micPower LCU621, Hall-Sensor-Based Load Monitor

Load Controller with built-in Shock Load Monitor function

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 LCU621 uses a **Hall-Sensor** for the current measurement. The **Hall-Sensor** is a very-high accuracy Current Sensor. Other members of the micPower family uses Current-Transducers or Shunt-Sensors for the Current Measurement. The LCU621 is a Single-Phase or Three-Phase Power Measurement Device that measures power on any asymmetric or symmetric load.

Family features:

- ♦ Single-Phase or Three-Phase Hall-Sensor-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 - 1000 A external transducer. 5 different Hall-Sensors.
- ♦ 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/comm).
- ♦ 4-digit Seven Segment Display and 14 LED User Interface.
- ♦ Dimension: 79 x 115 x 35 mm.

The LCU621 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.
An IP 66 Remote Control unit is available.

Synopsis.

The LCU621 measures true power from a symmetrical 3-phase load from the formula:

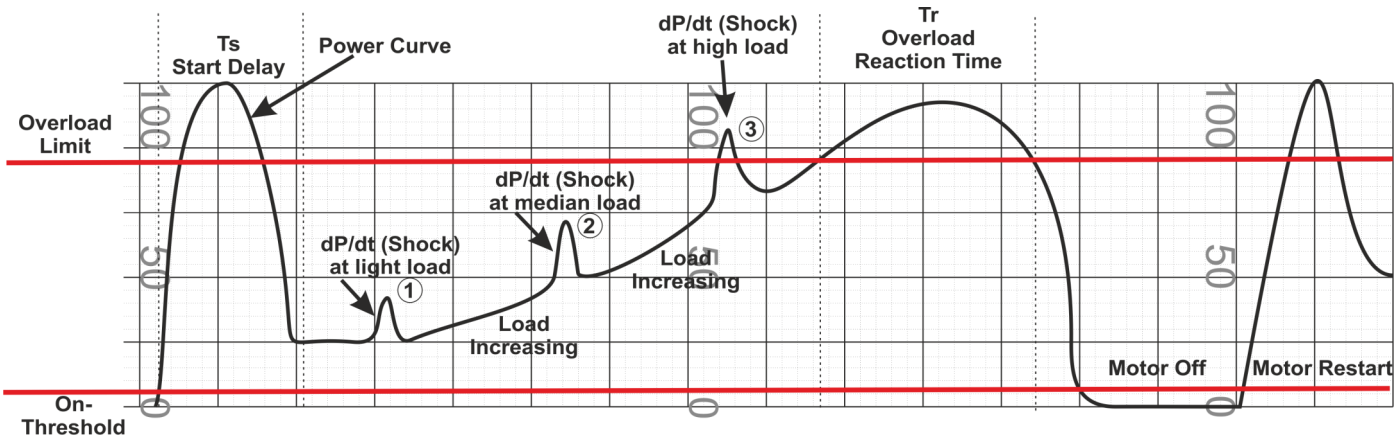
$$P_T = \frac{1}{T}\int_0^T \left(V(t) \times I(t)\right) dt$$

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 LCU621 is a Shock Load Monitor. The Shock Load Monitor is designed for machinery that experience variable load such as for example a conveyor system. A single Maximum Load Limit is often not enough to Load Protect a conveyor. If the conveyor experience a sudden load increase, when the belt or rollers are just very light loaded, a fixed Max. Load Limit may not be enough to protect the conveyor for overload. The dP/dt Limit is designed to protect for a Sudden Load Increase no matter, if it occur at light load or at high load. A dU/dt limit has been added in order to avoid false alarms, in case the of sudden mains voltage surges.

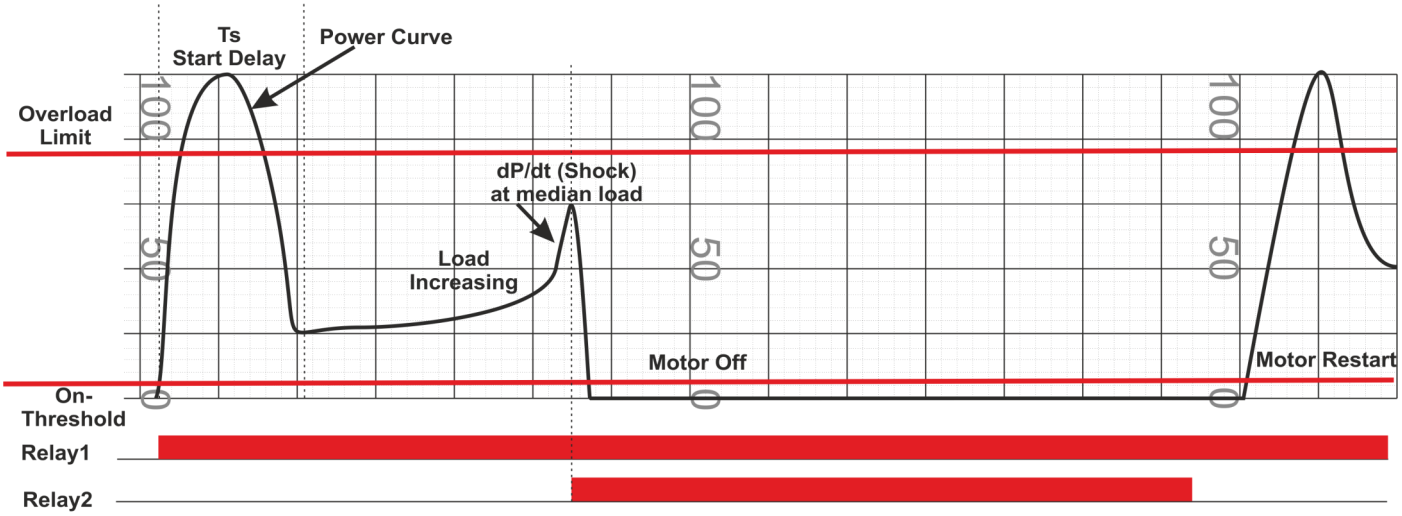
Shock Load Monitoring Applications:



Example #1 Shock Load Power (Torque) Curve.

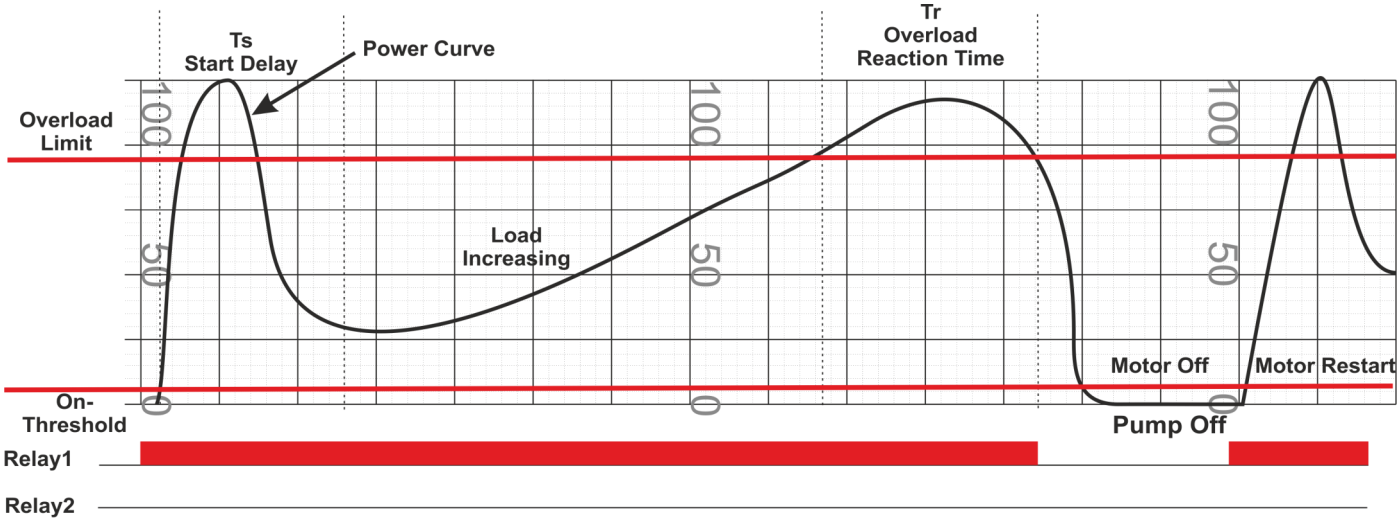
Shock Load Basics.

The figure above shows the basic philosophy of Shock Load Monitoring. The figure shows 3 x dP/dt spikes each occurring at different loads. Each of the 3 spikes would be able to shut off the machinery. The fixed overload Limit1 is not able to catch the exception.



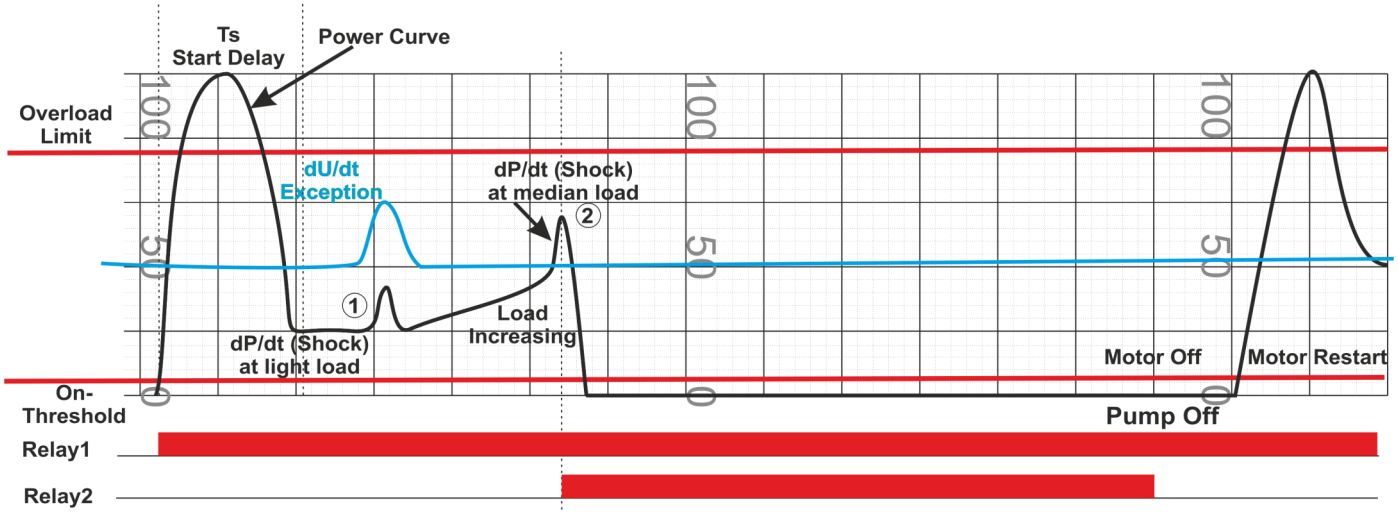
Example #2 Shock Load Exception (Torque) Curve.

The figure above shows how the Shock Limit generates an exception on the Relay #2 output. The fixed overload limit is not affected from the dt/dt exception.



Example #3 Shock Load Power (Torque) Curve.

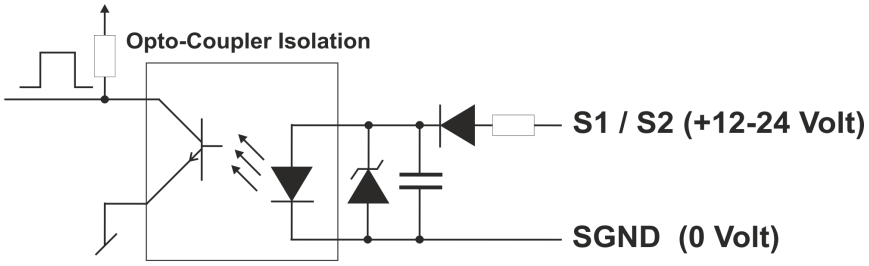
The figure above shows how the overload limit1 triggers an exception, if the Power (torque) gradually slips above after the limit. The slow Power increase is not able to trigger the dP/dt exception. The slow power increase might be caused from a bad bearing or from other problems with the drive train.



Example #4 Shockload Power (Torque) Curve.

The dU/dt limit function.

The dU/dt limit serves to ignore dP/dt limit exceptions, caused from sudden Mains Voltage Increases. Such Voltage Increases might be generated from the start/stop of large machinery located in the neighborhood. The figure shows how no dP/dt exception is generated, when a spike in the mains voltage is detected.
The dU/dt limit must be programmed so that the dU/dt LED is not lit by normal operations. The dU/dt limit may be set to like 5-8% and maybe up to the value of 10%, if the mains is unstable. The dP/dt limit typically varies from 5-15%, but the value is application specific.



Inputs S1 & S2 (Positive Logic)

Input S1 is used to reset exception alarms. An indication alarm is does not require a reset (see P-04). The input S2 may get used to block alarms from occurring. Alarms may also get reset from the Front Panel Reset key, unless it has been disabled from parameter P-07.

Technical Specifications:

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micPower

Model:	LCU621P1
Type:	Load Monitor
Firmware Version:	1.0
Rev:	1.0 HW
Electrical:	
No of Phases:	1
Voltage Input:	3 x 0-500 VAC max.
Current Input:	50 Amp. HS1
Frequency Range:	0Hz - 30 kHz AC.
Power Factor Range:	0 - 1.
AC Motor Power Range:	0 - 39.837 kW AC, 460V internal CT.
Supply:	18-36 VDC, Max. 4.0 Watt.
Remote Control:	Yes, 2 wire, power and communication.
Relay Outputs:	240 VAC/5 Amp.
Digital Inputs:	24V Positive Logic
Analog Output:	Not Present
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 35.0 mm.

CE

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

0520

micPower

Model:	LCU621P3
Type:	Load Monitor
Firmware Version:	1.0
Rev:	1.0 HW
Electrical:	
No of Phases:	1
Voltage Input:	3 x 0-500 VAC max.
Current Input:	3x50 Amp. HS1
Frequency Range:	0Hz - 30 kHz AC.
Power Factor Range:	0 - 1.
AC Motor Power Range:	0 - 39.837 kW AC, 460V internal CT.
Supply:	18-36 VDC, Max. 4.0 Watt.
Remote Control:	Yes, 2 wire, power and communication.
Relay Outputs:	240 VAC/5 Amp.
Digital Inputs:	24V Positive Logic
Analog Output:	Not Present
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 35.0 mm.

CE

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

Functional Ranges:

Mode	Function	Range	Comment
kW%	kW[%]	0—100%	Show kW[%]
Display	kW[%], kW, HP, U, I, PF		Display Function
Limit1	Max. Limit (Overload or Running)	5.0-99.9 (0.0 = Off)	Limit1 (see parameter P-04)
Tr1	Max. Limit Reaction Time	0.01-999.99 seconds	Limit1 Exception Reaction Time
Limit2 dP/dt	dP/dt Limit	0.0-50.0 % (0.0 = Off)	dP/dt Limit2
Limit2 dU/dt	dU/dt Limit	0.0.50.0 % (0.0 = Off))	dU/dt Limit2
Range[A]	Current Range Programming	See the range table on page 4	Current Range
Ts	Start Delay	0.1-999.9 seconds	Start Delay
Param	Parameters Programming	P-00 to P-21	See the list on next page

Programming

The LCU621 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.

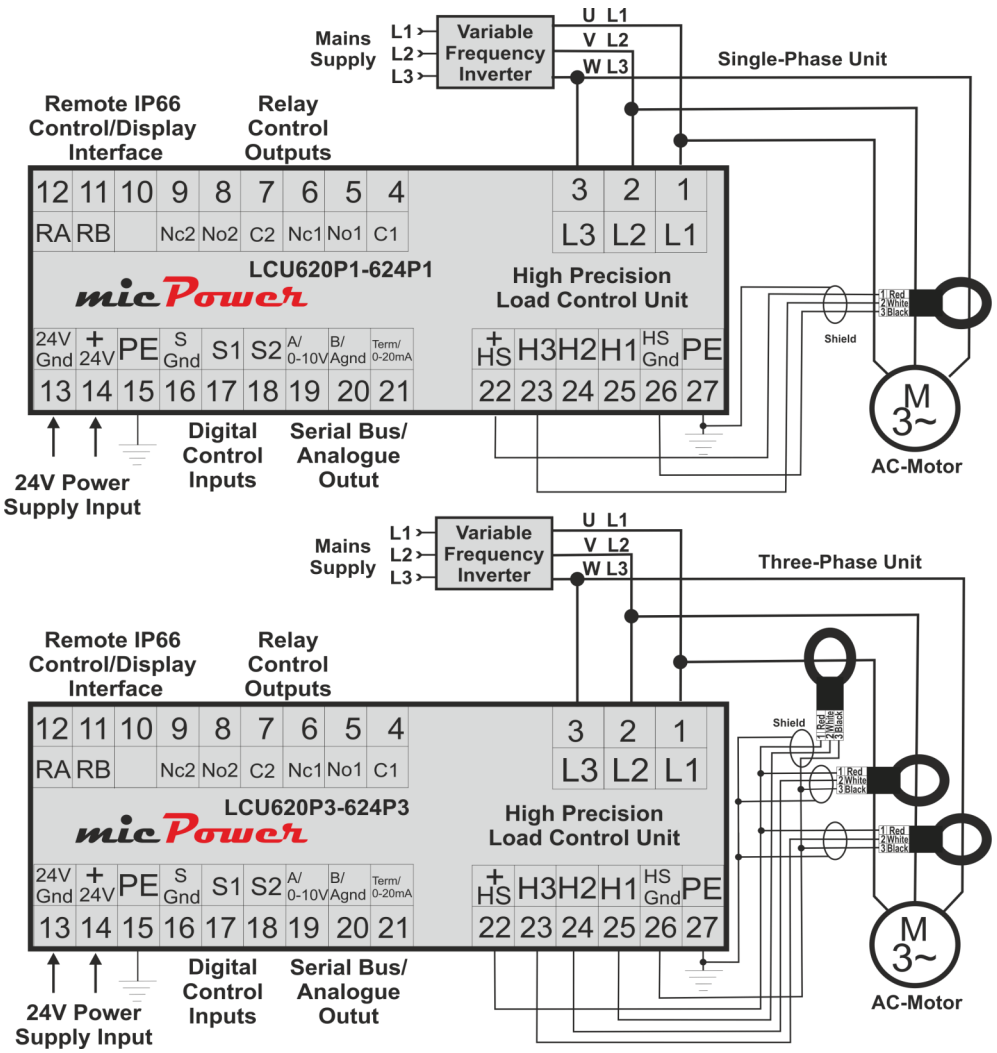
Measurement Ranges

The LCU621 includes **Hall-Sensors** for currents up to 1000 Amps.

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	Reserved		
P-02	Reserved		
P-03	Averaging Programming	1-20	Measurement Averaging
P-04	Reserved		
P-05	On threshold	1.0-25.0 % (Default 3.0%)	Motor Start-Threshold
P-06	Remote Update Enable	On/Off (Default = On)	Enable/Disable Remote Control Update
P-07	Alarm Reset Key Enable	On/Off (Default = On)	Front Panel Reset Key Enable/Disable
P-08	Lock Enable	On/Off (Default = Off)	Enable/Disable Keyboard Lock Function
P-09	Reserved		
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	Analog P1Max programming	51-100 % (Default = 100%)	Analog P1Max
P-12	Analog P1Min programming	0-49% (Default = 0%)	Analog P1Min
P-13	Analog Polarity Mode	Normal or Inverted (Default = Normal)	Analog Output Polarity
P-14	dP/dt Polarity	Plus/Both	dP/dt Polarity Select
P-15 to P-17	Reserved		
P-18	Hall-Sensor Type	HS1, HS2, HS3, HS4, HS5	Hall-Sensor Type
P-19	Reserved		
P-20	Show S1 Input State	1.On/1.Off	Show Input S1 state (for testing)
P-21	Show S2 Input State	2.On/2.Off	Show Input S1 state (for testing)

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 = Reserved

P-02 = Reserved

P-03 = Averaging Programming
Measurement averaging.

P-04 = Reserved

P-05 = On Threshold
Motor On Threshold.

P-06 = Remote Update Enable
Remote controller enable On/Off.

P-07 = Alarm Reset Key Enable
Enable the reset key from the Front Panel.

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 = Reserved

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 = Analog P1Max programming
Analog zoom P1Max.

P-12 = Analog P1Min programming
Analog zoom P1Min.

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

P-14 = dP/dt Mode
DP/dt Polarity Select. The polarity must be either 'Plus' (only positive power peaks) or 'Both' (both positive and negative power peaks).

P-15 to P-17 = Reserved

P-18 = Hall-Sensor Type
HS1, HS2, HS3, HS4, or HS5.

P-19 = Reserved

P-20 = Show S1 Input State
Show the state of the input the S1. On/Off.

P-21 = Show S2 Input State
Show the state of the input the S2. On/Off.

Power Measurement Range

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

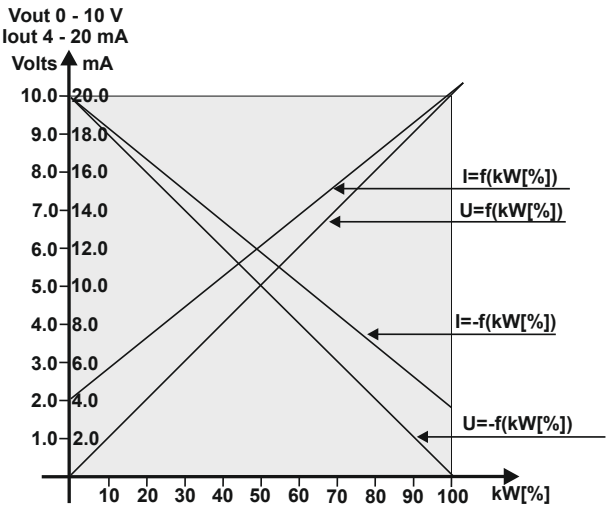
P[W] = √**3** * Unom[V] * Current-Range[A]

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].

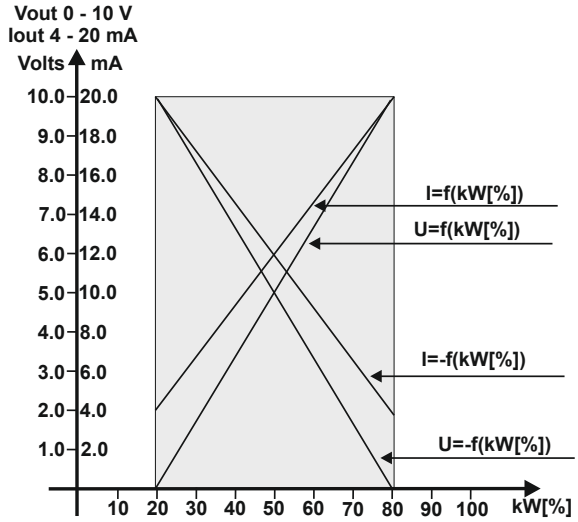
The current measurement phase that runs through the unit MUST be the phase that connects to L3 on the Voltage Input Terminal (#3). The direction of the wire is not important as this unit is designed to measure inductive power only. This also mean that it is assumed that the motor cannot work as a generator 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 LCU621 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.



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%

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
Int. 21	16.73	22.43
Int. 22	17.53	23.50
Int. 23	18.33	24.56
Int. 24	19.13	25.63
Int. 25	19.92	26.70
Int. 26	20.72	27.77
Int. 27	21.51	28.84
Int. 28	22.31	29.90
Int. 29	23.11	30.97
Int. 30	23.90	32.04
Int. 31	24.70	33.11
Int. 32	25.50	34.18
Int. 33	26.29	35.24
Int. 34	27.09	36.31
Int. 35	27.89	37.38
Int. 36	28.62	38.45
Int. 37	29.48	39.52
Int. 38	30.28	40.58
Int. 39	31.07	41.65
Int. 40	31.87	42.72
Int. 41	32.67	43.79
Int. 42	33.46	44.86
Int. 43	34.26	45.92
Int. 44	35.06	46.99
Int. 45	35.85	48.06
Int. 46	36.65	49.13
Int. 47	37.45	50.20
Int. 48	38.24	51.26
Int. 49	39.04	52.33
Int. 50	39.84	53.40
Ext. 30/5	23.90	32.04
Ext. 50/5	39.84	53.40
Ext. 75/5	59.76	80.10
Ext. 100/5	79.67	106.8
Ext. 150/5	119.5	160.2
Ext. 200/5	159.3	213.6
Ext. 250/5	199.2	267.0
Ext. 300/5	239.0	320.4
Ext. 400/5	318.7	427.2
Ext. 500/5	398.4	534.1
Ext. 600/5	478.0	640.8
Ext. 700/5	557.7	747.6
Ext. 800/5	637.4	854.4
Ext. 900/5	717.1	961.2
Ext. 1000/5	796.7	1068

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).