CONTROL UNIT FOR FAST LBIC MEASUREMENT WORKPLACE

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ABSTRACT

In this contribution we describe further improvement of novel diagnostic technique based on LBIC (Light Beam Induced Current) method for fast evaluation of solar cells quality. LBIC analysis is a widely used as universal method for detecting of local defects in the solar cell structure. Scanning of solar cell surface with single point light source (laser or LED focused beam) could take several hours of processing time depending on demanded picture resolution. An innovative method for fast scanning of solar cells based on the LBIC measurement was proposed and tested. Instead of laser beam a linear light source consistent of multiple SMD LED diodes is used. Scanning is performed in both X and Y axes. In principle one scan in each coordinate is sufficient. Microcontroller Atmel was use in control unit for measurement workplace. Control unit can be programming online and it allows communication with personal computer by serial port..

1. INRODUCTION

For fast scanning method is possible use the same workplace as for the LBIC method. In distinction to one point source of light in case of LBIC using fast scanning method there is a LED diodes light strip, which illumine exactly defined narrow section of the cell. The workplace (Fig. 1.) allows exact movement of light source in X direction. Light strip is about 110 mm long so the 100 x 100 mm^2 solar cell can be scanned completely in the whole width. To comply with the requirement of small proportions SMD – technology is used. Red LED diodes were selected, because of large depth of red light penetration into the silicon junction. When is finished the X direction scan, give a contact field quarter turn. Then go light source back – as Y axis. Thus be created the square matrix.

The Fast LBIC method must be controlled by control unit. We used small control unit with the microcontroller from the Atmel Company. We were choosing the microcontroller ATMega8, because it has A/D converter and serial communications.

2. CONTROL UNITS

The basic part of control unit is the microcontroller ATmega8 from the ATMEL Company. This type of microcontroller was choosing for many A/D converters. Next parts of this chip are interrupts, which they were using for the End limit switch. Next ports of this chip are using to control of motor.

The control unit is composite from this parts:

- Power supply – 12V (adapter) and 5V (on the board)
- Communications with pc – chip MAX 232 – serial port
- Driving of steps motor – ATmega8 ports + Transistors (Darlington connections)
- A/D converters – in ATmega8 chip
- End limit switch control – interrupts in ATmega8

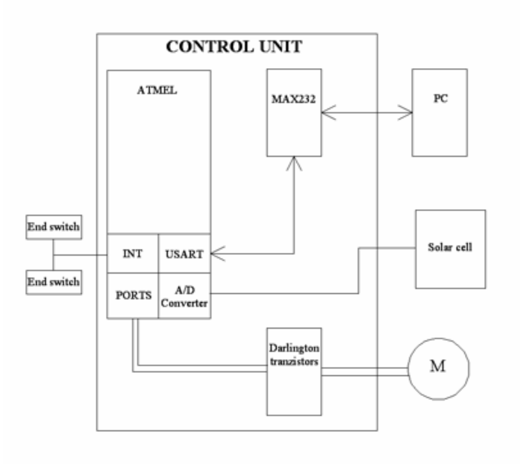
Power supply for the control unit is realized by the standard adapter into the electric outlet. This adapter provided for the motor and for voltage converter 12V voltage. This converter makes stationary 5V voltage. 5V is used for the chips power supply.

Communications with PC is realized by the RS232. A serial communications was choosing because all main development software's support this type of communications. Programmers need any special driver for serial communication. Software can be created in MATLAB, Borland C++ or in Java for this measurement.

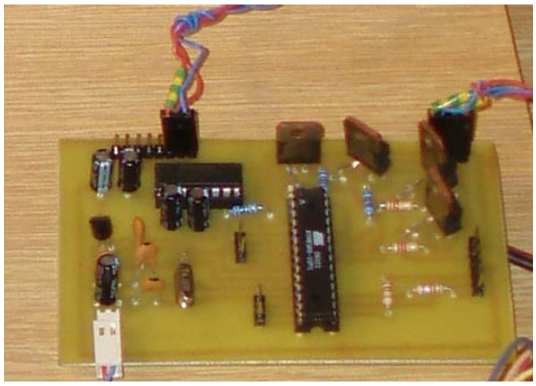
Driving of steps motor is realized due to program in ATmega8. Pins in port are activating in time-sequential manner. The pins are connecting through Darlington transistors to motor. These transistors are use as amplifiers to 12V voltage, because ATmega chip works only with 5V.

Workplace has two end limit switch controls. They are locating on the frame of measurement workplace. End limit switch give the signal to microcontroller if mobile light source attain ends of tracks. The microcontroller stops the motor and waits to signal from user.

Last part of work is internal program for ATmega. Program for microcontroller was creating in AVR studio. This is program for make programs in C language. AVR Studio has a very good wizard and work in this development software is very easy and fast. In this program was creating source program which communicate with PC, control motor a check end limit switch.



a) Block scheme



b) Realized control unit

Figure 1: Control unit

3. MEASUREMENT PROGRAM

Measurement program was created for control of measure and for result analysis. This program was creating in MATLAB. MATLAB environment was choosing from some arguments. First argument is too much functions for graphical display and analysis of results. Second argument is communications with control unit by help serial port.

Program can be separated to same parts which are joining in one graphics user interface. First part is control of results. User can control type of axis (x or y axis) in scanning and numbers of steps on one solar cell.

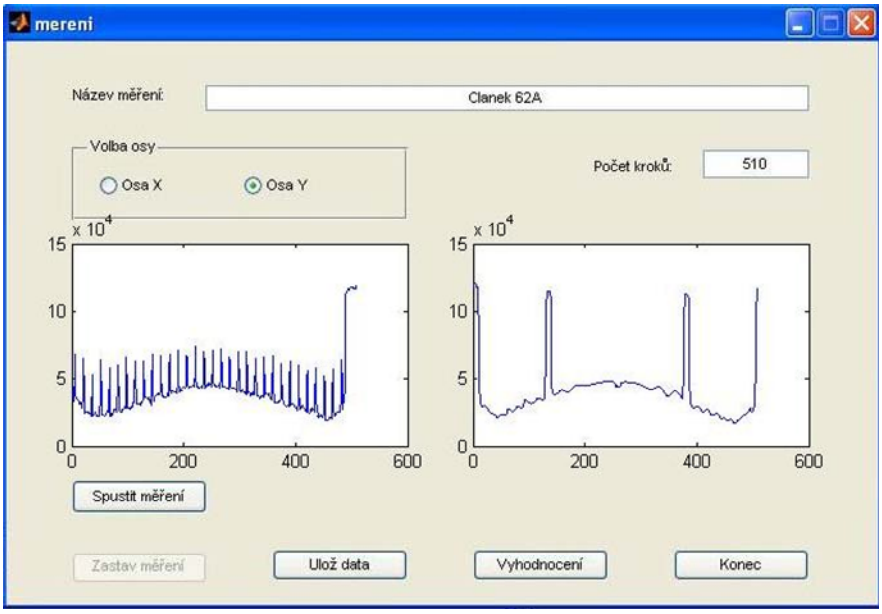


Figure 2: Measurement program

4. RESULTS

Results of FAST LBIC methods are two vectors. First vector contains values of voltage in X-axis and second vector in Y-axis. Any value is total value of voltage in solar cell when we light with light source on solar cell. Light source is strip of SMD LED's in this case.

On the next pictures are displayed results from FAST LBIC Scanning method and one picture from standard LBIC method (Figure 4) for comparison. If you compare figure 4 and figure 5, can you see small difference between this methods. FAST LBIC method is less exact then LBIC. But time necessary to measurement is very different. Standard LBIC method need 45 minutes for result. This is on figure 4. But FAST LBIC method needs only 15 minutes for results (On pictures 3 and 5).

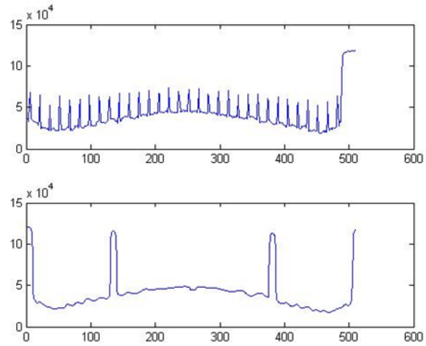


Figure 3: Measurement results of FAST LBIC Method

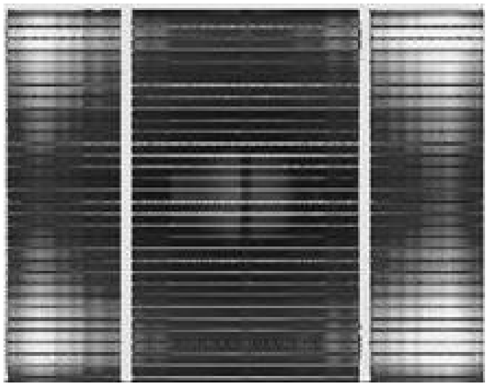


Figure 4: Result of LBIC method

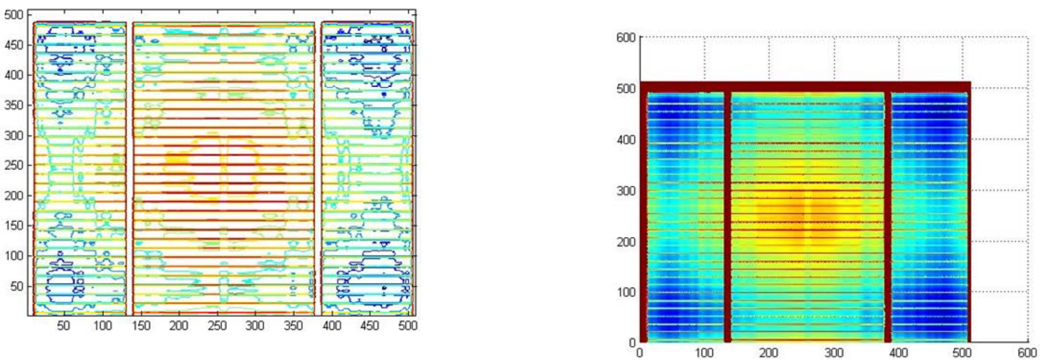


Figure 5: Results over combination vectors

5. CONCLUSION

In photovoltaic industry, like in other industrial processes, there is necessary to check incoming materials and find a product faults. Integration of elementary control components and fast defection and localization of these faults is undoubtedly the way to higher yield and reliability of the solar cells. First experiments using the fast LBIC scanning method has shown that it is necessary to improve accuracy of this method. Therefore the simulation program was created and this way it is possible to make an assessment of real defects position and shape. Fast scanning method can be used in serial production for fast verification of solar cells. As compared to conventional LBIC proposed fast scanning method is not so accurate but for more accurate defect determination there is always a possibility of subsequent use of LBIC method, which already can be applied only by defective parts of investigated cells. Considerable reduction of time needed for verification of single cells is thus possible.

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