DATAKOM

DPR 350

NETWORK ANALYZER & PROTECTION RELAY

DESCRIPTION

DPR-350 is a state of the art network analyzer and protection relay in 96x96 standard panel dimensions. Thanks to its low depth, it provides space economy.

The DPR-350 features dual current measurement circuits. It is both a precise analyzer and a protection relay. Protection curves can be selected among IEC, ANSI, UK and US standards. Multiple protection curves can be activated simultaneously.

Multiple measurements can be viewed on the 128x64 pixel graphic display of the device.

The unit records every electrical parameter to its built-in 1MB (16MB optional) memory at the desired sampling rate. The records can be read via Modbus.

Through its RS-485 port, the unit can connect to various Scada systems and can be remotely monitored. Parameter configuration is done via USB port.

The unit offers 4 digital inputs, 2 relay outputs, and 3 analog outputs as standard. Analog outputs can be used to receive desired measurements in the form of 4-20mA signals, or to drive a visual fault mechanism.

PROTECTION CURVES

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

COMMUNICATIONS

- USB 2.0 PC connection
- RS-485 (isolated) 2400-115200 baud
- Modbus RTU
- IEC60870-5-103 communication protocol

RECORD MEMORY

- 35x event records with time stamp.
- 15.000 periodic records with time stamp.
- Adjustable sampling rate.
- 1MB total record memory.

ANALYZER MEASUREMENTS

- Phase voltages: V1-V2-V3-U12-U23-U31
- Phase currents: I1-I2-I3-Ineutral
- Active power: P1-P2-P3-∑P
- Reactive power: Q1-Q2-Q3-∑Q
- Apparent power: S1-S2-S3-∑S
- Power factor: cos1-cos2-cos3-∑cos
- Frequency: F
- Negative sequence currents and voltages
- Zero sequence currents and voltages
- T32Q value

FEATURES

- *128x64 pixels graphic displays*
- *% 0.5 accuracy OG analyzer features*
- *4 quadrant energy counters*
- *Multiple protection curves*
- *1MB records memory*
- *Self-test, internal failure monitoring*
- *Cold reclosure*
- *Configurable optically isolated digital inputs*
- *Configurable relay outputs*
- *Configurable analog outputs*
- *2 independent configuration sets*
- *English menus*
- *Setup parameters on the device*
- *3-level password protection*
- *Connection via USB or RS-485*
- *Free PC configuration software*
- *Manual open/close from front panel and Scada*
- *Software update via USB*
- *Wide supply voltage range: 19-150VDC*
- *IP65 protection with optional gasket*
- *Low panel depth*

STANDARDS

- EN60255 Electrical Relays
- EN61010 Safety Requirements
- EN61326 Electromagnetic Compatibility
- EN60068 Environmental Conditions
- EN60529 Protection Levels

PROTECTION FUNCTIONS

ANSI CODE	DESCRIPTION
50,51	Overcurrent
46	Negative Sequence Overcurrent
67	Directional Overcurrent
50BF	Breaker Failure
79	Reclosure

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ABOUT THIS DOCUMENT

This document describes the minimum requirements and necessary steps for the successful installation of the DPR-350 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.

REVISION HISTORY

REVISION	DATE	AUTHOR	DESCRIPTION
01	07.02.2017	AY	First Edition

RELATED DOCUMENTS

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

TERMINOLOGY

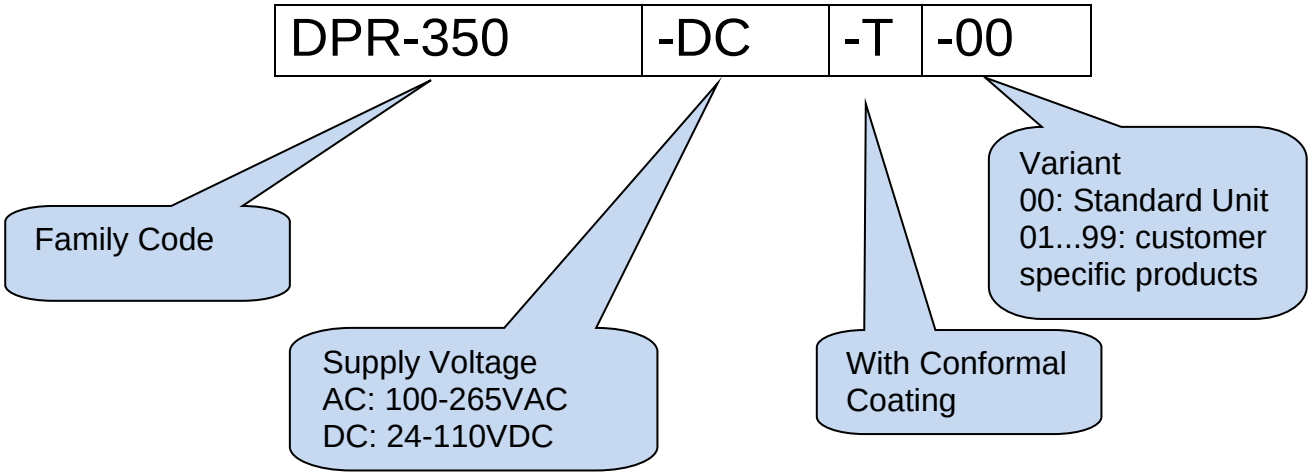
CAUTION: Potential risk of injury or death.

WARNING: Potential risk of malfunction or material damage.

ATTENTION: Useful hints for the understanding of device operation.

ORDERING CODES

The DPR-350 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= J63P01

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 (C-type) 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.**

Current Transformers must be used for current measurement. No direct connection allowed.

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 on 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.

Current transformers must be used for current measurement.

No direct connection allowed.

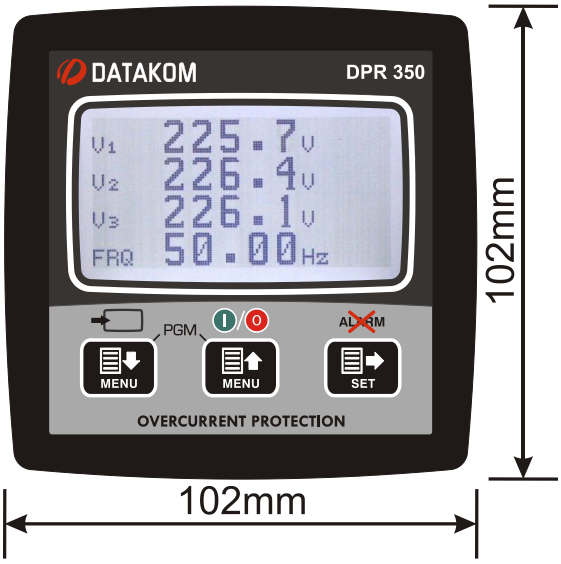
Below conditions may cause abnormal operation:

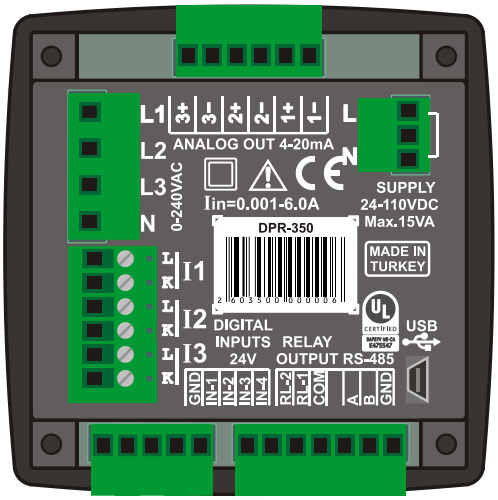
- Power supply voltage below minimum acceptable level.
- Frequency outside specified limits.
- Phase order fault.
- Faulty current transformer input.
- Incorrect current transformer polarity.
- Incomplete grounding.

2. MOUNTING

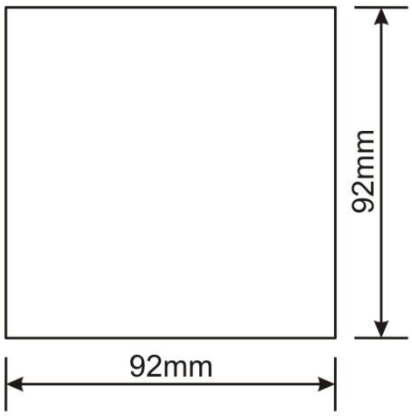
2.1. DIMENSIONS

Dimensions: 102x102x53mm (4.0”x4.0”x2.0”)
Installation: Panel mounted, rear retaining plastic brackets.
Weight: 200g (0.44 lb)

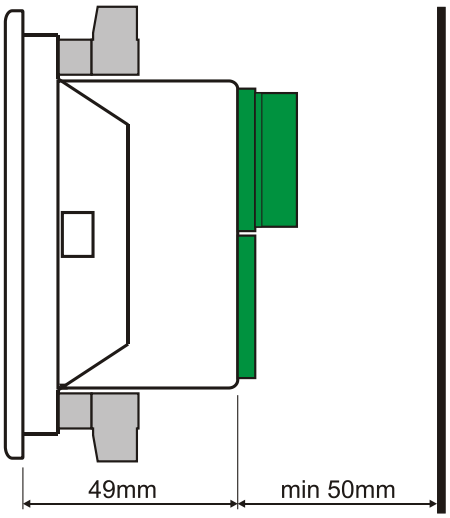




2.2. MECHANICAL INSTALLATION



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.

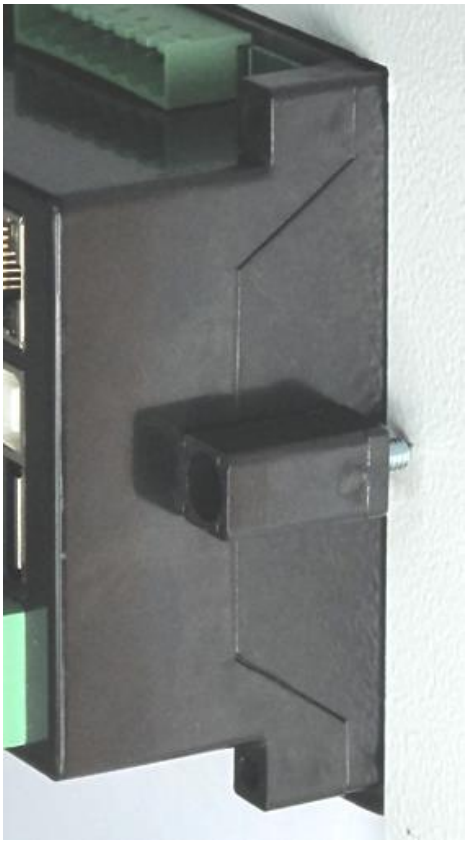
Mount the unit on a flat, vertical surface. Before mounting, remove the mounting brackets and connectors from the unit, then pass the unit through the mounting opening.

Place and tighten mounting brackets.

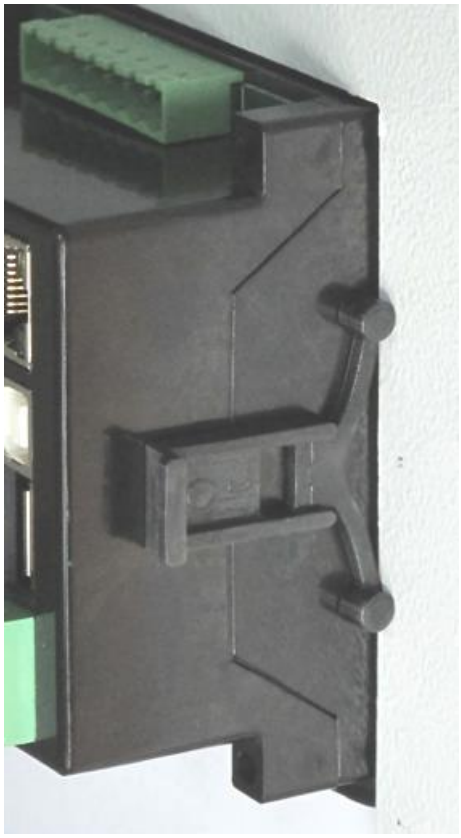
Two different types of brackets are provided:

Screw type bracket

Self-retaining type bracket



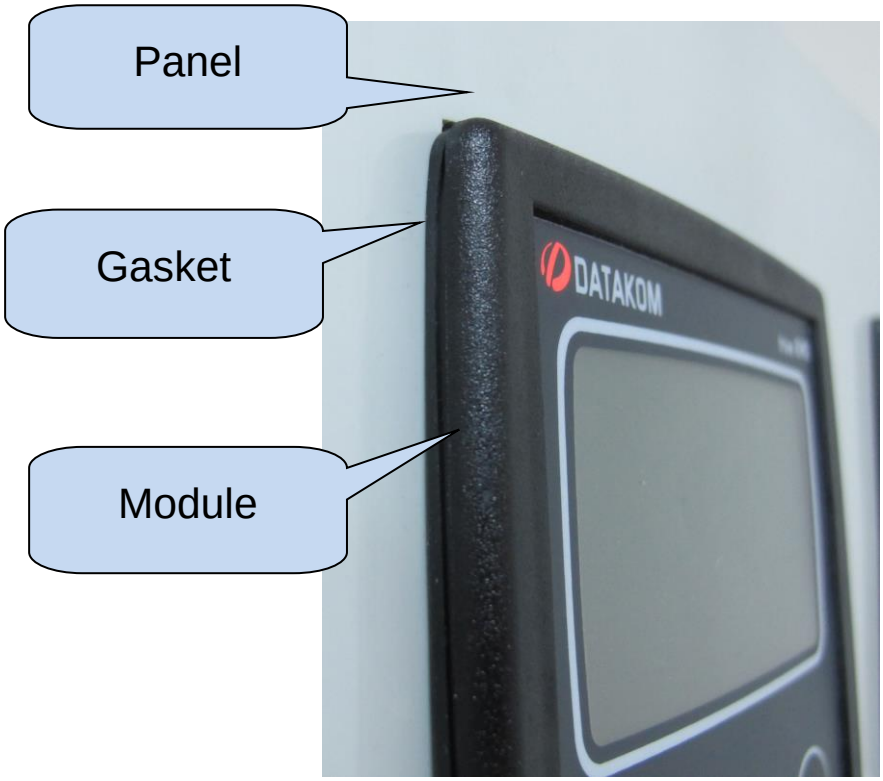
Installation of screw type bracket



Installation of self-retaining type bracket

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

2.3. 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

2.4. ELECTRICAL INSTALLATION

Do not install the unit close to high electromagnetic noise emitting devices like contactors, high current busbars, switchmode 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 (C-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.**

Current transformers must be used for current measurement.

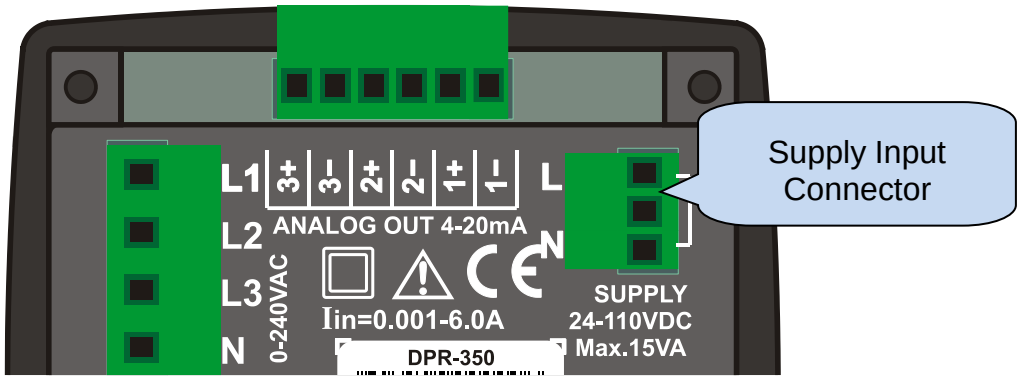
No direct connection allowed.

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

3. TERMINAL TECHNICAL SPECIFICATIONS

3.1. SUPPLY VOLTAGE INPUT

Power Supply Voltage:	**AC SUPPLY TYPES:** 100-265VAC(±%15), 50-60Hz (±%10), 88-400VDC **DC SUPPLY TYPES:** 24-110VDC (±%20)
Reverse Voltage:	Directionless inputs, operates with both polarities.
Maximum Input Power:	15 VA
Isolation:	3500VAC/1minute from all other terminals.



Power supply input must be fused. (6A type C).

3.2. AC VOLTAGE INPUTS

Measurement Method:	True RMS
Sampling Rate:	8192 Hz
Input Voltage Range:	0 - 300 VAC (phase-neutral)
Measurement Range:	7 - 330VAC Ph-N (14 to 520VAC Ph-Ph)
Input Impedance:	4.5M-ohm
Display Resolution:	0.1VAC
Accuracy:	0.5% + 1 digit @ 230VAC Ph-N (±2VAC Ph-N) 0.5% + 1 digit @ 400VAC Ph-Ph (±3VAC Ph-Ph)
Withstanding:	1300V-AC continuous

Frequency Range:	30 to 100 Hz
Frequency Display Resolution:	0.01 Hz
Frequency Accuracy:	0.5% + 1 digit

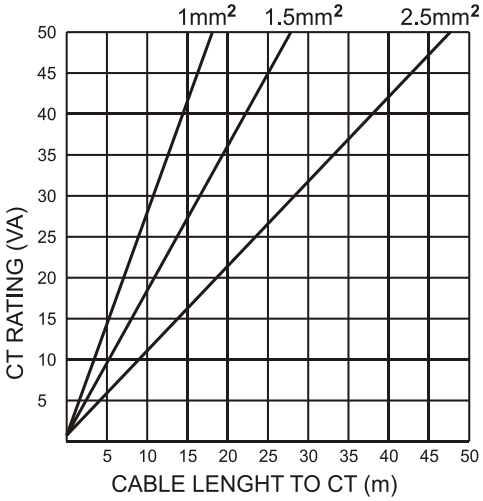
3.3. AC CURRENT INPUTS

Structure:	Isolated, integrated current transformers
Measurement Method:	True RMS
Sampling Rate:	8192 Hz
CT Secondary Rating:	5A
CT Range:	5/5 - 25000/5A minimum
Input Impedance:	15 milliohms
Burden:	0.375W @ 5A
Maximum Current:	6A continuous
Measurement Range:	0.001 to 6A AC
Display Resolution:	0.1A
Accuracy:	0.5% + 1 digit
Isolation:	1000VAC/1minute from all other terminals.
Withstanding:	100A-AC 1 second

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:

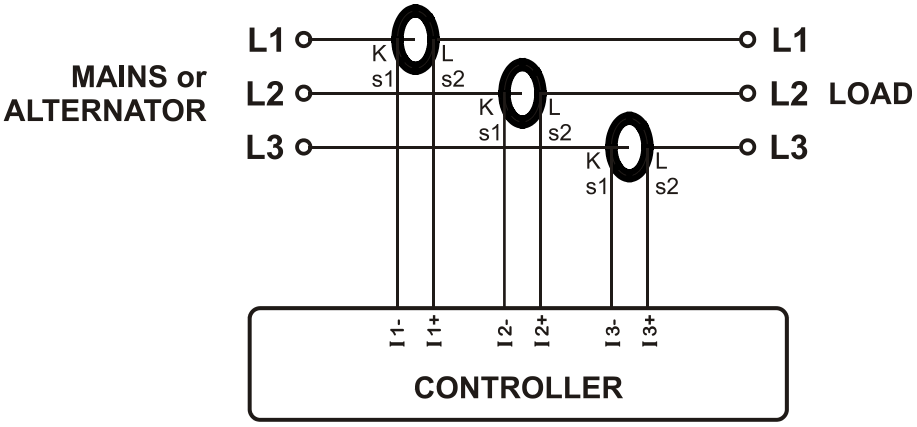
The CT accuracy class should be selected in accordance with the required measurement precision. The accuracy class of the controller is 0.5%. Thus 0.5% class CTs are advised for the best result.

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.

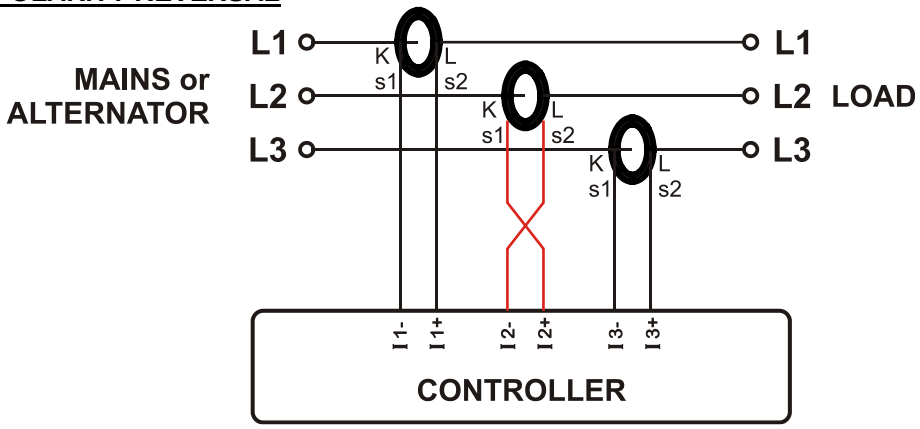
CORRECT CT CONNECTIONS



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

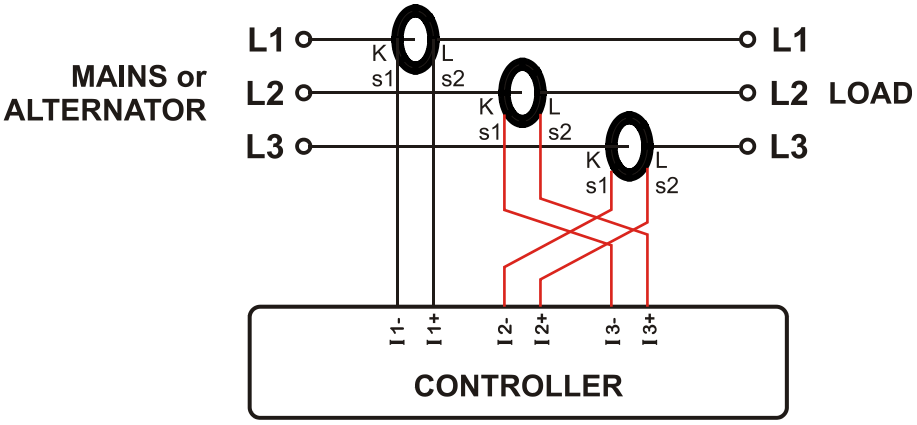


The utility mains is still loaded with 100 kW on each phase. The load power factor (PF) on Phase L2 will show -1.00 due to reverse CT polarity.
As a result, total load power displayed will be 100 kW.

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.
Input Type:	Optically isolated, digital input
Function Selection:	From list
Contact Type:	Normally open or normally closed (programmable)
Minimum Sensing Duration:	250ms
Active Signal Level:	40-135V-DC or 30-265V-AC
Isolation:	1000VAC, 1 minute
Noise Filtering:	Var

3.5. RELAY OUTPUTS

Structure:	Relay output, normally open contact, single common terminal free contact output.
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, adjustable.
Data type:	8 bit data, no parity, 1 bit stop
Termination	External 120 ohms required.
Common mode voltage:	-0.5 VDC ... +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

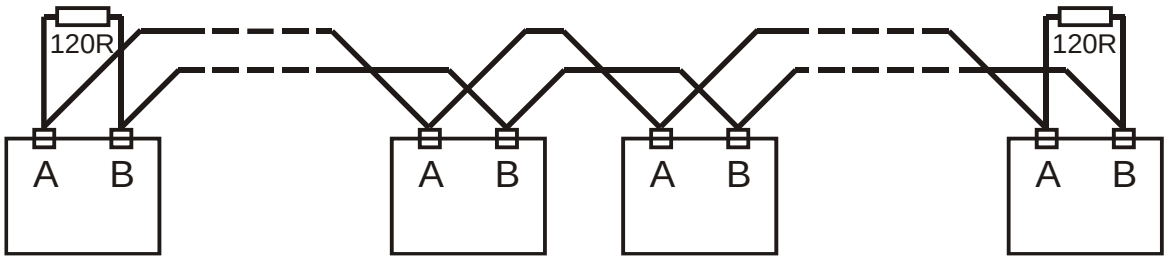
The RS-485 port supports MODBUS-RTU protocol. Multiple modules may be paralleled on the same RS-485 line in order to provide data transfer to automation or building management systems.

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 on a single RS-485 line. A repeater is required in order to connect more controllers.



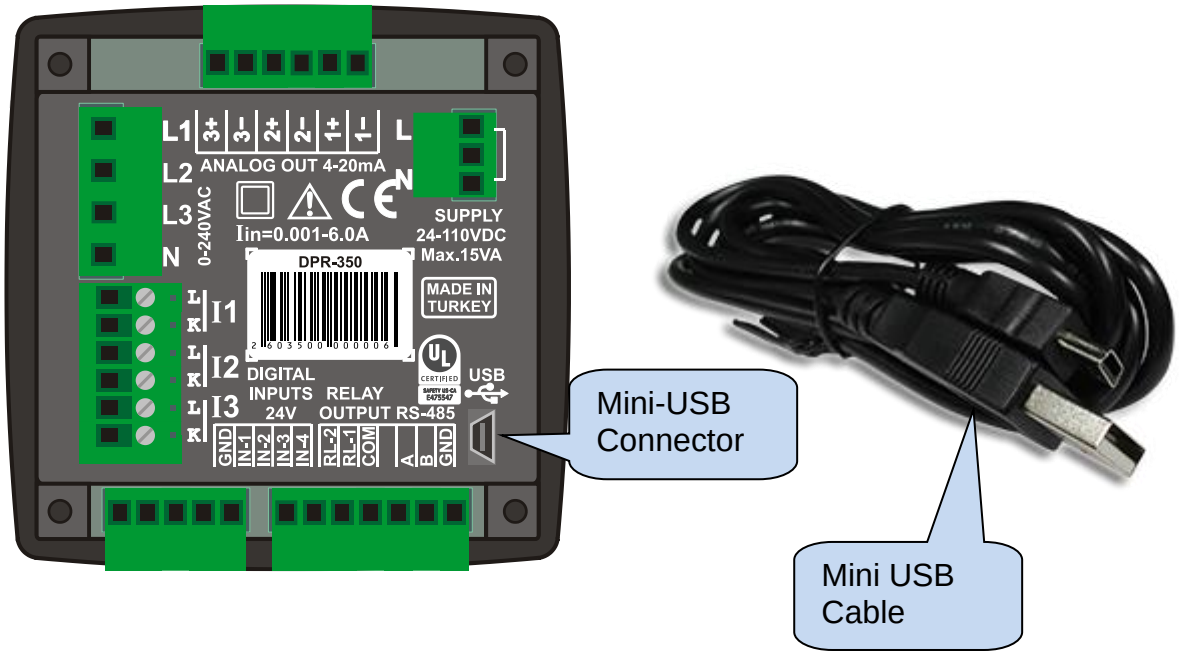
The line must be terminated by 120 ohms on each end.

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:	Modbus RTU

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.

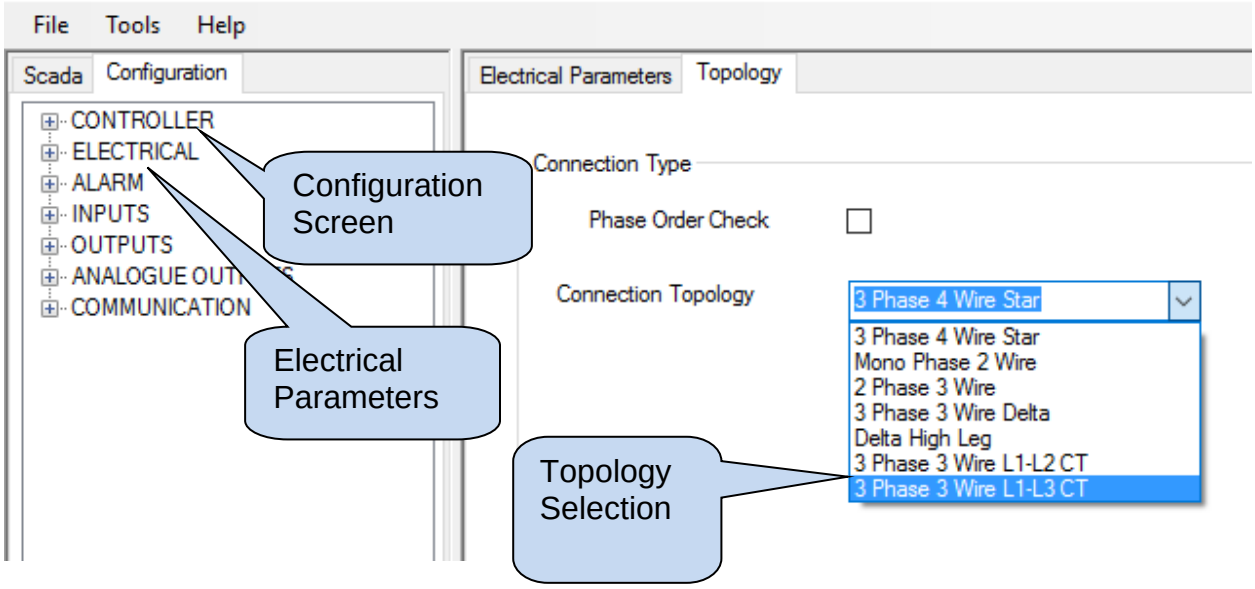
Please refer to the RainbowPlus user manual for more detailed information about monitoring, programming, and control.

4. TOPOLOGIES

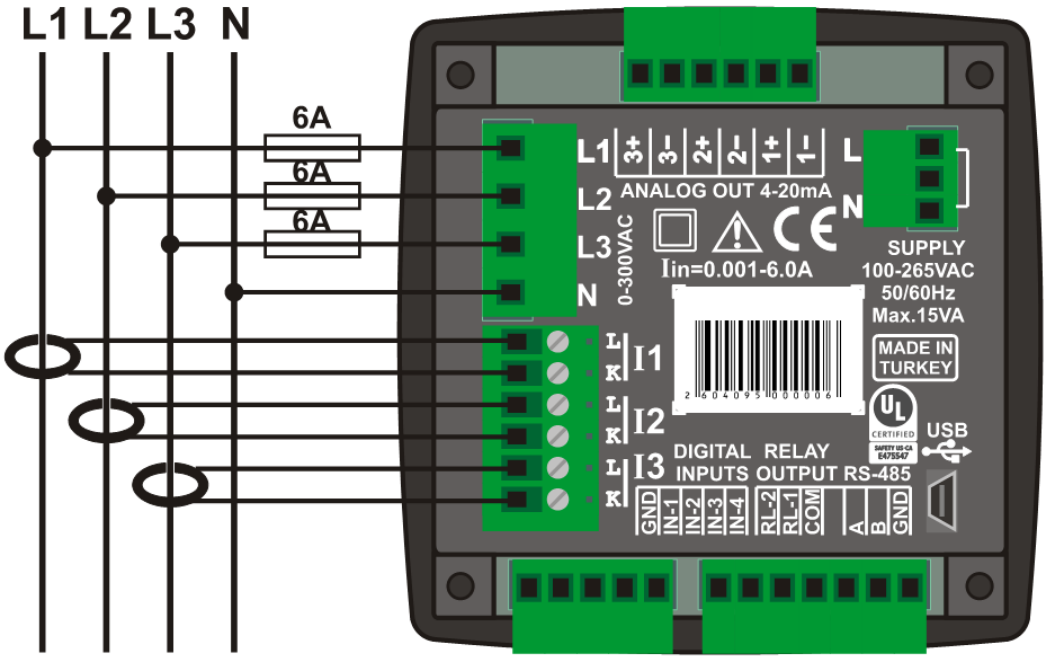
Topologies are selected from program parameters.

Mains grid topologies are shown in the picture below.

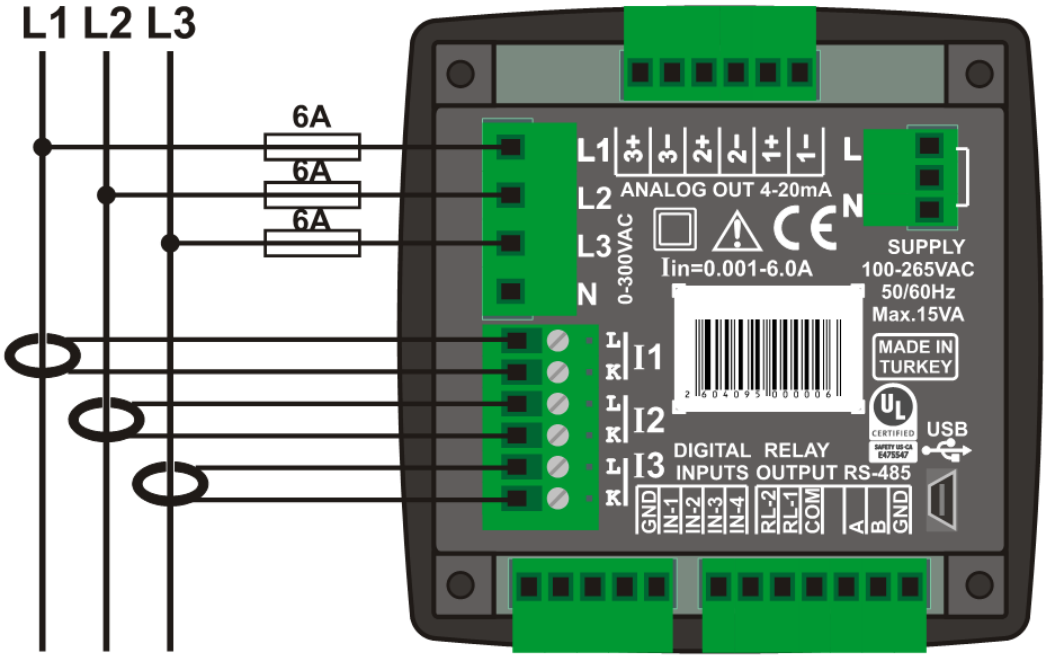
4.1. TOPOLOGY SELECTION



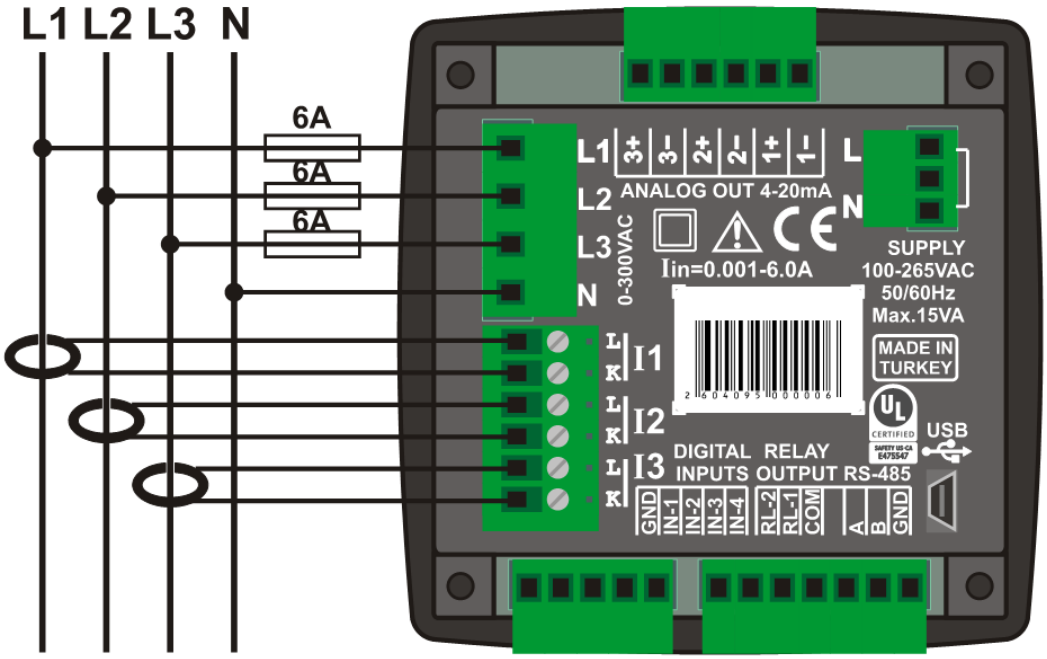
4.2. 3 PHASE, 4 WIRE, STAR



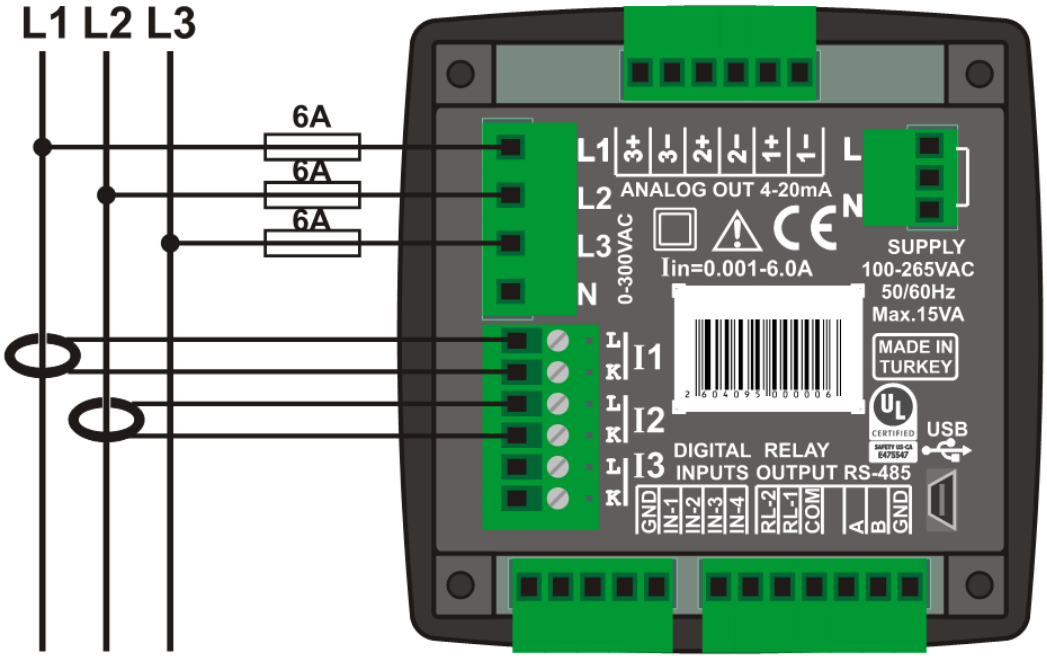
4.3. 3 PHASE, 3 WIRE, DELTA



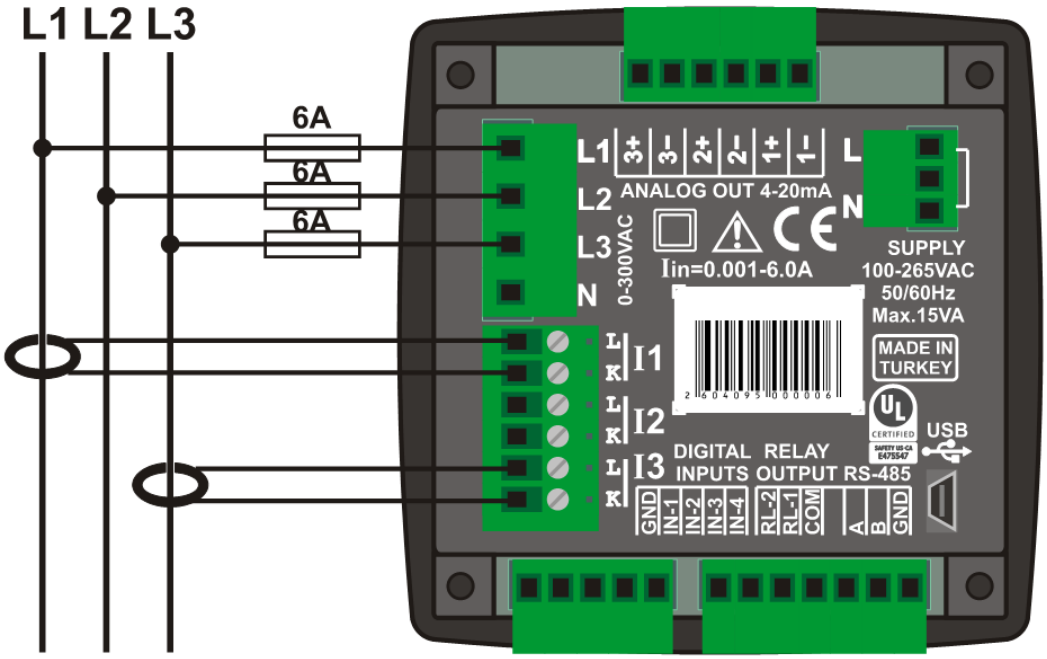
4.4. 3 PHASE, 4 WIRE, DELTA



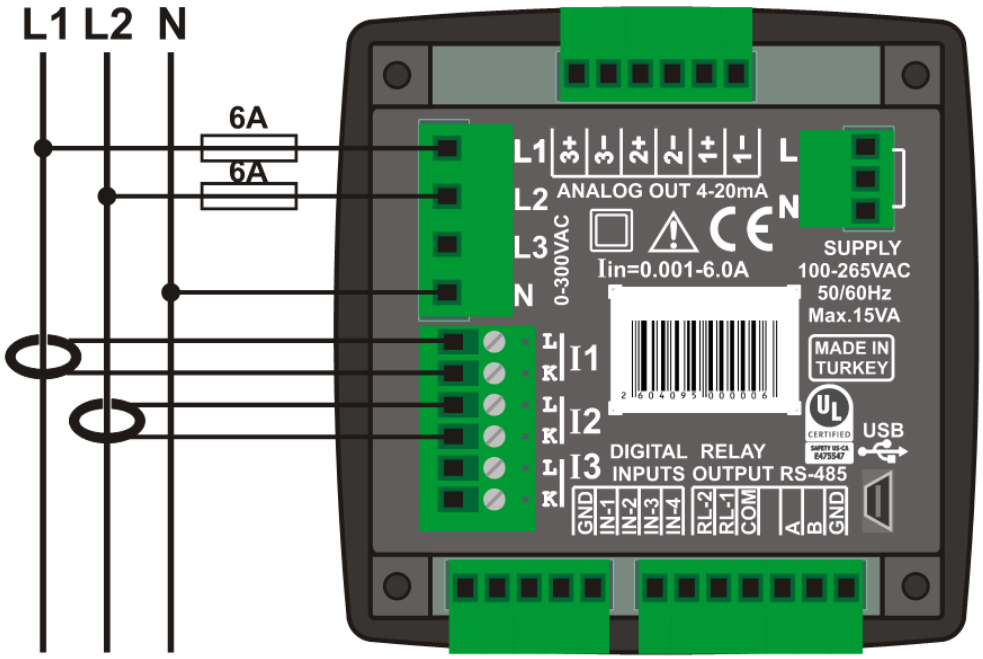
4.5. 3 PHASE, 3 WIRE, DELTA, 2 CT (L1-L2)



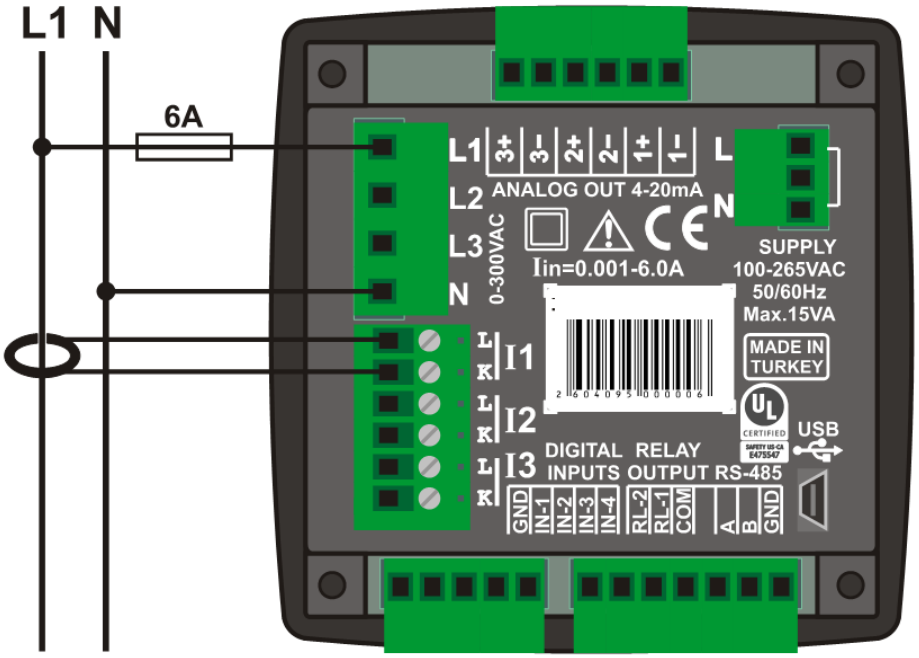
4.6. 3 PHASE, 3 WIRE, DELTA, 2 CT (L1-L3)



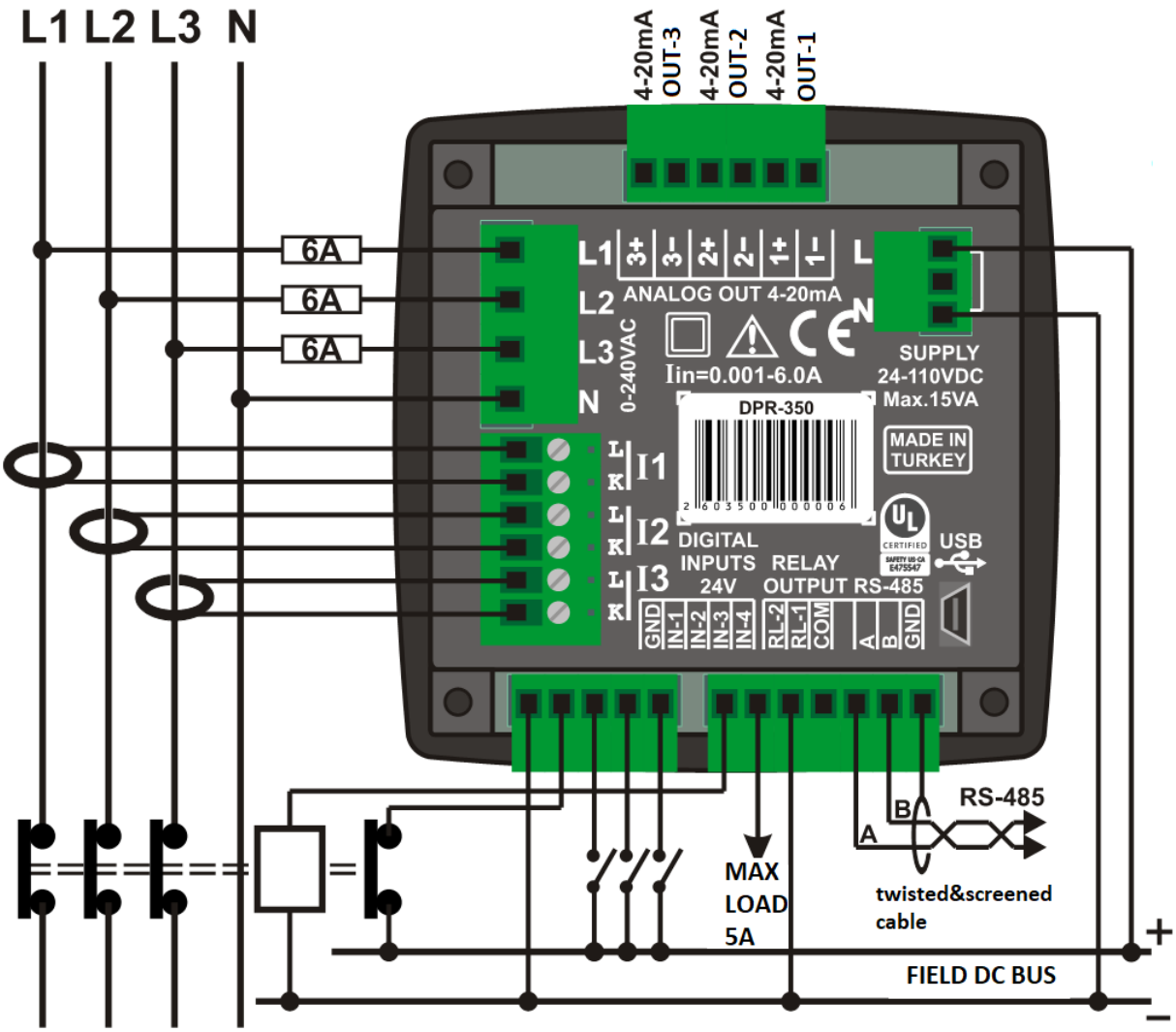
4.7. 2 PHASE, 3 WIRE, DELTA, 2 CTs (L1-L2)



4.8. 1 PHASE, 2 WIRE



5. CONNECTION DIAGRAM



6. TECHNICAL SPECIFICATIONS

Power Supply Input: 19 - 150VDC
Power Consumption: < 4 W / 15VA
Nominal Frequency: 50/60 Hz
Phase CT Secondary Rating: 1A/5A
Protection Current Range: 0.1 – 25.0 A AC
Measuring Inputs:
Current: 0.001 – 6.0 A AC
Voltage: 7 - 300 V AC (Ph-N)
14 - 520 V AC (Ph-Ph)
Analog outputs: active, 4-20mA
Output accuracy: 16 bit
Withstanding:
Current inputs: 100 A AC for 1 second
Voltage inputs: 1300 V AC (continuous)
Burden:
Voltage inputs: < 0.02VA per phase
Current inputs: < 0.5 VA per phase
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 25000**/**5A
VT range: 1.0**/**1 to 5000.0**/**1
kW range: 1.0 kW to 5000 MW
Relay outputs: 5A (250VAC / 30VDC)
Digital Inputs:
Active level: 19 - 140V DC or AC
Min pulse: 100ms.
Isolation: 1000V AC, 1 minute
USB Port: USB Device, full speed (12Mbit)
Serial Port:
Signal Type: RS-485
Communication: Modbus RTU, 60870-5-103
Data Transfer Rate:2400-115200baud, adjustable
Isolation: 500V AC, 1 minute
Operating Environment Temperature: -20°C...+70 °C
Maximum Rekative Humidity: %95 non-condensing
Altitude: 2000 meters max.
Protection Rating: IP 65 (Front Panel, with gasket)
IP 30 (Back Panell)
Enclosure: Flame retardant, ROHS compliant, high temperature non-flammable ABS/PC (UL94-V0)
Mounting: Panel mounted with rear retaining plastic brackets
Dimensions: 102x102x53mm (WxHxD)
Panel Cutout Dimensions: 92x92mm
Weight: 200 gr

EU Directives:	**Reference Standards:**
2006/95/EC (LVD)	EN 61010 (safety)
2004/108/EC (EMC)	EN 61326 (EMC)

UL-CSA Certificate:
UL 61010-1, 3rd Edition, 2012-05,
CAN/CSA-C22.2
File: E475547, Vol. D1

7. TERMINAL DESCRIPTIONS

Terminal	Function	Technical Data	Description
	AUXILIARY SUPPLY +	19 – 150V DC	Supply input positive terminal.
	-	-	No connection.
	AUXILIARY SUPPLY -	19 – 150V DC	Supply input negative terminal.

Terminal	Function	Technical Data	Description
	L1	Phase inputs, 0-300V-AC	Connect the voltage measurement terminals to these terminals
	L2		
	L3		
	NEUTRAL	Input, 0-300V-AC	Connect the neutral input to this terminal.

Terminal	Function	Technical Data	Description
	CURR_1_L	CT Inputs, 1/5A-AC	Connect the current transformer to these terminals. Be sure to connect CTs to the correct inputs with the correct polarity. CT primary values must be the same for each of the 3 phases.. CT Secondary current must be 1 or 5 Amps.. (ex: 200/5 A).
	CURR_1_K		
	CURR_2_L		
	CURR_2_K		
	CURR_3_L		
	CURR_3_K		

Terminal	Function	Technical Data	Description
	RS-485 A	Digital communications port	Connect the A-B terminals of the RS-485 datalink to these terminals.
	RS-485 B		
	PROTECTION GROUND	Grounding terminal	Connect the ground terminal of the RS-485 cable to this terminal.

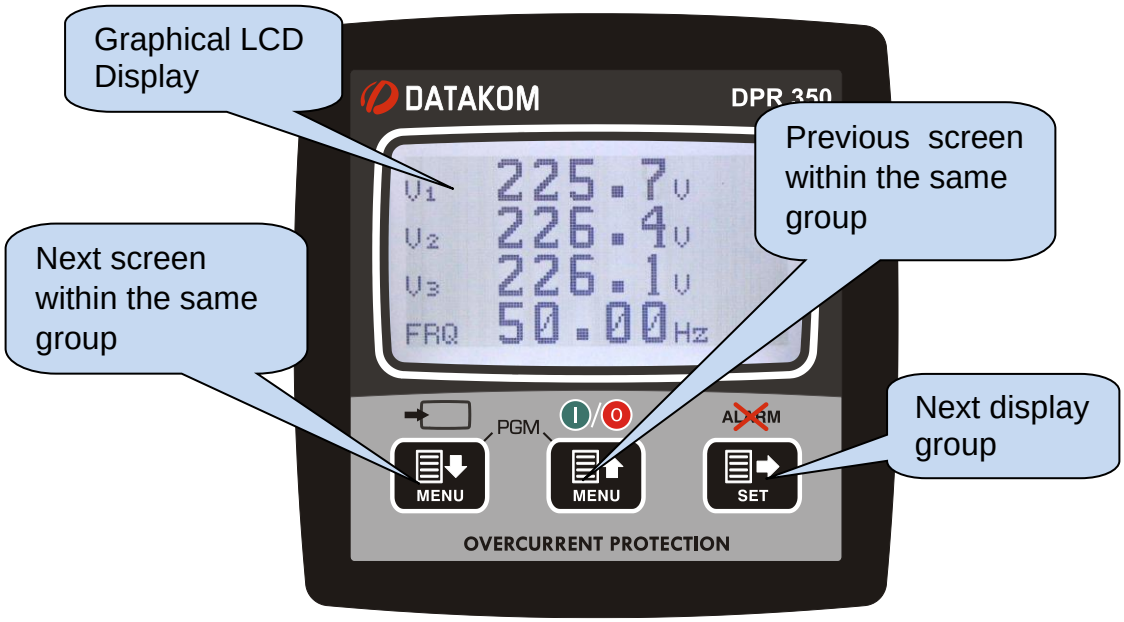
Terminal	Function	Technical Data	Description
	DIGITAL INPUT 1	Digital inputs, 40-135V-DC or 30-265V-AC	Digital inputs are programmable.
	DIGITAL INPUT 2		
	DIGITAL INPUT 3		
	DIGITAL INPUT 4		
	DIGITAL INPUT COMMON	Common terminal	Common negative terminal for digital inputs.

Terminal	Function	Technical Data	Description
	DIGITAL OUTPUT 1	Relay output, 5A/250VAC	Relay output, normally open contact. Relay functions are programmable.
	DIGITAL OUTPUT 2	Relay output, 5A/250VAC	Relay output, normally open contact. Relay functions are programmable.
	DIGITAL OUTPUT COMMON	Common terminal	Common input voltage for both relays.

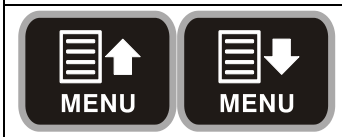
Terminal	Function	Technical Data	Description
	AN1-	Active analog outputs, 4-20mA, non-isolated	These analog outputs send information to external PLC systems. Any measured analog value can be assigned to these outputs.
	AN1+		
	AN2-		
	AN2+		
	AN3-		
	AN3+		

8. DESCRIPTION OF CONTROLS

8.1. FRONT PANEL FUNCTIONALITY



8.2. PUSHBUTTON FUNCTIONS

BUTTON	FUNCTION
	Move to next display group. Hold pressed for 3 seconds: Reset all alarms.
	Move to previous screen within the group. Hold pressed for 10 seconds: The current screen is assigned as main opening screen.
	Move to next screen within the group. Hold pressed for 3 seconds: Manual open/close screen is displayed.
	Hold pressed together for 3 seconds: Enter programming mode.

8.3. 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
L1 current (coarse measurement)
L2 current (coarse measurement)
L3 current (coarse measurement)
Neutral current
Iavg: average current
Frequency (Hz)
Total active power
Total reactive power
Total apparent power
Total power factor
Average Ph-N voltage
Average Ph-Ph voltage
Average current
L1 active power (kW)
L2 active power (kW)
L3 active power (kW)
L1 reactive power (kVAr)
L2 reactive power (kVAr)
L3 reactive power (kVAr)
L1 apparent power (kVA)
L2 apparent power (kVA)
L3 apparent power (kVA)
L1 power factor (pf)
L2 power factor (pf)
L3 power factor (pf)

Harmonic analysis channels:

L1-N voltage
L2-N voltage
L3-N voltage
L1-L2 voltage
L2-L3 voltage
L3-L1 voltage
L1 current
L2 current
L3 current
Neutral current

9. 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
I1r	Phase 1 AC RMS Current (Coarse measurement for protection)
I2r	Phase 2 AC RMS Current (Coarse measurement for protection)
I3r	Phase 3 AC RMS 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)
S1	Phase 1 Apparent Power (kVA)
S2	Phase 2 Apparent Power (kVA)
S3	Phase 3 Apparent Power (kVA)
∑S	Total Apparent Power (kVA)
PF1	Phase 1 Power Factor
PF2	Phase 2 Power Factor
PF3	Phase 3 Power Factor
PF	Total Power Factor
I1mx	Phase 1 Maximum Current
I2mx	Phase 2 Maximum Current
I3mx	Phase 3 Maximum Current
Pmax	Maximum Total Active Power
PIm1	Import Power Counter 1 (kWh)
PEx1	Export Power Counter 1 (kWh)
PIm2	Import Power Counter 2 (kWh)
PEx2	Export Power Counter 2 (kWh)
QIn1	Inductive Power Counter 1 (kVar)
QCp1	Capacitive Power Counter 1 (kVar)
QIn2	Inductive Power Counter 2 (kVar)
QCp2	Capacitive Power Counter 2 (kVar)
AO-1	Analog Output 1
AO-2	Analog Output 2
AO-3	Analog Output 3
THD	Total Harmonic Distortion
Th…	Total Harmonics… (V1,V2,V3,I1,I2,I3,U1,U2,U3)
H03-H49	Harmonics

9.1. AUTOMATIC DISPLAY SCROLL

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

Moving between different display groups is done by 

button.

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.

Moving within the same display group is done using the 

and 

buttons.

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.

Each time 

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

Parameter groups are listed below:

Mimic Diagram: Screens showing protection status.

Measurement Screens: Voltage, current, kW, kVA, kVAr, pf, active and reactive energy counters.

Demand Screens: Demand current, demand power; minimum, maximum currents, voltages, inductive and capacitive powers.

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

User Screens: User configured screens.

Oscilloscope Screens: Voltage and current waveforms can be viewed as if with an oscilloscope in this screen group. All Phase-Neutral and Phase-Phase voltages and phase currents are displayed. This feature enables visual monitoring of waveform and harmonic distortions.

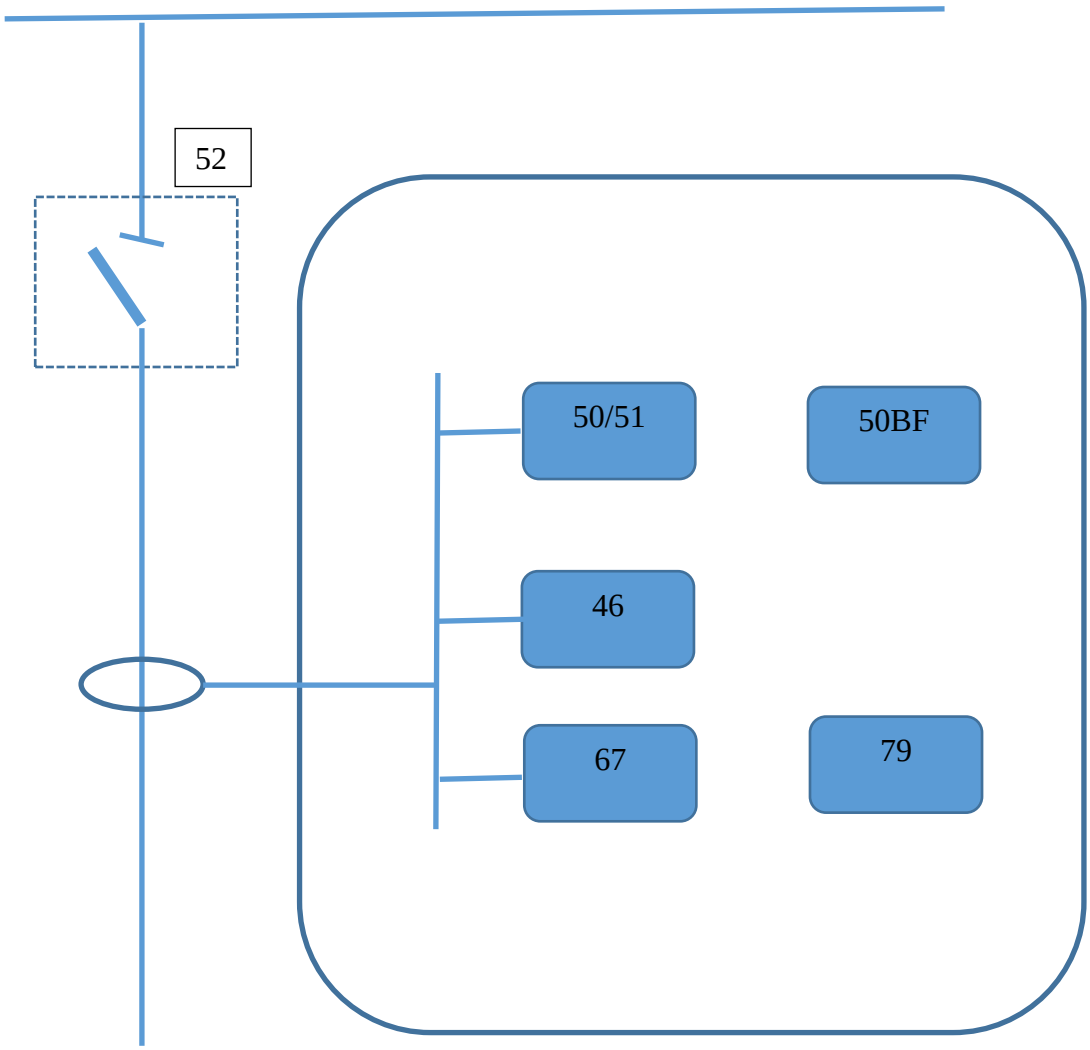
Digital Harmonic Analysis Results: In this screen, the current and voltage total harmonics are displayed with 0.1% resolution. All Phase-Neutral and Phase-Phase voltages and phase currents are displayed. This feature allows for monitoring harmonics due to complex loads.

10. PROTECTION FUNCTIONS

10.1. GENERAL FEATURES

DPR-350 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 Protection (ANSI 46)
- Directional Overcurrent Protection (ANSI 67)
- Breaker Failure (ANSI 50BF)
- Circuit Connection Supervision (ANSI 74)
- Reclosure (ANSI 79)
- Motorized Switch – Contactor Control (ANSI 94/69)



DPR350 allows for two levels of “Overcurrent Protection” and “Negative Sequence Overcurrent Protection” functions.

10.2. TIME CALCULATION FOR CURVES

The DPR-350 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	$If I > Is; set = T$		
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-350 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

10.3. 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 2 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.

10.4. NEGATIVE SEQUENCE OVERCURRENT PROTECTION (ANSI 46)

The controller continuously measures the negative sequence current component and provides 2 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 2 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.

10.5. 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.

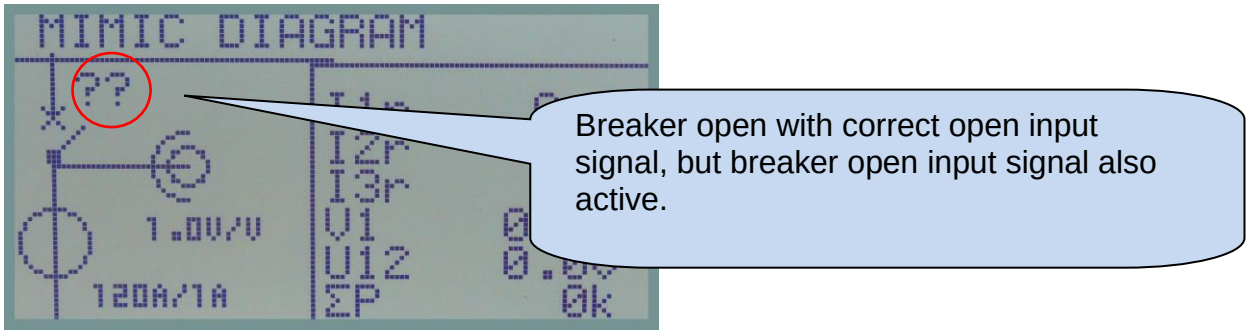
10.6. BREAKER FAILURE (ANSI 50BF)

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. One of the outputs can be configured as breaker failure output.

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.

Example;



10.7. 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 timers 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.

10.8. COLD LOAD PICKUP (CLPU 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.

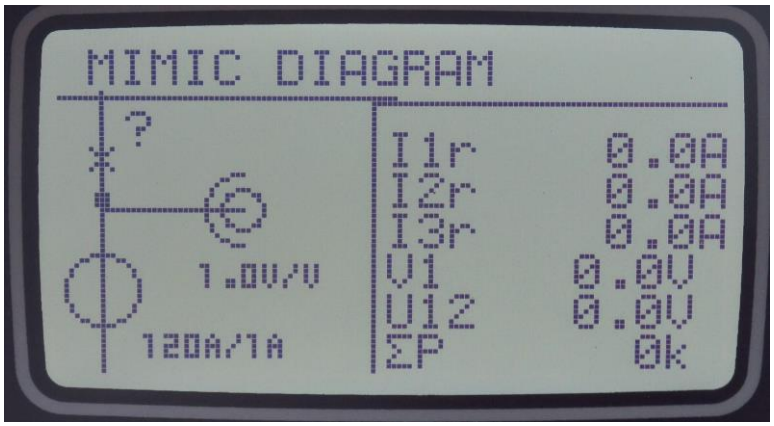
11. MIMIC DIAGRAM

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; phase currents, phase 1-neutral voltage, phase 1-phase 2 voltage and total active power are displayed.

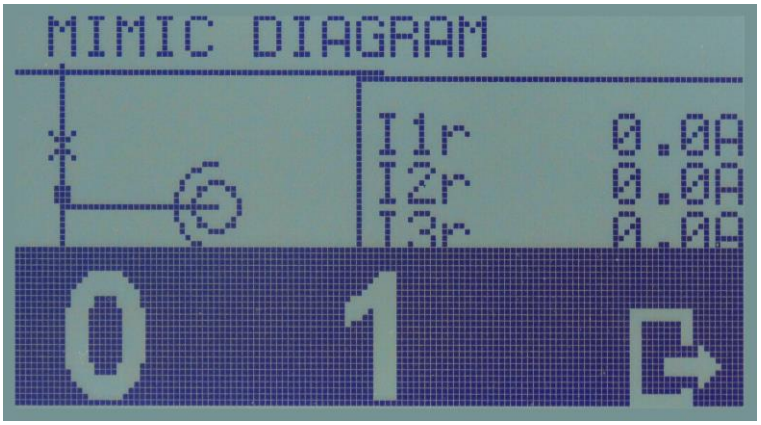
If digital inputs have been configured to breaker open and closed contact, this screen displays the related error symbols. For detailed information about the symbols, refer to "**CIRCUIT CONNECTION MONITORING (ANSI 50BF)"** section.

In addition, the mimic diagram screen displays the current and voltage transformer ratios.



Mimic Diagram Display

Press and hold the MENU button for 3 seconds to reach the manual open/close screen. Press SET to exit without making changes.



Manual Control Screen

12. ASTRONOMIC TIMER RELAY FUNCTION

The astronomic relay function enables the unit to accurately calculate sunrise and sunset times according to date and location.

This function allows the user to operate streetlamps according to sunrise and sunset hours, and also activating and deactivating various systems.

Astronomic Timer Relay Screen

Astronomic timer relay can be configured from Location Settings in programming.

The unit takes date and time information from its internal Real Time Clock.

Geographical location information can be entered by choosing city plate code or directly via longitude and latitude.

The unit can activate or deactivate a relay according to sunrise and sunset hours. Relay switching time before sunrise or after sunset is configured separately.

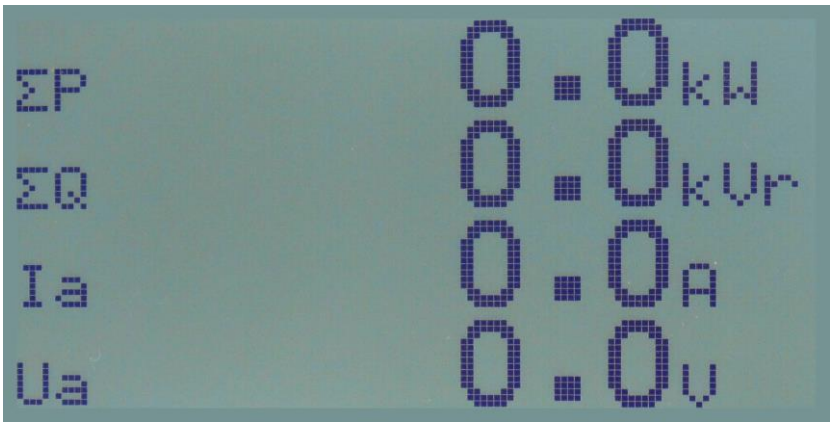
13. USER SCREEN CONFIGURATION

The unit offers a flexible and easy to use screen design tool in programming mode.

The user can freely design a needed screen. Any measured value can be displayed using 2 different character sizes.

The screen can show 4 lines with large characters and 8 lines with small characters. The values are shown as 2 columns with small characters; thus, the screen capacity is 4 values for large characters and 16 values for small characters. Small and large characters can be used on the same screen if desired.

Below is a user screen example.

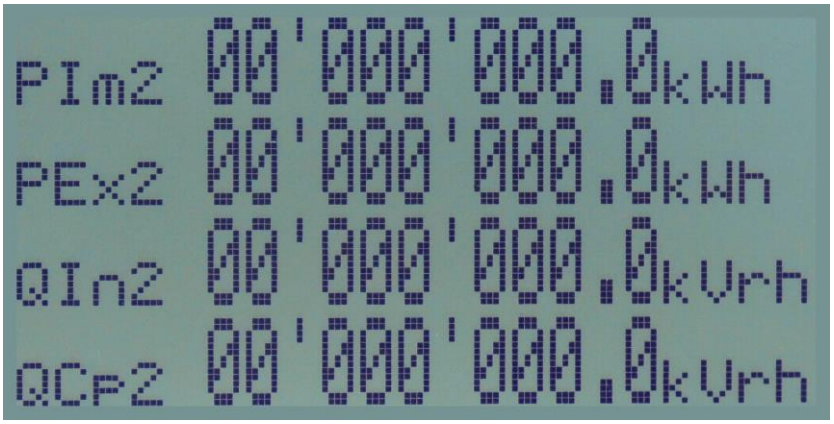


The unit offers 4 independent user screens. Up to 64 values in total can be shown with user screens.

Screen names are also programmable.

For detailed information on how to configure user screens, refer to USER SCREEN CONFIGURATION under PROGRAMMING in this document.

14. COUNTERS



Counters

The unit features counters for statistical calculations. These counters are stored in non-volatile device memory and maintain their values even if the unit is powered off.

The unit also features counters which count signal pulses for digital inputs. This allows for counting and reading external events with communication channels.

Counters:

-Total import kWh-1
-Total export kWh-1
-Total inductive kVArh-1
-Total capacitive kVArh-1

-Total import kWh-2
-Total export kWh-2
-Total inductive kVArh-2
-Total capacitive kVArh-2

-Digital input timer counter-1
-Digital input timer counter-2
-Digital input pulse counter-1
-Digital input pulse counter-2

15. DEMAND VALUES

Demand values are the average of the measured values over a given period.

Average values are compared with the demand values at the end of each period. If the new value is greater than the demand value, the new value is recorded as the demand value.

Demand values are automatically reset at the start of each month. Therefore, the demand values are only valid for the current month.

Demand values can also be reset manually following the procedure detailed in RESETTING THE COUNTERS section in the programming menu.

Demand values are stored in non-volatile memory and they are not affected by power losses.

Demand is calculated for the below values:

-demand I1
-demand I2
-demand I3
-demand Ia (average current)
-demand import active power
-demand export active power

16. MIN-MAX VALUES

Min-max values depend on internal measurements. Since they don't have an average period, they are sensitive to short-term changes such as starting currents of electric motors.

While the device is active, it compares actual values to recorded values. If the actual value fulfills the condition (greater than max value or lower than min value), it is recorded as the new value.

Min-max values can be reset from the programming menu. The relevant parameter is:
MIN/MAX/COUNTER CONFIG>Min/Max Restart

Min/Max values are stored in non-volatile device memory, so they are not affected by power losses.

Min/max detection starts 5 seconds after the device powers on in order to achieve more robust results.

Min/max is calculated for the values below:

-Min voltage L1-N
-Min voltage L2-N
-Min voltage L3-N
-Min voltage L12
-Min voltage L23
-Min voltage L31
-Min frequency
-Min current I1
-Min current I2
-Min current I3
-Min current Ia (average current)
-Min import active power
-Min export active power
-Min inductive reactive power
-Min capacitive reactive power

-Max voltage L1-N
-Max voltage L2-N
-Max voltage L3-N
-Max voltage L12
-Max voltage L23
-Max voltage L31
-Max frequency
-Max current I1
-Max current I2
-Max current I3
-Max current Ia (average current)
-Max import active power
-Max export active power
-Max inductive reactive power
-Max capacitive reactive power

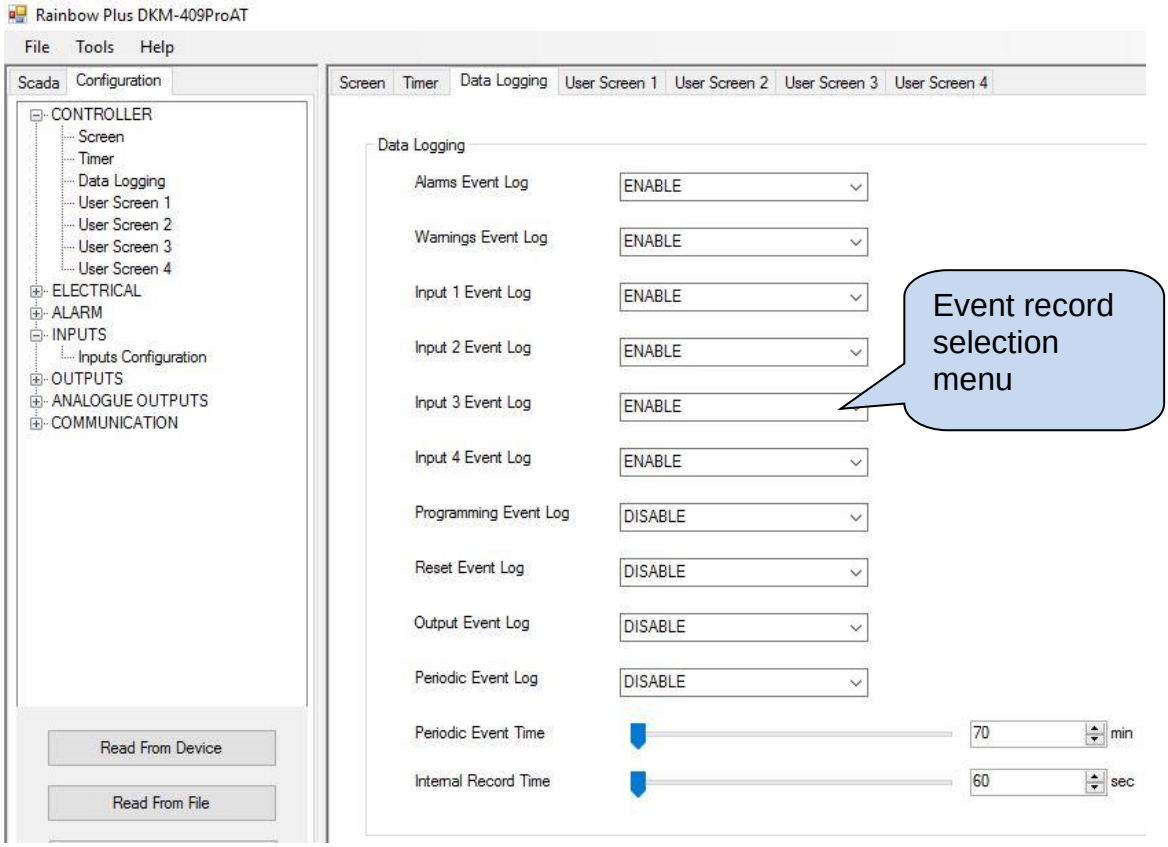
17. DISPLAYING EVENT RECORDS

The unit records more than 35 events with date-time and measurement values at the time of the event.

Event records include the following:

-Event ordinal number
-Event type / fault definition (detailed later in this section)
-date and time
-alarm/input/output bits
-Ph-N voltages: V1-V2-V3
-Ph-Ph voltages: U12-U23-U31
-Phase currents: I1-I2-I3
-frequency
-total active power (kW)
-total reactive power (kVAr)
-total apparent power (kVA)
-total power factor
-total harmonic distortion: V1-V2-V3-U12-U23-U31-I1-I2-I3

Events that trigger records can be selected as shown below:

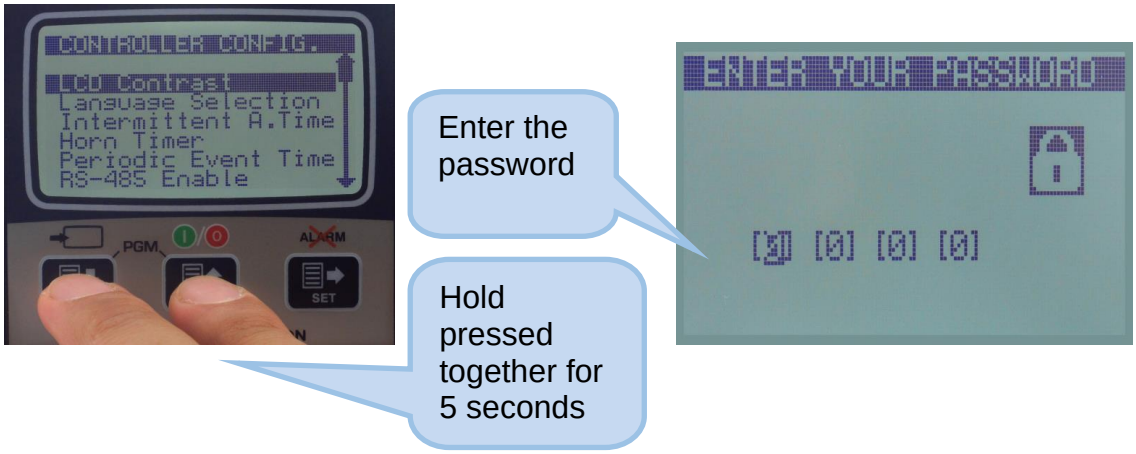


Alarm events: Recorded if an alarm occurs.
Warning events: Recorded if a warning occurs.
Input events: Recorded if the relevant digital input changes position.
Programming mode entered : Recorded if programming mode is entered using a password.
Reset event: Recorded each time the device is powered on.
Output event: Recorded if one of the outputs change position.
Periodic record: Automatically record with a given interval configured with a parameter.

Event records can be viewed from the programming menu. This prevents confusion of the event records with other measurements.

To enter **Event Records** menu, press together MENU and MENU buttons for 5 seconds.

The following password prompt will be displayed upon entering program mode.



Enter “9876” as the password. The value of the highlighted digit can be changed using the MENU and MENU buttons, The SET button moves to the next digit. Pressing the SET button shows the programming menu.

Pressing the SET button again displays the most recently recorded event. The event number, event type and date-time information can be viewed in the first page.

While viewing event records:

Press the SET button to view the next page within the event. Press and hold to return to main programming screen.

Press the MENU button to view the same information for the previous event.

Press the MENU button to view the same information for the next event.

18. PROTECTIONS & ALARMS

If any of the analog values of the measured parameters are outside the configured limits cause an ALARM situation.

In case of a fault condition, the alarm pop-up screen is displayed and the alarm function is activated. Alarm status can be assigned to a relay output in order to control various systems.

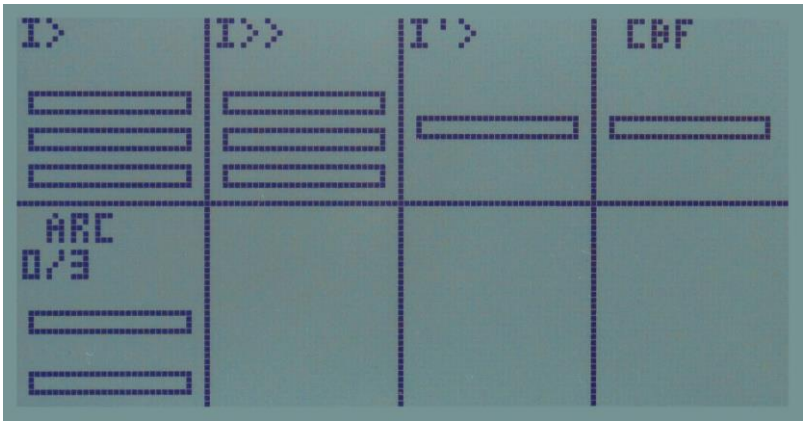
If a fault condition occurs, the alarm pop-up screen will be displayed automatically.

There are low/high levels and timers for every alarm. If the fault condition is removed before the programmed timer expires, no alarm is raised.

Alarms can be configured as latching. For a latching alarm, the alarm will be displayed even if the fault condition is removed.

Alarm levels can be configured for many alarms. Refer to programming section for alarm level configuration.

Active protections can be viewed in the protections screen given below. In case of a fault, the relevant protection bar will start to fill. The alarm will be raised when the bar is completely full.



Protections Screen

19. PROGRAMMING

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

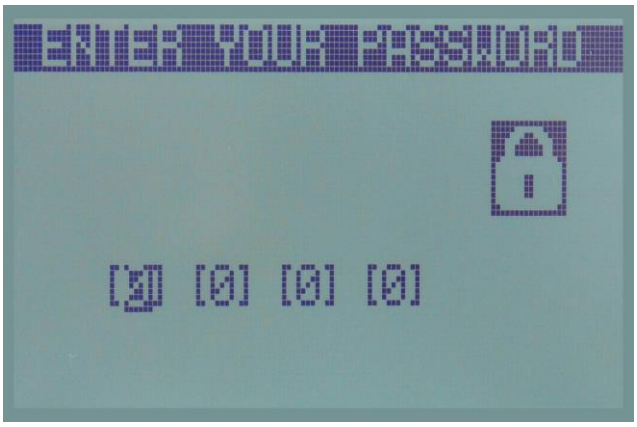
Every parameter can be changed from the front panel of the device as well as via the free Rainbow Plus software.

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

Entering the programming mode does not affect device operation.

19.1. ENTERING PROGRAM MODE

To enter programming mode, press and hold the MENU and MENU buttons for 5 seconds. The following password prompt will be displayed upon entering program mode:



The 4-digit password must be entered using the MENU, MENU and SET buttons.

Pressing the MENU and MENU buttons changes the digit value. The SET button moves to the next digit.

There are 3 password levels in the device. Level 1 password allows access to parameter configurations which can be performed on the field. Level 2 password allows access to parameter configurations which should be done in the factory. Level 3 password is reserved for calibration parameters.

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

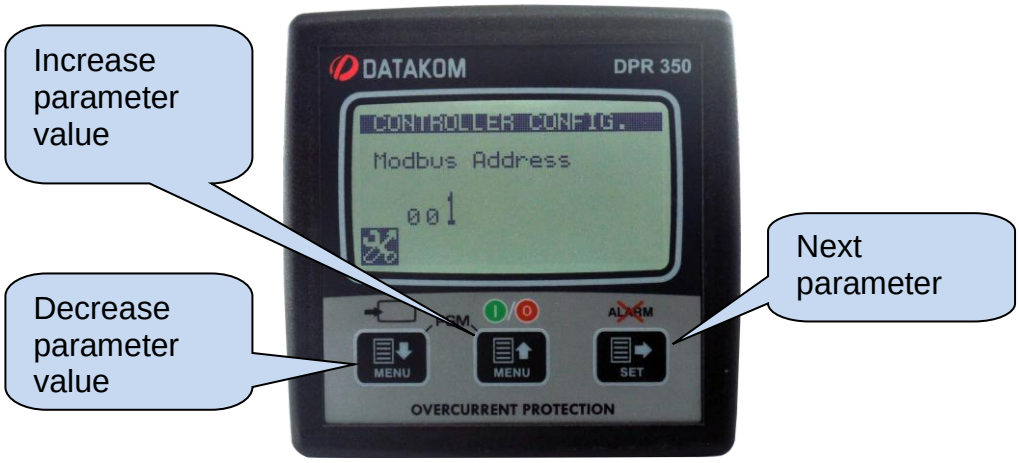
19.2. NAVIGATING BETWEEN MENUS

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 is displayed. Navigation between groups is done using MENU and MENU buttons. The selected group is highlighted with a dark background. To enter the group, press the SET button. To go back to the main menu, press and hold the SET button.

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

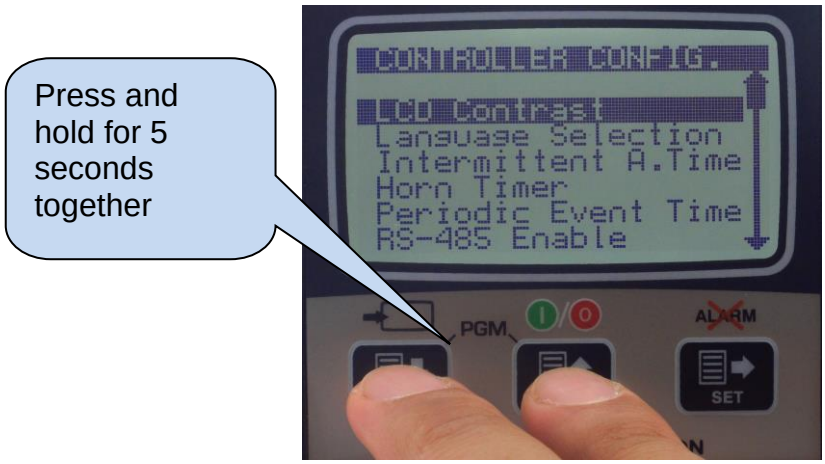
19.3. MODIFYING PARAMETER VALUE



19.4. EXITING PROGRAM MODE

In order to exit program mode, press and hold the MENU and MENU buttons together for 5 seconds.

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



20. PROGRAM PARAMETER LIST

20.1. CONTROLLER CONFIGURATION GROUP

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Language Selection	-	0	1	0	**0:** English **1:** Turkish. This option can vary according to the country of use. Different languages can be uploaded using Rainbow Plus software.
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.
Horn Timer	Sec	0	120	60	If a warning or an alarm occurs, the **HORN** output is energized for the duration of this timer. If this timer is set to 0, the horn output is energized indefinitely.
Periodic Record Timer	Min	0	65000	60	Sets the periodic event record timer
RS-485 Enable	-	0	1	1	**0:** RS-485 port disabled **1:** RS-485 port enabled
Modbus Address	-	0	254	1	This parameter is the Modbus address of the device.
RS-485 Communication Rate	Baud	2400	115200	9600	RS-485 Modbus port communication rate
Intermittent Relay Active	-	0	1	0	**0:** continuous **1:** intermittent
Alarm Event Record	-	0	1	1	0: Disabled 1: Enabled
Warning Event Record	-	0	1	1	0: Disabled 1: Enabled
Digital Input 1 Event Record	-	0	1	1	0: Disabled 1: Enabled
Digital Input 2 Event Record	-	0	1	1	0: Disabled 1: Enabled
Digital Input 3 Event Record	-	0	1	1	0: Disabled 1: Enabled
Digital Input 4 Event Record	-	0	1	1	0: Disabled 1: Enabled
Programming Event Record	-	0	1	1	0: Disabled 1: Enabled
Reset Event Record	-	0	1	0	0: Disabled 1: Enabled
Output Event Record	-	0	1	1	0: Disabled 1: Enabled
Periodic Event Record	-	0	1	0	0: Disabled 1: Enabled
LCD Backlight Timer	Min	0	1440	0	If no buttons are pressed in this duration, the LCD backlight turns off.
Flashing Relay ACTIVE Timer	Min	0	6000	0	Flashing relay ACTIVE timer.
Flashing Relay PASSIVE Timer	Min	0	6000	0	Flashing relay PASSIVE timer.
Internal Record Period	Sec	2	65000	60	Configures the frequency of records in the internal memory. More frequent records will cause the memory to fill quickly. Once memory is full, the oldest record will be deleted.
Modbus Packet Type		0	1	0	Do not change this parameter. Affects the Modbus map structure.

20.2. ELECTRICAL PARAMETERS GROUP

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Current Transformer Ratio	-	5/5	25000/1	600/1	Enter the primary and secondary values for the current transformer.
Voltage Transformer Ratio	-	0	5000	1.0	Voltage transformer ratio. This ratio is multiplied by the values measured in the voltage and power measurements. If no transformers are used, this value must be set to 1.0.
Alarm End Timer	Sec	0	255	20	When the alarm cause is removed, the alarm ends after this duration unless it is latching type.
Phase Order Check	-	0	1	0	0: phase order not checked 1: alarm occurs if phase order is faulty.
Low Voltage Alarm	V	0	65000	0	If one of the phase voltages drops below this value, the unit concludes that mains power is lost. If this value is set to 0, it is not checked.
High Voltage Alarm	V	0	65000	0	If one of the phase voltages exceeds this value, the unit concludes that mains power is faulty. If this value is set to 0, it is not checked.
Voltage Fault Delay	Sec	0	255	30	If phase voltages are outside the limits for this duration, the unit concludes that mains power is faulty.
Voltage Alarm Latching	-	0	1	1	0: non-latching 1: latching
Low Frequency Alarm	Hz	0	400	0	If the mains frequency drops below this value, an alarm occurs. If this value is set to 0, the alarm is not checked.
High Frequency Alarm	Hz	0	400	0	If mains frequency exceeds this limit, an alarm occurs. If this value is set to 0, the alarm is not checked.
Frequency Alarm Timer	Sec	0	255	30	If mains frequency is outside the limits for this duration, an alarm occurs.
Frequency Alarm Latching	-	0	1	1	0: non-latching 1: latching
Low Active Power Alarm	kW	0	9999	0	If the active power of any channel drops below this value, an alarm occurs. If this value is set to 0, the alarm is not checked.
High Active Power Alarm	kW	0	9999	0	If the active power of any channel exceeds this value, an alarm occurs. If this value is set to 0, the alarm is not checked.
Active Power Alarm Timer	Sec	0	255	30	If the active power of any channel is outside the limits for this duration, an alarm occurs.
Active Power Alarm Latching	-	0	1	1	0: non-latching 1: latching

20.2. ELECTRICAL PARAMETERS GROUP

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Reactive Capacitive Alarm	kVAr	0	9999	0	If the reactive power of any channel is capacitive and above this limit, an alarm occurs. If this value is set to 0, the alarm is not checked.
Reactive Inductive Alarm	kVAr	0	9999	0	If the reactive power of any channel is inductive and above this limit, an alarm occurs. If this value is set to 0, the alarm is not checked.
Reactive Alarm Timer	Sec	0	255	30	If the reactive power of any channel is outside the limits for this duration, an alarm occurs.
Reactive Power Alarm Latching	-	0	1	1	0: non-latching 1: latching
PF Capacitive Alarm	-	0.000	1.000	0.000	If the power factor of any channel is capacitive and below this limit, an alarm occurs. If this value is set to 0, the alarm is not checked.
PF Inductive Alarm	-	0.000	1.000	0.000	If the power factor of any channel is inductive and below this limit, an alarm occurs. If this value is set to 0, the alarm is not checked.
PF Alarm Timer	Sec	0	255	30	If the PF of any channel is outside the limits for this duration, an alarm occurs.
Overcurrent Alarm	A	0	25000	0	If the current measurement of any channel exceeds this limit, an alarm occurs. If this value is set to 0, the alarm is not checked.
Current Alarm Timer	Sec	0	255	30	If the current measurement of any channel exceeds the limit for the duration of this timer, an alarm occurs.
Current Alarm Latching	-	0	1	1	0: non-latching 1: latching
High THD-V Alarm	%	0	50	0	If the total harmonic distortion of any voltage input exceeds this limit, an alarm occurs. If this value is set to 0, the alarm is not checked.
THD-V Alarm Timer	Sec	0	255	30	If THD-V is above the limit for this duration, an alarm occurs.
THD-V Alarm Latching	-	0	1	1	0: non-latching 1: latching
High THD-I Alarm	%	0	50	0	If the total harmonic distortion of any current input exceeds this limit, an alarm occurs. If this value is set to 0, the alarm is not checked.
THD-I Alarm Timer	Sec	0	255	30	If THD-I is above the limit for this duration, an alarm occurs.

20.2. ELECTRICAL PARAMETERS GROUP

Parameter Definition	Unit	Min	Max	Factory Setting	Description
THD-I Alarm Latching	-	0	1	1	0: non-latching 1: latching
Voltage Unbalance Alarm	%	0	50	0	If voltage unbalance exceeds his value, an alarm occurs. If this value is set to 0, the alarm is not checked. Voltage unbalance is calculated as the maximum deviation from the average.
Voltage Unbalance Alarm Timer	Sec	0	255	30	If voltage unbalance is above the limit for this duration, an alarm occurs.
Voltage Unbalance Alarm Latching	-	0	1	1	0: non-latching 1: latching
Current Unbalance Alarm	%	0	50	0	If current unbalance exceeds his value, an alarm occurs. If this value is set to 0, the alarm is not checked. Current unbalance is calculated as the maximum deviation from the average.
Current Unbalance Alarm Timer	Sec	0	255	30	If current unbalance is above the limit for this duration, an alarm occurs.
Current Unbalance Alarm Latching	-	0	1	1	0: non-latching 1: latching
kW tick type	-	0	2	1	0: Always 1: If Group 1 counters are active 2: If Group 2 counters are active
Connection Type (Topology)	-			0	0: 3 phase, 4 wire, star 1: 1 phase, 2 wire 2: 2 phase, 3 wire 3: 3 phase, 3 wire, delta 4: delta high-leg 5: 3 phase, 3 wire, L1-L2 CT 6: 3 phase, 3 wire, L1-L3 CT
Demand Time Interval	min	1	240	15	The recalculation period for demand values.
Energy Counter Unit	-	0	1	0	0: kWh 1: MWh

20.3. INPUT PARAMETERS

The unit features 4 digital inputs. The parameters of one digital input are explained below. The other input functions have identical parameters.

Input functions can be assigned user defined strings. This enables digital inputs to be used in any function.

Input functions can only be assigned custom names using Rainbow Plus program.

Each digital input has the following programmable parameters:

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Latching	-	0	1		**0:** non-latching. The alarm pop-up screen is dismissed once the fault condition is removed. **1:** latching. The alarm pop-up screen remains until manually dismissed even if the fault condition is removed.
Delay Timer	-	0.1	10		The duration between receiving a fault signal and raising the alarm.
Contact Type	-	0	1		**0:** Normally open **1:** Normally closed
Input Function	-	0	99		Selected from list of pre-defined input functions. Any function from the list below can be selected. If a user function is selected, the display name will be a user input string. **0:** User Function-1 **10:** Alarm Mute **11:** High Temperature **12:** Panel Lock

DIGITAL INPUT FUNCTION LIST

No	Description
0	User Function 1
1	User Function 2
2	User Function 3
3	User Function 4
4	User Function 5
5	Input Counter 1 Reset
6	Input Counter 1 Increment
7	Input Counter 2 Reset
8	Input Counter 2 Increment
9	Change Counter Group
10	Alarm Mute
11	High Temperature
12	Panel Lock
13	Breaker Closed Contact
14	Breaker Open Contact

20.4. OUTPUT PARAMETERS

The parameters below determine the functions of the unit's digital outputs. The unit features 2 relay outputs and each can be configured as one of the functions listed below.

The following is a short list of output functions. Use the RainbowPlus software for the complete list.

RELAY OUTPUT FUNCTION LIST

No	Description
1	Horn
2	Flashing relay
3	Phase order alarm
4	Voltage alarm
5	Voltage OK
6	Internal alarm
7	Input alarm
8	Warning
9	Internal input alarm
10	kWh tick
11	kVArh tick
12	Low voltage alarm
13	High voltage alarm
14	Low frequency alarm
15	High frequency alarm
16	Frequency alarm
17	Low active power alarm
18	High active power alarm
19	Active power alarm
20	Capacitive reactive alarm
21	Inductive reactive alarm
22	Reactive power alarm
23	Capacitive PF alarm
24	Inductive PF alarm
25	PF alarm
26	High current alarm
27	THD-V alarm
28	THD-I alarm
29	THD alarm
30	Voltage unbalance alarm

No	Description
31	Current unbalance alarm
32	Unbalance alarm
33	User input alarm-1
34	User input alarm-2
35	User input alarm-3
36	User input alarm-4
37	Button 1 simulation
38	Button 2 simulation
39	Button 3 simulation
40	Input-1 simulation
41	Input-2 simulation
42	Input-3 simulation
43	Input-4 simulation
44	User Output 1
45	User Output 2
46	High neutral current alarm
47	High ground current alarm
48	Astronomic timer relay output
49	Breaker Relay (CB)
50	Breaker Fault (CBF)
51	Automatic reclosure
52	WatchDog relay
53	Successful close

20.5. ANALOG OUTPUTS

The unit features 3 analog outputs. Any measurement value selected from the list can be assigned to any output. Values can be set for 4mA and 20mA.

Each channel has its distinct program block.

Analog Output 1 Setting	Analog output-1 Program Parameters
Analog Output 2 Setting	Analog output-2 Program Parameters
Analog Output 3 Setting	Analog output-3 Program Parameters

Parameter Definition	Unit	Min	Max	Factory Setting	Description
Function	-	1	42		Select the measurement to assign to the Analog output.
Minimum	-				The value of the measurement selected by FUNCTION corresponding to 4mA.
Maximum	-				The value of the measurement selected by FUNCTION corresponding to 20mA.

The functions which can be assigned to analog outputs are listed below. The unit offers 3 analog outputs which can be programmed with their desired minimum and maximum values according to the list below.

OUTPUT FUNCTION LIST

No	Description
1	L1-N Voltage
2	L2-N Voltage
3	L3-N Voltage
4	L1-L2 Voltage
5	L2-L3 Voltage
6	L3-L1 Voltage
7	L1 Current
8	L2 Current
9	L3 Current
10	Neutral Current
11	Ground Current (reserved)
12	L1 Active Power
13	L2 Active Power
14	L3 Active Power
15	Total Active Power
16	L1 Reactive Power
17	L2 Reactive Power
18	L3 Reactive Power
19	Total Reactive Power
20	L1 Apparent Power

No	Description
21	L2 Apparent Power
22	L3 Apparent Power
23	Total Apparent Power
24	L1 Power Factor
25	L2 Power Factor
26	L3 Power Factor
27	Total Power Factor
28	Frequency
29	Internal Supply
30	Average L-N Voltage
31	Average L-L Voltage
32	Average L-N Current
33	L1 Q/P Ratio
34	L2 Q/P Ratio
35	L3 Q/P Ratio

20.6. INPUT & DISPLAY STRINGS

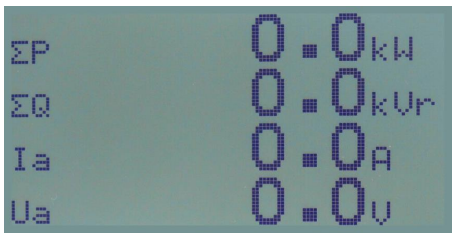
In this parameter group, user input strings and digital input names can be entered.

20.7. RESETTING THE COUNTERS

In this parameter group, the counters and the demand period of measurements can be reset and configured.

20.8. USER SCREEN CONFIGURATION

The 4 user screens on the device are configured from this menu.



There are 2 options for character size. (5x7 and 10x14 pixels)

1) Select the character size with the MENU and MENU buttons and press the SET button.
2) Select the parameter to be displayed on screen from the “Select an Item” menu and press the SET button.

For the next item, return to the character size selection. Steps 1 and 2 can be repeated until the screen is full.

The User Screen is constantly updated while in this menu.

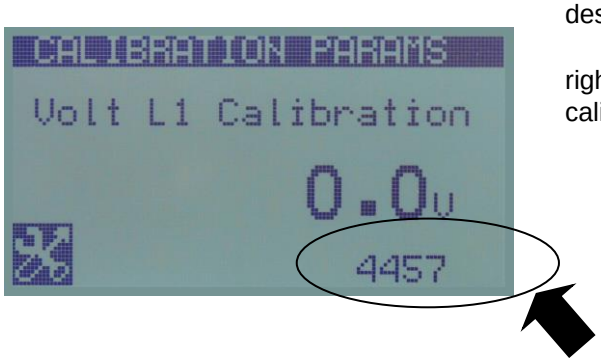
When the screen is filled, the device automatically exits this menu.

If desired, pressing and holding the SET button before the screen is filled returns to Programming mode.

20.9. CHANGING SERIAL NUMBER

The device's serial number can be changed from this menu.

20.10. CALIBRATION



MEASUREMENT VALUE

The unit is calibrated before it leaves the factory, but it is possible to recalibrate.

In "**PROGRAMMING**" mode, go to "**CALIBRATION**".

Then, select the measurement using the MENU and MENU buttons and press the SET button.

After that, increase or decrease the coefficient until the desired measurement value is displayed on the bottom right of the screen, and press SET to record the calibration and return to "**PROGRAMMING**" mode.

20.11. DATE AND TIME SETTINGS

The battery supplied real time clock in the device is configured with these parameters. Once the clock is set, it keeps working even if the device loses power.

Parameter definition	Unit	Min	Max	Description
Day	-	01	31	Day of month
Month	-	01	12	Month information
Year	-	00	99	Last two digits of the year
Hour	-	00	23	Hour of day
Minute	-	00	59	Minute of hour
Second	-	00	59	Second of minute

20.12. CHANGING THE PASSWORD

The unit has 3 levels of password protection. Each password is a 4 digit number.

The password can only be changed at the factory.

20.13. FACTORY RESET

When this menu is selected, the device will ask for confirmation.

Select the desired value with the MENU and MENU buttons and push the SET button to set it and return to “PROGRAMMING”.

Recovering the previous configuration is not possible after factory reset.

20.14. LOCATION SETTINGS

The parameters set in this menu are used in astronomical timer relay function.

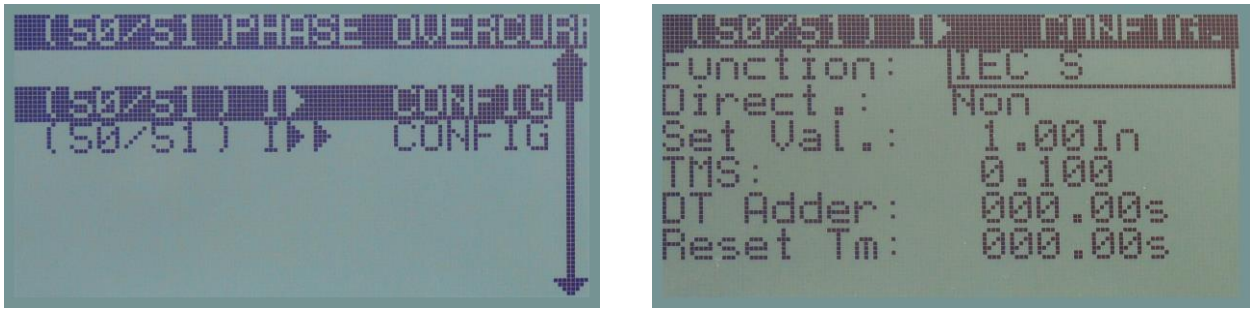
Parameter Definition	Unit	Min	Max	Factory Setting	Description
Clock Source	-	-	-	RTC	The unit receives date-time information only from the internal real time clock.
Location Source	-	-	-	SET	This parameter shows how the geographical location information is received. The unit only supports manually set locations.
Latitude	Degrees	66S	66N	41,000N	This parameter gives the latitude information in degrees. Turkish cities are available as a table for ease of use. **NOTE:** For latitudes within the polar circles, sunset and sunrise are not calculated.
Longitude	Degrees	180W	180E	36,444E	This parameter gives the longitude information in degrees. Turkish cities are available as a table for ease of use.
Time Zone	Hours	-12	+12	+2	Time Zone of the current location. Use the “+” sigh for East of GMT and “-“ for West of GMT.
Time Before Sunrise	Minutes			30	Determines the deactivation time delay of the astronomical timer relay before sunrise.
Time After Sunset	Minutes			30	Determines the activation time delay of the astronomical timer relay after sunset.
License Plate Number	-	1	100	34	Latitude-longitude information of Turkish cities can be automatically selected here.

20.15. OVERCURRENT PROTECTION (ANSI 50/51)

The controller offers 2 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

After selecting the desired protection level, the following screen which shows and allows changing only the selected function's parameters is displayed. Press and hold the SET button to return to programming.



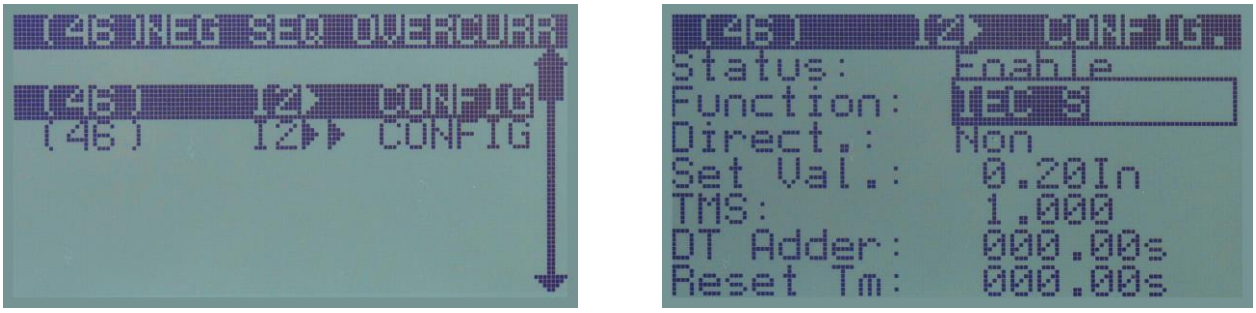
Function Configuration Screen

20.16. NEGATIVE SEQUENCE OVERCURRENT PROTECTION (ANSI 46)

The controller offers 2 levels of negative component overcurrent protection, each with its own distinct parameter group.

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. Press and hold the SET button to return to programming.

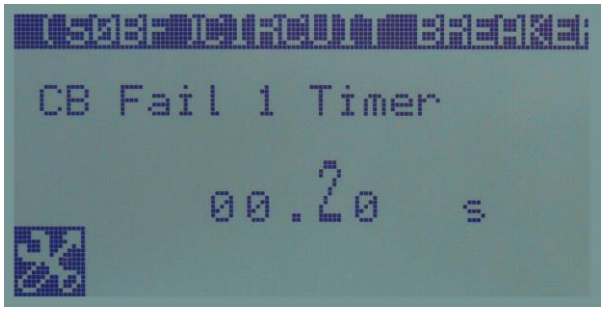


Function Configuration Screen

20.17. BREAKER FAILURE (ANSI 50BF)

The unit offers single level 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



Function Configuration Screen

20.18. 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.

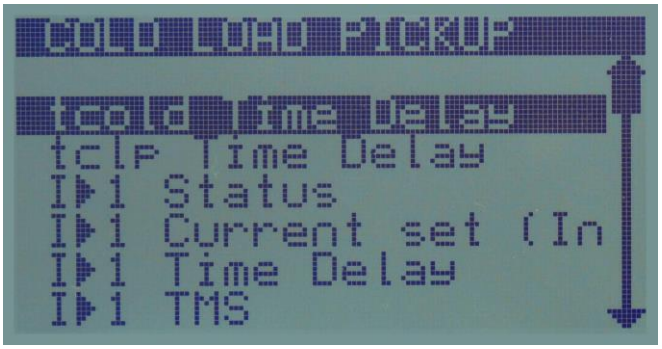
Parameter Definition	Unit	Min	Max	Factory Setting	Description
3 Phase	-	0	4	1	Maximum number of allowed retries
Dead Time 1	Sec	0.05	30.00	0.30	Period for trial 1
Dead Time 2	Sec	1	1800	60	Period for trial 2
Dead Time 3	Sec	1	3600	60	Period for trial 3
Dead Time 4	Sec	1	3600	60	Period for trial 4
Reset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

Function Configuration Screen

20.19. 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)"**. The protections are valid for the parameter group defined in this section for a set duration after the system has been energized.

Parameter Definition	Unit	Min	Max	Factory Setting	Description
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
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



Function Configuration Screen

20.20. 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.

21. INTERNAL RECORDS MEMORY

The unit's 1 MB internal memory can store 15000 records, 64 bytes each.

Record frequency configuration parameter: **CONTROLLER CONFIGURATION>Internal Record Period**.

The records can be read via Modbus. For detailed information on record reading, please refer to MODBUS COMMUNICATION section.

The internal records can be read and saved to a PC via Rainbow Plus software.

The records are composed of the following values:

- Record date/time
- Status of digital inputs and relay outputs
- Analog output 1 percentage
- Voltages V1, V2, V3, U12, U23, U31
- Currents I1, I2, I3
- Frequency
- Active power P1, P2, P3, Ptot
- Reactive power Q1, Q2, Q3
- Total apparent power
- Average power factor
- Neutral current
- Ground current
- Alarm bits
- THD of V1, V2, V3, U12, U23, U31, I1, I2, I3

22. MODBUS COMMUNICATIONS

The unit offers MODBUS in the following modes:

-RS485 serial port, adjustable baud rate from 2400 to 115200

MODBUS features of the device:

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

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.

22.1. PARAMETERS FOR RS-485 MODBUS COMMUNICATION

Modbus Address: May be set as a value between 1 and 240.
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.

22.2. 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.

22.3. 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

22.4. 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

22.5. 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

22.6. INTERNAL RECORD STORAGE STRUCTURE

The unit has 15000 records of 64 bytes each in its 1MB memory. In order to read records, the record number (0 .. 14999) must be typed into the address "16389". Then, the relevant record can be read starting from the 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_BOT	Type	Register Type	8 BIT	R-O	unsigned byte	-
+2_TOP	Argument	Register Info	8 BIT	R-O	unsigned byte	-
+3_BOT	Input - Output Status	Bits 0-4: digital input status Bits 5-7: digital output status	8 BIT	R-O	bitmap	100
+3_TOP	-	Reserved				
+4	V1	Voltage / Voltage Transformer Ratio	16 BIT	R-O	Unsigned word	x1
+5	V2					
+6	V3					
+7	U12					
+8	U23					
+9	U31					

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE (BIT)	R/W	TYPE	X
+10	I1	Current / Current Transformer Ratio	16 BIT	R-O	Unsigned word	x1000
+11	I2					
+12	I3					
+13	Frequency	Mains Frequency	16 BIT	R-O	Unsigned word	x100
+14	P1	P1/(VT Ratio/CT Ratio)	16 BIT	R-O	Unsigned word	x1
+15	P2	P2/(VT Ratio/CT Ratio)	16 BIT	R-O	Unsigned word	x1
+16	P3	P3/(VT Ratio/CT Ratio)	16 BIT	R-O	Unsigned word	x1
+17	P_tot	P/(VT Ratio/CT Ratio)	16 BIT	R-O	Unsigned word	x1
+18	Q1	Q1/(VT Ratio/CT Ratio)	16 BIT	R-O	Unsigned word	x1
+19	Q2	Q2/(VT Ratio/CT Ratio)	16 BIT	R-O	Unsigned word	x1
+20	Q3	Q3/(VT Ratio/CT Ratio)	16 BIT	R-O	Unsigned word	x1
+21	V_supply	Device Power Supply	16 BIT	R-O	Unsigned word	x10
+22	S_tot	S/(VT Ratio/CT Ratio)	16 BIT	R-O	Unsigned word	x1
+23	Cos_tot	Power Factor	16 BIT	R-O	Unsigned word	x1000
+24	I_neut	Neutral Current / CT Ratio	16 BIT	R-O	Unsigned word	x1000
+25	Alarm	Alarm Bits	16 BIT	R-O	Unsigned word	-
+26	Alarm	Alarm Bits	16 BIT	R-O	Unsigned word	-
+27_BOT	THD_V1	% THD V1	8 BIT	R-O	Unsigned word	x1
+27_TOP	THD_V2	% THD V2	8 BIT	R-O	Unsigned word	x1
+28_BOT	THD_V3	% THD V3	8 BIT	R-O	Unsigned word	x1
+28_TOP	THD_U12	% THD U12	8 BIT	R-O	Unsigned word	x1
+29_BOT	THD_U23	% THD U23	8 BIT	R-O	Unsigned word	x1
+29_TOP	THD_U31	% THD U31	8 BIT	R-O	Unsigned word	x1
+30_BOT	THD_I1	% THD I1	8 BIT	R-O	Unsigned word	x1
+30_TOP	THD_I2	% THD I2	8 BIT	R-O	Unsigned word	x1
+31_BOT	THD_I3	% THD I3	8 BIT	R-O	Unsigned word	x1
+31_TOP	CRC	Checksum: Sum of the first 63 bytes+ 76h	16 BIT	R-O	Unsigned word	-

22.7. 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
16392	kWh1-i	Write kWh1-import counter value	16 BIT	W-O	Unsigned word	x1
16393	kWh1-e	Write kWh1-export counter value	16 BIT	W-O	Unsigned word	x1
16394	kVArh1-i	Write kVArh1-inductive counter value	16 BIT	W-O	Unsigned word	x1
16395	kVArh1-c	Write kVArh1-capacitive counter value	16 BIT	W-O	Unsigned word	x1
16396	Hours_1	Write Hours_1 counter value	16 BIT	W-O	Unsigned word	x1
16397	kWh2-i	Write kWh2-import counter value	16 BIT	W-O	Unsigned word	x1
16398	kWh2-e	Write kWh2-export counter value	16 BIT	W-O	Unsigned word	x1
16399	kVArh2-i	Write kVArh2-inductive counter value	16 BIT	W-O	Unsigned word	x1
16400	kVArh2-c	Write kVArh2-capacitive counter value	16 BIT	W-O	Unsigned word	x1
16401	Hours_2	Write Hours_2 counter value	16 BIT	W-O	Unsigned word	x1
16405	Scope_Ch	Oscilloscope channel (0-9)	16 BIT	W-O	unsigned word	x1

22.8. 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
8199	Latitude	Latitude (+- 66.499) Negative latitude corresponds to “SOUTH”.	32 BIT	R-O	Signed long	x1000
8201	Longitude	Longitude (+- 179.999) negative longitude corresponds to “WEST”.	32 BIT	R-O	Signed long	x1000

22.9. COUNTERS

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE	R/W	TYPE	X
12288	kWh1_I	kWh1_import counter value	32 BIT	R-O	Unsigned long	x10
12290	kWh1_E	kWh1_export counter value	32 BIT	R-O	Unsigned long	x10
12292	kVArh1_Ind	kVArh1_inductive counter value	32 BIT	R-O	Unsigned long	x10
12294	kVArh1_Ca	kVArh1_capacitive counter value	32 BIT	R-O	Unsigned long	x10
12296	Hour_2	Hour_1 counter value	32 BIT	R-O	Unsigned long	x10
12298	kWh2_I	kWh2_import counter value	32 BIT	R-O	Unsigned long	x10
12300	kWh2_E	kWh2_export counter value	32 BIT	R-O	Unsigned long	x10
12302	kVArh2Ind	kVArh2_inductive counter value	32 BIT	R-O	Unsigned long	x10
12304	kVArh2Cap	kVArh2_capacitive counter value	32 BIT	R-O	Unsigned long	x10
12306	Hour_2	Hour_2 counter value	32 BIT	R-O	Unsigned long	x10

22.10. 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	U12 RMS	U12 Phase – Phase Voltage	32 BIT	R-O	Unsigned long	x10
20488	U23 RMS	U23 Phase – Phase Voltage	32 BIT	R-O	Unsigned long	x10
20490	U31 RMS	U31 Phase – Phase Voltage	32 BIT	R-O	Unsigned long	x10
20492	I1 RMS	I1 Current	32 BIT	R-O	Unsigned long	x1000
20494	I2 RMS	I2 Current	32 BIT	R-O	Unsigned long	x1000
20496	I3 RMS	I3 Current	32 BIT	R-O	Unsigned long	x1000
20498	IN RMS	Neutral Current	32 BIT	R-O	Unsigned long	x1000
20502	P1	Phase 1 Active Power (kW)	32 BIT	R-O	Signed long	x100
20504	P2	Phase 2 Active Power (kW)	32 BIT	R-O	Signed long	x100
20506	P3	Phase Active Power (kW)	32 BIT	R-O	Signed long	x100
20508	∑P	Total Active Power (kW)	32 BIT	R-O	Signed long	x100
20510	Q1	Phase 1 Reactive Power (kVAr)	32 BIT	R-O	Signed long	x100
20512	Q2	Phase 2 Reactive Power (kVAr)	32 BIT	R-O	Signed long	x100
20514	Q3	Phase 3 Reactive Power (kVAr)	32 BIT	R-O	Signed long	x100
20516	∑Q	Total Reactive Power (kVAr)	32 BIT	R-O	Signed long	x100
20518	S1	Phase 1 Apparent Power (kVA)	32 BIT	R-O	Signed long	x100
20520	S2	Phase 2 Apparent Power (kVA)	32 BIT	R-O	Signed long	x100
20522	S3	Phase 3 Apparent Power (kVA)	32 BIT	R-O	Signed long	x100
20524	∑S	Total Apparent Power (kVA)	32 BIT	R-O	Signed long	x100
20526	Cosφ 1	Phase 1 Power Factor	16 BIT	R-O	Signed word	x1000
20527	Cosφ 2	Phase 2 Power Factor	16 BIT	R-O	Signed word	x1000
20528	Cosφ 3	Phase 3 Power Factor	16 BIT	R-O	Signed word	x1000
20529	∑Cosφ	Total Power Factor	16 BIT	R-O	Signed word	x1000
20530	Frequency	Frequncy	16 BIT	R-O	Unsigned word	x100
20532	Va RMS	Average Phase – Neutral Voltage	32 BIT	R-O	Unsigned long	x10
20534	Ua RMS	Average Phase – Phase Voltage	32 BIT	R-O	Unsigned long	x10
20536	Ia RMS	Average Current	32 BIT	R-O	Unsigned long	x1000
20542	Dig-in	Digital Input	16 BIT	R-O	16 bit bitmap	-
20543	Dig-out	Digital Output	16 BIT	R-O	16 bit bitmap	-
21047	Scope_ch	Oscilloscope Channel Number	16 BIT	R-O	Unsigned word	-

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE	R/W	TYPE	X
21048-21147	Scope	Oscilloscopic Data	16 BIT	R-O	Signed word	x1
21148-21151	Relay F.	Relay Functions Status Bits	16 BIT	R-O	Array 4x16 bit	-
21152	Anl_1_Val	Analog Output 1 ADC	16 BIT	R-O	Unsigned word	x1
21153	Anl_2_Val	Analog Output 2 ADC	16 BIT	R-O	Unsigned word	x1
21154	Anl_3_Val	Analog Output 3 ADC	16 BIT	R-O	Unsigned word	x1
21155	Anl_1_Rat	Analog Output 1 %	16 BIT	R-O	Unsigned word	x100
21156	Anl_2_Rat	Analog Output 2 %	16 BIT	R-O	Unsigned word	x100
21157	Anl_3_Rat	Analog Output 3 %	16 BIT	R-O	Unsigned word	x100
21158	SF_Page	Current Record Number	16 BIT	R-O	Unsigned word	x1
21159	Event_No	Current Event Number	16 BIT	R-O	Unsigned word	x1
21160	Reset_sta	Last Reset Cause	16 BIT	R-O	16 bit bitmap	-
21161	Topology	Topology	16 BIT	R-O	Unsigned word	x1
21162	Dev_Type	Device Model Type	16 BIT	R-O	Unsigned word	x1
21163	SW_Vers	Software Revision	16 BIT	R-O	Unsigned word	x1
21164	HW_Cnf	Hardware Configuration	16 BIT	R-O	Unsigned word	x1
21165	Flash_sta	Flash Write Status Info	16 BIT	R-O	16 bit bitmap	-
21166	Ev_RD_sta	Event Record Read Status	16 BIT	R-O	16 bit bitmap	-
21167	Unlock_cnt	Password Unlocked Counter	16 BIT	R-O	Unsigned word	x1
21168-21679	LCD_buf	LCD Buffer	512x16bit	R_O	Array 128x64 bit	-
21680	LCD_sta	LCD Status	16 BIT	R-O	16 bit bitmap	-
21681	Warning	Auxiliary	16 BIT	R-O	16 bit bitmap	-
21682	Alarm	Alarm Function Bits 0-15	16 BIT	R-O	16 bit bitmap	-
21683	Alarm	Alarm Function Bits 16-31	16 BIT	R-O	16 bit bitmap	-

22.11. FUNCTION ALARM BITS

BIT	DESCRIPTION	BIT	DESCRIPTION
0	High Voltage	16	Input-1 Alarm
1	Low Voltage	17	Input-2 Alarm
2	High Frequency	18	Input-3 Alarm
3	Low Frequency	19	Input-4 Alarm
4	High kW	20	High Neutral Current
5	Low kW	21	Auxiliary
6	High kVar	22	Overcurrent Protection
7	Low kVar	23	Reverse Direction Overcurrent Protection
8	High Cos	24	Broken Conductor Protection (AUX)
9	Low Cos	25	Earth Fault Protection (AUX)
10	High Current	26	High Precision Earth Fault Protection (AUX)
11	High THD_V	27	Instantaneous High Voltage Protection (AUX)
12	High THD_V	28	Overvoltage Protection (AUX)
13	Voltage Unbalance	29	Low Voltage Protection (AUX)
14	Current Unbalance	30	Reverse Direction Overvoltage Protection (AUX)
15	Phase Order Fault	31	Breaker Failure Protection

22.12. DEMAND-MIN-MAX

REGISTER ADDRESS	VARIABLE	DESCRIPTION	SIZE	R/W	TYPE	X
12308	In_1_Pulse	Input-1 Pulse Counter	32 BIT	R-O	unsigned long	10
12310	In_2_Pulse	Input-2 Pulse Counter	32 BIT	R-O	unsigned long	10
12312	In_3_Pulse	Input-3 Pulse Counter	32 BIT	R-O	unsigned long	10
12314	In_4_Pulse	Input-4 Pulse Counter	32 BIT	R-O	unsigned long	10
12316	In_5_Pulse	Input-5 Pulse Counter	32 BIT	R-O	unsigned long	10
12318	In_1_Time	Input-1 Time Counter	32 BIT	R-O	unsigned long	10
12320	In_2_Time	Input-2 Time Counter	32 BIT	R-O	unsigned long	10
12322	In_3_Time	Input-3 Time Counter	32 BIT	R-O	unsigned long	10
12324	In_4_Time	Input-4 Time Counter	32 BIT	R-O	unsigned long	10
12326	In_5_Time	Input-5 Time Counter	32 BIT	R-O	unsigned long	10
12328	Dem_I1	Demand I_1	32 BIT	R-O	unsigned long	10
12330	Dem_I2	Demand I_2	32 BIT	R-O	unsigned long	10
12332	Dem_I3	Demand I_3	32 BIT	R-O	unsigned long	10
12334	Dem_In	Demand I_I_neutral	32 BIT	R-O	unsigned long	10
12336	Dem_kWi	Demand kW_import	32 BIT	R-O	unsigned long	10
12338	Dem_kWe	Demand kW_export	32 BIT	R-O	unsigned long	10
12340	Min_V1	Minimum V1	32 BIT	R-O	unsigned long	10
12342	Min_V2	Minimum V2	32 BIT	R-O	unsigned long	10
12344	Min_V3	Minimum V3	32 BIT	R-O	unsigned long	10
12346	Min_U12	Minimum U12	32 BIT	R-O	unsigned long	10
12348	Min_U23	Minimum U23	32 BIT	R-O	unsigned long	10
12350	Min_U31	Minimum U31	32 BIT	R-O	unsigned long	10
12352	Min_I1	Minimum I1	32 BIT	R-O	unsigned long	10
12354	Min_I2	Minimum I2	32 BIT	R-O	unsigned long	10
12356	Min_I3	Minimum I3	32 BIT	R-O	unsigned long	10
12358	Min_In	Minimum In	32 BIT	R-O	unsigned long	10
12360	Min_Freq	Minimum frequency	32 BIT	R-O	unsigned long	10
12362	Min_kWi	Minimum kW_import	32 BIT	R-O	unsigned long	10
12364	Min_kWe	Minimum kW_export	32 BIT	R-O	unsigned long	10
12366	Min_kVAri	Minimum kVAr_inductive	32 BIT	R-O	unsigned long	10
12368	Min_kVArc	Minimum kVAr_ capacitive	32 BIT	R-O	unsigned long	10
12370	Max_V1	Maximum V1	32 BIT	R-O	unsigned long	10
12372	Max_V2	Maximum V2	32 BIT	R-O	unsigned long	10
12374	Max_V3	Maximum V3	32 BIT	R-O	unsigned long	10
12376	Max_U12	Maximum U12	32 BIT	R-O	unsigned long	10
12378	Max_U23	Maximum U23	32 BIT	R-O	unsigned long	10
12380	Max_U31	Maximum U31	32 BIT	R-O	unsigned long	10
12382	Max_I1	Maximum I1	32 BIT	R-O	unsigned long	10
12384	Max_I2	Maximum I2	32 BIT	R-O	unsigned long	10
12386	Max_I3	Maximum I3	32 BIT	R-O	unsigned long	10
12388	Max_In	Maximum In	32 BIT	R-O	unsigned long	10
12390	Max_Freq	Maximum frequency	32 BIT	R-O	unsigned long	10
12392	Max_kWi	Maximum kW_import	32 BIT	R-O	unsigned long	10
12394	Max_kWe	Maximum kW_export	32 BIT	R-O	unsigned long	10
12396	Max_kVAri	Maximum kVAr_inductive	32 BIT	R-O	unsigned long	10
12398	Max_kVArc	Maximum kVAr_capacitive	32 BIT	R-O	unsigned long	10

23. 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.

UL / CSA Approval:
UL 61010-1, 3rd Edition, 2012-05,
CAN/CSA-C22.2
File: E475547, Vol. D1

24. 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.

25. 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.

26. 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)