

MEASUREMENT ON COMPENSATION CAPACITANCE IN INDUCTIVE NETWORK BY MICROCONTROLLER

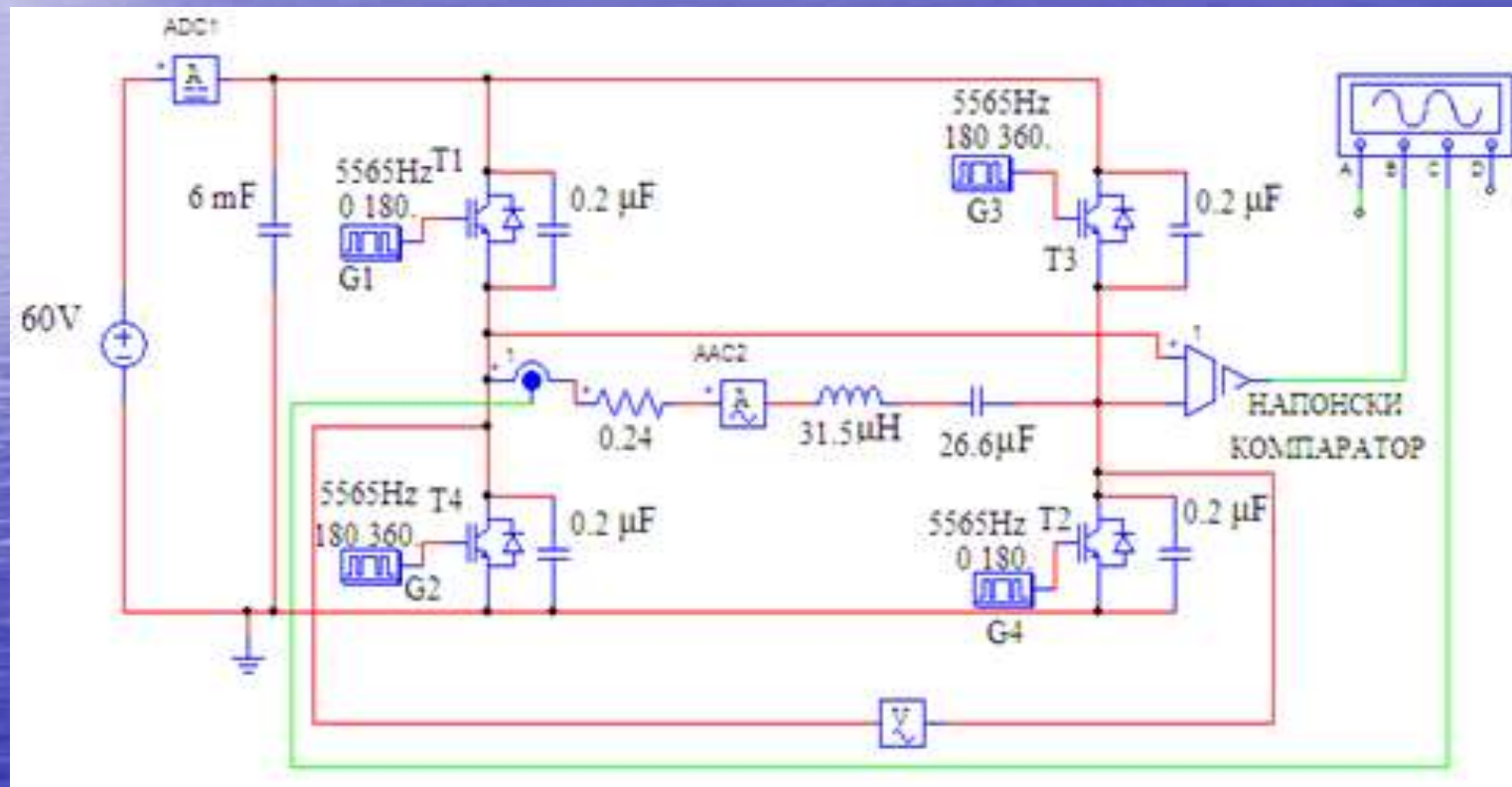
Purpose of the paper

- Design and of *a* practically realized on prototype microcontroller circuit for determined on the compensation capacitance in inductive network
- The realized measuring circuit, in addition to determining the value of the compensation capacitor, determines the current, voltage, active power, active energy and reactive energy

- The circuit is based on Atmega 328 microcontroller and smart power meter PZEM004
- The capacitance value is visualized on an LCD display, and the values of current, voltage, active power, compensation capacitance and power factor are displayed on a serial monitor on the computer

In energy networks with high inductive load the reactive energy is high and therefore these networks operate with a low power factor. In such networks to reduce the reactive energy are installed compensating capacitors. The solution in the paper determines the required capacitance in inductive networks to reduce reactive energy and increase the power factor to one unit

Electrical scheme of inductive actuators which is supply from full bridge converter



Output voltage and current waveforms on full bridge converter loading with inductive load

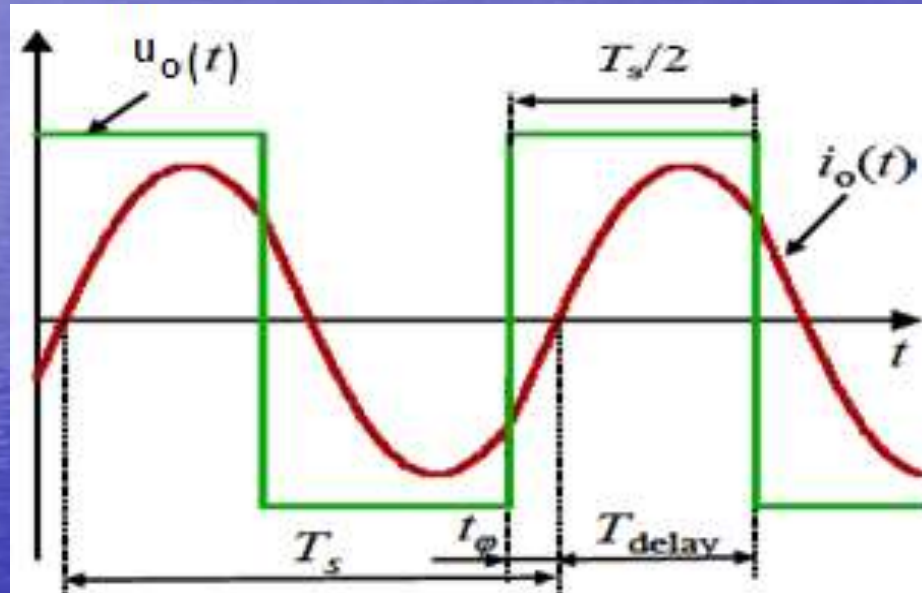


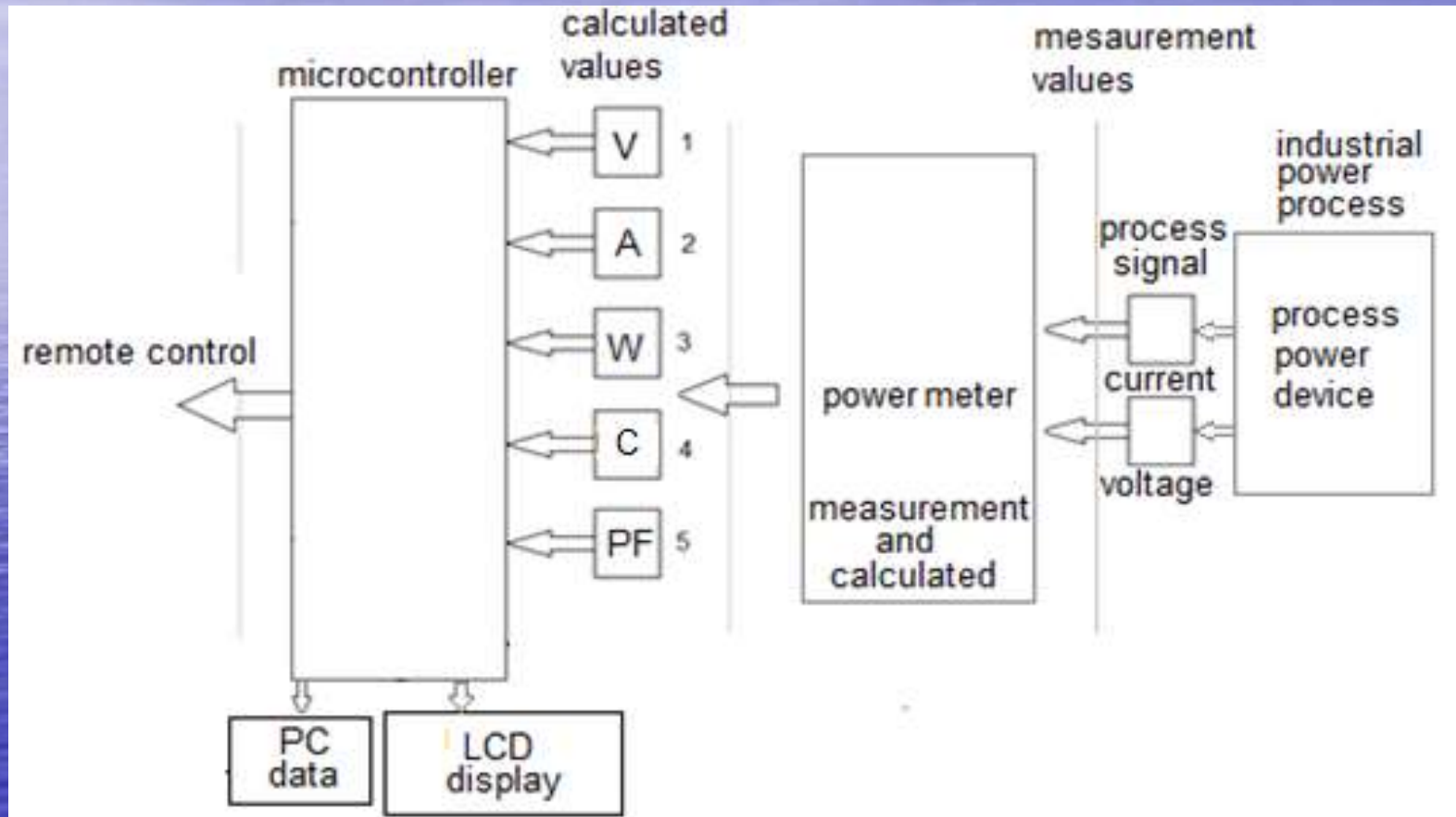
TABLE I: VALUE ON OUTPUT CONVERTER
PARAMETERS FOR CHANGE ON INDUCTANCE FROM
20%

L [μH]	R [Ω]	φ_i [$^\circ$]	f_{sw} [kHz]	I_o [A]	U_o [V]	P_o [kVA]
26,5	0,24	5,00	6.27	208	56	10,7
31,5	0,29	31,34	6.27	145	56	6,16

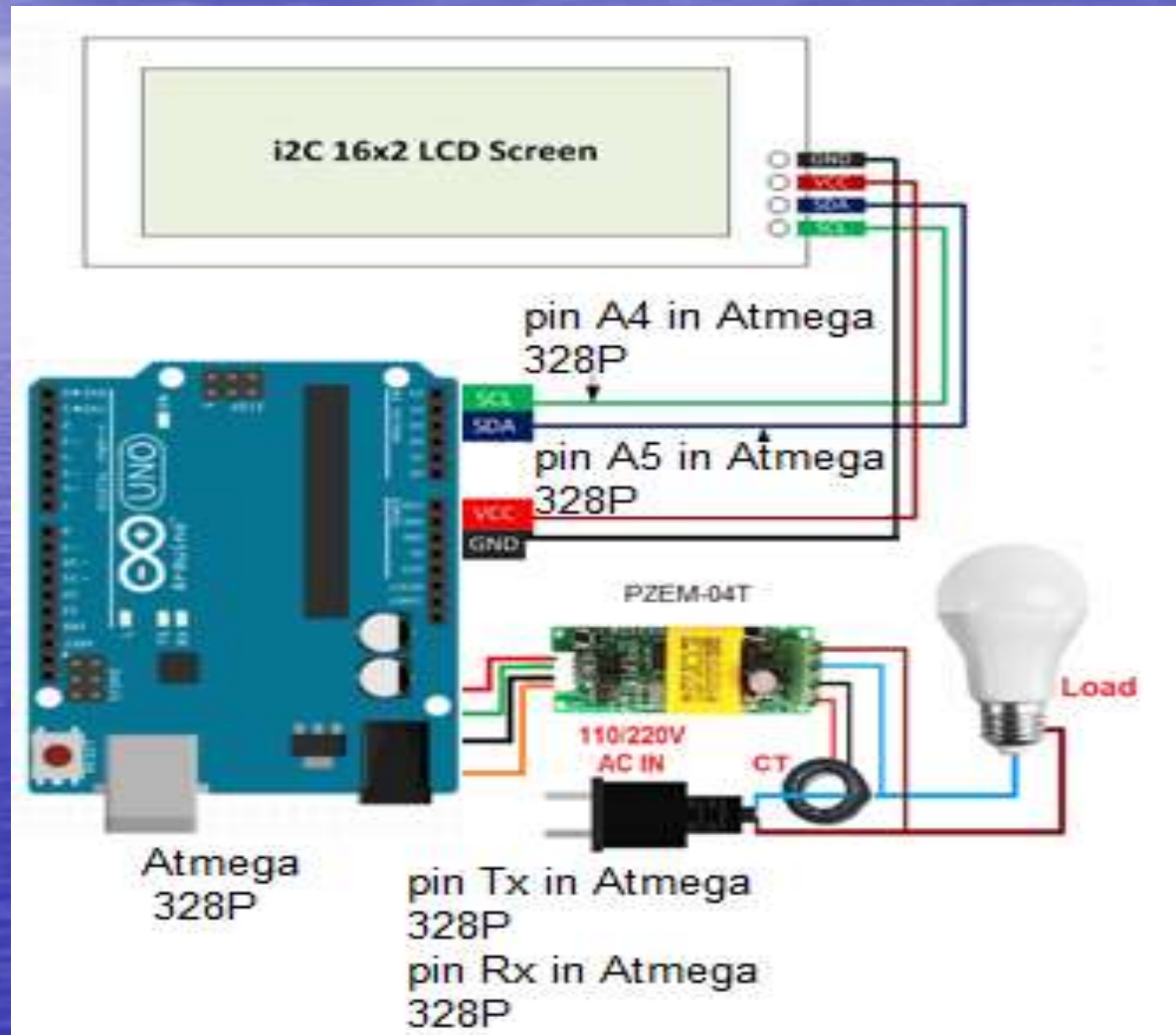
TABLE I: VALUE ON COMPENSATION
CAPACITANCE AND POWER

L [μH]	R [Ω]	C [μF]	φ_i [$^\circ$]	f_{sw} [kHz]	I_o [A]	U_o [V]	P_o [kVA]
26,5	0,24	26.6	5.00	6.27	208	56	10,7
31,5	0,24	21.28	5.00	6.27	208	56	10.7

Block diagram of the specific solution of an microcontroller power meter.

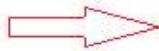


Connection diagram of the realized solution

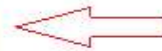


Arduino Uno

DC Power Jack



USB Port



Reset Button



No Connection
5 V
Reset Input
3.3 V
5 V
Ground
Ground
Vin 7-12 V

Analog Pin 0	A0
Analog Pin 1	A1
Analog Pin 2	A2
Analog Pin 3	A3
Analog Pin 4	A4
Analog Pin 5	A5

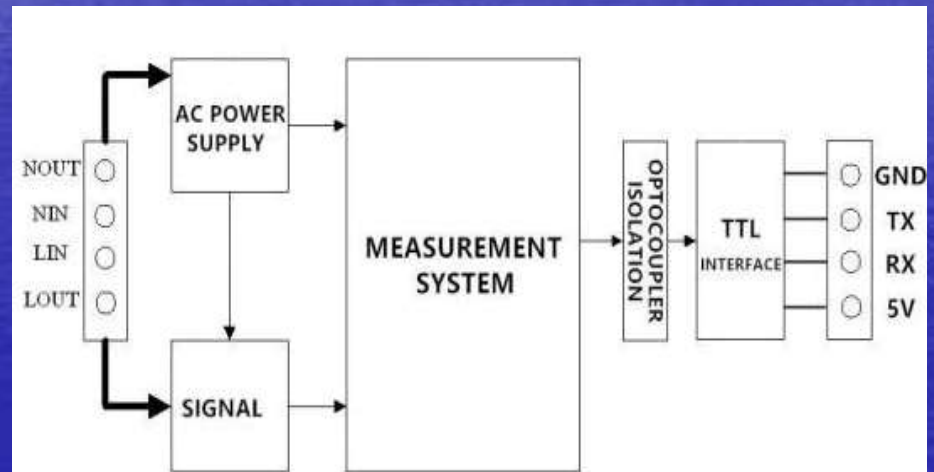
I2C/SDA
I2C/SCL



I2C/SCL	Serial Clock
I2C/SDA	Serial Data
Analog Reference Voltage	

Ground			
13	Digital Pin13	SPI/SCK	
12	Digital Pin12	SPI/MISO	
11	Digital Pin11	SPI/MOSI	PWM
10	Digital Pin10	SPI/SS	PWM
9	Digital Pin9		PWM
8	Digital Pin8		
7	Digital Pin7		
6	Digital Pin6	PWM	
5	Digital Pin5	PWM	
4	Digital Pin4		
3	Digital Pin3	Ext Int 1	PWM
2	Digital Pin2	Ext Int 0	
1	Digital Pin1	Serial Port TXD	
0	Digital Pin0	Serial Port RXD	

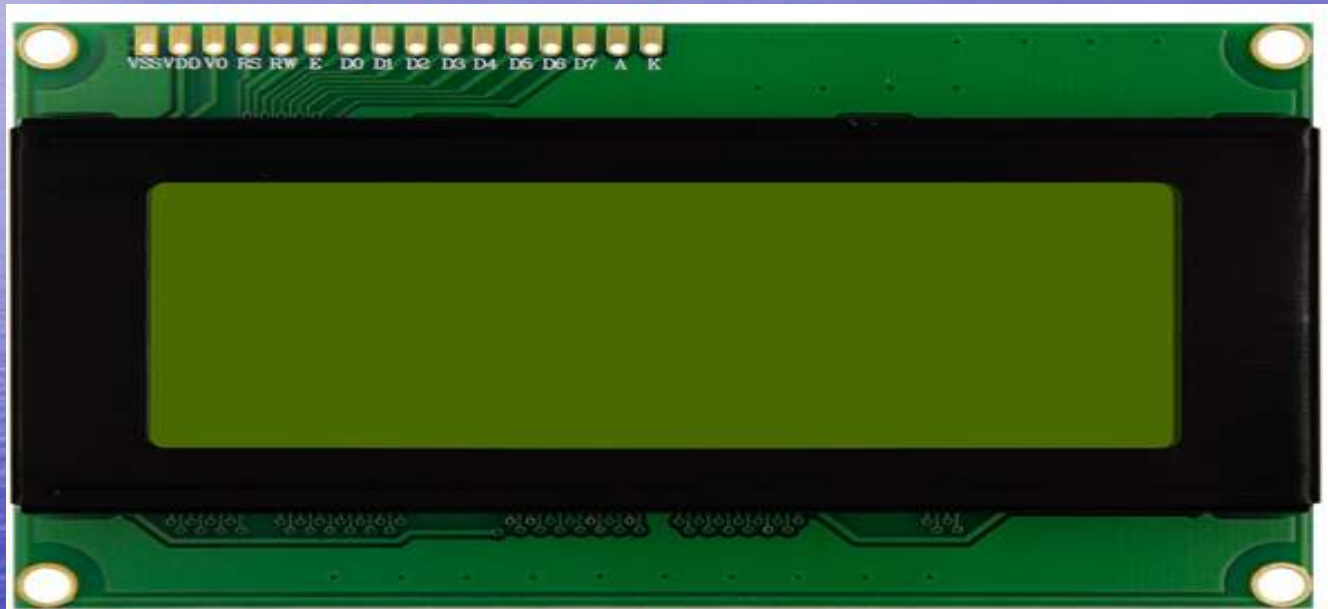
PZEM-004T board on power meter, and block diagram on this module.



- ***Function description***

- Voltage measuring range is 80~260V.
- Current measuring range is 0~10A(PZEM-004T-10A); 0~100A(PZEM-004T-100A)
- Active power measuring range is 0~2.3kW(PZEM-004T-10A); 0~23kW(PZEM-004T-100A)
- Starting measure power is 0.4W.
Resolution is 0.1W.
- Frequency measuring range is 45Hz~65Hz, resolution is 0.1Hz.
- Active energy measuring range is 0~

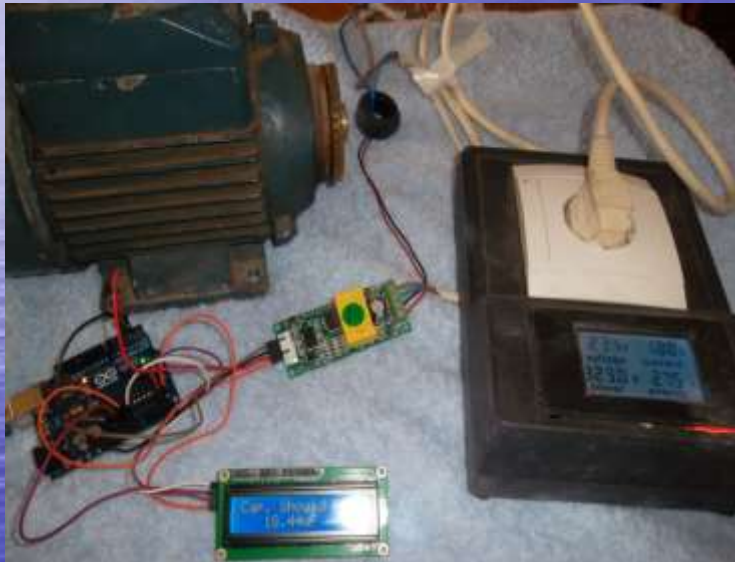
LCD 20x4 display





Experimental results

Prototype on the microcontroller power meter and the complete process microcontroller power meter.



The data for voltage, current, power, capacitance and power factor in serial monitor

```
11:44:24.176 -> 238.20V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:26.136 -> 238.20V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:28.136 -> 238.20V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:30.136 -> 238.20V; 0.06A; 11.00W; 0.51uF PF= 0.77
11:44:32.176 -> 237.80V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:34.136 -> 237.80V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:36.136 -> 237.90V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:38.136 -> 237.90V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:40.176 -> 238.10V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:42.136 -> 238.10V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:44.136 -> 237.70V; 0.06A; 11.00W; 0.51uF PF= 0.77
11:44:46.136 -> 237.70V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:48.136 -> 237.70V; 0.06A; 11.00W; 0.51uF PF= 0.77
11:44:50.136 -> 237.70V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:52.176 -> 237.40V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:54.136 -> 237.40V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:56.136 -> 237.40V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:44:58.136 -> 237.40V; 0.06A; 11.00W; 0.51uF PF= 0.77
11:45:00.136 -> 237.70V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:02.136 -> 237.70V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:04.176 -> 237.10V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:06.136 -> 237.10V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:08.136 -> 237.80V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:10.136 -> 237.80V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:12.176 -> 237.60V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:14.136 -> 237.60V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:16.136 -> 237.20V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:18.136 -> 237.20V; 0.06A; 11.00W; 0.51uF PF= 0.77
11:45:20.176 -> 237.80V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:22.136 -> 237.80V; 0.06A; 11.00W; 0.51uF PF= 0.77
11:45:24.176 -> 237.90V; 0.06A; 11.00W; 0.51uF PF= 0.77
11:45:26.136 -> 237.90V; 0.06A; 11.00W; 0.51uF PF= 0.77
11:45:28.136 -> 237.10V; 0.06A; 10.00W; 0.57uF PF= 0.70
11:45:30.136 -> 237.10V; 0.06A; 11.00W; 0.51uF PF= 0.77
11:45:32.136 -> 237.40V; 0.06A; 9.00W; 0.62uF PF= 0.63
11:45:34.136 -> 237.40V; 0.06A; 11.00W; 0.51uF PF= 0.77
11:45:36.136 -> 237.80V;
```


Conclusions

- In paper is designed and practically realized microcontroller power meter
- power meter allows data on power, compensation capacitance and power factor to be obtained only by measuring the voltage and current of a process device
 - the required compensatory capacity is visualized on an LCD screen and data for voltage, current, power, capacitance and power factor are sent in serial monitor
- The solution also provides the ability for upgrade to remote control on the process quantities