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EXPERIMENT MODEL OF PHOTOVOLTAIC SYSTEMS

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ABSTRACT
Goal of application of laboratory experiment model, marked as DE10 of system LABI is oriented to photovoltaic technology. There is a reaction to great increasing of applications of photovoltaic systems at present time. The model will be used to university studying and as a pilot system for all extern experts. New needed technical means are developed for measurement and control for system. The new devices are used to measurement of special parameters (global energy flow, wind direction and force, position of panel to sun) and to control of position according to run of sun and to maximum of wind force. In the next period there will be added new photovoltaic panel with concentration of radiation into model. The user can study of power of sun energy, of efficiency of photovoltaic, dependence of position on power during day. Asset of the photovoltaic model is remote access too. Study and access are able to connection via the Internet or PDA communication.
Keywords: Sun energy, automation, photovoltaic system, measurement

1. INTRUDUCTION
The experiment laboratory system LABI [1,2] is going to extend. It is a new real system tagged DE10- photovoltaic laboratory experiment system [3]. The process of experiment is measurement and control production of electrical energy from sun in education criteria. The measurement and control of its parameters is provided in remote and local process. The remote access is realized in the way Internet thru PC or PDA technique.
The functions of the DE10 are the control of position of PV (photovoltaic panel) according to sun in the given date and time of day and measurement of electrical power or according to measured global radiation of sun for extreme radiation. The measurement system has next circuits: direction and force of wind, temperature and moisture of extern area, voltage and current of electrical energy production.

2. TECHNICAL MEANS OF DE10
In the figure 1 is presented a scheme of the model DE10. The one has three parts: solar PV cells as the PV panel, mechanical construction and measurement and control system.
At the present time there is used the PV panel with monocrystal technology and materials. The area is 1x0,45 m and the power 60 W. In the next time there is going to extend the panel area by a panel with concentrated PV cells. Then model DE10 will serve for study two kind of PV cells.
The mechanical construction is based on tracker system. It is a two axis´s rotation system. The azimuth position is from 0 to +/- 90°. The elevation position is in the range from 0 to 90°. The tracker system is set on two mechanical gearboxes for azimuth and elevation with ratio 1:80. The motors are for both axis and used step motors. The view of all mechanical system is in the figure 2.
The measurement and control system is a main part of DE10. The one is used to give a measured date, to control of position in difference modes and to connect into network of Internet.
The measured date is:

- Global energy flow from sun radiation for the panel position.
- Direction and force of wind.

- Temperature and moisture of ambient area.
- Azimuth and elevation position.
- End position of azimuth and elevation.
- Output voltage of panel and of input battery.
- Current from the PV panel.
- In the future: concentration of CO2 in ambient area and atmospherical pressure.

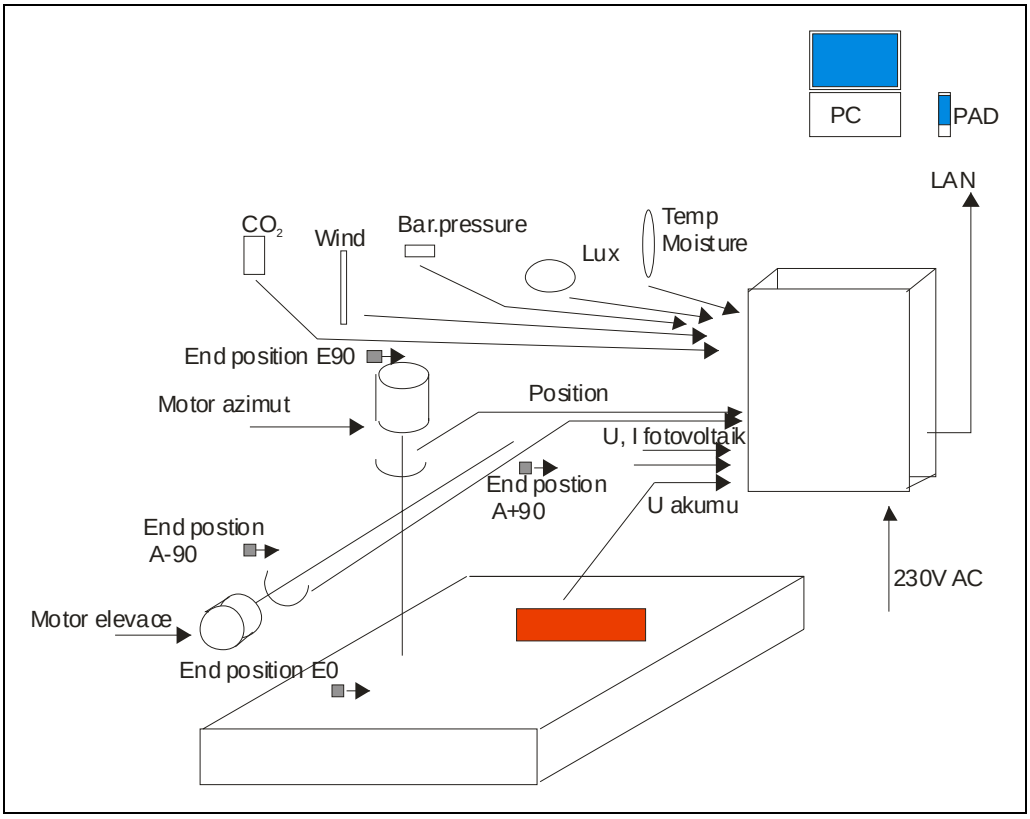

Figure 1. Block scheme of photovoltaik model DE10

Figure 2. Photo of photovoltaik model DE10(view on the mechanical part)

3. PARAMETERS OF MODEL

Position solar system:

- two axis tracker system,
- rotation of azimuth ratio from 0 (direction to south) to +90°(direction to west) and -90°(direction to east),
- rotation of the elevation is from 0 to 90°,
- control of position is according to radiation of sun (extreme control into maximum of radiation and calculation of the position)
- or control of position for given position (according to azimuth 0-+/-90°and elevation 0-+/- 90°),
- max. rotary moment to 20 Nm,
- measurement of analogue position of potentiometer sensors,
- limits visualising of position according to 2+2 end switch units.

Out of electrical energy is saved into accumulator. There is used a special battery for solar system with a special controller. The capacity is 55 Ah.

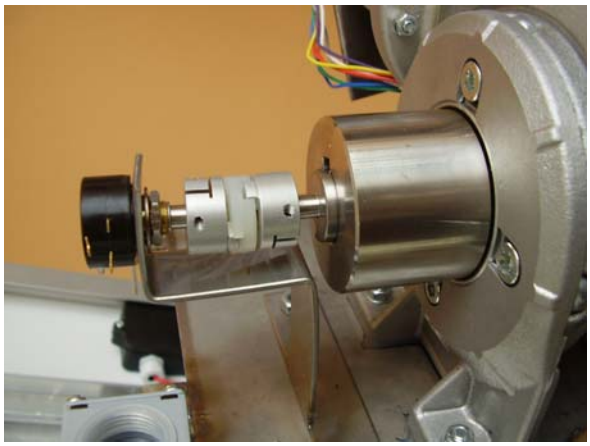

Figure 3: Measurement of position with potenciometer sensor

The measurement and control system is modern equipment. It is built measurement and control circuits. They serve to process function and archiving of date of experiments. The DE10 has the measurement circuits for:

- temperature and moisture of ambient air (archiving parameters), range -40 to +50°C and 0 to 100%
- direction and force of wind (archiving parameters), range 0 to 360° and 0 to 50 km/h
- position of azimuth and elevation (controlled parameters), range 0 to +/- 90°and 0 to 90° (see Fig. 3)
- voltage and current from PV panel (archiving parameters), 0 to 25 V, or from 0 to 3A
- global radiation (controlled parameters) range 0 to 1500 W/m^2.

The main control circuit is for position setting of photovoltaic panel. Its function is in automation mode based on measurement of global radiation and controlling of the panel position according to maximum radiation or in the date and time mode setting of panel position according to set date and time. The action process does a step motor and gear. It is all for azimuth and elevation axis.
The measurement and control devices are connected to industrial computer system (see figure 4).

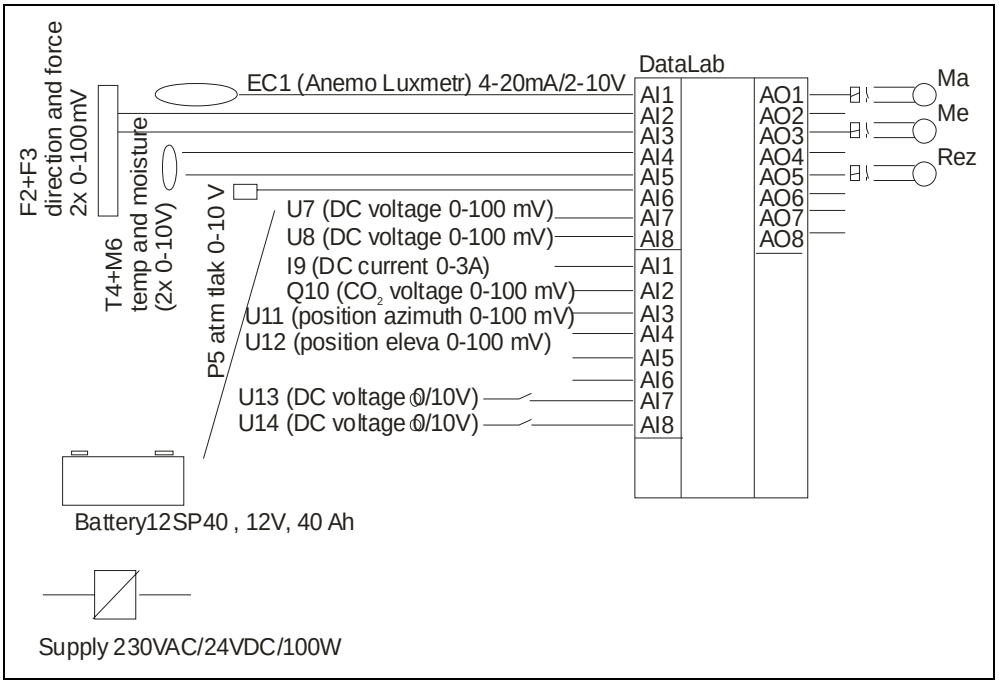

Figure 4. Scheme of connection the measurement and control system of photovoltaik model DE10

The system of DataLab is IPC type of industry compatible personal computer. The decision about the using of IPC was done according to new trends automation technique. The structure of central part of system has two parts: central IPC and I/O´s part for inputs from measuring loops and outputs to action units.
The all system has preferring:

    a. Microprocessor VIA EDEN 600 MHz
    b. Memory 256 MB DDR 266SDRAM with shared video memory
    c. Watchdog
    d. Interfaces for VGA, PS/2, RS232, RS485, 2x 10/100 MBps Ethernet, 4xUSB
    e. Slot for CF Card Type 1
    f. Audio in/output
    g. Standard 2,5" IDE HDD
- Analog input interface (ADI3):
    a. 8 analog inputs
    b. 16 bit Delta-Sigma ADC
    c. galvanic isolation of inputs
    d. voltage inputs from 0+/-0.1 to 0+/-10V
    e. current inputs 0-20/4-20 mA
- Analog output interface (AO1):
    a. 8 analog outputs with common ground
    b. 12 bit DAC
    c. galvanic isolation of outputs
    d. voltage outputs from 0+/-10V
    e. current inputs (only four) 0-20 mA.

Software is developed with a SCADA system, it is a Control WEB (CW) system. The CW system helps to write the programs for remote measurement, acquisition, control, visualization, archiving and connecting on the Internet. A example the CW are in www-address **LABI.FAI. UTB. CZ**, where all experiments are done. Our experience with the CW are all positive. We can look together at Labi application in TBU in Zlin.
The measured date can be over calculated in EXCEL. The file in format *.cvs is transformed in Excel, date can be calculated in tables, in graphs, according to statistic parameters etc. The results will use in education, in advertising by pilot using in the Czech Republic.

4. CONCLUSION

The automation system is a result of development and solving the experiment laboratory photovoltaic system. Next the local automation system is being a possibility to connect into the Internet and to remote access. The all project has theme of pilot plant. The photovoltaic system is built as a new next model DE10 in LABI, it is very suited to education of problems of technical means and automation theory. We have very positive experience by laboratory exercise with remote access.
The experiment DE10 has solid several special problems. In the first position there is two axis tracker system for set position of photovoltaic panel according the position of sun. A special solving was used for measurement of direction and force of wind. The remote access has developed other function and uses connection in PDA clients.

5. REFERENCES

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