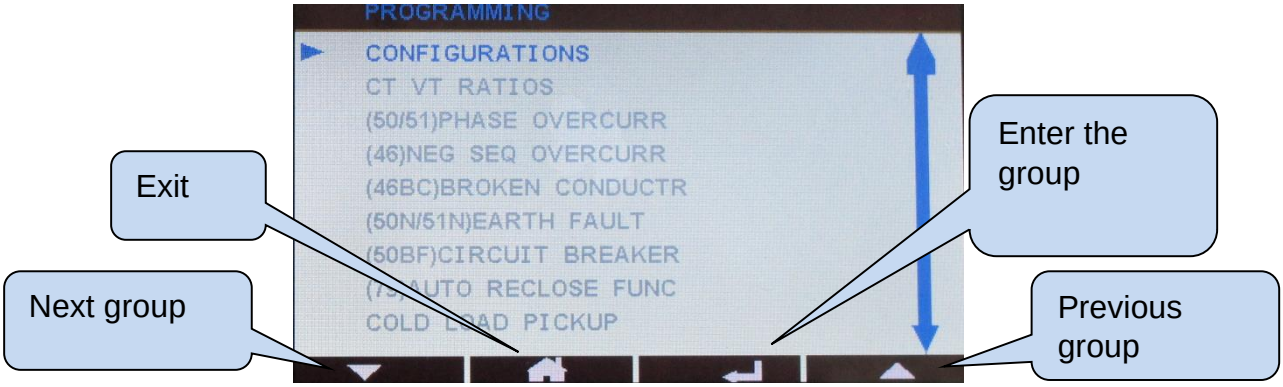
The controller stores 3 different passwords. Level_1 password allows necessary parameter changes on the field. Level_2 password is used to enter factory level settings. Level_3 password is reserved for calibration parameters.

Level-1 password is '**1234**' and level-2 password is '**9876**'.

11.2. NAVIGATING BETWEEN MENUS

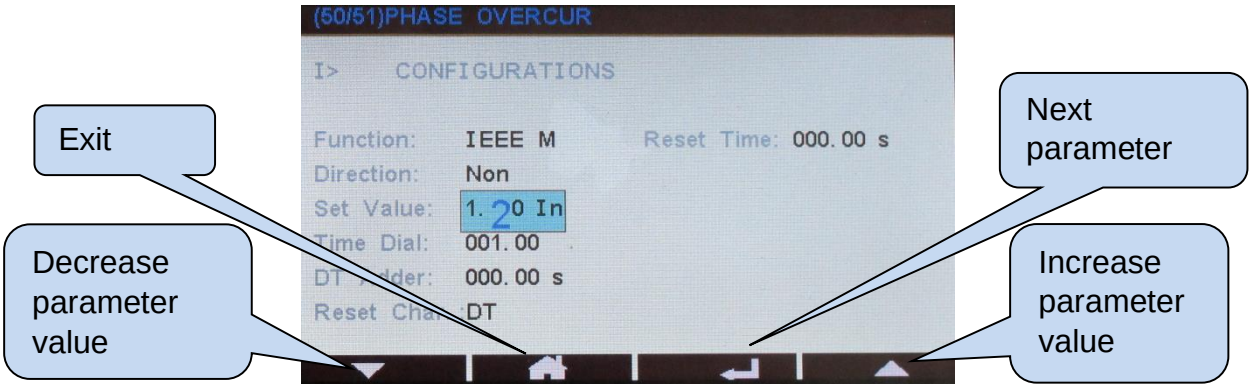
The programming mode is organized into a 2-level menu system. Main menu is composed of program groups. Program parameters are located within the groups.

Upon entering the programming mode, the list of program groups are displayed. Navigation between groups is done using and buttons. The selected groups is highlighted in blue with a blue arrow to its left. To enter the group, press button. To go back to the main menu from the group, press button.



Within the group, and buttons are used to navigate between program parameters. Valid parameters are listed on the screen. The selected parameter is highlighted in blue with a blue arrow to its left. To view / change the value of this parameter, press button. The parameter value is increased / decreased with and buttons. The parameter value is saved to memory once it has been modified. button moves to the next parameter.

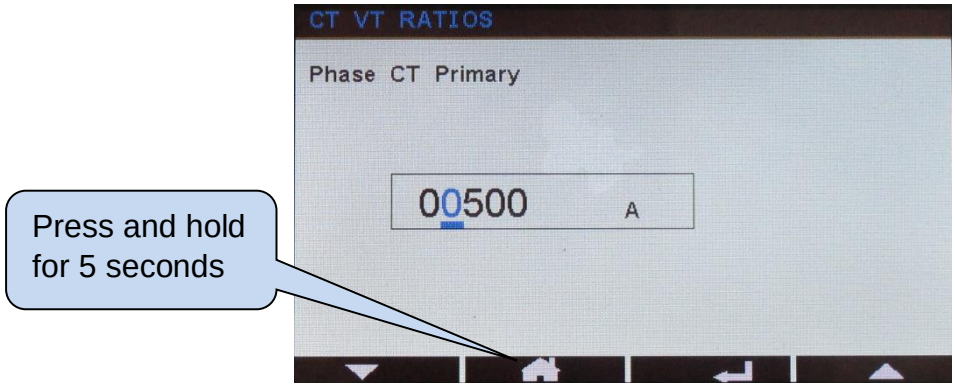
11.3. MODIFYING PARAMETER VALUE



11.4. EXITING PROGRAM MODE

In order to exit program mode, press and hold button for 5 seconds.

The controller exits the program mode automatically if there is no action after 2 minutes.



12. PROGRAM PARAMETER LIST

12.1. EVENT RECORDS

The controller records 95 most recent events with 1 millisecond accuracy. These records are independent from the oscillographic (Comtrade) records. Any change of position at any digital input or relay output, any changes made in controller configuration or any manual control of the breaker will trigger a record.

In the event record, information such as input positions, output positions, electrical measurements are stored.

Event records are listed from most recent to earliest. Last event is listed first.

12.2. CONTROLLER CONFIGURATION GROUP

Parameter Definition	Unit	Min	Max	Factory Setting	Description
LCD Backlight	%	3	100	100	LCD background brightness ratio
Language Selection	-	0	1	0	**0:** English **1:** Local Language. This option can vary according to the country of use. Different languages can be uploaded using Rainbow Plus software.
Active Parameter Group	-	0	2	0	Protection functions can be configured in 3 distinct groups. The protections corresponding to the selected group are active. Group selection can also be configured from digital inputs. **0:** A Group **1:** B Group **2:** C Group
Intermittent Relay Timer	Sec	0	255	1	If Intermittent Relay Active parameter is set to 1, the horn relay engages and disengages intermittently for the duration of this timer.

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Ethernet Active	-	0	1	1	**0:** ETHERNET port off **1:** ETHERNET port on
Fine Clock Adjustment	-	0	255	117	
Periodic Record Timer	Min	0	70000	60	Configures the periodic event record timer.
Intermittent Relay Active	-	0	1	0	**0:** continuous **1:** intermittent
Relay-2 Control Active	-	0	1	0	**0:** Off **1:** On
Relay-3 Control Active	-	0	1	0	**0:** Off **1:** On
Alarm Event Record	-	0	1	1	**0:** Off **1:** On
Warning Event Record	-	0	1	0	**0:** Off **1:** On
Output Modified Record	-	0	1	1	**0:** Off **1:** On
Input Modified Record	-	0	1	1	**0:** Off **1:** On
Controller Reset Record	-	0	1	1	**0:** Off **1:** On
Periodic Event Record	-	0	1	1	**0:** Off **1:** On
Programming Mode Entry Record	-	0	1	0	**0:** Off **1:** On
Manual Control Password Protection	-	0	1	0	**0:** free **1:** password protected
Ping Period	Sec	30	900	120	The controller checks the activity of the Internet connection periodically with period configured here.
Rainbow Refresh Timer	Sec	0	65535	60	The controller sends data to the remote monitoring system periodically with period configured here.
Rainbow Address 1 Port	-	0	65535	90	The port number of the first address which will receive the data sent by the controller
Rainbow Address 2 Port	-	0	65535	90	The port number of the second address which will receive the data sent by the controller.
Web Server Port	-	0	65535	80	This is the integrated web server port number. The controller responds to queries sent from this port only.
Modbus Over IP Port	-	0	65535	502	Internal Modbus TCP/IP server port number. The controller responds to Modbus queries sent from this port only.
E-mail Server Port	-	0	65535	587	Server port for e-mail sending.
LCD Backlight Timer	Min	0	1440	60	LCD background lighting timer
DEVICE SERIAL NUMBER	Char	-	-	-	Device serial number

12.3. TRANSFORMER CONFIGURATION

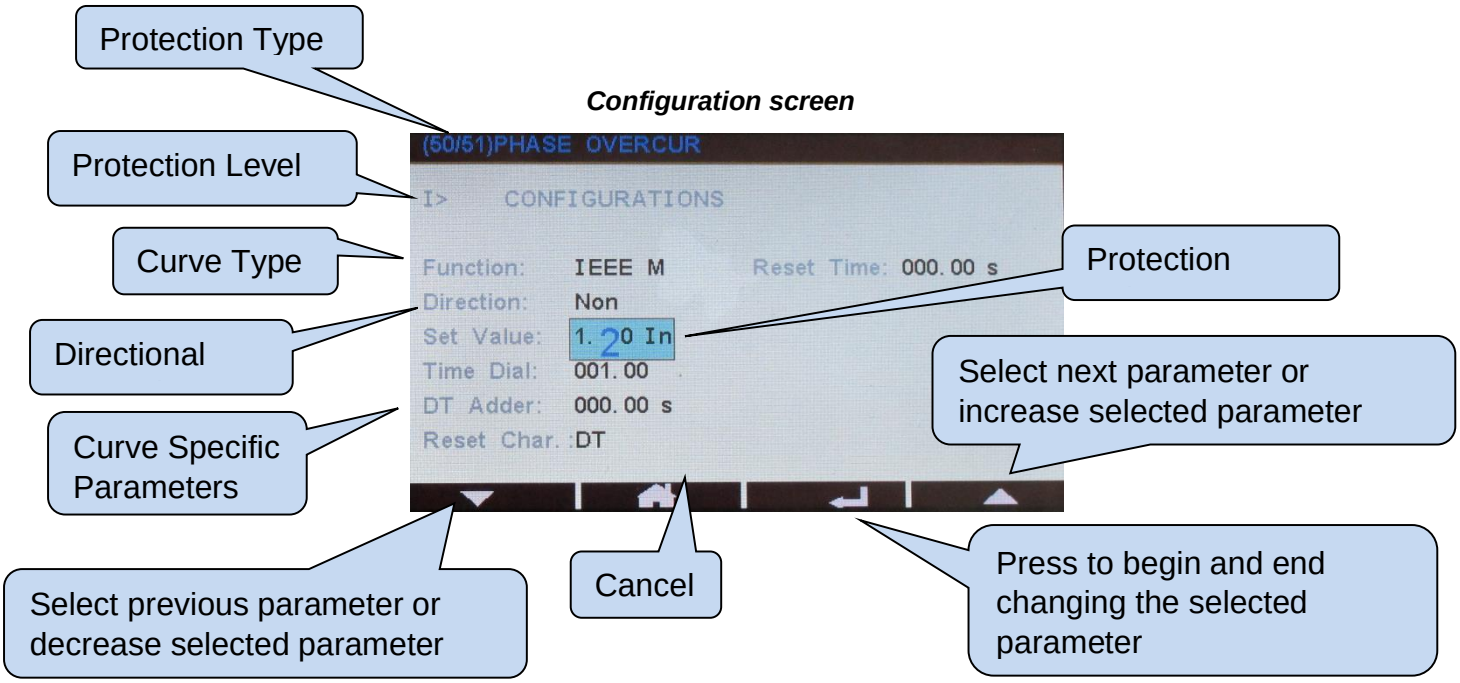
Parameter Definition	Unit	Min	Max	Factory Setting	Description
Voltage (VT) Primary	V	100	655350	100	Voltage transformer primary value. Must be set to 100V if not used.
Voltage (VT) Secondary	V	10	600	100	Voltage transformer secondary value. Must be set to 100 V if not used.
Current (CT) Primary	A	1	30000	500	Current transformer primary value
Current (CT) Secondary	-	0(5A)	1(1A)	0(5A)	**0:** 5A **1:** 1A This value is also used as nominal current value (In).
Ground Current (CT) Primary	A	1	30000	500	Current transformer primary value
Ground Current (CT) Secondary	-	0(5A)	1(1A)	0(5A)	**0:** 5A **1:** 1A This value is also used as nominal current value (In).
Nominal Frequency	Hz	50	69	50	Nominal frequency selection; 50 or 60Hz.

12.4. OVERCURRENT PROTECTION (ANSI 50/51)

The controller offers 4 levels of overcurrent protection, each with its own distinct parameter group.

Parameter Definition	Description	Factory Setting
I> Set	Parameters for level 1 protection	IEC, 1.00In, TMS=0.1
I>> Set	Parameters for level 2 protection	DT, 4.00In, Dly= 0.00s
I>>> Set	Parameters for level 3 protection	Inactive
I>>>> Set	Parameters for level 4 protection	Inactive

After selecting the desired protection level, the following screen which shows and allows changing only the selected function's parameters is displayed. One can return to programming mode by pressing button. Refer to ***Table 12.1*** for curve specific parameters.



Curve specific parameters:

PARAMETER	DT	IEC-S,V,E	UK-LT,Rec	RI	IEEE-M,V,E	US,US-ST	IDG
Status	X	X	X	X	X	X	X
Function	X	X	X	X	X	X	X
Direction	X	X	X	X	X	X	X
Set Value	X	X	X	X	X	X	
Time delay	X	X	X		X	X	
TMS		X	X				
Time Dial					X	X	
K				X			
DT Adder		X	X		X	X	
Reset Char					X	X	
Reset Time	X	X	X	X	X	X	
IDG Is							X
IDG Time							X
Type							
INH							

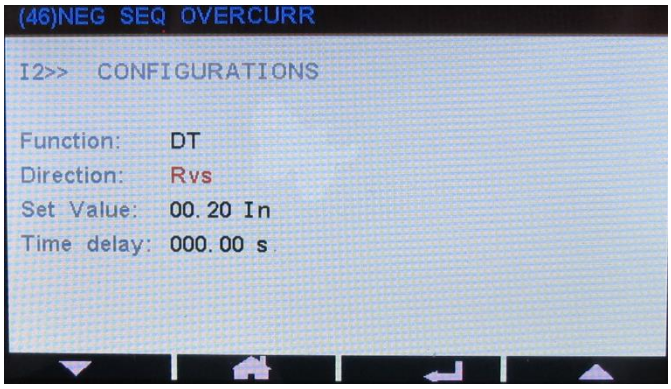
Table 12.1

12.5. NEGATIVE SEQUENCE OVERCURRENT PROTECTION (ANSI 46)

The controller offers 2 levels of negative component overcurrent protection, each with its own distinct parameter group. Refer to ***Table 12.1*** for curve specific parameters.

Parameter Definition	Description	Factory Setting
I2> SET	Parameters for level 1 protection	Inactive
I2>> SET	Parameters for level 2 protection	Inactive

After selecting the desired protection level, the following screen which shows and allows changing only the selected function's parameters is displayed. One can return to programming mode by pressing button.



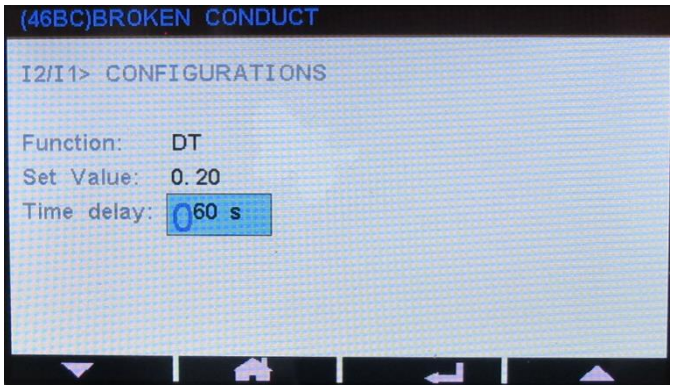
Configuration Screen

12.6. BROKEN CONDUCTOR (ANSI 46BC)

The unit offers 1 level of protection for broken conductor detection. Refer to ***Table 12.1*** for curve specific parameters.

Parameter Definition	Description	Factory Setting
I2/I1> SET	Parameters for level 1 protection	Inactive

After selecting the desired protection level, the following screen which shows and allows changing only the selected function's parameters is displayed. One can return to programming mode by pressing button.



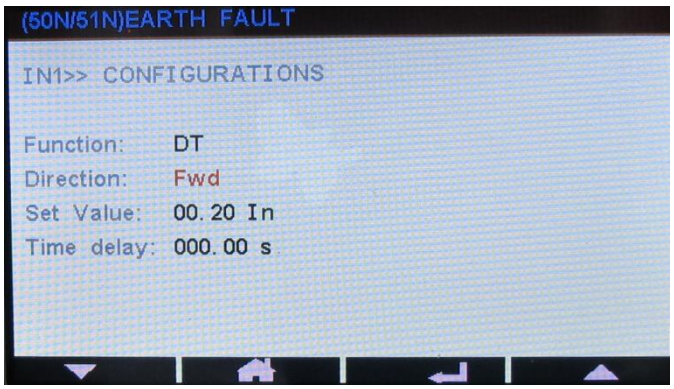
Function Configuration Screen

12.7. GROUND OVERCURRENT (ANSI 50N/51N)

The unit offers 2 levels of protection for ground overcurrent, each with its own distinct parameter group. Refer to table ***Table 12.1*** for curve specific parameters.

Parameter Definition	Description	Factory Setting
IN1> SET	Parameters for level 1 protection	Inactive
IN1>> SET	Parameters for level 2 protection	Inactive

After selecting the desired protection level, the following screen which shows and allows changing only the selected function's parameters is displayed. One can return to programming mode by pressing button.



Configuration Screen

12.8. FREQUENCY PROTECTION (ANSI 81U / 81O)

Parameter Definition	Description	Factory Setting
F< SET	Parameters for level 1 low frequency protection	Inactive
F<< SET	Parameters for level 2 low frequency protection	Inactive
F> SET	Parameters for level 3 low frequency protection	Inactive
F>> SET	Parameters for level 4 low frequency protection	Inactive

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Function	-	0	2	0	**0**: Inactive **1**: Constant Timer (DT) **2**: Inverse Timer (IEC S)
Frequency Setting	Hz	10.0	120.0	45.0	Threshold for low frequency protection
Delay Timer	Sec	0.00	100.00	10.00	Time delay for low frequency protection. Used for constant time protection.
TMS	-	0.5	100.0	1.0	Time multiplier for low frequency protection. Used for inverse time protection.
Dead Phase Protection INH	-	0	1	1	**0**: Inactive **1**: Active If the voltage value of phase R is 0, frequency protection is disabled.

12.9. THERMAL OVERLOAD PROTECTION (ANSI 49RMS)

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Characteristic	-	0	2	0	**0:** Off **1:** Single Thermal Overload running characteristic
Thermal Trip	In	0.08	4.00	1.00	Threshold value for thermal overload
Thermal Alarm	%	50	100	70	Alarm value before thermal overload threshold. Entered as percentage of threshold value.
Time Constant 1	Min	1	200	10	Time constant for thermal overload protection. For more details, please refer to **"9.13. THERMAL OVERLOAD (ANSI 49RMS)".**

12.10. VOLTAGE PROTECTION (ANSI 27/59)

Parameter Definition	Description	Factory Setting
V< SET	Parameters for level 1 low voltage protection	Inactive
V<< SET	Parameters for level 2 low voltage protection	Inactive
V> SET	Parameters for level 3 low voltage protection	Inactive
V>> SET	Parameters for level 4 low voltage protection	Inactive

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Function	-	0	2	0	**0**: Inactive **1**: Constant Time (DT) **2**: Inverse Time (IEC S)
Voltage Setting	V	10	120	80	Threshold value for level 1 protection
Delay Timer	Sec	0.00	100.00	10.00	Time delay for level 1 protection. Used for constant time protection.
TMS	-	0.5	100.0	1.0	Time multiplier for level 1 protection. Used for inverse time protection.
Dead Phase Protection INH	-	0	1	0	**0**: Inactive **1**: Active If the current and voltage values of a phase are 0 simultaneously, voltage protection for that phase is disabled.
Measurement Method	-	0	1	0	**0**: Phase-Phase **1**: Phase-Neutral
Operation Method	-	0	1	0	**0**: Any phase **1**: 3 phases simultaneously

12.11. NEGATIVE SEQUENCE OVER VOLTAGE (ANSI 47)

Parameter Definition	Description	Factory Setting
V2> SET	Parameters for negative sequence voltage protection	Inactive

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Function	-	0	1	0	**0**: Inactive **1**: Constant Timer (DT)
Voltage Setting	V	10	120	80	Threshold value for level 1 protection
Delay Timer	Sec	0.00	100.00	10.00	Time delay for level 1 protection. Used for constant time protection.

12.12. COLD LOAD PICKUP

This feature is used to prevent unnecessary trips which may occur in cases where the load is powered up suddenly after remaining unpowered for a long period of time. Only valid for **"OVERCURRENT PROTECTION (ANSI 50/51)"** and **"GROUND OVERCURRENT PROTECTION (ANSI 50N/51N)"**. The protections are valid for the parameter group defined in this section for a set duration after the system has been energized.

Parameter Definition	Description	Factory Setting
CLP I> SET	Parameters for level 1 cold load pickup.	Inactive
CLP I>> SET	Parameters for level 2 cold load pickup.	Inactive
CLP I>>> SET	Parameters for level 3 cold load pickup.	Inactive
CLP I>>>> SET	Parameters for level 4 cold load pickup.	Inactive
CLP IN1> SET	Parameters for ground overcurrent cold load pickup	Inactive
CLP I Hot		
CLP I Cold		

Parameter Definition	Unit	Min	Max	Factory Setting	Description
CLP I Hot In	In	0	0.5	0	If a current is measured which is higher than the configured In value upon energizing, TCLPTD condition starts. If this parameter is set to 0, TCLPTD conditions checks breaker position.
CLP I Cold In	In	0	0.5	0	If a current is measured which is lower than the configured In value upon deenergizing, TCOLDTD condition starts. If this parameter is set to 0, TCOLDTD condition checks breaker position.
TCOLDTD	Sec	0	14400	7200	If the load is not energized for this period, it is designated as cold load.
TCLPTD	Sec	0	14400	7200	The cold load condition is removed after this period is elapsed upon energizing.
I>1 Status	-	0	1	0	Active for level 1 protection
I>1 Current Setting	In	0.08	4.00	1.50	Current threshold for level 1 protection
I>1 Delay Timer	Sec	0.00	100.00	1.00	Constant time delay for level 1 protection.
I>1 TMS	-	0.025	1.200	1.000	Time multiplier for level 1 protection IEC curves
I>1 Time Dial	Sec	0.5	15.0	7.0	Time multiplier for level 1 protection IEEE curves

Parameter Definition	Unit	Min	Max	Factory Setting	Description
I>2 Status	-	0	1	0	Active for level 2 protection
I>2 Current Setting	In	0.08	40.00	1.50	Current threshold for level 2 protection
I>2 Delay Timer	Sec	0.00	100.00	1.00	Constant time delay for level 2 protection
I>2 TMS	-	0.025	1.200	1.000	Time multiplier for level 1 protection IEC curves
I>2 Time Dial	Sec	0.1	1000.0	7.0	Time multiplier for level 1 protection IEEE curves
I>3 Status	-	0	1	0	Active for level 3 protection
I>3 Current Setting	In	0.08	40.00	25.00	Current threshold for level 3 protection
I>3 Delay Timer	Sec	0.00	100.00	0.00	Constant time delay for level 3 protection
I>4 Status	-	0	1	0	Active for level 4 protection
I>4 Current Setting	In	0.08	40.00	25.00	Threshold level for level 4 protection
I>4 Delay Timer	Sec	0.00	100.00	0.00	Constant time delay for level 4 protection
IN>1 Status	-	0	1	0	Active for level 1 protection
IN>1 Current Setting (In)	In	0.08	4.00	0.20	Current threshold for level 1 protection
IN>1 IDG (Is)	Is	1.0	4.0	1.5	Current threshold for level 1 protection
IN>1 Delay Timer	Sec	0.00	100.00	1.00	Constant time delay for level 1 protection
IN>1 TMS	-	0.025	1.200	1.000	Time multiplier for level 1 protection IEC curves
IN>1 Time Dial	Sec	0.5	15.0	7.0	Time multiplier for level 1 protection IEEE curves
IN>1 k (RI)	-	0.1	10.0	1.0	Time multiplier for level 1 ground overcurrent protection. Used for RI type curve.

12.13. BREAKER FAILURE (ANSI 50BF)

The unit offers two levels of breaker failure protection. If the fault condition persists after the trip command has been sent to the breaker and the configured timer expires, this function is activated. The function status can be assigned to a relay output.

Parameter Definition	Unit	Min	Max	Factory Setting	Description
CB Fault 1 Status	-	0	1	0	**1:** Enabled **0:** Disabled
CB Fault 1 Delay	Sec	0.00	10.00	0.20	Delay timer for failure
CB Fault 2 Status	-	0	1	0	**1:** Enabled **0:** Disabled
CB Fault 2 Delay	Sec	0.00	10.00	0.20	Delay timer for failure

12.14. AUTOMATIC RECLOSURE (ANSI 79)

The unit offers an automatic reclosure function which enables the system to reclose if all the faults are corrected after a successful breaker trip. The number of trials, delay timers for each trial, and the decision period for successful reclosure are configurable parameters.

Parameter Definition	Unit	Min	Max	Factory Setting	Description
3 Phase	-	0	4	1	Maximum number of allowed retries
Dead Time 1	Sec	0.05	30.00	0.30	Period for trial 1
Dead Time 2	Sec	1	1800	60	Period for trial 2
Dead Time 3	Sec	1	3600	60	Period for trial 3
Dead Time 4	Sec	1	3600	60	Period for trial 4
Reset Time	Sec	0	600	180	The time period for verifying a successful reclosure

12.15. CT SUPERVISION (ANSI 74CT)

Parameter Definition	Unit	Min	Max	Factory Setting	Description
CT Monitoring	-	0	1	0	**1:** Enabled **0:** Disabled
CTS IN> Set	In	0	4	0	
CTS Delay Timer	Sec	0	99	0.20	
CTS VN< Setting	V	0.00	22	00	

12.16. COMTRADE CONFIGURATION

The unit features dedicated oscillographic (Comtrade) memory for the last 20 trip events. The record files contain the waveforms of the measuring channels as well as the instantaneous positions of the digital outputs and relays. Each record file consists of 512 samples. The percentage of the data recorded before the breaker trip can be adjusted, as well as the sampling rate.

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Sampling Rate	Hz	0	5000	1	Sampling frequency
Pre-trip percentage	%	10	90	50	Percentage of the record before trip

12.17. IEC60870-5-103 / MODBUS SETTINGS

The unit features an RS485 communication port. This port can be used to communicate using MODBUS or IEC60870-5-103 protocols.

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Protocol	-	0	1	0	**0:** MODBUS **1:** IEC-103
Address	-	1	247	1	Modbus device address
Baud rate	-	2400	115200	9600	Communication speed
Measurement period	Sec	1	60	5	IEC60870-5-103 measurement period

12.18. INPUT PARAMETERS

Detection times and contact types for digital inputs are configured from this screen. After configuring a digital input, use the ↵ button to navigate to the next digital input, and the ⌂ button to return to main menu.

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Type	-	0	1	0	**0:** Reserved **1:** Alarm
Timer	Sec	0.0	10.0	0.1	The time period between receiving a fault signal and raising an alarm.
Contact	-	0	1	0	**0:** Normally open **1:** Normally closed
Function	-	0	4	0	**0:** User Function **1:** CB External trip input **2:** Parameter Group A Select **3:** Parameter Group B Select **4:** Parameter Group C Select

12.19. OUTPUT PARAMETERS

Pulse duration and contact type for the relay outputs are adjusted from this screen. After configuring a relay output, use the ↵ button to navigate to the next relay output, and the 🏠 button to return to main menu.

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Pulse	Sec	0.00	100.00	0.00	**0.00:** Continuous **>0:** Engages the contact for the given duration, then releases it to apply a pulse.
Period	Sec	0	30	0	.
Contact	-	0	1	0	**0:** Normally open **1:** Normally closed

12.20. INPUT STRING SETTINGS

Channel name in the mimic diagram, load breaker, ground breaker, interrupter names are programmable. In addition, each digital input features an input string field. The user can define input strings either from the device or using the Rainbow Plus program.

12.21. OUTPUT STRING SETTINGS

Each relay features an output string field. The user can define input strings either from the device or using the Rainbow Plus program.

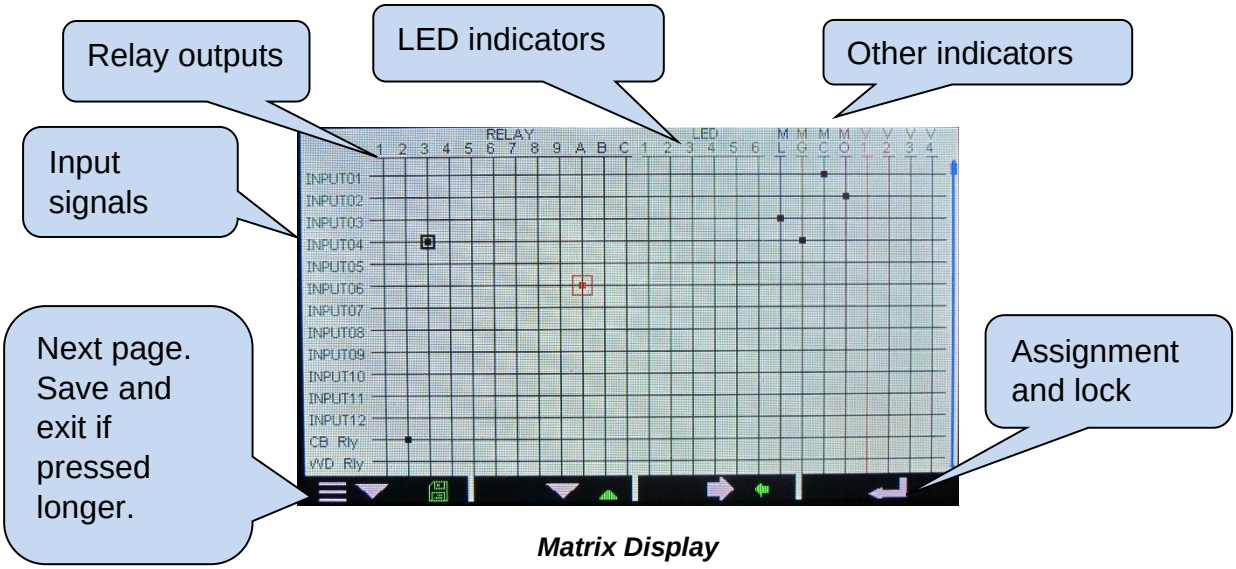
12.22. INPUT / OUTPUT MATRIX

The unit features a matrix display which allows for simple assignment of input signals to output variables.

Assignments can be set as locked.

The input signals are located from top to bottom in the matrix. These input signals are digital inputs, trip statuses and detection statuses for protection functions, and other function outputs.

The output variables are located from left to right in the matrix. These output signals are LED indicators, relay outputs and mimic diagram symbols.



Matrix Display

12.23. ETHERNET SETTINGS

Parameter Definition	Factory Setting	Description
Network IP Address	0.0.0.0	This is the IPv4 address given to the unit by the DHCP server. If this parameter is left as 0.0.0.0, the controller automatically takes an empty IP address. If you wish to give the controller a static IP address, enter the address in this parameter.
Gateway IP Address	0.0.0.0	This is the router IP address. If left unchanged as 0.0.0.0, the controller will take an empty IP address.
Subnet Mask	255.255.255.0	Reserved for IP professionals. If you are not an IP professional please leave this address as 255.255.255.0.
User IP Mask 1 (2) (3)	255.255.255.255 0.0.0.0 0.0.0.0	These parameters control the IPv4 access to the unit.
Domain Name	d500.dyndns-ip.com	This string is used in Dynamic DNS feature. The unit will register itself to the dynamic DNS server under this name. For detailed information, please refer to "**Dynamic DNS Feature**" and "**Dynamic DNS Account Setting**" documents.
Membership Address	members.dyndns.org	This string is used in Dynamic DNS feature. The unit will register itself to the dynamic DNS server under this name. For detailed information, please refer to "**Dynamic DNS Feature**" and "**Dynamic DNS Account Setting**" documents.
Username/Password		These strings are used in Dynamic DNS feature. The unit will register itself to the dynamic DNS server under this name. For detailed information, please refer to "**Dynamic DNS Feature**" and "**Dynamic DNS Account Setting**" documents.
Ping Address	www.google.com	This Internet address is accessed regularly in order to check the availability of Internet connectivity and access.
IP Confirmation Address	checkip.dyndns.org	This Internet address is accessed regularly in order to read the IPv4 address of the unit.
Rainbow Address-1 Rainbow Address-2	wss1.datakom.com.tr	The server addresses which will receive the data periodically sent by the controller must be entered here. The unit sends a data packet to the defined address at each refresh period. The DATAKOM server address is set as the first server address.
E-mail Account Name	d500_a	This is the account name appearing in the **"from"** tab of the e-mail recipient.
E-mail Account Password	d500_1234	This is the password of the above e-mail account.
E-mail Server Name	smtp.mail.yahoo.com	This is the outgoing mail server address of the above e-mail account (ex: smtp.gmail.com)
E-mail Address-1 E-mail Address-2 E-mail Address-3	- - -	The unit sends e-mails to 3 users. The e-mail addresses of the users must be entered here.

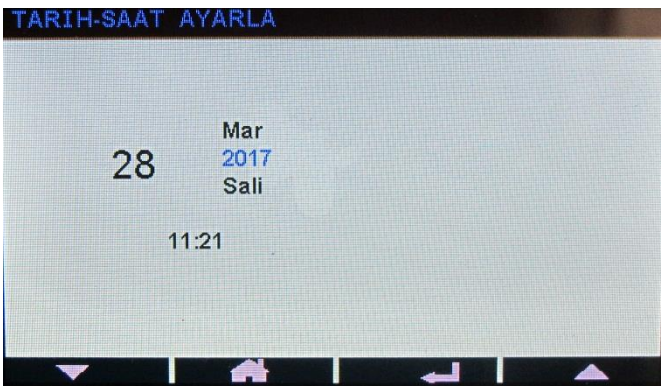
12.23. ETHERNET SETTINGS (continued)

The following Ethernet parameters are located under Controller Configuration group.

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Web Refresh Rate	Sec	0	240	5	The unit refreshes the Webpage periodically at this interval.
Ping Period	Min	0	240	0	The unit checks the availability of Internet connection at this interval.
Rainbow Refresh Rate	Sec	0	65535	60	The unit will update the remote monitoring terminal at this rate.
Rainbow Scada Address-1 Port	-	0	65535	90	This is the port number of the first monitoring terminal address.
Rainbow Scada Address-2 Port	-	0	65535	90	This is the port number of the second remote monitoring terminal address.
Web Server Port	-	0	65535	80	This is the port number of the internal Web server. The unit will respond to queries to this port only.
Modbus TCP/IP Port	-	0	65535	502	This is the port number of the internal Modbus TCP/IP terminal. The unit will respond to Modbus requests to this port only.
SMTP Port	-	0	65535	587	This is the port number used for e-mail sending.
Ethernet Enable	-	0	1	1	**0: E**thernet port OFF **1: E**thernet port ON

12.24. DATE & TIME SETTINGS

The adjustment screen for the unit's real time clock is as shown below. Using the ↑ and ↓ buttons, the parameter values can be changed. Pressing the ↵ button navigates to the next parameter. Pressing and holding the ↵ button saves changes and returns to main menu. The ⌂ button discards changes and returns to main menu.



Date/Time Display

12.25. COUNTER SETTINGS

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Parameter Definition	Unit	Min	Max	Factory Setting	Description
Reset CB service counter	-	0	1	0	When this parameter is set to 1, number of CB trips counter is reset.
Counter 1 (kWh-Im)	kWh	0	99999999.9	0	Import energy counter
Counter 2 (kWh-Ex)	kWh	0	99999999.9	0	Export energy counter
Counter 3 (kVArh-In)	kVArh	0	99999999.9	0	Inductive energy counter
Counter 4 (kVArh-Cp)	kVArh	0	99999999.9	0	Capacitive energy counter
Set CB service counter	-	0	999999999	0	Enter the number of CB trips here.
CB service alarm	-	0	1	0	**0**: Disabled **1**: Enabled

12.26. CHANGING THE PASSWORD

The unit offer 3 levels of 4-digit password protection.

Passwords can only be changed at the factory.

12.27. FACTORY RESET

The unit will request for verification when this menu is selected.

Using the and buttons, adjust the desired value and return to programming mode by pressing .

It is impossible to restore back to previous settings after a factory reset.

12.28. SAFE EXIT

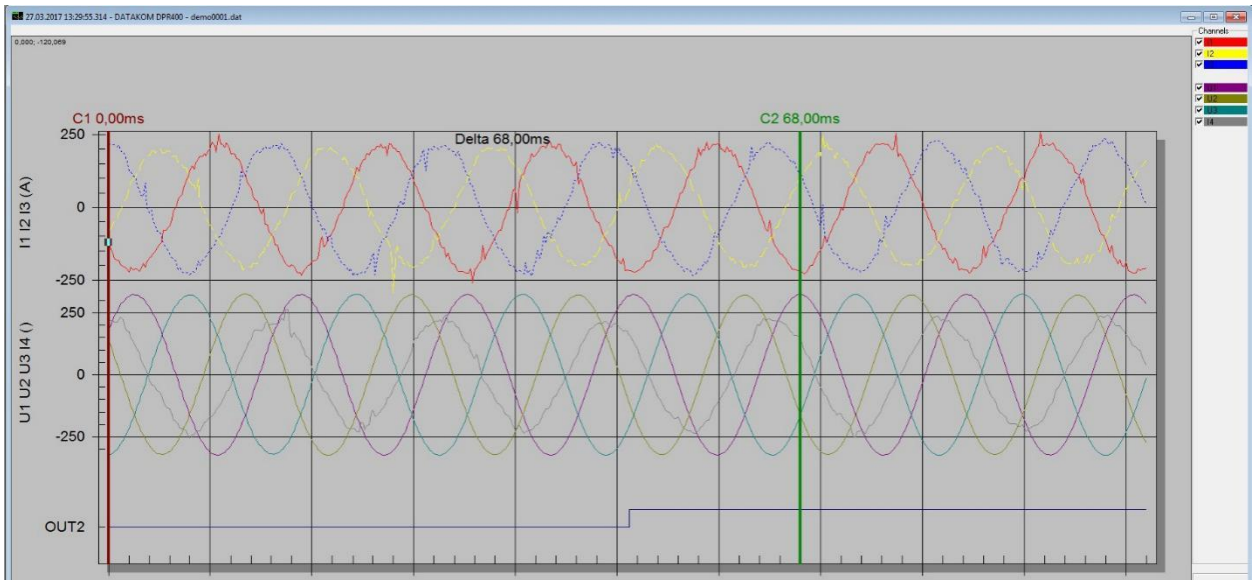
When a password is entered for programming or manual control, it is valid for 2 minutes. Entering programming or manual control does not require a password within this period. This feature can be enabled to make the system ask for the password, ignoring the 2 minute password period.

13. OSCILLOGRAPHIC (COMTRADE) RECORD SETTINGS

The unit has memory space sufficient for 7 oscillographic Comtrade records. Each record consists of 512 samples. Sampling rate and percentage of samples before CB trip are adjustable. Recorded variables are;

- Waveforms of phase currents
- Waveforms of phase voltages
- Level values for the first 8 digital inputs
- Level values for the first 8 relay outputs

Below is a record with 5000Hz sampling rate and 50% pre trip ratio.



Oscillographic Comtrade Record

14. MODBUS COMMUNICATIONS

The unit offers MODBUS functionality in the following forms:

-RS485 serial port, adjustable baud rate between 2400 and 115200 baud
-Modbus TCP/IP over Ethernet port

MODBUS features of the unit:

-Data transfer mode: RTU
-Serial data: adjustable baud rate, 8-bit data, no parity, 1 bit stop
-Supported functions:
-Function 3 (read multiple register)
-Function 6 (write single register)
-Function 16 (read multiple register)

Each register consists of 2bytes (16 bits). Larger data structures are provided using multiple registers.

Each device in the Modbus communication network must have a distinct address. The unit supports addresses in the range 1-247.

Each device in the RS-485 serial network must have a distinct address. Otherwise, Modbus communication will not function.

14.1. PARAMETERS FOR RS-485 MODBUS COMMUNICATION

Modbus Address: May be set as a value between 1 and 247.
RS-485 Enabled: Must be set as 1 (or the parameter box must be checked).
RS-485 Baud Rate: Adjustable between 2400 and 115200 bauds. Every device in the communication group must have the same baud rate.

Increasing the baud rate provides faster communication at a shorter communication distance. Decreasing the baud rate allows communication at longer distances with a slower rate of data transmission.

9600 bauds communication speed can be reached with a 120ohm balanced cable at 1200m distance.

14.2. ETHERNET MODBUS-TCP/IP PARAMETERS

Modbus Slave Address: May be set to any value between 1 and 240. If there is only one device at a given IP address, it is advised to set this parameter to 1.
Ethernet Enabled: This parameter must be set to 1 in order for the Ethernet port to be active.
Modbus TCP/IP Port: This parameter is typically set to 502. However, the device can operate with any port address.
User IP Mask: These parameters are used to control incoming IPv4 input to the device.
Ethernet Network IP: If the device is required to take a dynamic IP, this parameter must be left at its default value, 0.0.0.0. In order to give the device a static IP, the desired Ip address must be entered here.
Ethernet Gateway IP: Must be set according to your router.
Ethernet Subnet Mask: Must be set according to your router.

Please refer to **Ethernet Configuration Guide** for detailed information regarding Ethernet features.

14.3. DATA FORMATS

16-bit variables: These variables are stored in a single register. Bit_0 is the least significant bit (LSB) and Bit_15 is the most significant bit (MSB).

32-bit variables: These variables are stored in 2 consecutive registers. The 16 least significant bits are located in the first register and the 16 most significant bits are located in the second register.

Bit arrays: Arrays larger than 16 bits are stored in multiple registers. The LSB of the first register is bit_0. The MSB of the first register is bit_15. The LSB of the second register is bit_16. The MSB of the second register is bit_31, and so on.

14.4. READING DATA

Record reading is performed using function code 03 (read multiple registers). The MODBUS master device sends a query. The response can be either the required data or an error message. Up to 123 registers can be read at once. If a query for more than 123 registers is made, an error message is sent as a reply. Message structure is as follows.

BYTE	DESCRIPTION	VALUE
0	Device Address	1-253
1	Function Code	3
2	Starting Address (Top)	Detailed explanation given below
3	Starting Address (Bottom)	Detailed explanation given below
4	Number of Registers (Top)	0
5	Number of Registers (Bottom)	Max 7Bh (123 decimal)
6	CRC Bottom Byte	CRC calculation is explained below in detail
7	CRC Top Byte	CRC calculation is explained below in detail

An example for reading 16 registers starting with the address 20h (32 decimal) is explained below.
01 03 00 20 00 10 45 CC (each byte is expressed by 2 hexadecimal characters)
Expected reply:

BYTE	DESCRIPTION	VALUE
0	Device Address	Same as query
1	Function Code	3
2	Data Byte Size	Number of Registers x 2
3	1st Register Top Byte	
4	1st Register Bottom Byte	
5	2nd Register Top Byte	
6	2nd Register Bottom Byte	
…	…	…
L+1	Last Register Top Byte	
L+2	Last Register Bottom Byte	
L+3	CRC Bottom Byte	CRC calculation is explained below
L+4	CRC Top Byte	CRC calculation is explained below

Error return message:

BYTE	DESCRIPTION	VALUE
0	Device Address	Same as query
1	Function code	131 (Function code+128)
2	Error Code	2 (invalid address)
3	CRC Bottom Byte	CRC calculation is explained below
4	CRC Top Byte	CRC calculation is explained below

14.5. WRITING DATA

Data writing can be achieved with functions 06 (write single register) or 16 (write multiple registers). Writing single register writes on only a single register. MODBUS master device sends the query which includes the data to be written. The reply can be either “write successful” message or an error message.

BYTE	DESCRIPTION	VALUE
0	Device Address	1 - 253
1	Function Code	6
2	Register Address (Top)	Writeable register addresses are listed below
3	Register Address (Bottom)	Writeable register addresses are listed below
4	Data Top Byte	
5	Data Bottom Byte	
6	CRC Bottom Byte	CRC calculation is explained below
7	CRC Top Byte	CRC calculation is explained below

An example message is given below which writes the value 0010h to the address 40h (64 decimal).
01 06 00 40 00 10 89 D2 (each byte is expressed by 2 hexadecimal characters)

Expected return message same as query:

BYTE	DESCRIPTION	VALUE
0	Device Address	1 - 253
1	Function Code	6
2	Register Address (Top)	Writeable register addresses are listed below
3	Register Address (Bottom)	Writeable register addresses are listed below
4	Data Top Byte	
5	Data Bottom Byte	
6	CRC Bottom Byte	CRC calculation explained below
7	CRC Top Byte	CRC calculation explained below

Error return message:

BYTE	AÇIKLAMA	DEĞER
0	Device Address	Same as query
1	Function Code	134 (Function code+128)
2	Error Code	2: Invalid Address 10: Write Protected
3	CRC Bottom Byte	CRC calculation explained below
4	CRC Top Byte	CRC calculation explained below

14.6. CRC CALCULATION

Follow the method shown below for CRC calculation,

1) A 16-bit variable named CRC with every bit set to 1 is initialized.
2) The result of the Boolean logic operation XOR of the bottom byte of CRC and the first byte of the message (Function Code) is appended to CRC.
3) The least significant bit (LSB) of CRC has been defined. CRC is shifted right by 1 bit. Most significant bit (MSB) of the CRC is set to 0.
4) If the LSB of the CRC is 1, CRC is XOR'd by A001h. The result is appended to CRC.
5) Steps 3 and 4 are repeated until 8 bits have been shifted.
6) Steps 2, 3, 4, 5 are repeated for the remaining 8 bits.
7) Once the process is complete for the entire data, the intermediate CRC value becomes final.
8) The calculated CRC is appended to the message packet starting with the bottom byte. The final CRC value that must be calculated by the algorithm is shown below.

   01 03 00 20 00 10 45 CC
   01 06 00 40 00 10 89 D2

14.7. INTERNAL RECORD STORAGE STRUCTURE

The unit features a 32-event capacity memory. To read the record memory, the record number from the address "20899" is read. The read register value must be entered in the address "16389". Then, the relevant record can be read starting from address "4096".

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE (BIT)	R/W	TYPE	X
+0 +1	Date – Time	32-bit date and time information Bits 0-4: second/2 (0-29) Bits 5-10: minute (0-59) Bits 11-15: hour (0-23) Bits 16-20: day (1-31) Bits 21-24: month (1-12) Bit 25-31: year-2000 (0-127=2000-2127)	32	R-O	bitmap	
+2	millisecond	Milliseconds (0-1999)	16	R-O	unsigned	-
+3_BOT	Type	Register Type	8	R-O	unsigned	-
+3_TOP	Argument	Register Info	8	R-O	unsigned	-
+4 +5 +6 +7 +8 +9 +10 +11	Matrix Input	Bit 0-15 – digital inputs Bit 16-62 – protection outputs Bit 63-127 - reserved	8x16	R-O	unsigned word	x1

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE (BIT)	R/W	TYPE	X
+12	Relay Out	Relay Output Positions	16	R-O	unsigned	x1
+13	LED	LED Indicators	16	R-O	unsigned	x1
+14	Symbol	Mimic Diagram Symbols	16	R-O	unsigned	x1
+15	V1	Voltage / Voltage Transformer Ratio	16	R-O	Unsigned word	x1
+16	V2					
+17	V3					
+18	U12					
+19	U23					
+20	U31					
+21	I1	Current / Current Transformer Ratio	16	R-O	Unsigned word	x1000
+22	I2					
+23	I3					
+24	IE					
+25	I1s	Precise Current Measurements Current / Current Transformer Ratio	16	R-O	Unsigned word	x1000
+26	I2s					
+27	I3s					
+28	IEs					
+29	Frequency	Mains Frequency	16	R-O	Unsigned word	x100
+30	P1	P/(VT Ratio/CT Ratio)	16	R-O	Unsigned word	x1
+31	P2					
+32	P3					
+33	P_tot					
+34	Q1	Q1/(VT Ratio/CT Ratio)	16	R-O	Unsigned word	x1
+35	Q2					
+36	Q3					
+37	Q_tot					
+38	S_tot	S/(VT Ratio/CT Ratio)	16	R-O	Unsigned word	x1
+39	Cos_tot	Power Factor	16	R-O	Unsigned word	x1000
+40 +41	Alarm	Alarm Bits	16	R-O	Unsigned word	-
+42++63	Reserved	For future use	22x16	R-O	Unsigned word	-

14.8. COMMANDS

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE (BIT)	R/W	TYPE	X
16384	Password	Programming Password	16	W-O	Unsigned word	x1
16385	Button	Button Simulation	16	W-O	Unsigned word	x1
16386	Factory	Factory Reset	16	W-O	Unsigned word	x1
16387	Reset Counter	Reset All Counters	16	W-O	Unsigned word	x1
16388	Write Flash	Write to internal Flash memory	16	W-O	Unsigned word	x1
16389	Read Register	Copy register to modifying field	16	W-O	Unsigned word	x1
16390	BOOT	Boot Jump	16	W-O	Unsigned word	x1
16391	Relay	Write to remote control relay outputs	16	W-O	Unsigned word	x1

14.9. REAL TIME CLOCK (RTC)

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE (BIT)	R/W	TYPE	X
8192	Year	Year (0-4096)	16	R-O	Unsigned word	x1
8193	Month	Month (1-12)	16	R-O	Unsigned word	x1
8194	Day	Day (1-31)	16	R-O	Unsigned word	x1
8195	Weekday	Day of the week (0-6)	16	R-O	Unsigned word	x1
8196	Hour	Hour (0-23)	16	R-O	Unsigned word	x1
8197	Minute	Minute (0-59)	16	R-O	Unsigned word	x1
8198	Second	Second (0-59)	16	R-O	Unsigned word	x1

14.10. MEASUREMENTS

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE	R/W	TYPE	X
20480	V1 RMS	V1 Phase – Neutral Voltage	32	R-O	Unsigned long	x10
20482	V2 RMS	V2 Phase – Neutral Voltage	32	R-O	Unsigned long	x10
20484	V3 RMS	V3 Phase – Neutral Voltage	32	R-O	Unsigned long	x10
20486	I1 RMS	I1 Current	32	R-O	Unsigned long	x1000
20488	I2 RMS	I2 Current	32	R-O	Unsigned long	x1000
20490	I3 RMS	I3 Current	32	R-O	Unsigned long	x1000
20492	IE RMS	Ground Current	32	R-O	Unsigned long	x1000
20494	IEs RMS	Precise Ground Current	32	R-O	Unsigned long	x1000
20496	I1s RMS	Precise I1 Current	32	R-O	Unsigned long	x1000
20498	I2s RMS	Precise I2 Current	32	R-O	Unsigned long	x1000
20500	I3s RMS	Precise I3 Current	32	R-O	Unsigned long	x1000
20502	V_2	Voltage Negative Sequence Component NSQ	32	R-O	Unsigned long	x10
20504	I_2	Current Negative Sequence Component NSQ	32	R-O	Unsigned long	x1000
20506	T32Q	T32Q	32	R-O	Unsigned long	x100
20508	V_1	Voltage Positive Sequence Component PSQ	32	R-O	Unsigned long	x10
20510	I_1	Current Positive Sequence Component PSQ	32	R-O	Unsigned long	x1000
20512	V0	Voltage Zero Sequence Component ZSQ	32	R-O	Unsigned long	x10
20514	I0	Current Zero Sequence Component ZSQ	32	R-O	Unsigned long	x1000
20516	U12 RMS	U12 Phase – Phase Voltage	32	R-O	Unsigned long	x10
20518	U23 RMS	U23 Phase – Phase	32	R-O	Unsigned	x10

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE	R/W	TYPE	X
20520	U31 RMS	U31 Phase – Phase Voltage	32	R-O	Unsigned long	x10
20522	P1	Phase 1 Active Power (kW)	32	R-O	Signed long	x100
20524	P2	Phase 2 Active Power (kW)	32	R-O	Signed long	x100
20526	P3	Phase Active Power (kW)	32	R-O	Signed long	x100
20528	∑P	Total Active Power (kW)	32	R-O	Signed long	x100
20530	Q1	Phase 1 Reactive Power (kVAr)	32	R-O	Signed long	x100
20532	Q2	Phase 2 Reactive Power (kVAr)	32	R-O	Signed long	x100
20534	Q3	Phase 3 Reactive Power (kVAr)	32	R-O	Signed long	x100
20536	∑Q	Total Reactive Power (kVAr)	32	R-O	Signed long	x100
20550	Frequency	Frequncy	16	R-O	Unsigned word	x100
20576	Alarm	Function Alarm Bits 0-63	64	R-O	Long Long	-
20580	Warning		64	R-O	Long Long	-
20584	İnput	Input Status	32	R-O	Unsigned long	-
20586	Output	Output Status	32	R-O	Unsigned long	-
20588	Input Count	Number of digital inputs	16	R-O	Unsigned word	x1
20589	Output Count	Number of digital outputs	16	R-O	Unsigned word	x1
20590	LED Count	Number of LEDs on the unit	16	R-O	Unsigned word	x1
20591	Reset_sta	Last Reset Cause	16	R-O	16 bit bitmap	-
20592	-	Reserved	16	R-O	Unsigned word	x1
20593	Dig-in	OG Digital Input Statuses	32	R-O	16 bit bitmap	-
20595	Matrix	Status information for matrix inputs	8x16	R-O	128 bit bitmap	-
20603	DeviceID	Device type (0xD400)	16	R-O	Unsigned word	-
20604	HWVersion	Hardware Version	16	R-O	Unsigned word	-
20605	SWVersion	Software Version	16 BIT	R-O	Unsigned word	-

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE	R/W	TYPE	X
20606	CnfgWord	Device Configuration	16	R-O	Unsigned word	-
20607	IAPStatus	Flash write status (0:ok 1:error)	16	R-O	Unsigned word	x1
20608	ReadUnloc	Flash parameter read unlock timer	16	R-O	Unsigned word	x1
20609	PacketScc	Number of successfully sent packets	16	R-O	Unsigned word	x1
20610	CB Status	Circuit Breaker information	16	R-O	Unsigned word	x1
20611	GprsIP	GPRS IP address (Reserved)	4x8	R-O	Unsigned char	x1
20613	TcpIP	Device IP address	4x8	R-O	Unsigned char	x1
20615	DK_Mflg1	Ram output flags 1, total 256 bits				
20616	-	Reserved	2x16	R-O	Unsigned word	x1
20618	Dig-out	Digital Output Statuses	64	R-O	Long Long	-
20622	MAC_adr	Ethernet MAC address	6x8	R-O	Unsigned char	x1
20625	WAN_IP	Ethernet WAN address	4x8	R-O	Unsigned char	x1
20627	ProtectFlgs	Protection flags	32	R-O	Unsigned long	-
20629	Dig-int	Digital Input Statuses	32	R-O	Unsigned word	x1
20631	-	Reserved	16	R-O	Long Long	-
20632	SaveRescueParamFlags	Save Parameters Rescue Registers Flags	32	R-O		
20634	IMEI	Modem IMEI number (Reserved)	16x8 BIT	R-O	Unsigned char	x1

14.11. FUNCTION ALARM INFORMATION

BIT	DESCRIPTION	BIT	DESCRIPTION
0	Overcurrent Protection	9	Negative Sequence Voltage Protection
1	Negative Sequence Current Protection	10	Breaker Failure Protection
2	Broken Conductor Protection	11	Thermal Overload Protection
3	Neutral Current Protection	17	Current Transformer Monitoring Protection
7	High Voltage Protection	19	Under Frequency Protection
8	Under Voltage Protection	20	High Frequency Protection

14.12. DIGITAL OUTPUT INFORMATION

BIT	DESCRIPTION	BIT	DESCRIPTION
0	Relay Output 1	20	LED Indicator 5
1	Relay Output 2	21	LED Indicator 6
2	Relay Output 3	22	LED Indicator 7
3	Relay Output 4	23	LED Indicator 8
4	Relay Output 5	24	LED Indicator 9
5	Relay Output 6	25	LED Indicator 10
6	Relay Output 7	26	LED Indicator 11
7	Relay Output 8	27	LED Indicator 12
8	Relay Output 9	28	LED Indicator 13
9	Relay Output 10	29	LED Indicator 14
10	Relay Output 11	30	LED Indicator 15
11	Relay Output 12	31	LED Indicator 16
12	Relay Output 13	32	Mimic Load Separator
13	Relay Output 14	33	Mimic Ground Separator
14	Relay Output 15	34	Mimic Breaker Closed Contact
15	Relay Output 16	35	Mimic Breaker Open Contact
16	LED Indicator 1	36	Visual Output 1
17	LED Indicator 2	37	Visual Output 2
18	LED Indicator 3	38	Visual Output 3
19	LED Indicator 4	39	Visual Output 4
		40-127	Reserved

14.13. MATRIX INPUT INFORMATION

BIT	DESCRIPTION	BIT	DESCRIPTION
0	Digital Input 1	33	IN > Start (IN: Neutral Overcurrent)
1	Digital Input 2	34	IN > Trip
2	Digital Input 3	35	IN >> Start
3	Digital Input 4	36	IN >> Trip
4	Digital Input 5	37	Cold Load Close
5	Digital Input 6	38	I2/I1 > Start (I1: Zero Component Overcurrent)
6	Digital Input 7	39	I2/I1 > Trip
7	Digital Input 8	40	Idef > Start (Idef: Directional Neutral Current)
8	Digital Input 9	41	Idef > Trip
9	Digital Input 10	42	Isef > Start (Isef: Precise Neutral Current)
10	Digital Input 11	43	Isef > Trip
11	Digital Input 12	44	Isef >> Start
12	Digital Input 13	45	Isef >> Trip
13	Digital Input 14	46	VN > Start (VN: Residual Voltage)
14	Digital Input 15	47	VN > Trip
15	Digital Input 16	48	VN >> Start
16	Breaker Status	49	VN >> Trip
17	Watchdog Relay Status	50	T > Start (T: Thermal Overload)
18	I > Start (I: Overcurrent)	51	T > Trip
19	I > Trip	52	V < Start (V: Voltage)
20	I >> Start	53	V < Trip
21	I >> Trip	54	V << Start
22	I >>> Start	55	V << Trip
23	I >>> Trip	56	V > Start (V: Voltage)
24	I >>>> Start	57	V > Trip
25	I >>>> Trip	58	V >> Start
26	I2 > Start (I2: Negative Component Overcurrent)	59	V >> Trip
27	I2 > Trip	60	VN > Start (VN: Negative Sequence Voltage)
28	I2 >> Start	61	VN > Trip
29	I2 >> Trip	62	Successful Reclosure
30	Breaker Failure 1	63	f < Start (f: Frequency)
31	Breaker Failure 2	64	f < Trip
32	Automatic Reclosure	65 - 127	Reserved

15. DECLARATION OF CONFORMITY

The unit conforms to the EU directives:

-2014/35/EC (Low Voltage)

-2014/30/EC (electro-magnetic compatibility)

Norms of Reference:

EN 61010 (safety requirements)

EN 61326 (EMC requirements)

The CE mark indicates that this product complies with the European requirements for safety, health, environmental and customer protection.

16. MAINTENANCE

DO NOT OPEN THE UNIT!

There are NO serviceable parts inside the unit.

Wipe the unit, if necessary, with a soft damp cloth. Do not use chemical agents.

17. DISPOSAL OF THE UNIT

Following directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), this unit should be stored and disposed separately from usual waste.

18. ROHS COMPLIANCE

The unit is compliant to **"DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment".**

Any of below substances is not used in this device:

Lead (Pb)

Mercury (Hg)

Cadmium (Cd)

Hexavalent chromium (Cr6+)

Polybrominated biphenyls (PBB)

Polybrominated diphenyl ether (PBDE)

Bis(2-ethylhexyl) phthalate (DEHP)

Butyl benzyl phthalate (BBP)