micPower LCU500A, Shunt-Based Load Monitor

Shunt-Based 3-Phase Power Transducer with dual analog outputs.

A member of the micPower family of Programmable Digital Load Monitors for machinery monitoring, supervising and control. The new micPower family of load controllers are based upon the latest advance in 32-bit Microcontroller technology. The micPower units are designed to measure true electrical power, either from a motor that is connected directly through the main supply or controlled by a variable frequency inverter. The LCU500A uses a **Shunt Sensor** for the current measurement. The **Shunt Sensor** is a ultra-high accuracy Current Sensor. Other members of the micPower family uses Current-Transducers or Hall Sensors for the Current Measurement. The LCU500A is a Three-Phase Power Measurement Device that measures power on any asymmetric or symmetric load.

Family features:

♦ Three-Phase Shunt-Based design.

♦ True Digital Design, High Measurement Bandwidth 0–30 kHz.

♦ Measures Power before or after a Variable Frequency Inverter.

♦ Measures Inductive Load only.

♦ Displays kW[%], kW, HP, RMS Voltage, RMS Current and Power Factor.

♦ 0,5 A - 20 A internal transducer. (Optional 32 Amp.).

♦ 24V DC Power Supply, electrically isolated.

♦ Two Analog Outputs 0(4) - 20(24)mA and 0-10V, electrically isolated.

♦ Modbus RTU available on custom demand.

♦ IP66 Remote Control. Two wire isolated, short circuit proof interface (power/com).

♦ 4-digit Seven Segment Display and 14 LED User Interface.

♦ Dimension: 79 x 115 x 45 mm.

The LCU500A is able to display kW[%], kW, HP, RMS voltage, RMS current and Power Factor of the 3 phase load connected. As a true digital design any power related parameter may be calculated. Watch out for a version with Graphic Display to be released at a later point in time.
A IP 66 Remote Control unit is available.

Synopsis.
The LCU500A measures true power from a asymmetrical 3-phase load from the formula:

$$P_T = \frac{1}{T}\int_0^T \big(V(t)\times I(t)\big)dt$$

Applications.
The power measurement, which is proportional to machine torque, is very fast down to 10ms (50 Hz) or 8.33ms (60 Hz). This fast measurement makes it possible to react to a blocking condition in order to even stop the machine before it is able to destroy itself. Load Monitoring does **not** protect the motor, it protects the machine or let us say the drive chain. If the machine is not stopped, it is often so strong that it may damage the drive chain. So a Load Monitor gives the operator the possibility to remove the blocking condition before a disaster occur. As a side effect even a bad bearing in the drive train will cause an overload eventually.

The LCU500A is a dedicated power transducer without any control function. The control function must be done by a associated PLC. The LCU500A has got two isolated analog outputs, one current loop output 0(4) - 20(24)mA and one voltage output 0-10 Volt.

For some application the power signal needs to get inverted for a particular control function. Two parameters P1Max and P1Min may be used to zoom the analog output to reflect only a part of the measurement range.

Functional Ranges:

tMode	Function	Range	Comment
kW%	kW[%]	0–100%	Show kW[%]
kW	kW	True kW	Show True kW
HP	HP	True HP	Show True HP
U[V]	Voltage Display	0-600	Show Voltage
I[A]	Current Display	0-9999	Show Current
PF	Power Factor Display	0-1.0	Show Power Factor
Average	Set Averaging	1-20	Show Averaging
P1Max	P1Max programming	51.0–100.0	Set P1Max
P1Min	P1Min programming	0.0–49.0	Set P1Min
Range[A]	Current Range Programming	Se the range table on page 4	Set Range[A]
Param	Parameters Programming	P-00, P-08, P-09. P-10 and P-13	See the list on next page
Locked	Locked function	On/Off	Unlock if lock function is enable

Programming

The LCU500A is programmed from the use of only four keys located on the front panel. The "Mode" key is used to select programmable parameters. When a parameter is chosen the value may be altered from the use of the arrow keys.
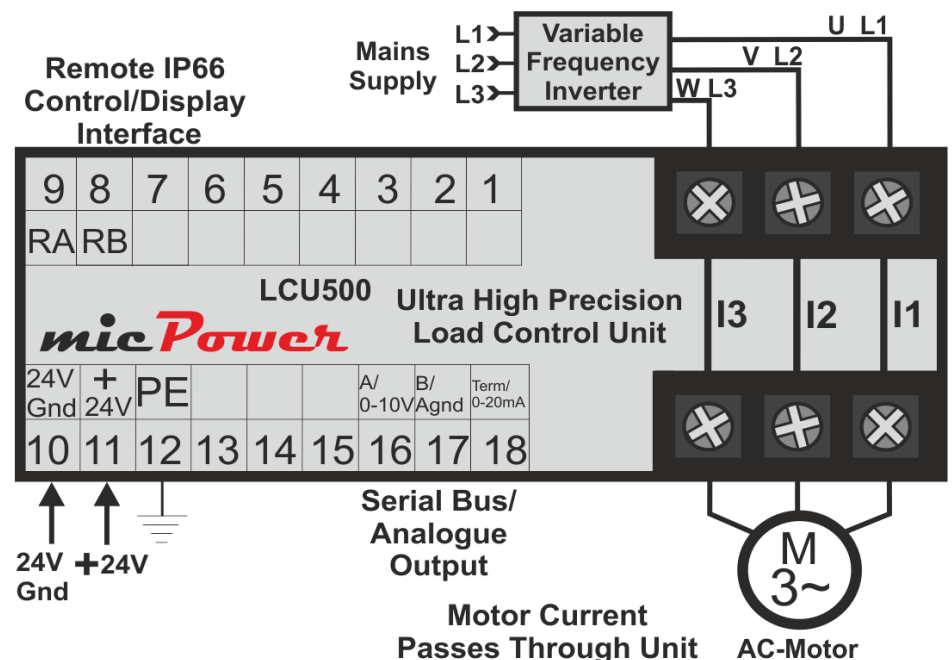
Locked

If the 'Lock Enable' P-08 parameter has been enabled then the unit must be unlocked before a variable can be changed. This is done by selecting Locked with the mode key and the hold Both the Arrow Keys down for 5 seconds.

Peak Detectors

Leave the motor running at normal operation and load. Read the peak detectors by pressing the arrow up/down key when kW or kW[%] is being displayed. If both arrow keys are activated the max power range (100%) in true kW is displayed.
Reset the peak detectors from the reset key.

Wire Diagram:

Parameter List:

Mode	Function	Range	Comment
P-00	Nominal Voltage	110V-500 (Default = 400V)	Nominal Voltage Setup
P-01 to P-07	Reserved		
P-08	Lock Enable	On/Off (Default = Off)	Enable/Disable Keyboard Lock Function
P-09	Remote Update Disable	On/Off (Default = Off)	Enable/Disable Remote Control Update
P-10	Analog Output Mode	4-20 mA (Default), 0-20 mA or 0–24mA	Analog Current Output Mode Voltage is always 0-10 volt
P-11 to P-12	Reserved		
P-13	Analog Polarity Mode	Normal or Inverted (Default = Normal)	Analog Output Polarity
P-14 to P-21	Reserved		

Global Parameter Programming:

Use the mode key to move to the 'Param' Led. The display will the show 'Prog'. When the reset key is pushed the parameter number 0 is shown flashing between P-00 and the actual parameter display.

The parameter may now get altered from the arrow keys. The mode key is used to advance to the next parameter in the list. If no key is activated for about 30 seconds the display reverse to the default display position: 'kW%'

P-00 = Nominal Voltage
Nominal voltage range. This is necessary to calculate the currently selected Power Range. See table Range[A].

P-01 to P-07 = Reserved

P-08 = Lock Function Enable/Disable
Enable and disable of the keyboard lock function. If the lock function is used it must get unlocked before the user is able to modify parameters.

In order to unlock the unit, use the mode key to select "locked" position and then press both arrow keys for about 5 seconds in order to unlock the unit

P-09 = Remote Update Disable
This parameter on/off is used to eventually block the unit from being updated from the remote control.

The parameters below are only shown if the analog output is present in the hardware.

P-10 = Analog Output Mode
This Parameter defines the Analog Current Output mode. Options are: 4-20mA, 0 –20mA or 0 –24mA. The voltage output is always 0-10V.

P-11 to P-12 = Reserved

P-13 = Analog Output Polarity Mode
Analog Output Polarity may be Normal or Inverted. Some regulations need Inverted polarity.

P-14 to P-21 = Reserved

Technical Specifications:

mic Power

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Model:	LCU500A
Type:	Load Monitor
Firmware Version:	1.0
Rev:	1.0 HW
Electrical:	
No of Phases:	3
Voltage Input:	3 x 0-500 VAC max.
Current Input:	3 x 20 Amp.
Frequency Range:	0Hz - 30 kHz AC.
Power Factor Range:	0 - 1.
AC Motor Power Range:	0 - 15.916 kW AC, 460V
Supply:	18-36 VDC, Max. 4.0 Watt.
Remote Control:	Yes, 2 wire, power and communication.
Relay Outputs:	240 VAC/5 Amp.
Digital Inputs:	Not Present.
Analog Output:	0(4)-20(24)mA and 0-10V
Serial Interface:	Not Present.
Mechanical:	
Housing:	Blend PC/ABS self-extinguishing.
Mounting:	35mm Din Rail.
Operating Temperature:	-15 - +50 °C.
Weight:	Approximately 200 gram.
Dimensions:	79 x 115 x 45.0 mm.

CE

Measurement: $P_T = \dfrac{1}{T}\displaystyle\int_0^T \big(V(t) \times I(t)\big)\,dt$

Power Measurement Range

The Power Measurement Range of the unit is given by the formula:

$$P[W] = \sqrt{3} * Unom[V] * Current\text{-}Range[A]$$

P is the power consumption for all 3 phases together. The Phase to Phase Nominal Voltage must be set in Global Parameter #0. The Current Range is programmable from the Front Panel under point Range[A].

The current measurement phase that runs through the unit MUST be the phase that connects to L3 on the Voltage Input Terminal (#3). The direction of the wire is not important as this unit is designed to measure inductive power only. This also mean that it is assumed that the motor cannot work as a generator that sends power back to the main supply.

Notes on the Analog Output

The unit has two simultaneous active analog outputs. A 0-10 Volt output and a current output. The voltage output is fixed but the current output takes 3 different formats: 4-20 mA, 0-20mA or 0-24 mA. The Global Parameter #10 defines which format the current output takes. The default format is 4-20mA. When 4-20 mA is chosen the censor wire is monitored for wire break. A power consumption of zero is supposed to output 4 mA. The LCU500A would never output a value less than 4mA so when the PLC reads a current close to zero mA, it knows the sensor is not connected or powered on. After the Nominal Voltage Range and the CT Range has been set, then 10 Volt on the voltage output and 20/24mA on the current output will occur at the kilowatt or horse power shown at the right side of the page.

Range [A]	kW (460V)	HP (460V)
Int. 0.5	0.398	0.534
Int. 1	0.797	1.068
Int. 2	1.593	2.136
Int. 3	2.390	3.204
Int. 4	3.187	4.272
Int. 5	3.984	5.340
Int. 6	4.780	6.408
Int. 7	5.577	7.476
Int. 8	6.374	8.544
Int. 9	7.171	9.612
Int. 10	7.967	10.68
Int. 11	8.764	11.75
Int. 12	9.561	12.82
Int. 13	10.36	13.88
Int. 14	11.15	14.95
Int. 15	11.95	16.02
Int. 16	12.75	17.09
Int. 17	13.54	18.16
Int. 18	14.34	19.22
Int. 19	15.14	20.29
Int. 20	15.93	21.36
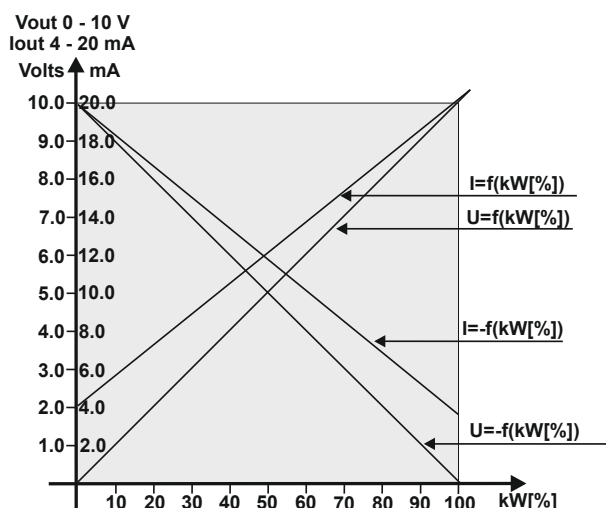
Analog Output 0 - 10Volt and 4-20mA Normal and Inverted
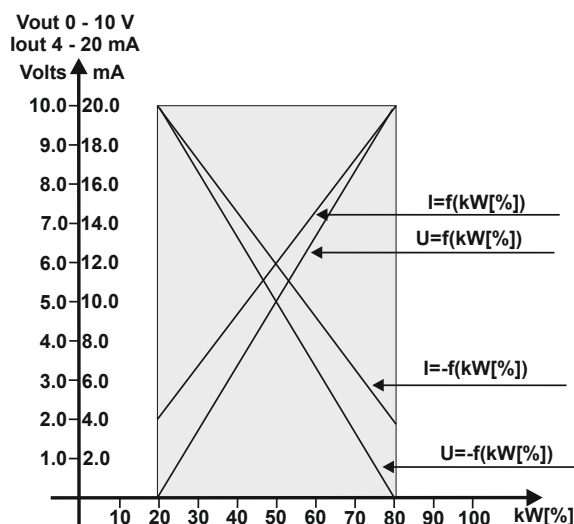
Analog Output 0 - 10Volt and 4-20mA Normal and Inverted
Zoom: P1Min = 20.0 % and P1Max = 80.0%

Quick Setup Guide

1. **Apply 24 VDC Power to terminals 10 (Gnd) and 11.**
   The unit powers on and shows its type and version during power on.

2. **Unlock the Unit.**
   Unlock if this function is enabled from parameter #8.
   Push the mode key multiple times until the LED '**Locked**' is lit and the display shows '**On**'. This means that the lock function is now on and you cannot alter any variables. Now hold both arrow keys down for about 5 seconds. After about 5 seconds the display shows '**Off**' and the '**Locked**' LED starts flashing. Now the unit is open for setup (programming).

3. **Set the Current Range.**
   Use the mode key to go to the point on the Front Plate named Current Range. Now select the immediate current range you think you need. Fine tune later.

4. **Set the Nominal Voltage.**
   Nominal Voltage is one of the seldom programmed variables that may have been set before shipping to the customer.
   The nominal voltage is the RMS Phase to Phase voltage. You can change it like this: unlock the unit (2). Use the mode key to move to the point Param on the front plate. Now push reset key once to enter parameter mode. Now the display flashes between P-00 and 460 (nominal voltage). Now the nominal voltage can be increased or decreased from the Arrow Keys. Please note that the setup of these special parameters must be carried out with a certain speed or the displays drops back to normal display mode.
   Hint. When Nominal Voltage and Current Range has been set you can display the Power Measurement range like this. Go to the point on the Front Plate named kW or HP. Now push both arrow keys simultaneously and the display shows the Power Range in true kW or HKP.

5. **Fine Tune Current Range.**
   If the unit default operating range is in the 30 – 70% of the selected range. Turn on the motor and select kW% as display mode. When the motor is running normal load it should display like 30 – 70 %. If measurement is too small you should now decrease the Current Range and if the display reading is too large you should increase the Current Range (point 3).