



DUCATI energia s.p.a.

DUCA-LCD ETH

ETHERNET INTERFACE USER'S MANUAL



Vers. 0 Rev. A

REVISIONS

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1. GENERAL DESCRIPTION

The instrument **DUCA-LCD ETH**, part code **DUCATI** energia **468001305**, is a model of network analyzers DUCA-LCD family with Ethernet interface, with the following main features available:

- Webservice functionality (that can handle multiple simultaneous accesses from different browsers) – http protocol
- MODBUS-TCP communication protocol – Modbus-TCP protocol

Both features are available simultaneously.

1.1 ETHERNET CONNECTION

The DUCA-LCD ETH interfacing to the Ethernet network is made via an RJ45 female insulated connector located on the back of the instrument.

The Ethernet interface is also equipped with the MDI/MDX auto-crossover functionality, for this reason the user can use any of both cables types, “patch” or “cross”.

1.2 POWER-ON SELFTEST

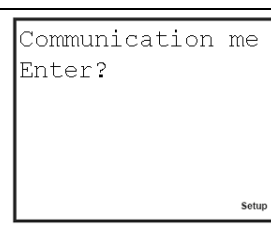
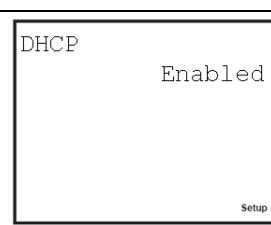
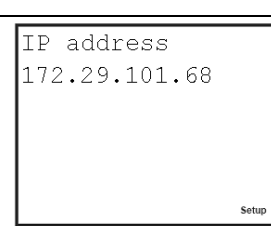
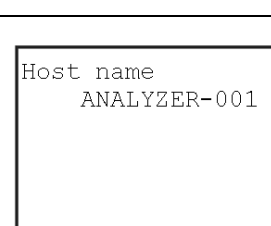
At power-on the instrument performs a self-test of the hardware interface, if there is a failure initializing the instrument then the message "Test ETH Failed" will be displayed. In these cases is necessary to contact **DUCATI** energia.

Keep in mind that the self-diagnostic performed by the instrument refers only to the internal hardware and dos not cover any errors of communication or interfacing to the Ethernet network.

2. INSTRUMENT SETUP

The Ethernet interface is available only in the DUCA-LCD ETH model (Part Number 468001305).

From the setup menu of the instrument is possible to perform the following settings:

From the “Communication menu” →	
Is possible to enable/disable the <i>DHCP</i> (Dynamic Host Configuration Protocol), selecting: “Enabled” or “Disabled”	
Is possible to set the IP address of the device (only if DHCP is disabled). When DHCP is enabled, this page shows instead the IP address obtained from DHCP.	
Is possible to set the host name of the device. It can be changed only the last 3 digits within the range 001÷999; then the Host name will be ANALYZER-xxx (where xxx = 001 ÷ 999). The host name is used to access the device by name rather than by IP address, useful especially when the address is obtained dynamically (DHCP enabled).	

NOTES:

- The device doesn’t accept an IP address like: 0.0.0.0
- Whenever the network cable is disconnected from the instrument, or when DHCP is enabled and it is not reachable or as long as it has not assigned an address, the IP address is automatically set to 255.255.25.255
- The host name is managed by the NetBios service. In networks where NetBios isn’t available, it will be possible to access the device only using its IP address.

All previous configurations are also possible via the Ethernet interface, accessing the “NETWORK” menu of the Webserver.

2.1 DEFAULT SETTINGS

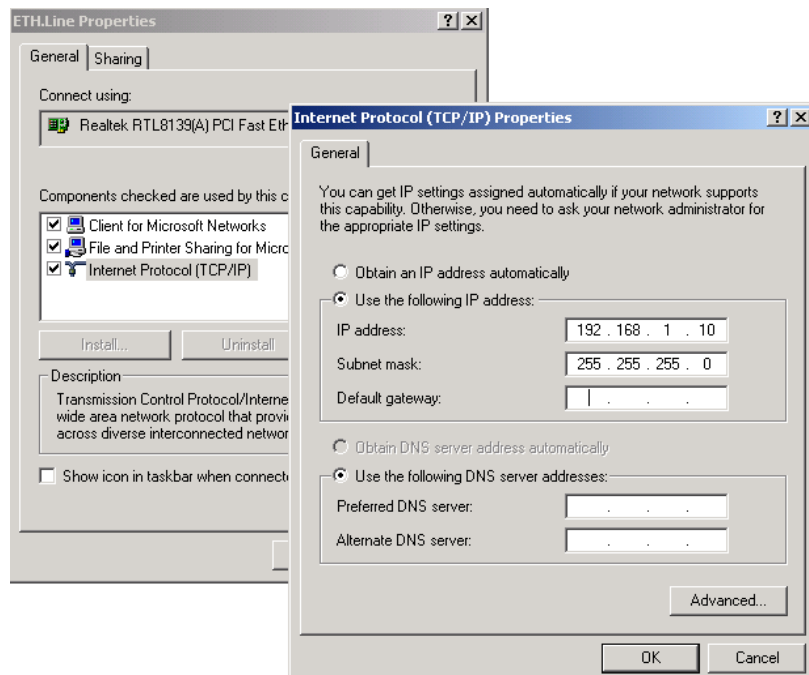
The default settings of the instrument are as follows:

- DHCP = *Disabled*
- IP = *192.168.1.239*
- Host name = *ANALYZER-001*

2.2 INSTRUMENT CONFIGURATION

To configure the instrument for the first time, you can alternatively proceed in one of the following ways:

1. Enable the DHCP from the setup menu of the instrument, connect the DUCA-LCD to the Ethernet network and then, from a PC also connected to the network, access the device with any browser (Internet Explorer, Mozilla Firefox, etc.) typing <http://analyzer-001> (default *Host name*ⁱ). At this point is possible to change appropriately all the configuration parameters. Should the Host name be not available, read from the setup menu of the instrument the IP address assigned (page “*IP Address*” of the “*Communication menu*”) and use it to access.
2. First configure the PC with an IP = 192.168.1.xxx, with xxx other than 239, and with Subnet Mask = 255.255.255.0. To do this start from *Settings* → *Control Panel* → *Network Connections* → *Local Area Connection (LAN)* → *Properties* → *Internet Protocol (TCP / IP)* (*Properties*), select “*Use the following IP address*” and set IP and Subnet mask with the previous mentioned parameters (see next picture for more details). Then press “*OK*” and confirm all the settings, then restart the PC to activate any changes made



Picture 1 – PC network configuration

ⁱ The access to the instrument through its Host name will be possible only if the NetBios service is enabled.

Afterwards, still leaving the DHCP of the instrument disabled, alternatively proceed as follows:

- Connect the PC directly to the DUCA-LCD using a network cable
- Alternatively, connect the PC directly to the Ethernet network. This option is only possible if there aren't already present on the network other devices with IP address 192.168.1.239 and = 192.168.1.xxx (where xxx = address previously set on the PC)

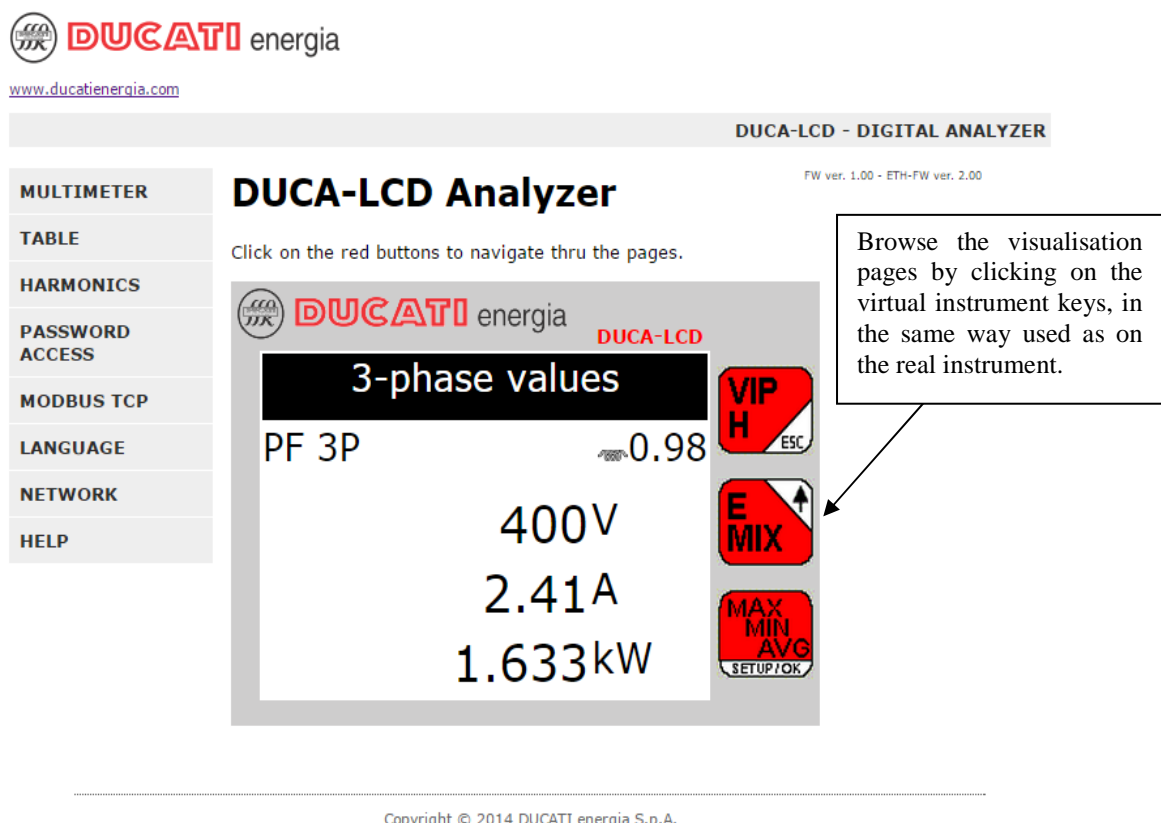
After that, it will be possible to access the instrument via any browser (Internet Explorer, Mozilla Firefox, etc.) typing <http://192.168.1.239> or <http://analyzer-001>ⁱ. At this point it's possible to change the various configuration parameters appropriately.

NOTE: if you have problems opening the Web page, check that the proxy server should be disabled.

3. WEBSERVER

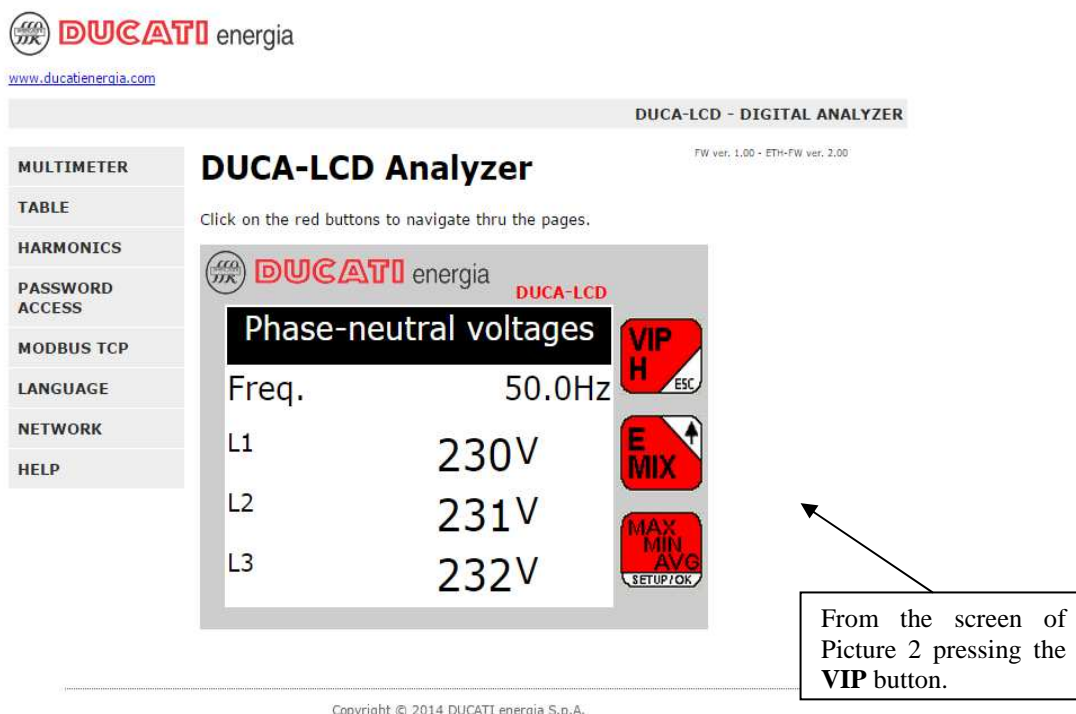
The instrument has an internal Web server, making available to the user some pages of visualisation and configuration. In this way the Web server makes available a **virtual instrument** on the remote user's PC. Is possible to access the device via any browser (Internet Explorer, Mozilla Firefox, etc.) typing <http://instrument-IP-address> or <http://instrument-host-name>ⁱ.

After logging the device, the first page displayed will be the following (menu **MULTIMETER**):

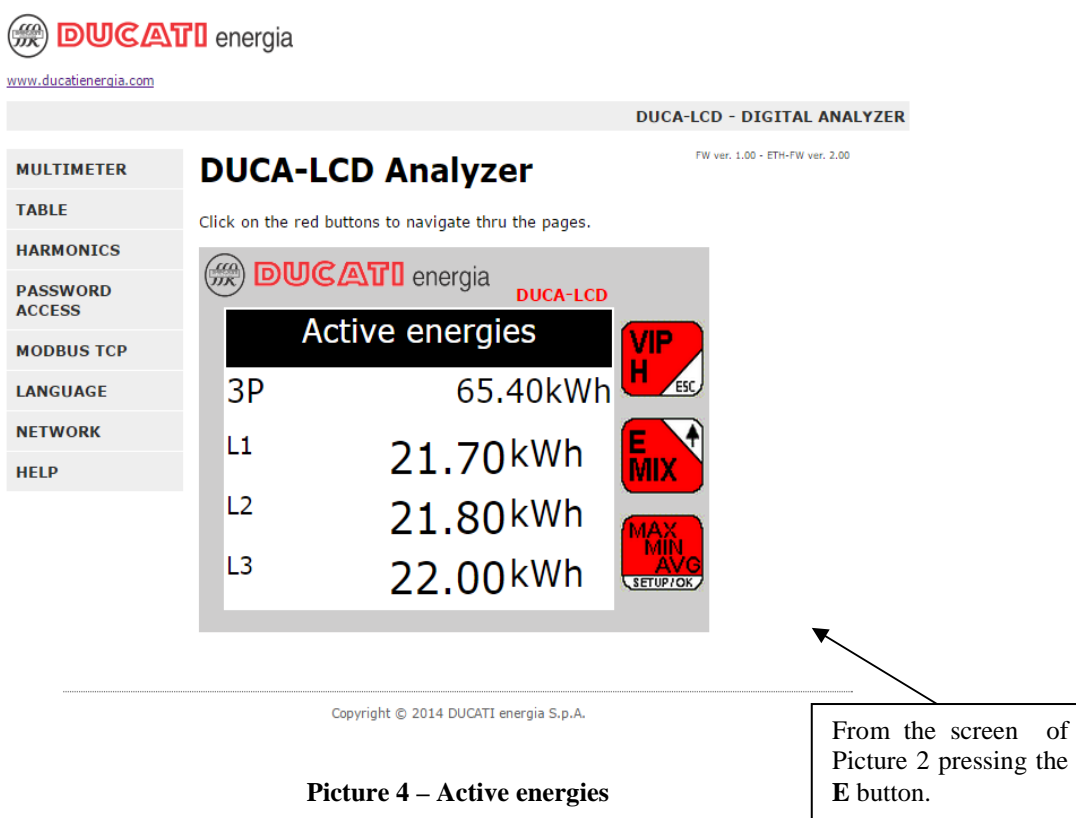


Picture 2 – First visualisation page

It will be possible to show other remote instrument's measures, browsing through the various pages of the visualisation menu, clicking the instrument keys. See some examples in the following pictures.







Picture 3 – Phase-neutral voltages



Picture 4 – Active energies

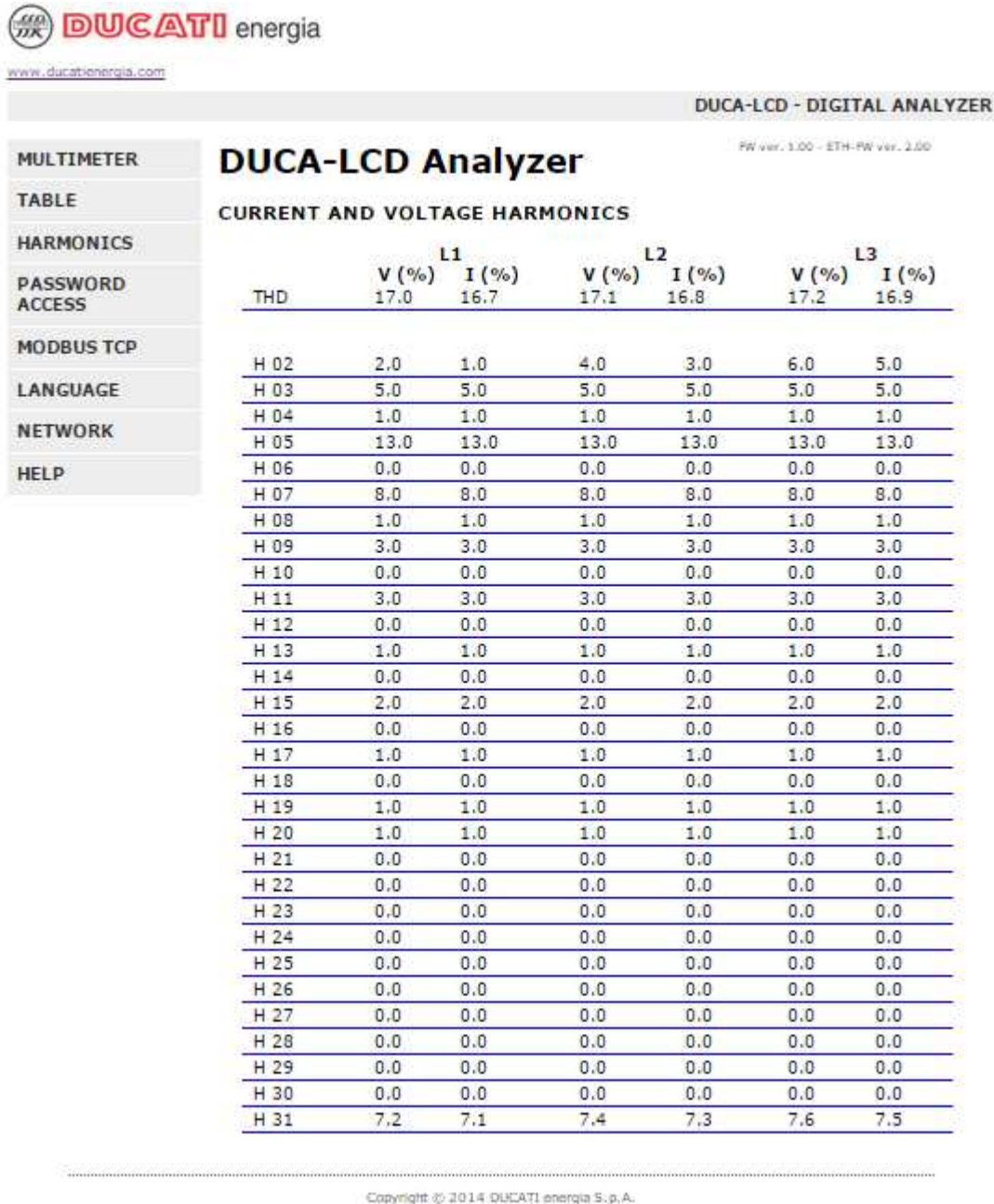
Selecting the **TABLE** menu located in the top left, allows to see some of the measured values shown in tabular format.


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DUCA-LCD - DIGITAL ANALYZER									
MULTIMETER TABLE HARMONICS PASSWORD ACCESS MODBUS TCP LANGUAGE NETWORK HELP	DUCA-LCD Analyzer								
	Global analyzer values Table								
	E+ = Absorbed Active Energy; E- = Generated Active Energy; 3P = Three-Phase.								
		3P		L1		L2		L3	
	L-N	50.0	Hz	230	V	231	V	232	V
	L-L	400	V	399	V	401	V	400	V
	I	2.41	A	2.40	A	2.41	A	2.42	A
	PF	0.98		0.98		0.98		0.98	
	P	1.633	kW	540	W	544	W	549	W
	Q	344	VAr	114	VAr	115	VAr	115	VAr
	S	1.669	kVA	552	VA	556	VA	561	VA
	E+	65.10	kWh	21.60	kWh	21.70	kWh	21.90	kWh
	E-	0	Wh	0	Wh	0	Wh	0	Wh
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Picture 5 – Global analyzer values summary table

Selecting the **HARMONICS** menu located in the top left, allows to see the measured harmonics shown in tabular format.



THD	L1		L2		L3	
	V (%)	I (%)	V (%)	I (%)	V (%)	I (%)
	17.0	16.7	17.1	16.8	17.2	16.9
H 02	2.0	1.0	4.0	3.0	6.0	5.0
H 03	5.0	5.0	5.0	5.0	5.0	5.0
H 04	1.0	1.0	1.0	1.0	1.0	1.0
H 05	13.0	13.0	13.0	13.0	13.0	13.0
H 06	0.0	0.0	0.0	0.0	0.0	0.0
H 07	8.0	8.0	8.0	8.0	8.0	8.0
H 08	1.0	1.0	1.0	1.0	1.0	1.0
H 09	3.0	3.0	3.0	3.0	3.0	3.0
H 10	0.0	0.0	0.0	0.0	0.0	0.0
H 11	3.0	3.0	3.0	3.0	3.0	3.0
H 12	0.0	0.0	0.0	0.0	0.0	0.0
H 13	1.0	1.0	1.0	1.0	1.0	1.0
H 14	0.0	0.0	0.0	0.0	0.0	0.0
H 15	2.0	2.0	2.0	2.0	2.0	2.0
H 16	0.0	0.0	0.0	0.0	0.0	0.0
H 17	1.0	1.0	1.0	1.0	1.0	1.0
H 18	0.0	0.0	0.0	0.0	0.0	0.0
H 19	1.0	1.0	1.0	1.0	1.0	1.0
H 20	1.0	1.0	1.0	1.0	1.0	1.0
H 21	0.0	0.0	0.0	0.0	0.0	0.0
H 22	0.0	0.0	0.0	0.0	0.0	0.0
H 23	0.0	0.0	0.0	0.0	0.0	0.0
H 24	0.0	0.0	0.0	0.0	0.0	0.0
H 25	0.0	0.0	0.0	0.0	0.0	0.0
H 26	0.0	0.0	0.0	0.0	0.0	0.0
H 27	0.0	0.0	0.0	0.0	0.0	0.0
H 28	0.0	0.0	0.0	0.0	0.0	0.0
H 29	0.0	0.0	0.0	0.0	0.0	0.0
H 30	0.0	0.0	0.0	0.0	0.0	0.0
H 31	7.2	7.1	7.4	7.3	7.6	7.5

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Selecting the **PASSWORD ACCESS** menu allows to enter the edit page of *Username* and *Password*. This page is access protected, the default values are the following:

- Username: **admin** (default)
- Password: **admin** (default)

Once valid access data have been inserted, these will remain valid for the overall browser session. From now on it will be possible to modify *Password* and *Username* and access other configuration menus.


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DUCA-LCD - DIGITAL ANALYZER

MULTIMETER

TABLE

HARMONICS

PASSWORD
ACCESS

MODBUS TCP

LANGUAGE

NETWORK

HELP

Username and Password setting

This page allows to set/change the password for administration protect access.

WARNING: if username and/or password are lost, you will not be allowed to access the configuration setup pages.

Insert new Username and Password

User Name:	<input type="text" value="admin"/>
Password	<input type="password"/>
Confirm Password	<input type="password"/>
<input type="button" value="Save Configuration"/>	

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Picture 6 – Username and Password setting

If case the **Password is forgotten**, it is possible to reset the password to the default value: for this, please refer to chapter 3.1.

Selecting the **MODBUS TCP** menu (menu protected by password, authentication required) allows to enable the protocol on the device and configure the TCP port address (default = 502).


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MULTIMETER

TABLE

HARMONICS

PASSWORD
ACCESS

MODBUS TCP

LANGUAGE

NETWORK

HELP

Modbus TCP Configuration

Configuration page of the MODBUS TCP server

Enable Modbus TCP	<input checked="" type="checkbox"/>
TCP Port:	<input type="text" value="502"/>
<input type="button" value="Save Configuration"/>	

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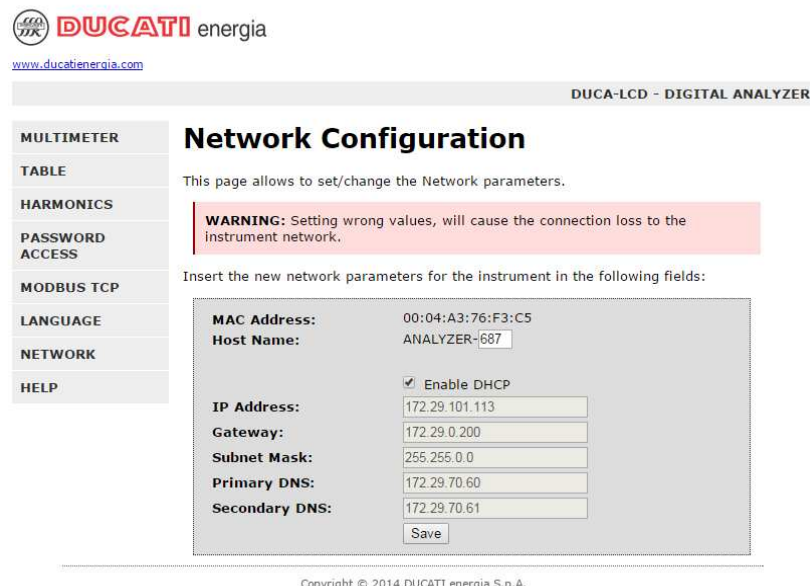
Picture 7 – Modbus TCP configuration

Selecting the **LANGUAGE** menu (menu protected by password, authentication required) allows to change the web user interface language (default English) by loading the appropriate language files with the extension “.bin”. The Language files (Italian and English) are available on the **DUCATI** energia FTP server, at the link below: download the file of interest on your PC and then select it from the page indicated in the picture below.



Picture 8 – Webserver language selection

Selecting the **NETWORK** menu (menu protected by password, authentication required) allows to select or modify the instrument network interface parameters: *Host name*, *IP address*, etc.



Picture 9 – Network configuration with enabled DHCP

NOTE: the *Host name* is used to access the device by name rather than by IP address, useful especially when the IP address is obtained dynamically (DHCP enabled). The *Host name* is handled by the NetBios service; in networks where this service isn't present, it will be possible to access the device only using its IP address.

Disabling the DHCP, the configuration parameters must be insert manually.



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MULTIMETER

TABLE

HARMONICS

PASSWORD
ACCESS

MODBUS TCP

LANGUAGE

NETWORK

HELP

Network Configuration

This page allows to set/change the Network parameters.

WARNING: Setting wrong values, will cause the connection loss to the instrument network.

Insert the new network parameters for the instrument in the following fields:

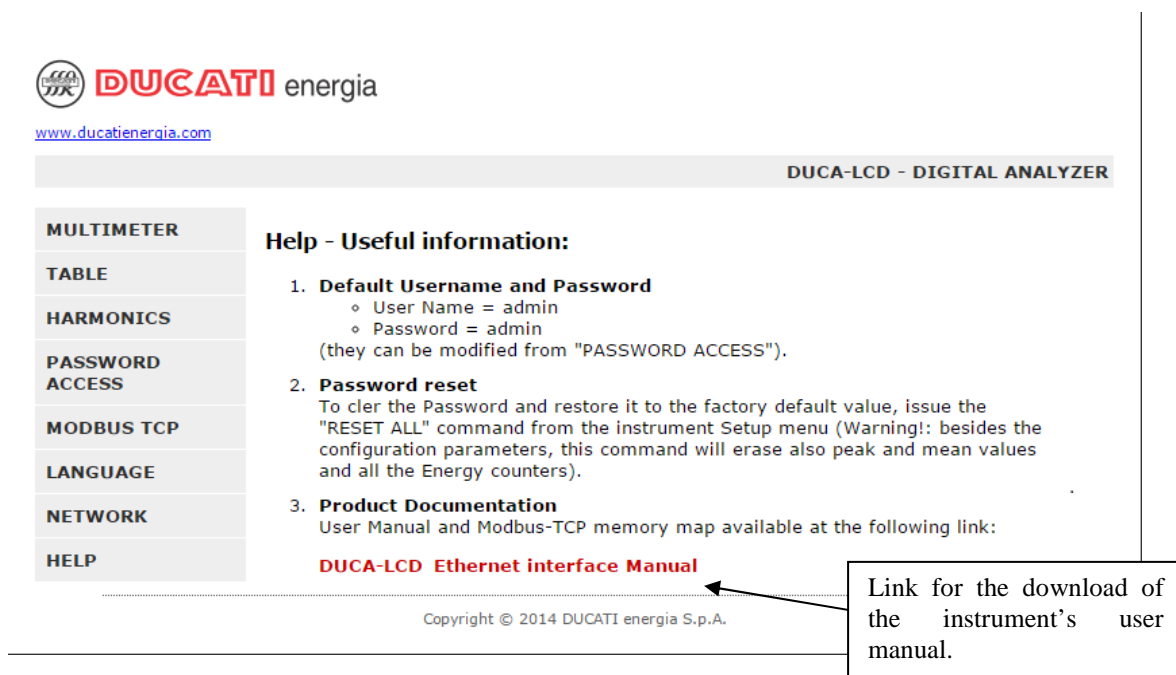
MAC Address:	00:04:A3:76:F3:C5
Host Name:	ANALYZER-687
	<input type="checkbox"/> Enable DHCP
IP Address:	172.29.101.113
Gateway:	172.29.0.200
Subnet Mask:	255.255.0.0
Primary DNS:	172.29.70.60
Secondary DNS:	172.29.70.61
	Save

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Picture 10 – Network configuration with disabled DHCP

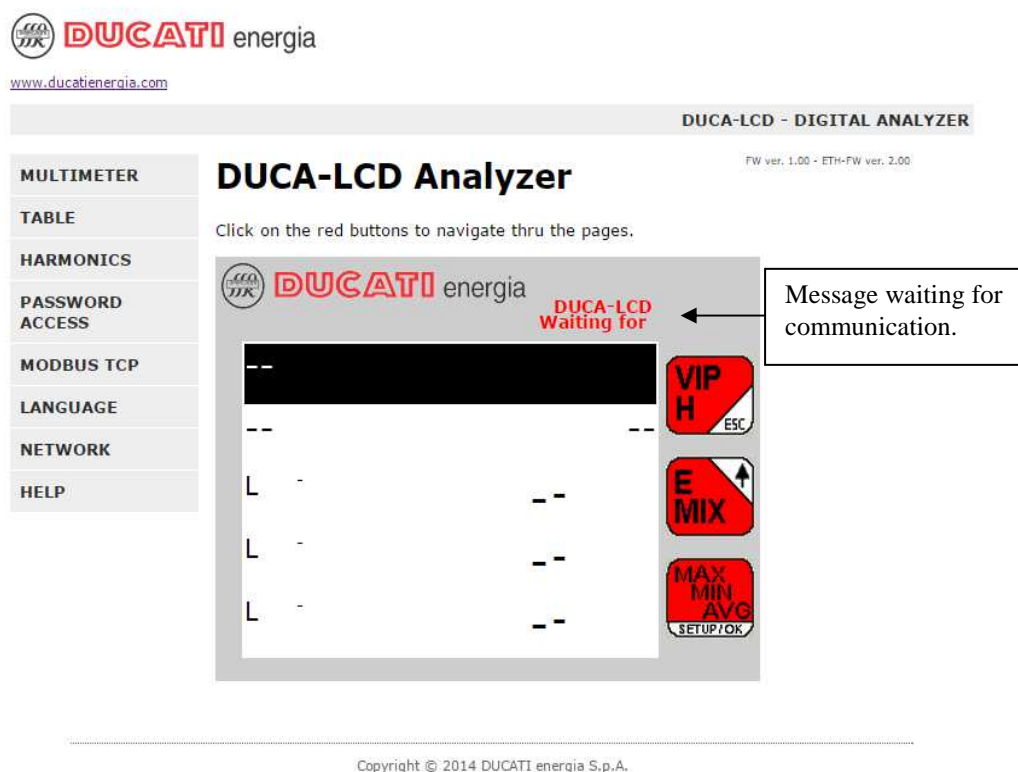
NOTE: the parameters *Primary DNS* and *Secondary DNS* are not used.

Selecting the **HELP** menu allows to access to a short online Help of the instrument, in which is also available the link to download this manual and other documents.



Picture 11 – Online Help

NOTE: during the access to the device and the visualization of the different menu pages, should communication's errors occur, it will displayed a screen as shown below (with no measured values).



Picture 12 – Communication error

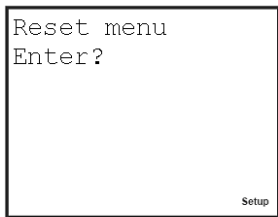
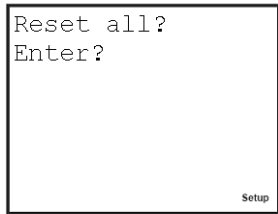
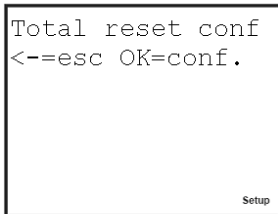
3.1 RESETTING PASSWORD

The default values for accessing the protected Webserver pages, are the following:

- Username = *admin*
- Password = *admin*

In case your password and username are forgotten, to reset them to the default values, is necessary to use a command to “Reset All” in the setup menu of the instrument (please take care, as well as all the configuration parameters of the instrument, the command also resets the peak values, mean values and all energy counters).

To reset, enter the setup menu of the instrument

From “Reset menu” →	
Select “Reset all”.	
Then confirm.	

Total reset on the device

4. MODBUS-TCP

4.1 READ HOLDING REGISTERS FUNCTION (03h)

The following table describes the **measurements** that the user can **read** from the instrument using the function READ HOLDING REGISTERS – function 3 (03h); this function reads in WORDs, so “Signed/Unsigned Long are 2 consecutive WORDs.

MODBUS-TCP address	Measurement description	Unit	Format
1000h	Three-phase Equivalent Voltage	Volt	Unsigned Long
1002h	Voltage between Phase and Neutral line 1	Volt	Unsigned Long
1004h	Voltage between Phase and Neutral line 2	Volt	Unsigned Long
1006h	Voltage between Phase and Neutral line 3	Volt	Unsigned Long
1008h	Line Voltage (Line 1 – Line 2)	Volt	Unsigned Long
100Ah	Line Voltage (Line 2 – Line 3)	Volt	Unsigned Long
100Ch	Line Voltage (Line 3 – Line 1)	Volt	Unsigned Long
100Eh	Three-phase Equivalent Current	mA	Unsigned Long
1010h	Current Line 1	mA	Unsigned Long
1012h	Current Line 2	mA	Unsigned Long
1014h	Current Line 3	mA	Unsigned Long
1016h	Three-phase Equivalent Power Factor (*1)	Thousandths	Signed Long
1018h	Power Factor Line 1 (*1)	Thousandths	Signed Long
101Ah	Power Factor Line 2 (*1)	Thousandths	Signed Long
101Ch	Power Factor Line 3 (*1)	Thousandths	Signed Long
101Eh	Three-phase Equivalent $\cos\varphi^{ii}$ (*1)	Thousandths	Signed Long
1020h	$\cos\varphi^{ii}$ Line 1 (*1)	Thousandths	Signed Long

ⁱⁱ The instrument does not provide the $\cos\varphi$, in its place it's sent the corresponding value of Power Factor.

MODBUS-TCP address	Measurement description	Unit	Format
1022h	$\cos\varphi^{ii}$ Line 2 (*1)	Thousandths	Signed Long
1024h	$\cos\varphi^{ii}$ Line 3 (*1)	Thousandths	Signed Long
1026h	Three-phase Equivalent Apparent Power	VA	Unsigned Long
1028h	Apparent Power Line 1	VA	Unsigned Long
102Ah	Apparent Power Line 2	VA	Unsigned Long
102Ch	Apparent Power Line 3	VA	Unsigned Long
102Eh	Three-phase Equivalent Active Power	W	Signed Long
1030h	Active Power Line 1	W	Signed Long
1032h	Active Power Line 2	W	Signed Long
1034h	Active Power Line 3	W	Signed Long
1036h	Three-phase Equivalent Reactive Power	Var	Signed Long
1038h	Reactive Power Line 1	Var	Signed Long
103Ah	Reactive Power Line 2	Var	Signed Long
103Ch	Reactive Power Line 3	Var	Signed Long
103Eh	Three-phase Active Energy	Hundreds of Wh (Wh*100) ⁱⁱⁱ	Unsigned Long
1040h	Three-phase Reactive Energy	Hundreds of Varh (Varh*100)	Unsigned Long
1046h	Frequency	mHz	Unsigned Long
1060h	Maximum Current Line 1	mA	Unsigned Long
1062h	Maximum Current Line 2	mA	Unsigned Long
1064h	Maximum Current Line 3	mA	Unsigned Long
1066h	Three-phase Maximum Active Power	W	Signed Long
1068h	Three-phase Maximum Apparent Power	VA	Unsigned Long
1070h	Three-phase Average Active Power	W	Signed Long
1072h	Three-phase Average Apparent Power	VA	Unsigned Long

ⁱⁱⁱ Example: if the reading from address 103Eh returns the value 325, means that the Active Energy is 32500Wh.

MODBUS-TCP address	Measurement description	Unit	Format
1074h	Active Energy Line 1	Hundreds of Wh (Wh*100)	Unsigned Long
1076h	Active Energy Line 2	Hundreds of Wh (Wh*100)	Unsigned Long
1078h	Active Energy Line 3	Hundreds of Wh (Wh*100)	Unsigned Long
107Ah	Reactive Energy 1	Hundreds of Varh (Varh*100)	Unsigned Long
107Ch	Reactive Energy 2	Hundreds of Varh (Varh*100)	Unsigned Long
107Eh	Reactive Energy 3	Hundreds of Varh (Varh*100)	Unsigned Long
1080h	Maximim Three-phase Average Active Power	W	Signed Long
1082h	Voltage ThdF L1 (Normal visualisation) (*2)	cents	Unsigned Long
1084h	Voltage ThdF L2 (Normal visualisation) (*2)	cents	Unsigned Long
1086h	Voltage ThdF L3 (Normal visualisation) (*2)	cents	Unsigned Long
1088h	Current ThdF L1 (Normal visualisation) (*2)	cents	Unsigned Long
108Ah	Current ThdF L2 (Normal visualisation) (*2)	cents	Unsigned Long
108Ch	Current ThdF L3 (Normal visualisation) (*2)	cents	Unsigned Long
108Eh	Maximum Average Active Power L1	W	Signed Long
1090h	Maximum Average Active Power L2	W	Signed Long
1092h	Maximum Average Active Power L3	W	Signed Long
1094h	Maximim Three-phase Apparent Active Power	VA	Unsigned Long
1096h	Maximum Apparent Active Power L1	VA	Unsigned Long
1098h	Maximum Apparent Active Power L1	VA	Unsigned Long
109Ah	Maximum Apparent Active Power L1	VA	Unsigned Long
109Ch	Average Active Power from Pulses Input CH1	W	Unsigned Long
109Eh	Average Reactive Power from Pulses Input CH2	Var	Unsigned Long
10A0h	Active Energy from Pulses Input CH1	Hundreds of Wh (Wh*100)	Unsigned Long

MODBUS-TCP address	Measurement description	Unit	Format
10A2h	Reactive Energy from Pulses Input CH2	Hundreds of Varh (Varh*100)	Unsigned Long
10A4h	Current Threshold for Timer 2 Activation	mA	Unsigned Long
10A6h	Three-phase Apparent Energy	Hundreds of VAh (VAh*100)	Unsigned Long
10A8h	Apparent Energy L1	Hundreds of VAh (VAh*100)	Unsigned Long
10AAh	Apparent Energy L2	Hundreds of VAh (VAh*100)	Unsigned Long
10ACh	Apparent Energy L3	Hundreds of VAh (VAh*100)	Unsigned Long
10AEh	Generated Three-phase Active Energy	Hundreds of Wh (Wh*100)	Unsigned Long
10B0h	Generated Active Energy L1	Hundreds of Wh (Wh*100)	Unsigned Long
10B2h	Generated Active Energy L2	Hundreds of Wh (Wh*100)	Unsigned Long
10B4h	Generated Active Energy L3	Hundreds of Wh (Wh*100)	Unsigned Long
10B6h	Generated Three-phase Reactive Energy	Hundreds of Varh (Varh*100)	Unsigned Long
10B8h	Generated Reactive Energy L1	Hundreds of Varh (Varh*100)	Unsigned Long
10BAh	Generated Reactive Energy L2	Hundreds of Varh (Varh*100)	Unsigned Long
10BCh	Generated Reactive Energy L3	Hundreds of Varh (Varh*100)	Unsigned Long
10BEh	Generated Three-phase Apparent Energy	Hundreds of VAh (VAh*100)	Unsigned Long
10C0h	Generated Apparent Energy L1	Hundreds of VAh (VAh*100)	Unsigned Long
10C2h	Generated Apparent Energy L2	Hundreds of VAh (VAh*100)	Unsigned Long
10C4h	Generated Apparent Energy L3	Hundreds of VAh (VAh*100)	Unsigned Long
11A0h	Current Transformation Ratio (CT)	Unit (range 1-2000)	Unsigned Long
11A2h	Voltage Transformation Ratio (VT)	Unit (range 1-600)	Unsigned Long
11A4h	Pulse Energy Weight (*3)	Unit (range 1-4)	Unsigned Long
1200h	Partial Balance Active Energy	Hundreds of Wh (Wh*100)	Signed Long
1202h	Partial Balance Reactive Energy	Hundreds of Varh (Varh*100)	Signed Long

MODBUS-TCP address	Measurement description	Unit	Format
1204h	Partial Balance Apparent Energy	Hundreds of VAh (VAh*100)	Signed Long
1206h	Factor €/Energy (moneyFact)	Cents €/KWh	Unsigned Long
1208h	Factor CO ₂ /Enrgy (CO ₂ Fact)	Cents CO ₂ /KWh	Unsigned Long
120Ah	Timer 1 free running	hh*100 + mm	Unsigned Long
120Ch	Timer 2 count-down	hh*100 + mm	Signed Long
120Eh	Average Active Power L1	W	Signed Long
1210h	Average Active Power L2	W	Signed Long
1212h	Average Active Power L3	W	Signed Long
1214h	Three-phase Equivalent Reactive Power	VA _r	Signed Long
1216h	Average Reactive Power L1	VA _r	Signed Long
1218h	Average Reactive Power L2	VA _r	Signed Long
121Ah	Average Reactive Power L3	VA _r	Signed Long
121Ch	Average Apparent Power L1	VA	Unsigned Long
121Eh	Average Apparent Power L2	VA	Unsigned Long
1220h	Average Apparent Power L3	VA	Unsigned Long
1222h	Maximum Active Power L1	W	Signed Long
1224h	Maximum Active Power L2	W	Signed Long
1226h	Maximum Active Power L3	W	Signed Long
1228h	Maximum Apparent Power L1	VA	Unsigned Long
122Ah	Maximum Apparent Power L2	VA	Unsigned Long
122Ch	Maximum Apparent Power L3	VA	Unsigned Long
122Eh	Insertion's configuration (*4)	Unit (range 1-4)	Unsigned Long
1230h	Status (*5)	-	Unsigned Long
1232h	IP address (*6)	-	Unsigned Long
1234h	HOST NAME (*7)	unit	Unsigned Long

MODBUS-TCP address	Measurement description	Unit	Format
1236h	Slave-ID + FW Ver. (*8)	-	Unsigned Long
1238h	Three-phase Maximum Current	mA	Unsigned Long
123Ah	Three-phase Minimum Current	mA	Unsigned Long
123Ch	Minimum Current Line 1	mA	Unsigned Long
123Eh	Minimum Current Line 2	mA	Unsigned Long
1240h	Minimum Current Line 3	mA	Unsigned Long
1242h	Maximum Three-phase Voltage	V	Unsigned Long
1244h	Maximum Voltage Line 1	V	Unsigned Long
1246h	Maximum Voltage Line 2	V	Unsigned Long
1248h	Maximum Voltage Line 3	V	Unsigned Long
124Ah	Minimum Three-phase Voltage	V	Unsigned Long
124Ch	Minimum Voltage Line 1	V	Unsigned Long
124Eh	Minimum Voltage Line 2	V	Unsigned Long
1250h	Minimum Voltage Line 3	V	Unsigned Long
1252h ... 1299h	Not used		
1300h	Total Harmonic Distortion (THDI1) current line 1	‰ (thousandths of fundamental harmonic)	Unsigned Long
1302h	Total Harmonic Distortion (THDI1) current line 2	‰ (thousandths of fundamental harmonic)	Unsigned Long
1304h	Total Harmonic Distortion (THDI1) current line 3	‰ (thousandths of fundamental harmonic)	Unsigned Long
1306h	Total Harmonic Distortion (THDV1) current line 1	‰ (thousandths of fundamental harmonic)	Unsigned Long
1308h	Total Harmonic Distortion (THDV2) current line 1	‰ (thousandths of fundamental harmonic)	Unsigned Long
130Ah	Total Harmonic Distortion (THDV3) current line 1	‰ (thousandths of fundamental harmonic)	Unsigned Long
130Ch ... 1999h	Not used		

MODBUS-TCP address	Measurement description	Unit	Format
2000h	Harmonic module H0 current line 1	‰ (thousandths of fundamental harmonic)	Unsigned int
2001h	Harmonic module H1 current line 1	‰ (thousandths of fundamental harmonic)	Unsigned int
2002h... 201Eh	Harmonic Module Hn current line 1	‰ (thousandths of fundamental harmonic)	Unsigned int
201Fh	Harmonic module H31 current line 1	‰ (thousandths of fundamental harmonic)	Unsigned int
2020h ... 20FFh	Not used		
2100h	Harmonic module H0 voltage line 1	‰ (thousandths of fundamental harmonic)	Unsigned int
2101h	Harmonic module H1 voltage line 1	‰ (thousandths of fundamental harmonic)	Unsigned int
2102h... 211Eh	Harmonic Module Hn voltage line 1	‰ (thousandths of fundamental harmonic)	Unsigned int
211Fh	Harmonic module H31 voltage line 1	‰ (thousandths of fundamental harmonic)	Unsigned int
2120h ... 21FFh	Not used		
2200h	Harmonic module H0 current line 2	‰ (thousandths of fundamental harmonic)	Unsigned int
2201h	Harmonic module H1 current line 2	‰ (thousandths of fundamental harmonic)	Unsigned int
2202h... 221Eh	Harmonic Module Hn current line 2	‰ (thousandths of fundamental harmonic)	Unsigned int
221Fh	Harmonic module H31 current line 2	‰ (thousandths of fundamental harmonic)	Unsigned int

2220h ... 22FFh	Not used		
2300h	Harmonic module H0 voltage line 2	‰ (thousandths of fundamental harmonic)	Unsigned int
2301h	Harmonic module H1 voltage line 2	‰ (thousandths of fundamental harmonic)	Unsigned int
2302h... 231Eh	Harmonic Module Hn voltage line 2	‰ (thousandths of fundamental harmonic)	Unsigned int
231Fh	Harmonic module H31 voltage line 2	‰ (thousandths of fundamental harmonic)	Unsigned int
2320h ... 23FFh	Not used		
2400h	Harmonic module H0 current line 3	‰ (thousandths of fundamental harmonic)	Unsigned int
2401h	Harmonic module H1 current line 3	‰ (thousandths of fundamental harmonic)	Unsigned int
2402h... 241Eh	Harmonic Module Hn current line 3	‰ (thousandths of fundamental harmonic)	Unsigned int
241Fh	Harmonic module H31 current line 3	‰ (thousandths of fundamental harmonic)	Unsigned int
2420h ... 24FFh	Not used		
2500h	Harmonic module H0 voltage line 3	‰ (thousandths of fundamental harmonic)	Unsigned int
2501h	Harmonic module H1 voltage line 3	‰ (thousandths of fundamental harmonic)	Unsigned int
2502h... 251Eh	Harmonic Module Hn voltage line 3	‰ (thousandths of fundamental harmonic)	Unsigned int
251Fh	Harmonic module H31 voltage line 3	‰ (thousandths of fundamental harmonic)	Unsigned int
2520h ... 25FFh	Not used		

MODBUS-TCP address	Measurement description	Unit	Format
2600h	α_{i1} factor for harmonic module conversion current line 1 (*9)	-	Unsigned long
2602h	αv_1 factor for harmonic module conversion voltage line 1 (*9)	-	Unsigned long
2604h	Real part Harmonic H1 current line 1	-	Signed int
2605h	Imaginary part Harmonic H1 current line 1	-	Signed int
2606h	Real part Harmonic H1 voltage line 1	-	Signed int
2607h	Imaginary part Harmonic H1 voltage line 1	-	Signed int
2608h ... 267Bh	Real and Imaginary parts Harmonic Hn current and voltage line 1	-	Signed int
267Ch	Real part Harmonic H31 current line 1	-	Signed int
267Dh	Imaginary part Harmonic H31 current line 1	-	Signed int
267Eh	Real part Harmonic H31 voltage line 1	-	Signed int
267Fh	Imaginary part Harmonic H31 voltage line 1	-	Signed int
2680h ... 27FFh	Not used		
2800h	α_{i2} factor for harmonic module conversion current line 2 (*9)	-	Unsigned long
2802h	αv_2 factor for harmonic module conversion voltage line 2 (*9)	-	Unsigned long
2804h	Real part Harmonic H1 current line 2	-	Signed int
2805h	Imaginary part Harmonic H1 current line 2	-	Signed int
2806h	Real part Harmonic H1 voltage line 2	-	Signed int
2807h	Imaginary part Harmonic H1 voltage line 2	-	Signed int
2808h ... 287Bh	Real and Imaginary parts Harmonic Hn current and voltage line 2	-	Signed int
287Ch	Real part Harmonic H31 current line 2	-	Signed int
287Dh	Imaginary part Harmonic H31 current line 2	-	Signed int
287Eh	Real part Harmonic H31 voltage line 2	-	Signed int
287Fh	Imaginary part Harmonic H31 voltage line 2	-	Signed int
2880h ... 29FFh	Not used		

MODBUS-TCP address	Measurement description	Unit	Format
2A00h	αi_3 factor for harmonic module conversion current line 3 (*9)	-	Unsigned long
2A02h	αv_3 factor for harmonic module conversion voltage line 3 (*9)	-	Unsigned long
2A04h	Real part Harmonic H1 current line 3	-	Signed int
2A05h	Imaginary part Harmonic H1 current line 3	-	Signed int
2A06h	Real part Harmonic H1 voltage line 3	-	Signed int
2A07h	Imaginary part Harmonic H1 voltage line 3	-	Signed int
2A08h ... 2A7Bh	Real and Imaginary parts Harmonic Hn current and voltage line 3	-	Signed int
2A7Ch	Real part Harmonic H31 current line 3	-	Signed int
2A7Dh	Imaginary part Harmonic H31 current line 3	-	Signed int
2A7Eh	Real part Harmonic H31 voltage line 3	-	Signed int
2A7Fh	Imaginary part Harmonic H31 voltage line 3	-	Signed int

NOTES:

(*1) Regarding the lines **Power Factor**, please note that:

- in case of inductive Power Factor, its value will be positive; viceversa in case of capacitive Power Factor
- when the Power Factor is undefined (current is zero), the instruments returns the value “2000” to report about this situation (it is the condition in which the instrument displays three dashes “- - -”)
- **Cosφ**: the instrument does not provide Cosφ, and reports instead the corresponding Power Factor value.

(*2) Regarding Current and Voltage **ThdF** please take note that:

- ThdF represents the normalised voltage and current crest factor
- $\text{ThdF}\% = |\text{ThdF}(\text{in cents}) - 100|$
- in case the ThdF is not computable (e.g. when current = 0), the instrument provides two words equal to FFFFh, corresponding to an invalid data (it is the condition in which the instrument displays three dashes “- - -”)

(*3) Possible values for **Pulse energy Weight**:

- 1: 10 Wh/VArh per pulse

- 2: 100 Wh/VArh per pulse
- 3: 1000 Wh/VArh per pulse
- 4: 10000 Wh/VArh per pulse

Even in case the instrument has the Output programmed as Alarm function (i.e. it is not using the Pulse function), the command always returns the weight value previously programmed

(*4) Possible values for **Insertion's Configuration**:

- 1: GENERIC
- 2: THREE-PHASE
- 3: BALANCED THREE-PHASE
- 4: SINGLE-PHASE

(*5) **Status** (1230h): following the meaning of the four bytes sent:

BYTE	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0	<i>Not used</i>				<i>Status OUT3</i>	<i>Status OUT2</i>	<i>Status OUT1</i>	<i>Status OUT0</i>
1	<i>Not used</i>							<i>DHCP</i>
2	<i>Not used</i>							
3	<i>Not used</i>							

Status OUTX = 1 → out-X activated

Status OUTX = 0 → out-X deactivated

DHCP = 1 → DHCP enabled

DHCP = 0 → DHCP disabled

(*6) **IP address** (1232h): returned on 4 byte, each describing an IP-address filed.

Example: 192.168.1.10 will be reported in:

Byte 3 = 10;

Byte 2 = 1;

Byte 1 = 168;

Byte 0 = 192;

(*7) **Host Name** (1234h): is the number (max 3 digits) to joint to the instrument name for the Host-Name service (NetBios)

Example: 14 yields the Host Name *ANALYZER-014*

(*8) **Slave_ID + FW ver.** (1236h) : following the *Unsigned Long* 4-bytes values and their meaning :

BYTE	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0	<i>FW Ver. (Low Byte)</i>							
1	<i>FW Ver. (High Byte)</i>							
2	<i>Slave ID</i>							
3	<i>Fixed to 00h</i>							

To get the actual Firmware version, the “FW Ver.” filed should be divided by 100;

Example: Slave_ID + FW ver.= 004B 066Ch corresponds to

Slave ID = 75 (004Bh)

FW Ver. = 1.02 (066Ch / 100)

The Duca-LCD-ETH instrument has **Slave ID = 75** (4Bh)

(*9) **Factor for harmonic module conversion**

In order to calculate the absolute values of harmonic modules of current and voltage (expressed in A and V) use the following formula including the conversion factor α_i e α_v (one for each phase):

$$|Hi_{kn}| = \frac{\sqrt{(\text{Re } i_{kn})^2 + (\text{Im } i_{kn})^2} * \alpha_i}{\sqrt{2} * 2^8 * 10^5} \text{ [A]} \quad n = 2, \dots, 31 \text{ and } k = 1, 2, 3$$

$|Hi_{kn}|$ = module of n-th harmonic of current line k

Re i_{kn} = Real part of n-th harmonic of current line k

Im i_{kn} = Imaginary part of n-th harmonic of current line k

α_i = conversion factor of current line k

$$|Hv_{kn}| = \frac{\sqrt{(\text{Re } v_{kn})^2 + (\text{Im } v_{kn})^2} * \alpha_v}{\sqrt{2} * 2^8 * 10^3} \text{ [V]} \quad n = 2, \dots, 31 \text{ and } k = 1, 2, 3$$

$|Hv_{kn}|$ = module of n-th harmonic of voltage line k

Re v_{kn} = Real part of n-th harmonic of voltage line k

Im v_{kn} = Imaginary part of n-th harmonic of voltage line k

α_v = conversion factor of voltage line k

Harmonic modules expressed in thousandths of the fundamental harmonic:

$$Hi_{kn}(\text{‰}) = \frac{|Hi_{kn}|}{|Hi_{k1}|} * 1000 \quad n = 2, \dots, 31 \text{ and } k = 1, 2, 3$$

$$Hv_{kn}(\text{‰}) = \frac{|Hv_{kn}|}{|Hv_{k1}|} * 1000 \quad n = 2, \dots, 31 \text{ and } k = 1, 2, 3$$

Total Harmonic Distortion values expressed in thousandths of the fundamental harmonic:

$$THDI_k (\%) = \frac{\sqrt{\sum_{n=2}^N |H_{i_{kn}}|^2}}{|H_{i_{k1}}|} * 1000 \quad k = 1, 2, 3 \text{ and } N = 21 \text{ o } 31 \text{ (see Note1)}$$

$$THDV_k (\%) = \frac{\sqrt{\sum_{n=2}^N |H_{v_{kn}}|^2}}{|H_{v_{k1}}|} * 1000 \quad k = 1, 2, 3 \text{ and } N = 21 \text{ o } 31 \text{ (see Note1)}$$

Note1: in the Setup menu of the instrument is possible to set the total number of harmonics through which are calculated THD values

DATA FORMAT:

- **Unsigned Long:** it means a binary number of 2 unsigned words (32 bit)
- **Signed Long:** it means a binary number of 2 words (32 bit); when this number is negative it is expressed in 2's complement format.
- **Unsigned Int:** it means a binary number of 1 unsigned words (16 bit)
- **Signed Int:** it means a binary number of 1 words (16 bit); when this number is negative it is expressed in 2's complement format.

In general, a part from the above mentioned case regarding Power Factor, when a value is not computable or exceeds its admitted input measurement range, the **null/invalid** value is :

- FFFF FFFFh for **Unsigned Long**
- FFFFh for **Unsigned Int**
- 7FFFh for **Unsigned Int**

This is the condition in which the instrument displays dashes “- - -”.

4.2 WRITE MULTIPLE REGISTERS FUNCTION (10h)

The following table describes the possible **commands** the user can send to the instrument, using the function WRITE MULTIPLE REGISTERS – function 16 (10h).

MODBUS-TCP address	Command description	Unit	Format
11B0h (Reset Energie) 11B2h (Reset min/Max Peak) 11B4h (Reset Average) 11C0h (Set Output status)	Commands for Reset and Outputs (*9)	-	2 Word
11A0h	Current Transformation Ratio (CT)	Units (range 1-2000)	Unsigned Long
11A2h	Voltage Transformation Ratio (VT)	Units (range 1-600)	Unsigned Long
11A4h	Pulse Energy Weight (*3)	Units (range 1-4)	Unsigned Long

NOTES:

(*9) Reset and Output Commands

It is possible to issue a **Reset** o to drive an **Output** using the command “Write Multiple Register” (Function 10h) at the following addresses, writing a specific value listed in the table below:

- **11B0h** (to Reset Energy counters)
- **11B2h** (to Reset min/Max Peak values)
- **11B4h** (to Reset Average values)
- **11C0h** (to drive an Output)

In order to execute a **Reset** command or to activate/deactivate an **Output**, the following value must be sent:

Address	Word	Description	MS Word	LS Word
11B0h	2	Energy Reset	11B0h	55AAh
11B2h	2	Peak Reset	11B2h	55AAh
11B4h	2	Average Reset	11B4h	55AAh
11C0h	2	Set (activate) Out 1	11C0h	55B1h
11C0h	2	Set (activate) Out 2	11C0h	55B2h
11C0h	2	Set (activate) Out 3 (^{iv})	11C0h	55B3h
11C0h	2	Set (activate) Out 4 (^{iv})	11C0h	55B4h
11C0h	2	Reset (deactivate) Out 1	11C0h	55A1h
11C0h	2	Reset (deactivate) Out 2	11C0h	55A2h
11C0h	2	Reset (deactivate) Out 3 (^{iv})	11C0h	55A3h
11C0h	2	Reset (deactivate) Out 4 (^{iv})	11C0h	55A4h

^{iv} Prepared to manage outputs 3 e 4

Example: in order to activate Output 1, you must write at address 11C0h the value 11C055B1h (= 297817521 decimal).

In general, if a value different from one of those listed in the table is sent, the instrument will return the Exception “ILLEGAL DATA VALID” (03).

Regarding the **Output** management, the following rules apply:

- The Outputs can be driven only one at a time.
- The Outputs can be remotely driven only if programmed in the instrument as *Alarm function* (and not as Pulse outputs).
- An Output can be driver only if not currently already activated by an Alarm condition; in case an Output is currently “in Alarm”, it cannot be deactivated by a remote command.

4.3 REPORT SLAVE ID FUNCTION (11h)

It is possible to get the instrument identifier (ID) using the function REPORT SLAVE ID – function 17 (11h). This function returns the instrument ID and the internal Firmware Version.

The answer format is the same as described for the Function 03 at the address location 1236h, with the description note (*8).

The Duca-LCD-ETH instrument has **Slave ID = 75** (4Bh).

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