UNITECH 2019 GABROVO

INTERNATIONAL SCIENTIFIC CONFERENCE
15 – 16 November 2019, GABROVO

MEASURING THE CONSUMPTION OF ELECTRONIC DEVICES IN A SLEEP MODE WITH LOW-COST DAQ DEVICE

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Abstract

Current paper presents a development of low-cost system for measurement of currents in micro-amps range which can be used for evaluation of consumption of electronic devices in sleep mode. The system consists of shunt resistor, amplifier devices, DAQ devices and LabVIEW virtual instrument for data processing. The system can be used for measurements of the profile of current consumption of the system with up to 10K samples/sec.

Keywords: DAQ, current measurement, virtual instrumentation.

INTRODUCTION

The current measurement [1,2] is basic task is in electrical measurements. Measuring current for a given period of time it is possible to determine the consumption of electronic devices. The consumption is vital characteristic for battery powered devices, because it characterizes the time for operation of devices related to the capacity of batteries.
Unfortunately, the equipment for measurement the current with sampling rate of several kHz is expensive while the commercially available multimeters are not suitable for measurements of short bursts of current consumption because of the slow rate of measurements.
Using DAQ devices it is possible to be built a system with sufficient sample rate which can gather measured data on PC.

TEST PROBE FOR CURRENT MEASUREMENTS

One of the ways to measure current is to use shunt resistor serially connected to the device under test. The shunt resistor can be connected to the high or low side. The voltage that can be measured across the shunt resister has a very low value because the low value of shunt resistor and therefor it is necessary to be amplified. The amplified voltage in current system is measured by DAQ NI-6008, and after that the received data are transferred to the personal computer. The block diagram of realized system is presented on Fig.1.

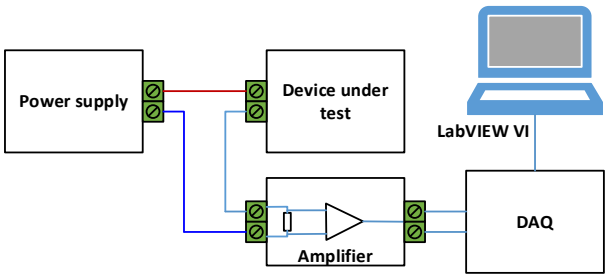

Fig. 1. *Block diagram of the system*

The main part of the system is the current sensor (Fig.2). It consists of shunt resistor and two operation amplifiers. The operational amplifier used in the circuit is OPA320AIDBVR [3]. It has the following characteristics: low offset voltage, high CMRR (common mode rejection ratio), Rail-to-Rail inputs and outputs, low noise and low quiescent current.

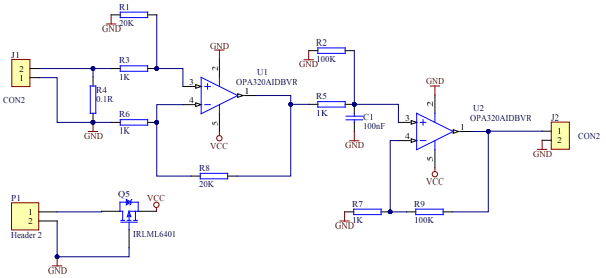

Fig. 2. *Electric circuit*

In the circuit is realized a RC filter for noise suppression. The cut-off frequency of the filter is evaluated to be 1.5kHz. The filter is used to minimize the effect of very short bursts in

current consumption. On Fig.3 is presented the response of the low-pass filter.

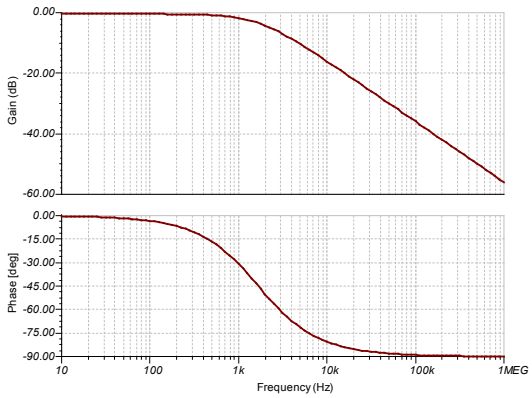

Fig. 3. *Low-pass filter characteristic*

The current sensor device is powered by two AA batteries and can be used for current measurement as low-side or high-side measurement probe. Fig.4 presents the view of the device.

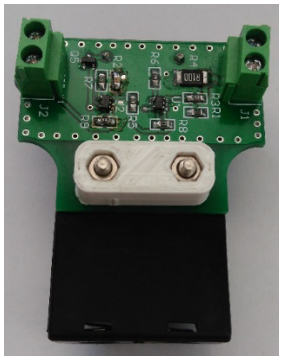

Fig. 4. *Current sensor*

LABVIEW VIRTUAL INSTRUMENT

For data acquisition is used DAQ device NI-6008 [4], a low-cost product of National Instruments. It has 8 analog inputs which can be used for data logging with up to 10ksamples/sec. The DAQ device is controlled by the personal computer which executes a LabVIEW[5] virtual instrument. The virtual instrument (VI) allows processing of incoming data for measured voltage and their conversion to current in µA range. The received data can be saved in Excel file. Fig.5 shows the Front panel of the virtual instrument.

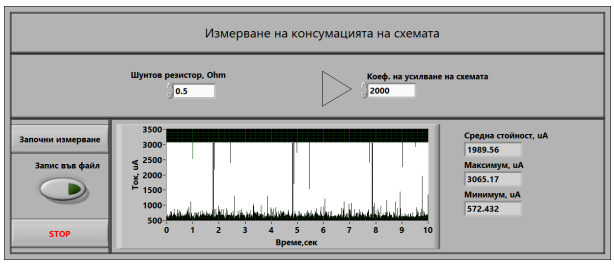

Fig.5. *Front panel of developed VI*

The Block diagram (Fig.6) of virtual instrument uses Express function for fast statistical processing of current values. The mean value for current consumption also as minimum and maximum values are evaluated.

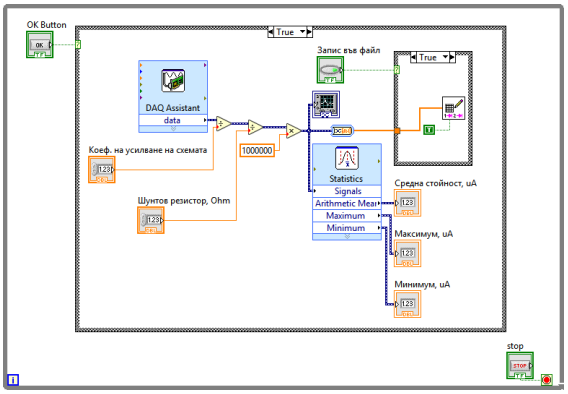

Fig. 6. *Block diagram*

TEST RESULTS

The device under test is battery powered electronic device. It works for less than 250ms with full power and next 3sec. switches off some of its periphery and operates in low-consumption modes. The DAQ system gives us possibility to gather data for relatively long periods of time. The sampling rate is selected to be 1ksamples/sec. For our case it is enough. The gathered data for current consumption is saved to a file.

Fig.7 shows the consumption of device measured by the developed current sensor for period of about 5 seconds. There definitely can be seen the moments of operation in full power of electronic device.

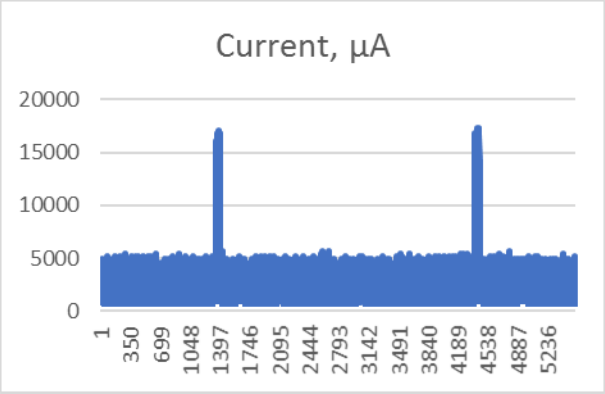

Fig. 7. *Current consumption of the device*

When we have all data, we can visualize it entirely or take portions of it for further processing. For partitioning of gathered data is developed a virtual instrument. It allows to be taken a part of entire data array and this part to be saved in new file. The VI also evaluates the mean value of selected data set. Fig.8 presents the Front panel of virtual instruments.

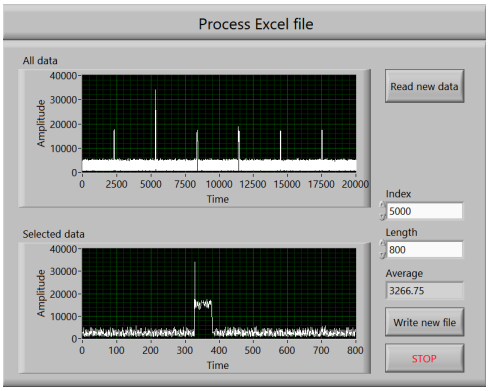

Fig.8. *Front panel of VI for data partitioning*

The block diagram of this VI is shown on Fig.9.

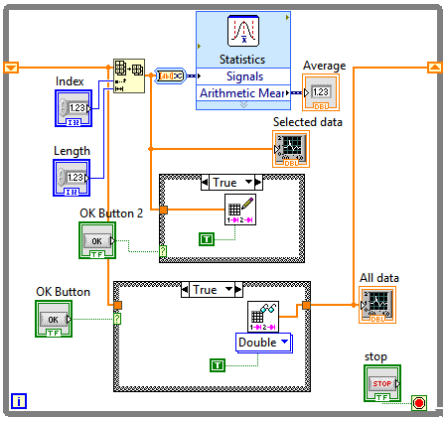

Fig. 9. *Block diagram of VI*

Using the VI for data partitioning we can separate data and after that to make more detailed view of acquired data. Fig.10 represents the current consumption of electronic device while operating in full power.

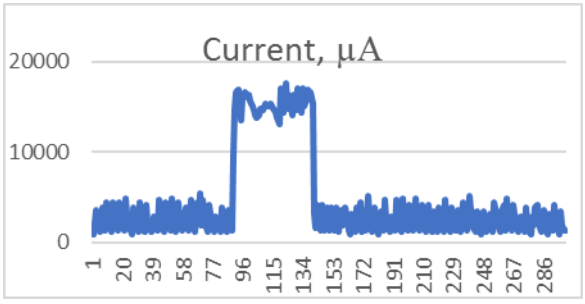

Fig. 10. *Current in full power mode of operation*

Interesting results are measured when the electronic device under test is in low consumption mode (Fig.11). In this mode of operation, the measured current is like a noise signal. The reason for this noisy signal is the operation of the buck regulator of electronic device.

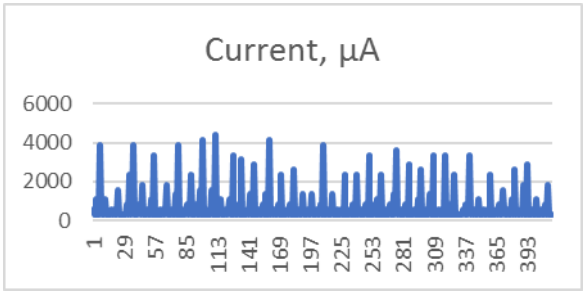

Fig. 11. *Current consumption in low-power mode*

The data acquisition can be implemented with higher sampling rate, if necessary, and in this case, we will have more detailed view of current change.

CONCLUSION

Developed system uses low-cost DAQ device and active current probe, tailored for measurement of currents in microampere and milliampere range. The system compared to other measurement hardware is cost effective alternative which can be used to measure current with speed up to 10ksamples/sec.

Developed LabVIEW virtual instruments allows visualization of measured data and partitioning of long data files to smaller ones and extraction of most interesting data sets from entire array for further analyses.

REFERENCE

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