ELTIME CONTROLS

THREE PHASE MULTIFUNCTION MONITOR

LDA-C

INSTRUCTION MANUAL

LDA-C

INDEX.

1. GENERAL DESCRIPTION

The LDA is a complete measuring unit housed in a compact DIN **96x96** enclosure. It monitors the current and voltage signals from an electric power line, and measures all its main variables, displaying them in a custom **LCD screen**. Multiple measurements can be displayed at the same time, and can be sent by means of a serial **communication line** to an appropriate receiver. Additionally, **two relays** can be configured as digital outputs, representing energy pulses or alarms.
Through the serial output every measured parameter is accessible, allowing the user to send them to a computer to allow recording and statistical analysis.
The unit uses a 16 bit microprocessor, including a ten bit A/D converter. This produces a unit with **high accuracy**, great flexibility in input range programming, and powerful communication capabilities.
Special care has been taken in the design, not only to provide high accuracy, but also good reliability, a strong immunity to EMC (in order to be used in industrial environments), and high isolation characteristics. The device is suitable for panel mounting, and all the connections are made with **detachable connectors**. Its compact dimensions make it very suitable for control panels with space constraints.

2. TECHNICAL DESCRIPTION

2.1. MEASURING PRINCIPLE

The measuring process is totally digital. After passing through the voltage divider and current transformers, the signals are sampled by the A/D converter. The microprocessor controls the A/D sampling, following the network frequency in order to get 32 samples per period for each signal. It then stores and processes the data, calculating the values as follows:

$Vi = sqr (\Sigma Vij^2 / 32)$ $Ii = sqr (\Sigma Iij^2 / 32)$

$Pi = \Sigma (Vij * Iij) / 32$ $Qi = \Sigma (Vi\,j-8 * Iij) / 32$ $Si = sqr (Pi^2 + Qi^2)$

$Pt = \Sigma (Pi)$ $Qt = \Sigma (Qi)$ $St = sqr (Pt^2 + Qt^2)$

In the case of three element systems, the calculations are done for the three voltage phases and the three current phases. In two element systems, the calculations refer only to the input signals used. That is, the only multiplications that are done are V12 * I1, and V32 * I3. These values added together provide the total active power, but they do not have a meaning corresponding to any specific phase. They appear in the positions defined by P1 and P3, (or Q1 and Q3), and then P2 and Q2 do not appear. As there is no I2, this value cannot be read, as well as the variables related to it, such as PF2 and QF2. V31, however is calculated by

$$V31^2 = V12^2 + V32^2 + \tfrac{1}{2}\ V12 * V32$$

This means that in the case where a single phase signal is applied to both V1 and V3, although there is not a voltage difference between them, the device will give a value corresponding to this calculation.

The frequency is measured using the microprocessor internal timers. Its value is also used when the energy is calculated, as well as to provide the sample synchronization, which must be exactly 32 samples per signal and period. The rest of the parameters are calculated from these basic parameters as shown in the table overleaf.

PARAMETER	Total	L1	L2	L3
Phase voltage	Mean	V1	V2	V3
Line voltage	Mean	V12	V23	V31
Line current	Mean	I1	I2	I3
Active power	P	P1	P2	P3
Reactive power	Q	Q1	Q2	Q3
Apparent power	S	S1	S2	S3
Power factor	PF	PF1	PF2	PF3
Reactive power factor	QF	QF1	QF2	QF3
Frequency	F	-	-	-
Active energy (pos.)	Ep+	-	-	-
Active energy (neg.)	Ep-	-	-	-
Reactive energy (ind.)	Eqind +	-	-	-
Reactive energy (cap.)	Eqcap(-)	-	-	-
THD (%) V	-	V1	V2	V3
THD (%) I	-	I1	I2	I3

THD values are calculated by means of the DFT for each signal, evaluating the fundamental content, for instance Vi1, and calculating

$$THD(Vi) = sqr(Vi^2 - Vi1^2) / Vi$$

2.2. MEASUREMENT PROCESS

2.2.1. Input transformers
Current transformers provide isolation on the current input. No voltage transformers are used, and the voltage drop is achieved by resistor dividers.

2.2.2. Multiplexer and A/D converter
A ten-bit A/D converter and a multiplexer, included in the microprocessor, are used to digitize the six input signals. The sampling is done exactly at 32 samples per signal cycle. The microprocessor changes the timing accordingly to the supply frequency, and the device can work both at 50 and 60 Hz.

2.2.3. Microprocessor
The device used is the TLCS900 from TOSHIBA. It is a 16 bit unit, including 32Kbytes EEPROM, 1Kbyte RAM, two serial ports, a ten bit A/D converter, and timers.

2.2.4. EEPROM
The configuration data, as full scale definition, or identity, is stored in a 4Kbit EEPROM. In this memory the CT and VT ratios are also stored, as these can be altered by the user via switch commands.

2.2.5. WDT
A watchdog timer is used to reset the microprocessor in the case of switch failure due to a strong electrical interference field.

2.2.6. SERIAL OUTPUT
The RS485 serial output communication is isolated from the measuring circuit, as well as from the digital outputs. In this way, the serial line can be left floating, and can be connected to earth in only one point if needed. The RS485 link must be a 2 wire connection, and several baud rates can be selected. The physical connection is made through a MiniDIN connector located on the back of the unit.

2.2.7. DIGITAL OUTPUTS
Two digital outputs are provided. The operation mode is selectable as:
A - Energy pulses
B - Alarms
C - General outputs commanded by the computer

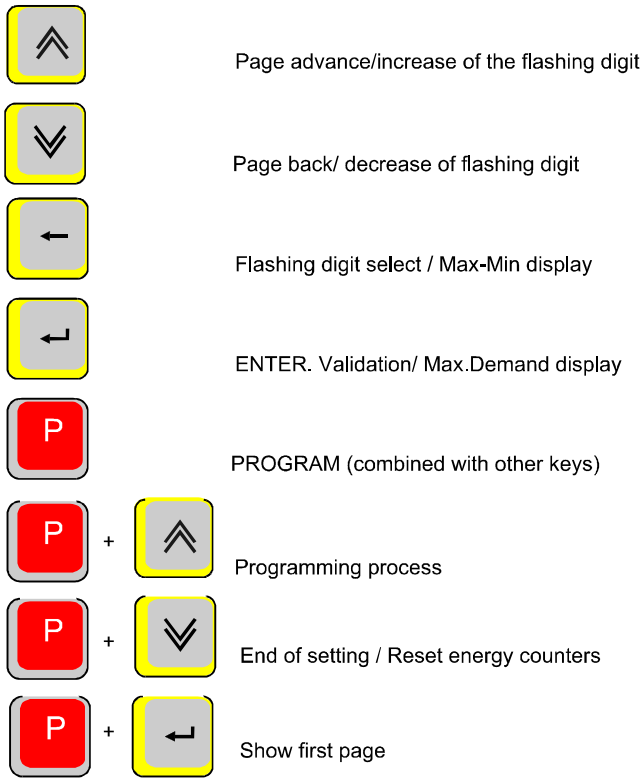
2.2.8. AC POWER SUPPLY
The auxiliary power supply provides the different voltages needed for operation. A double tap transformer is used, allowing the installer to connect the device to a choice of two different auxiliary voltage values.

3. KEYBOARD PROGRAMMING

The instrument is provided with five keys to program the nominal values, alarms, etc., and a multiple line LCD screen. When it is powered up for the first time, all LCD segments are on, to test they are all working. After four seconds, the display shows a message indicating the software version number e.g. 3.11 and the model, LDA-C.

After another four seconds, the instrument begins the measuring process.

The front keyboard displays the different pages, and allows the user to program the unit. The key functions are explained in the following figure.



There are several OPERATION MODES, and depending on the mode the keys have a different functions:

3.1. MEASURING MODE

The variables measured are displayed on sequential pages in the LCD. To go from one page to the next, press the **"UP"** or "**DOWN"** key. The order of appearance is as follows:

Page	Variables Displayed	Symbols	Unit	Meaning
1	V1, V2, V3	L1, L2, L3	V	Phase to neutral voltage
2	V12, V23, V31	L12, L23, L31	V	Line voltage
3	I1, I2, I3	L1, L2, L3	A	Line current
4	P, Q, S	P, Q, S	kW, kvar, kVA	Total P, Q, and S power
5	P1, P2, P3	P L1, L2, L3	kW	Active Phase Power
6	Q1, Q2, Q3	Q L1, L2, L3	kvar	Reactive Phase Power
7	S1, S2, S3	S L1, L2, L3	kVA	Apparent Phase Power
8	Cos1, Cos2, Cos3	Cos L1, L2, L3		CosØ for each phase
9	THD1, THD2, THD3	% L1, L2, L3	A	THD content in % for I
10	THD1, THD2, THD3	% L1, L2, L3	V	THD content in % for V
11	Cos, Id, Freq	Cos, Hz		Total cosØ, Identity, Freq.
12	In	In	A	Neutral current
13	COn, xxxxxxxxx		kWh	Consumed energy counter
14	GEn, xxxxxxxxx		kWh	Generated energy counter
15	Ind, xxxxxxxxx		kvar	Inductive energy counter
16	CAP, xxxxxxxxx		kvar	Capacitative energy counter

When the instrument is switched on the page displayed is the page last appearing before it was switched off.

3.2. MAXIMUM / MINIMUM MODE

To enter into the max/min mode, press **"MAX**". The values stored will appear in pages in a similar way to the measuring mode. To change the page, press **"UP**" or "**DOWN".**

Page	Variables displayed	Symbols	Unit	Meaning
1	V1, V2, V3	Max, L12, L23, L31	V	Max stored values
2	V1, V2, V3	Min, L12, L23, L31	V	Min stored values
3	I1, I2, I3	Max, L1, L2, L3	A	Max stored values
4	I1, I2, I3	Min, L1, L2, L3	A	Min stored values
5	P1, P2, P3	Max, L1,L2, L3	kW	Max phase stored values
6	P1, P2, P3	Min, L1,L2, L3	kW	Min phase stored values
7	P, Q, S	Max, P, Q, S	kW, kvar, kVA	Max total stored values
8	P, Q, S	Min, P, Q, S	kW, kvar, kVA	Min total stored values
9	Cos, Freq	Max cos, Hz		Max stored values
10	Cos, Freq	Min cos, Hz		Min stored values

To reset the values, press “P” and “UP”. Both the max and min values will be reset to the current value, and the max/min calculation process begins again.

3.3. MAX DEMAND MODE

To enter into this mode, press “**MD**”. The values stored will appear in pages as follows.
Each value is displayed in the three lines, as Present value, Last period value, and Max.Peak reached.

Page	Variables displayed	Symbols	Unit	Meaning
1	Ipresent, Last, Peak	MD, L1	A	MD stored values
2	Ipresent, Last, Peak	MD, L2	A	MD stored values
3	Ipresent, Last, Peak	MD, L3	A	MD stored values
4	kW present, Last, Peak	MD	kW	MD stored values
5	kvar present, Last, Peak	MD	kvar	MD stored values
6	kVA present, Last, Peak	MD	kVA	MD stored values
7	Int, time, value	-	-	Interval (15/30) and time

Pressing “**P”** and “**RESET**” resets the MD values.
Pressing “**MD**” changes the instrument again to the normal display mode.

3.4. RESET ENERGY COUNTERS MODE

To enter this mode, press **“P**” and “**DOWN**”. The instrument will require the password to enter any changes. At any point, pressing **“P”** and “**DOWN**” will exit the mode, without resetting the counters.

Page	Upper Display	Lower display	Units	Action
1	rSt	----	kWh,kvarh	Set password = XXXX (Default 0010) If password is not set correctly, the device reverts to measuring mode after about thirty seconds
2	rSt	nO	kWh,kvarh	Press “UP” to select reset
3	rSt	YES	kWh,kvarh	Press”DOWN” to skip

Press “ENTER” to reset counters

3.5. PROGRAMMING MODE

To enter the programming mode, press “**P”** and “**UP**”.
The word "PASS" appears in the upper display, and the lower display shows ----.
The right digit of the lower display starts flickering waiting for the introduction of the password. The standard password is **0010.**

The **"Up"** and **"Down"** keys must be pressed to change the flickering digit. The number to be changed then rotates.
The **ENTER** key validates the value and moves to the next parameter.
The " ←" key , to change to the next left digit
If the password is correct programming can begin. If not, the message “----“ appears again.
The following variables can be programmed through the keyboard:

Page	Upper display	Lower display	Action
1	PASS	- - - -	Set password to the right value If not set, the instrument reverts to the measuring mode
2	U Pr	00000400.0	Primary Voltage in tenths of volt, assuming a 400V Secondary, e.g. for 6600/110V, enter 24000.0 Change, and press ENTER when OK.
3	A Pr	000005000	Primary Current in Amps, assuming a 5A Secondary, e.g. for 100/1A, enter 500 Press ENTER when OK
4	EnEr	000000020	Value in Wh. Press ENTER when OK.
5	IdEn	0002	Change and press ENTER
6	bAud	09600	Baud rate. Press ENTER when OK.
7	Mode	000X	Output relays mode: 0, 1, and 2. 0= energy output. 1= contacts 2= alarms (see page 13) Change, and press ENTER.
8’	OUTP (Mode=1)	00XX X=1	activates the relay. Change and press ENTER.
8”	Al0(Mode=2)	Variable + Value	Change Variable and press ENTER Change Mode Max / Min and press ENTER Change Value and press ENTER
9”	Al1(Mode=2)	Variable + Value	Change Variable and press ENTER Change Mode Max / Min and press ENTER Change Value and press ENTER
10’’	Fr	Frequency	Change value and press ENTER
8	Int	15/30	Change between 15 and 30 min. Press ENTER.
11	PASS	xxxx	Change value and press ENTER. Go back to 1.

(Don’t forget the new password if you decide to change it.)

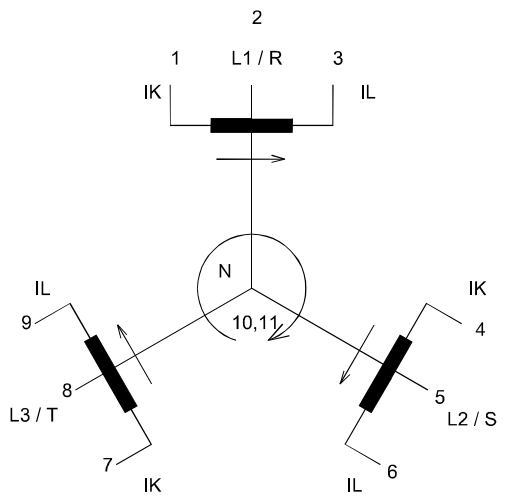
3.6. ALARM DEFINITION (mode 2)

Both alarms can be set to a level between 1 and 120% of the nominal value for V12, V23, V31, I1, I2, I3, P1, P2, P3, Ptotal, Qtotal, Pftotal, and Freq. The alarm triggering can be selected as low or high level.
For a PF alarm, adjustment is between 0 and 100% (since 0<cosØ<1).

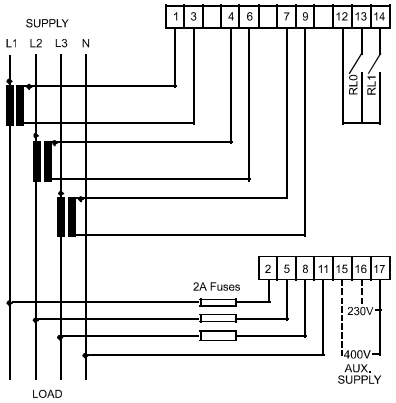
4. WIRING

4.1. ELECTRICAL CONNECTIONS

The markings are in accordance with the standard drawing for electrical lines, as depicted.

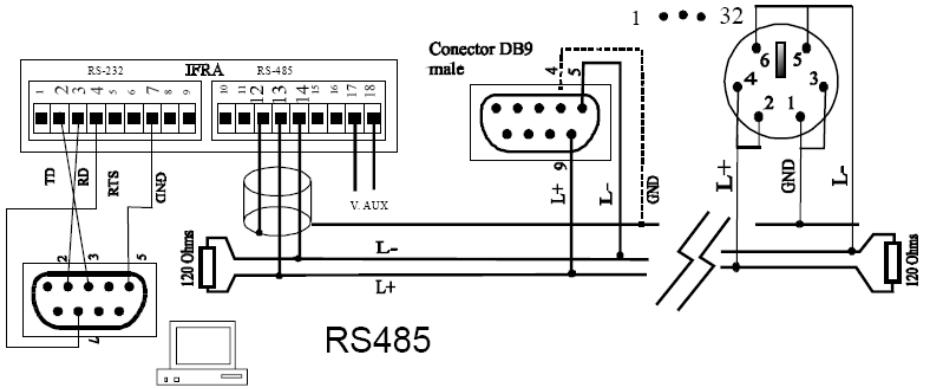


The label on the rear of the device is shown in the following picture, and is self-explanatory.

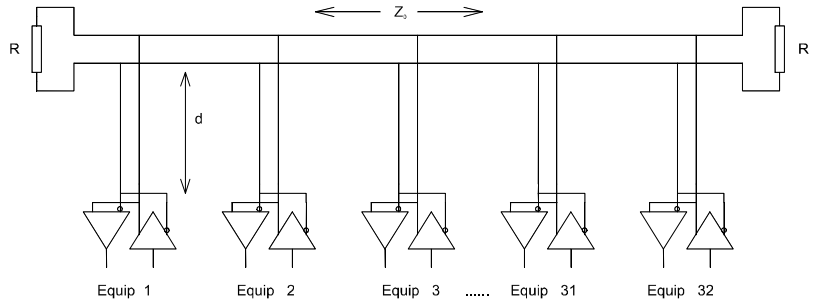


4.2. SERIAL LINE

The serial communication line uses a miniDIN connector located on the back of the meter for the RS485 communication.



RS485 connections are named L+ and L-. They must be connected to homologous terminals in the network, that is, the same wire goes to all terminals marked L+, and the other wire goes to all terminals marked L-. These terminals are marked as DATA A and DATA B in some RS485 converters. A schematic diagram is shown as a guide in the figure below.



Connection Diagram for up to 32 units

If the transmission line length is more than a few hundred meters, termination resistors (typically 120 ohms) must be used. It is always advisable to terminate the line rather than leave it without resistors.

4.3. DIGITAL OUTPUTS

The two relay outputs provided have several operating modes, as shown in the table.

MODE	RL0	RL1
0	Reactive energy pulses	Active energy pulses
1	Output 0	Output 1
2	Alarm 0	Alarm 1

For mode 0, an energy pulse value must be defined. Each time this amount of active or reactive energy is consumed, a 150ms pulse is sent through to the related output.
For mode 1 there is no need to program anything. The relays status can be changed manually pressing the **"UP"** key.
For alarm mode 2, the variable, direction, and trip level must be defined in the programming process. The trip level is expressed as percentage of the variable nominal value, and can be any value from –120% to +120% (for bi-directional power).

The output relay contacts are rated at 3A (125/250Vac, resistive load). No protection against overloading the relay output has been included, and therefore the manufacturer's characteristics must be carefully respected. The user must provide an external protective device if necessary.

Both alarms can be set to a level between 1 and 120% of the nominal value for V12, V23, V31, I1, I2, I3, P1, P2, P3, Ptotal, Qtotal, Pftotal, and Freq. The alarm triggering can be selected as low or high level.
For a PF alarm, adjustment is between 0 and 100% (since 0<cosØ<1).

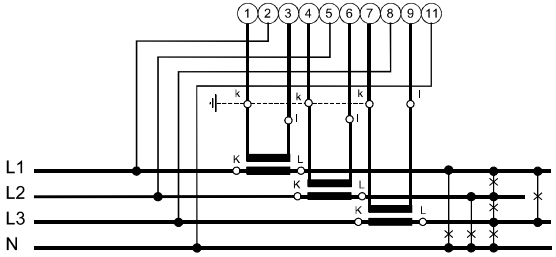
5. COMMUNICATION PROTOCOL

The LDA-C is equipped with a serial line output in order to be able to communicate all the measured variables to any device with a serial input capability. The RS485 communication allows connection of up to 32 devices (as the standard specifies) to the same communication line, up to a maximum length of 1200 meters, allowing data collection from any unit.
The communication output is isolated from the rest of circuitry by means of optical couplers. This avoids problems with earth connections, breaking any grounding loops, and allows connection of the cable screen to earth at the most suitable point in the installation.
The protocol used complies with the RTU JBUS/MODBUS protocol. This is a master-slave protocol, very common in PLC's. The communication is always started by the master, and no spontaneous messages are allowed. The standard transmission rate is 9600 bps, 8 bits, no parity, and one stop bit. Other speeds are possible to be programmed in the device from 300 to 19200 bps.
Each transaction consists of one request frame, generated by the master, and one reply frame, generated by the slave. When the master sends a writing command, the slave sends an acknowledgement message. No provisions have been made for
answering exception conditions. If any command is received
correctly, it will be executed. If not, no answer will be generated.

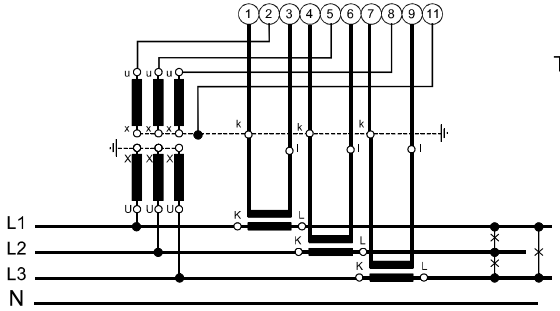
Function codes accepted are:

03H	Read Holding Registers (3xxxx)
04H	Read Input Registers (4xxxx)
06H	Preset Single Register (6xxxx)
10H	Preset Multiple Registers

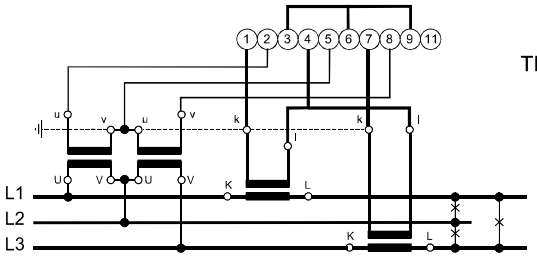
6. CONNECTION DIAGRAMS



THREE PHASE, UNBALANCED
FOUR WIRES
(THREE SYSTEMS)



THREE PHASE, UNBALANCED
THREE OR FOUR WIRES
(STAR CONNECTION)



THREE PHASE, UNBALANCED
THREE WIRES

Note: Voltage transformers are shown only for MV and HV applications.

esqlca3l.cdr

7. ⚠ SAFETY REQUIREMENTS

Before powering the instrument for the first time, verify the following points:

1) That the device hasn't suffered any damage in transit.
2) That the specifications correspond with those stated on your order form.
3) Before connecting the device check that all voltage inputs correspond with those specified on the wiring diagram.
4) Ensure the maximum overload voltage is not exceeded. The maximum overload Voltage is 1.2x *Un* continuously, or 10x *Un* for 2 seconds.
5) Ensure the maximum overload current is not exceeded. Through external transformers (x/5A or x/1A) the maximum overload current is 2x *In* continuously, or 40x *In* for 1 second.
6) We recommend that the auxiliary power supply is protected with a fuse rated at between 0.5 and 2 A. This circuit should also be fitted with a circuit breaker or equivalent to connect or disconnect the instrument from the power supply network.
7) Screw type terminals allow for a maximum cable entry of 2.5mm^2.
8) During operation, dangerous voltages are applied to certain parts. Ignoring the warning notes can result in severe injury or damage. Only qualified personal should be allowed to operate this device.
9) A protection device must be fitted both to the auxiliary supply and the measuring inputs. This device can be the one used in the installation, if its rated current does not exceed 10 Amps. In the case of using a specific protection device, a 1 Amp rating is recommended.
10) The communication cable screen must be connected to earth somewhere in the installation for safety purposes.

VERY IMPORTANT! *Once power is connected to the instrument, if incorrect polarity signs appear on the display with respect to the Phase Power, re-check the following points:*

-Check to see if the L1, L2 and L3 current connections are correct with respect to the relevant phase of the voltage connections

-Check the orientation of the current transformers is correct with respect to the supply and load

TECHNICAL SPECIFICATIONS

INPUT (3 phases 4 wires, consult for 3 wires)

Nominal **Voltage**, *Un*	100, 110, 230 or 400 V
Voltage Circuit Burden	1mA per phase
Measuring Range	0 - 120% *Un*
Nominal **Current**, *In*	1A or 5A
Current Circuit Burden	0.2VA per phase
Measuring Range	0 - 120% *In*
Frequency	45 to 65Hz

DOUBLE AUXILIARY SUPPLY

Auxiliary Voltage	63.5/110Vac or 230/400Vac (±15%)
Auxiliary Burden	3 VA

IMPULSE OR ALARM OUTPUT

Outputs	2 N.O. Relay Contacts
Output Rating	3A @ 250Vac
Impulse duration	>100 ms

SERIAL OUTPUT RS-485

Link	2 wires half duplex
Transmission speed	9600 bps, 8 bits, no parity, 1 stop bit. (Adjustable from 300 to 19200 bps)
Max. length of net per line	1200m
Max. number of units per line	32

OPERATING CONDITIONS

Temperature	-5ºC to +55ºC

ACCURACY

Class Accuracy	0.5%
P, Q, S, E and cosØ	1%

OTHER CHARACTERISTICS

Display	LCD
Mounting	Panel Mounting
Enclosure Code	Case IP42 Terminals IP20
Input / Output Connections	Plug-in type
Maximum Cable Entry	2.5 mm^2
Weight	500 grams
Mounting position	As Desired
Protection	Class II. Pollution degree 2 IEC 1010

ACCESSORIES

Current transformers X/1A or X/5A.

OPTIONAL SOFTWARE

Communications program
Application program (SACIGEST)

APPLICATIONS

The LDA is a tool for centralised controlling of multiple parameters of an electrical system, providing precise information for global management of the installation, not only related with energy consumption, but also detecting overloads, unbalances and voltage faults.

ELTIME CONTROLS
Hall Road, Maldon, Essex CM9 4NF
Tel. : +44 (0)1621 859500 Fax. : +44 (0)1621 855335
http://www.eltime.co.uk E-mail : sales@eltime.co.uk