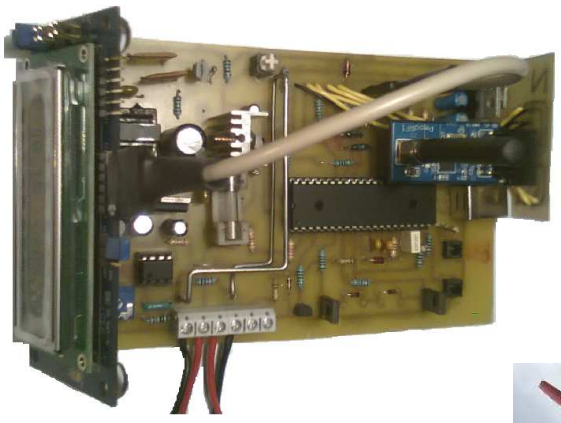
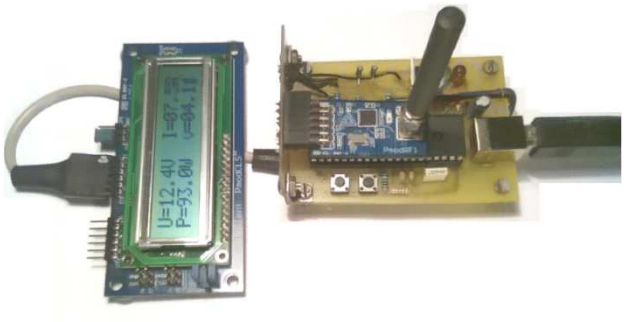
WIND GENERATOR MONITORING AND CONTROL SYSTEM

by

ZSOLT



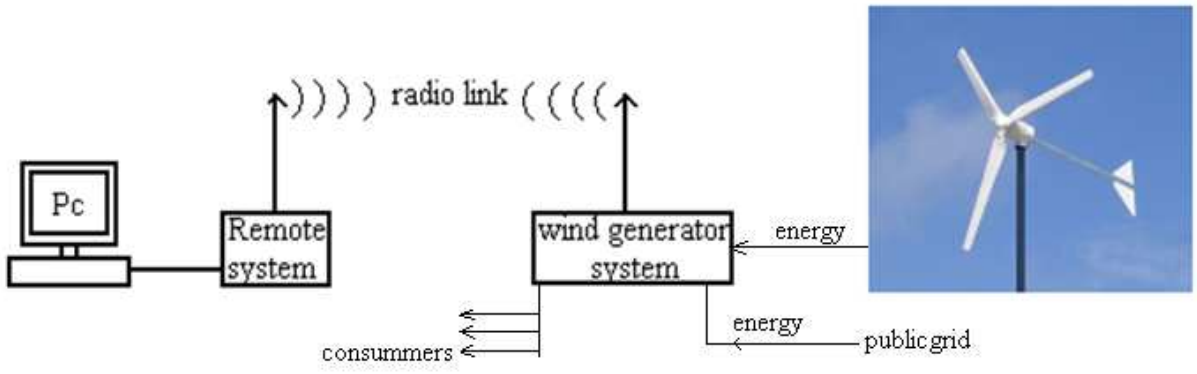


Small wind generators up to hundreds of watts work in paralell with chemical acumlators on 12 V, 24V or 48V direct current bus bar systems. Ac. onsummers take energy from these systems thru inverters.

Wind generators deliver energy when wind speed exceded a certain treshold value prox. 3 - 5 m/s depending on the wind generator size. If wind energy is absent for longer time, the acumlators start to dischrge, and at a certain value the consumers need to be disconected from the dc bus bar and to be conected to other energy sources if available, to avoid damage in the energy storage system .This kind of transition between energy sources can cause longer interupts in consumers function, or permanent shutdown.

In this conditions the main probem is the instability regarding the power suply of a small wind generator.

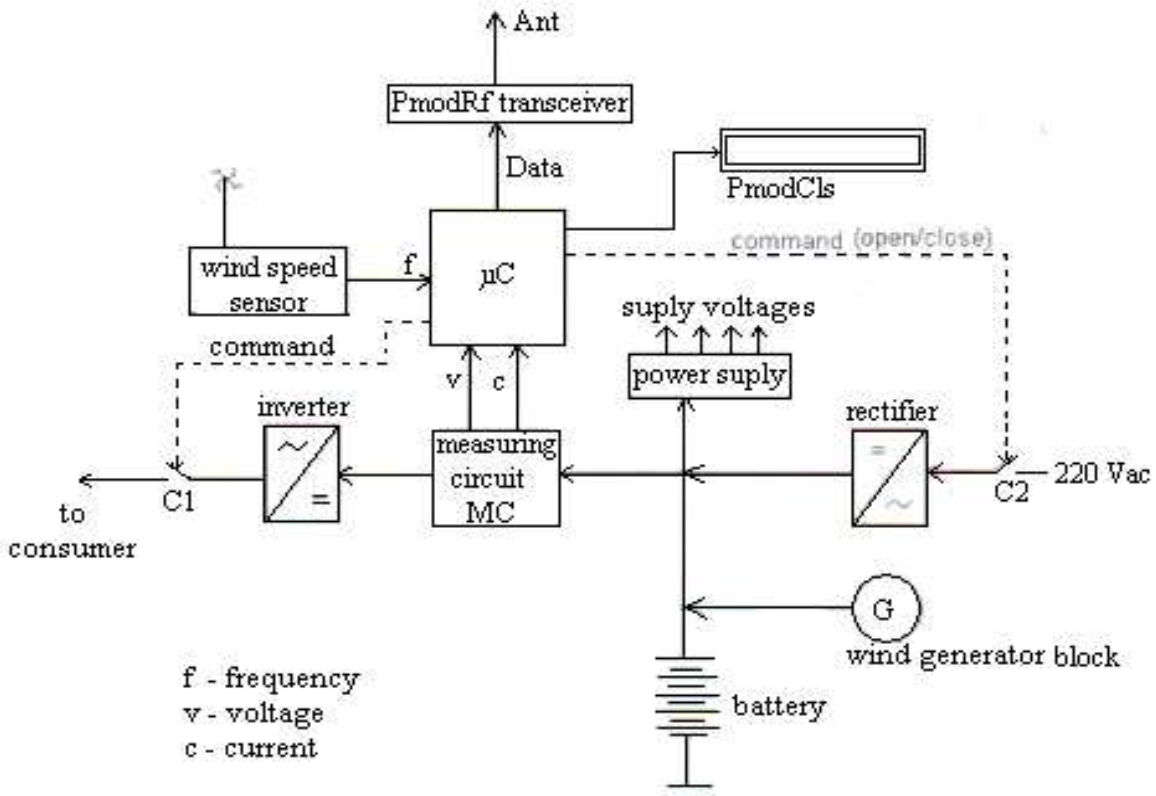
In the idea of a parallel operation between a renewable energy source and a relatively secure energy source, such as the public electric network, i sugest the folowing monitoring and control system for a wind generator, built around PIC microcontrolers:



Hardware description

Wind generator system

- this part of the equipment has the folowing block diagram:



The system has own power supply conected to the 12V dc. bus bar. Energy can com in to de system from wind generator, storage system (acumlator),public grid or from all sources together, depending from operating conditions wich the system has to handle, coordonated from the microcontroler.

The main block is the PIC microcontroler, which takes signals from wind speed sensor and measuring circuit, processes them, displays results on Digilent's PmodCLS , transmits system data to remote equipment and comands C1 and C2 circuit breakers as described in the folowing table.

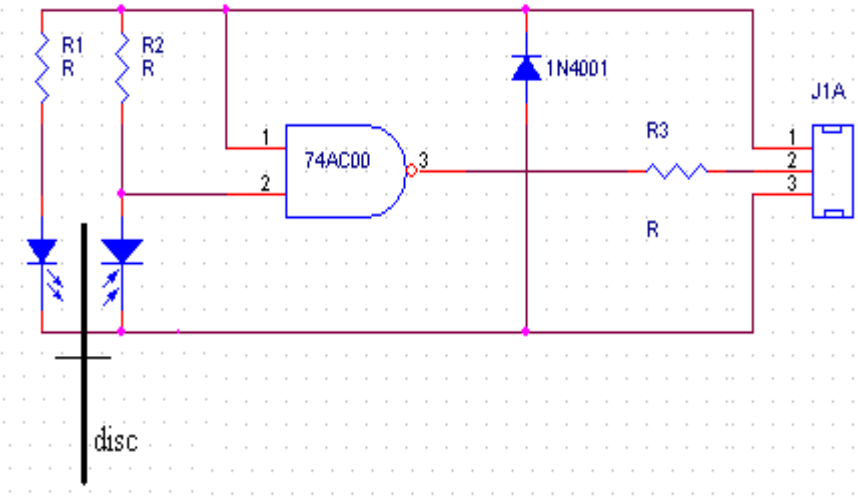
Control logic:

state	System events	C1 state	C2 state	Consumer's main energy source	Cause
1	wind speed normal current normal voltage normal	closed	open	Battery + wind generator	There is sufficient wind speed, the load current and output voltage are in normal limits
2	wind speed normal current abow normal voltage below normal	closed	closed	Network + wind generator	The wind generator is working, the battery is discharged due to overload
3	wind speed below normal current normal voltage normal	closed	open	Battery + wind generator	The wind generator is not working but the battery is full charged
4	wind speed below normal current abow normal voltage below normal	closed	closed	Network	Battery has discharged due to a persistent lack in incoming wind energy
5	Any wind speed current abow normal voltage below normal + c2 closed	open	closed	0	Consumer owerload , incoming energy from network fails to bring the system to normal parameters. Possible cause: inverter is defect

In case 5 the system remains stuck and after removing the possible defect the user can reset the system by microcontrollers reset button.

- components :

- anemometer (home built) :



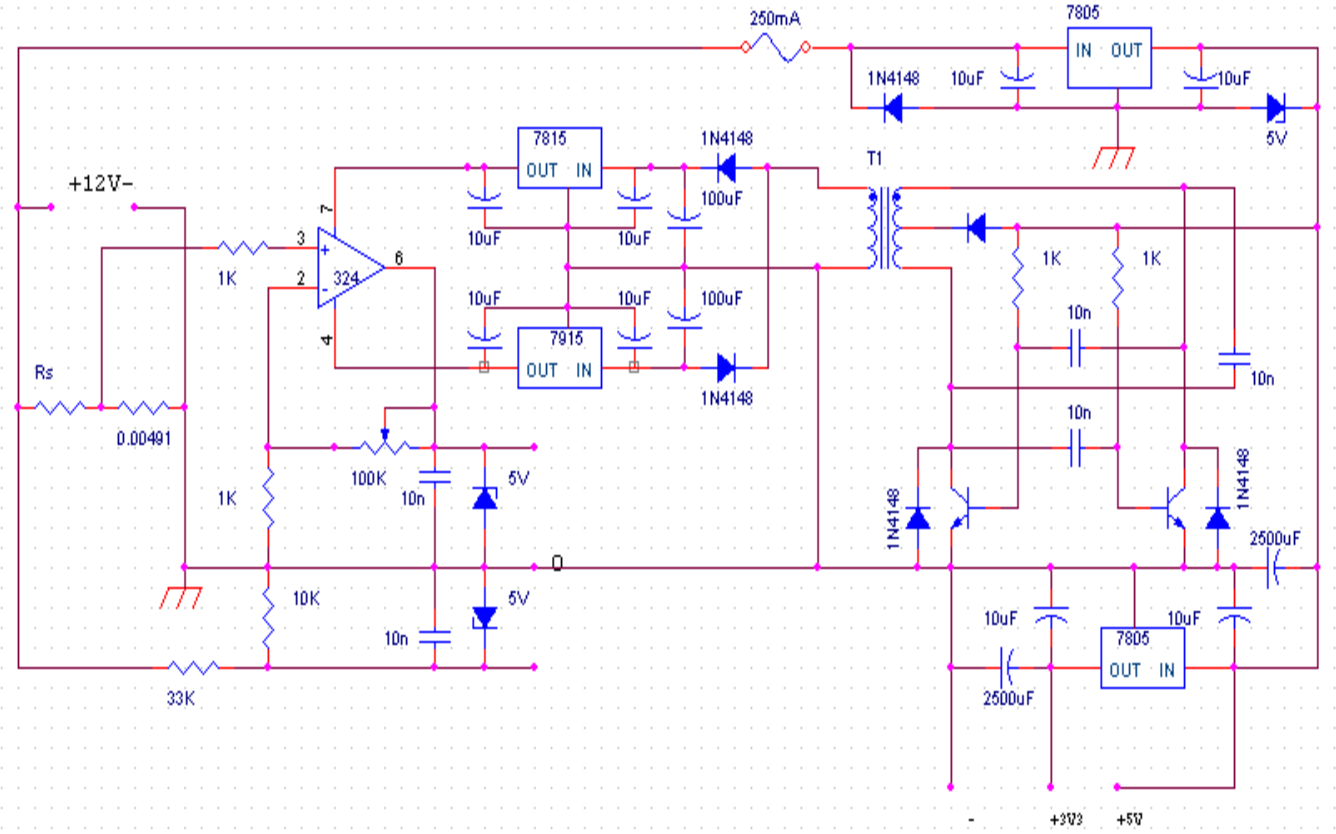
Disk and cup set are rotating on the same ax. Due to holes practiced on disk's perifery the fotodiode recives intermitent light from LED pozitioned on the other side of disk. Pulsatory voltage arises on pin 2 of IC 74AC00, which is a NAND Scmidt Triger circuit. On output pin 2 of J1A conector we can colect the TTL level signal and measure its frequency f with the PIC mcu.

The wind speed is : v = 20 x f [m/s] , where 20 is the anemometer's constant.

Operating range 0.3- 20 [m/s] .

- Power suply and measuring circuit

Suply voltage from dc. bus bar is applied to main stabilizer IC 7805. To avoid linking pover suply against bus bar polarization, diode 1N 4148 was introduced after 250 mA fuse. When wrong conected the diode enters in conduction and short circuit's the fuse so the circuit is interupted and no damage hapens.



From IC 7805 are supplied the PIC microcomtroler,anemometer, releys, a 15 V double source for measuring circuit and a 3.3V source for PmodCLS and PmodRf1.

The 15 V double source uses dc.dc converter to obtain the necesary voltages for LM 324 operational amplifier (op.amp.). The hart of the converter is a clasic astabil configuration of two NPN tranzistors with primary windings of transformer and a few discrete circuit components. 1N4148 fast switching diodes are used to eliminate autoinduction spikes.

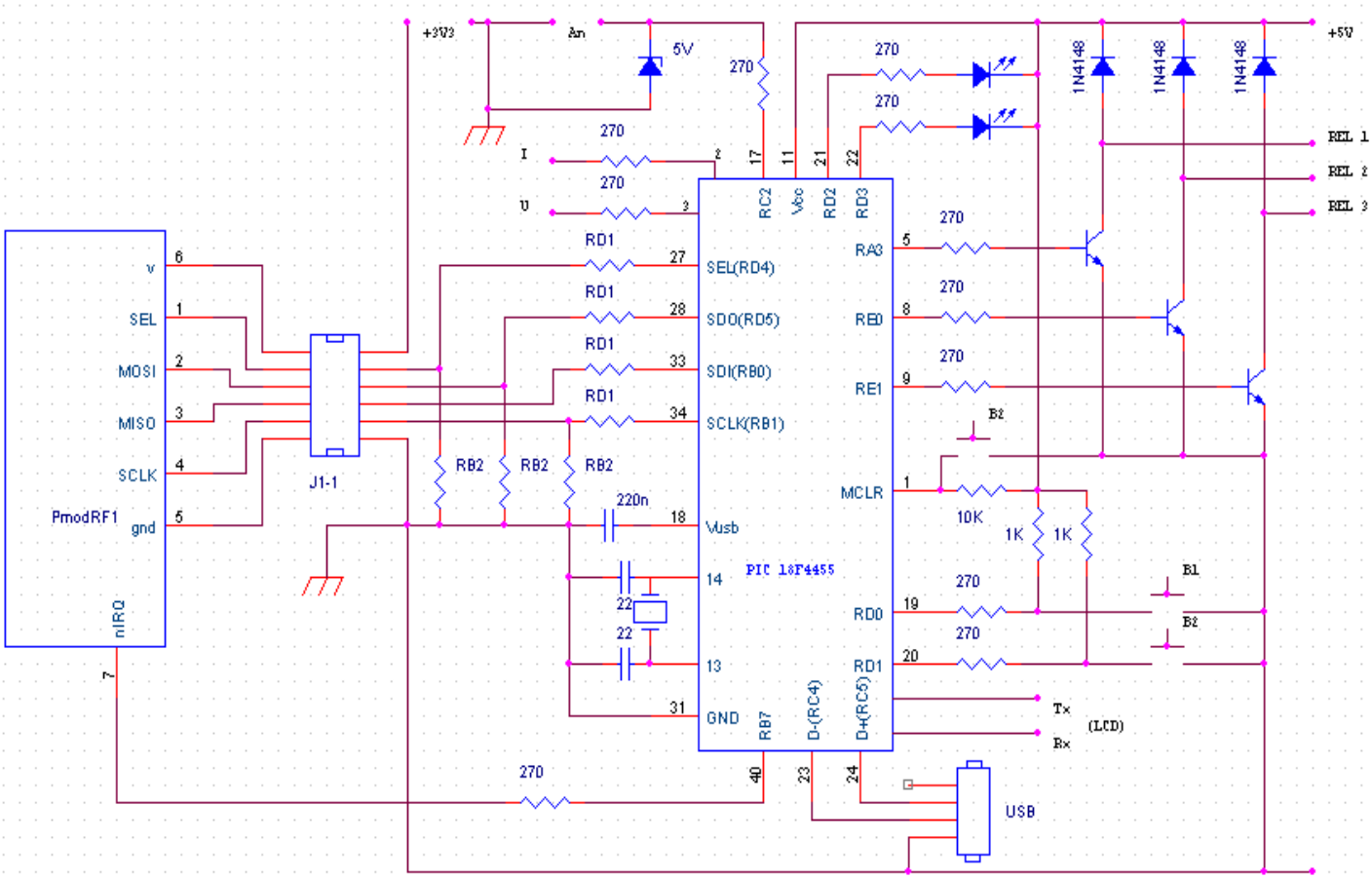
To measure the current one op.amp.with amplification of approx. 100 is used to get the voltage drop on the 0.0049 Ω shunt rezistor.
Voltage on bus bar is measured thru voltage divider realized with 10 kΩ and 33 kΩ resistors. Operating ranges: voltage 7.5÷24 V, current 0.1÷ 11 A

If malfuncion ocours the autputs of measuring circuit can't override standard TTL level due to the use of 5V Zenner diodes conected on them. Also

10nF capacitors are used to ground ac. noise signals that may apair during wind generator function.

- Microcontroller circuit

  - uses PIC 18F 4455 ic for ADC and capture operation,UART and SPI comunication, and also performs system state commandind thru relays .

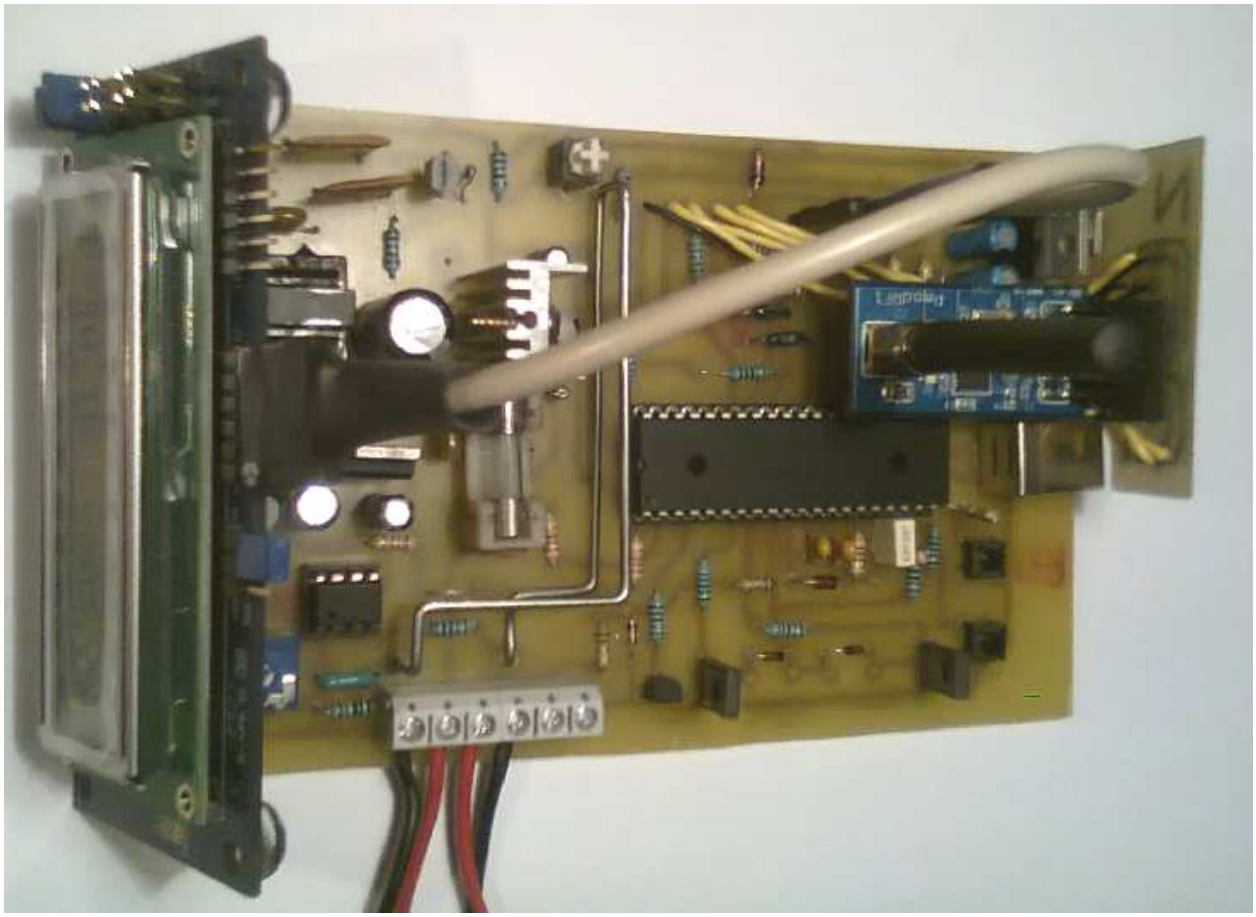


Almost evry io pin of the IC is protected by a 270 Ω resistor wich limits the current below 25 mA. Further 1 kΩ and 1.5 kΩ resistor dividers are used to interface PmodRf1 input pins with 5 V operating PIC mcu.

Tranzistor based amplifiers are used as reley drivers with protecton diodes against autoinduction voltage.

Buttons,led's,PmodCLS, and sockets are included for handling the system.

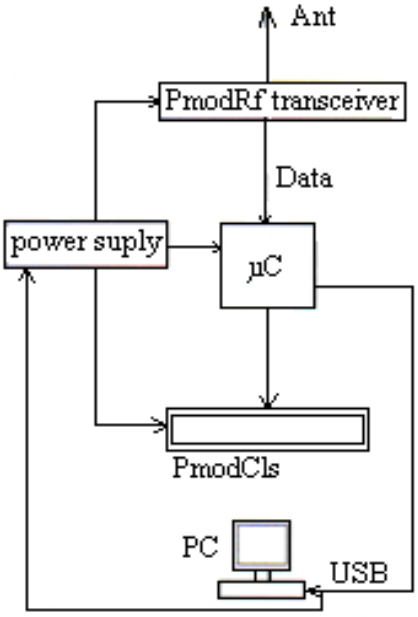
Relays are not on the pcb because of their size.



- The generator
  - home built generator with rectifier and electronic charging reley included :

To produce the magnetic flux , permanent magnets are used

Remote station



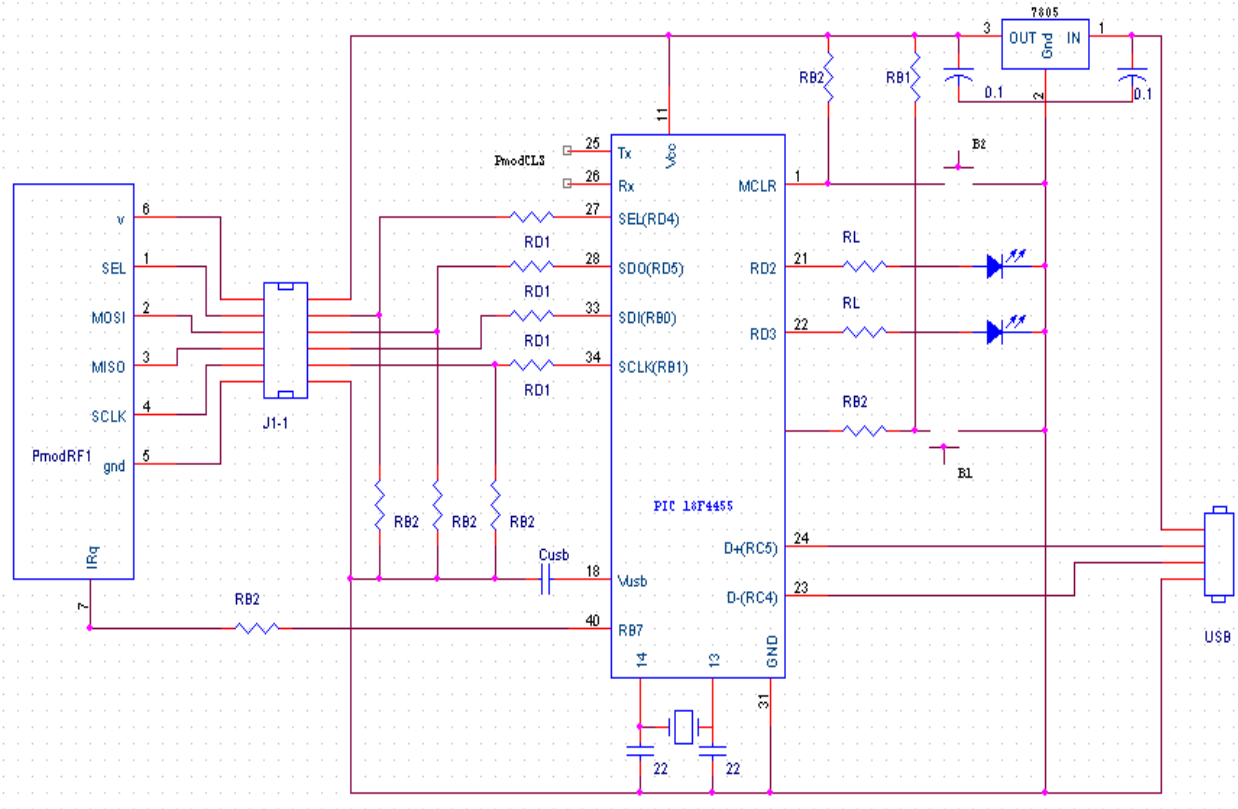
Uses PIC microcontroler to interface the PmodRf1 transceiver with Pc, and also offers posibility of data display on PmodCls module. SPI,UART and USB links are used here for data transfer.

On the Pc a LabWindows CVI application performs data procesing, storage and display tasks.

Power suply is taken from Pc's USB port or from other compatible source.

3.3 V stabilizer ic supplies the PmodRf1 and PmodCLS module

Two butons and two led's are awailable specilay for handling durig programing.




U=12.4V
P=93.0W
ProdRF1

3. Software

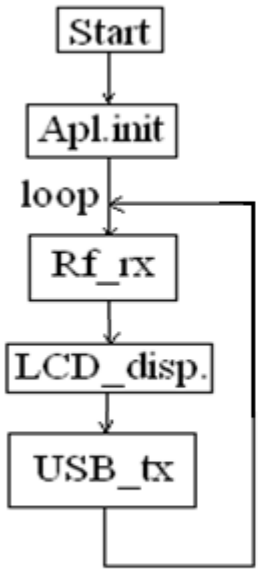
3.1 Comunication

UART,SPI, USB and Radio link , are implemented:
- between both PIC mcu's and PmodCLS's a 32 byt data packet is transmited with UART protocol;
- between both PIC mcu's and PmodRF1's , SPI inerface is used
- betweeen remote station and Pc USB conection is made
- between wind generator system and remote station unidirectional radio link makes shore the data transfer.

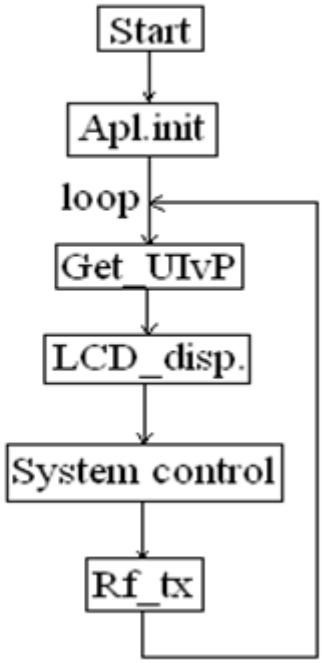
3.2 Microcontroller aplication

(MPLAB)

Remote system



Wind generator system



On both mcu's after initializations and configuration of peripherals the program enter's in a loop.

On remote system's mcu the loop starts with geting data from the radio link. If no data comes display will apear "No data" and if 32 byte data is recived, voltage,curent ,power, and wind speed numerical values are displayed.

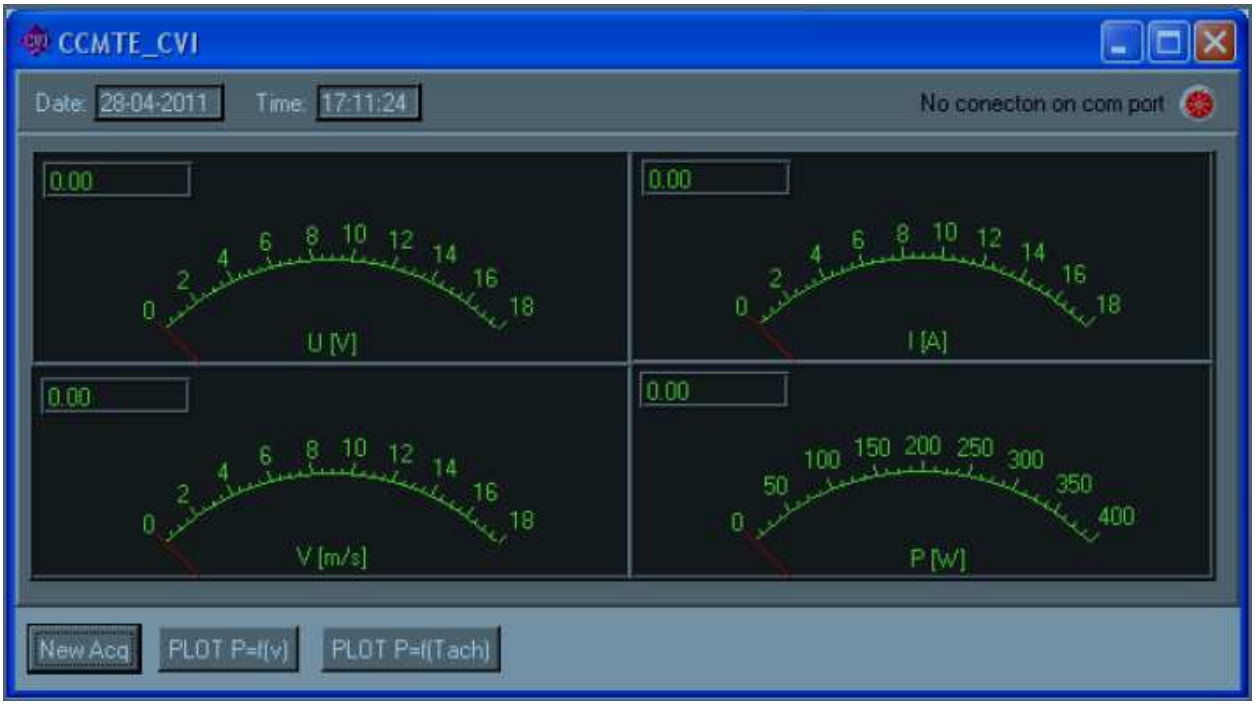
In 1 sec. time periods (by testing Timer0 IF flag bit) USB data transmision to Pc is executed.

On the wind generator sysem's mcu the loop begins vith geting voltage, current, power and wind speed values and displaying them. After dysplay the mcu check's if values are in normal limits and if not trys to establish normal parameters in the circuit by controling the circuit breaker's. After system control the mcu transmits data to PmodRf1.

This loop is not infinit. If the mcu can't bring back the system in normal parameters after 1 min. from first action on circuit breaker (C2), the loop stops at system comand and removes the load from 12V bus bar thru C1 circuit breaker.

3.3 PC aplication (LabWindowsCVI)

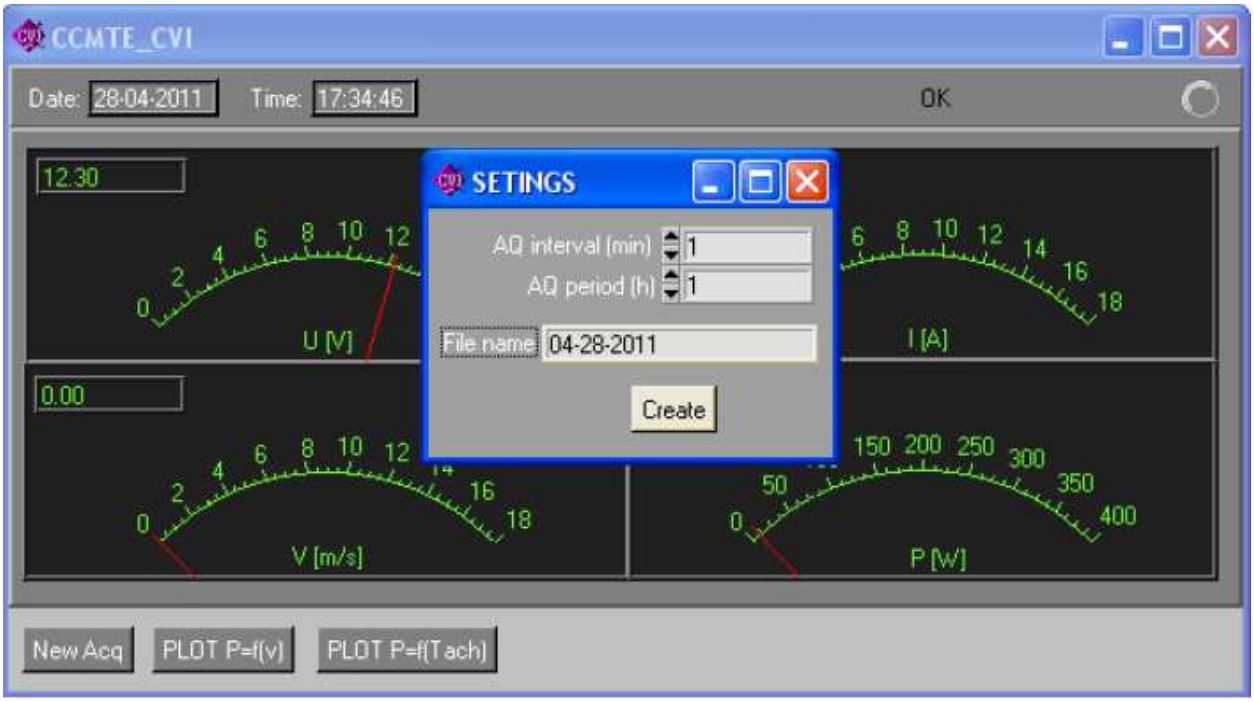
The monitoring and data acquisition program has the folowing main user interface :



Because the first variant of the wind generator monitoring and control system (.v1) uses UART comunication (cable) between Pc and generator system, i used a USB to virtual Com port emulator progrm packet provided from Microchip, so comunication with new systwm is possible without major hardware or software impact.

The main user interface contains 4 analog and 4 digital measuring instruments, text message, LED, butons and also displays time and date.

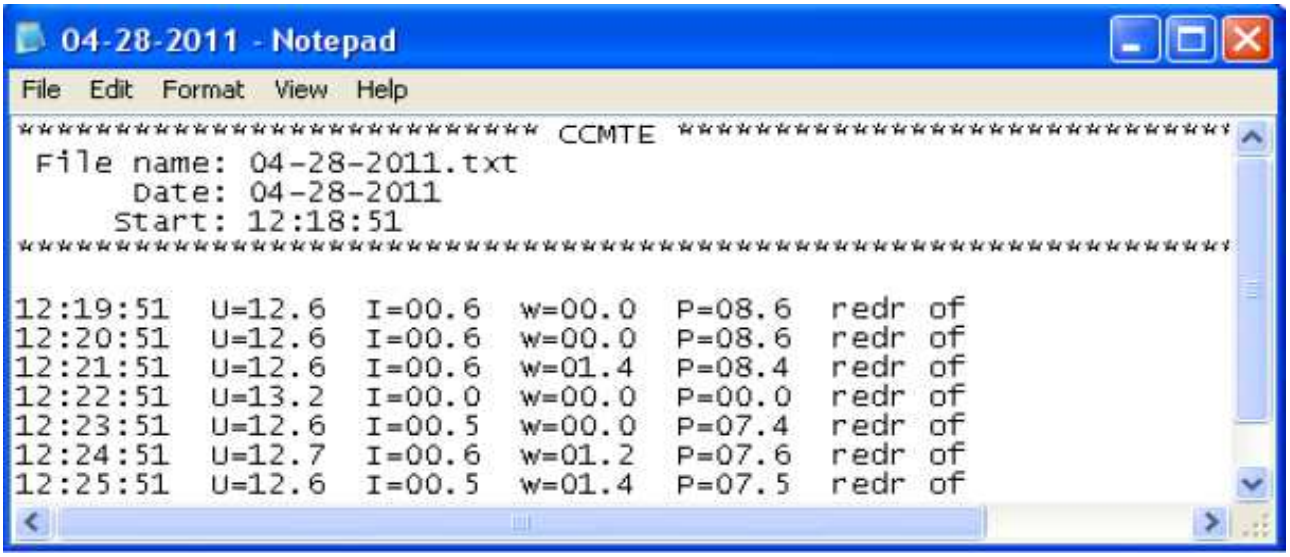
The "New Acq" buton starts a new data acquisition if no other acquisition is in progres. For this the user must select the acquisition interval, period and the name of the file in the setings box wich apears at the start. If no name is introduced the file wil have the curent datum as a name:



If the name alredy exists a prompt message alerts the user:

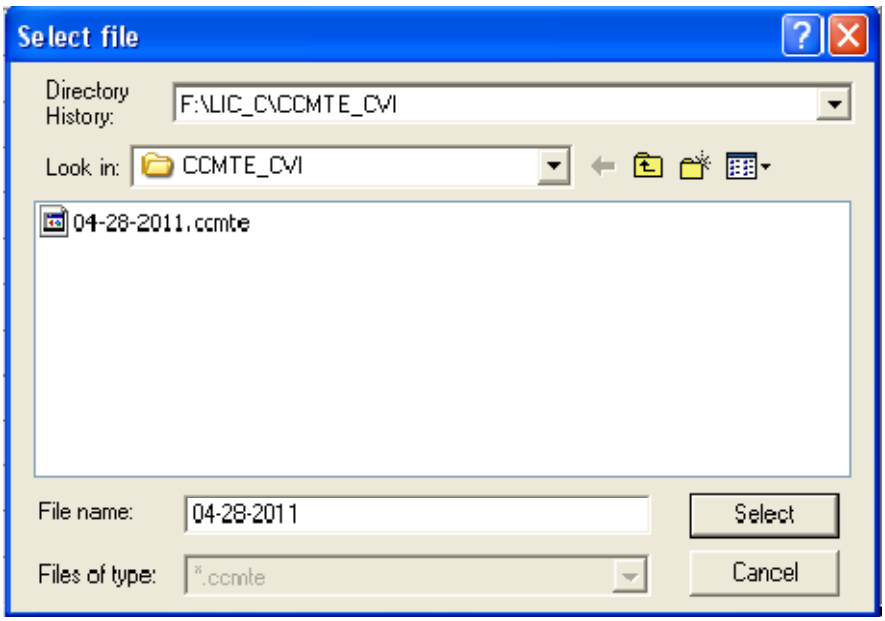
Owerwriting a file is not posible and if the user does not change the introduced name no acquisition will start

When creating a new acquisition two files are created in the poject's director, one *.txt file and a *.ccmte file, both are read only files. The first file type can be

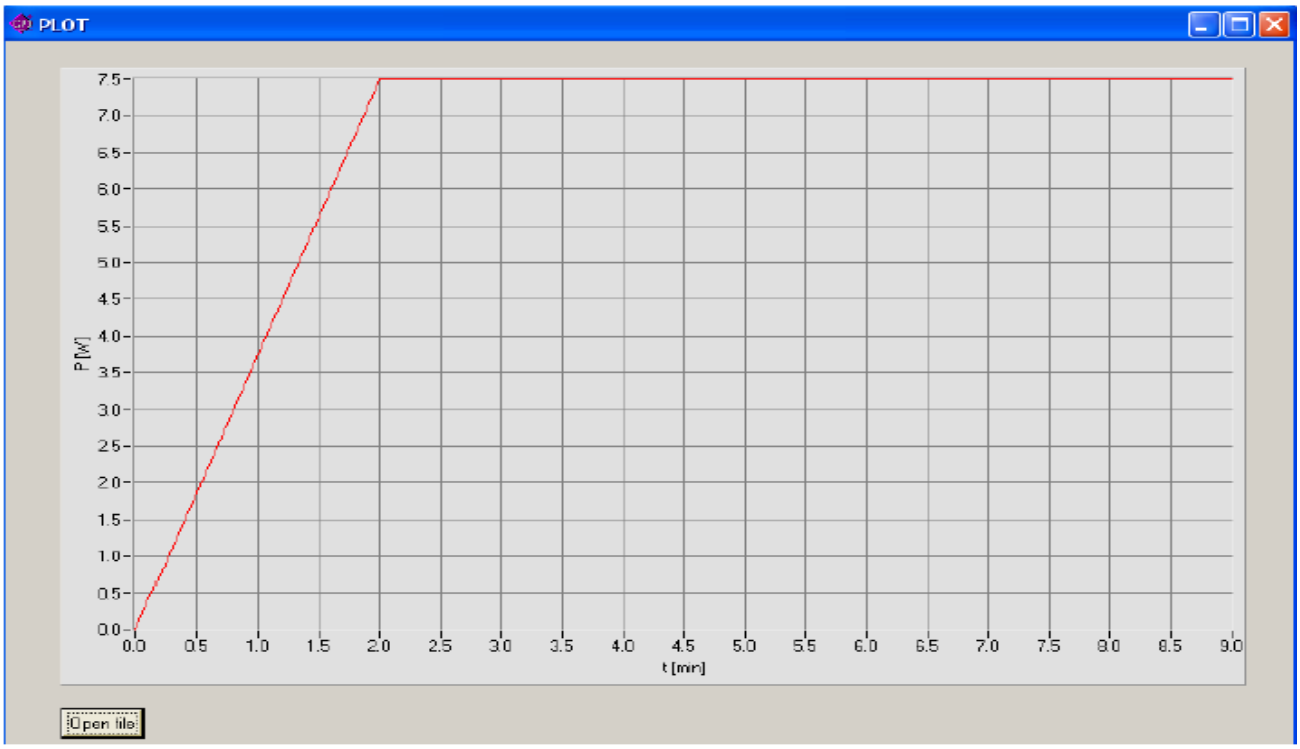


opend with any file handling program, and the second one is used only by the program to store data neded for plots and graphics.

To wiew results on a graph the user selects one of the plot butons on the main user interface. A file selection window wil apear with a list of available files:



After selcting a file, the plot apears in a new window with the generic name "Plot":



For selecting an other file from the list an "Open file" buton is placed on the window.