UNIVERSAL FIRE PANEL TESTER

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ABSTRACT

This work is aimed on design of a device for testing of fire detectors and various components of fire detection system, communicating with the fire panel over a fire bus or a loop. The device generates voltages, supplying the detectors, as well as communicating over the bus generating communication waveforms and performing detection of responses measuring voltage and current on the connection. The loop signal is processed by the developed unit and data or result sent to a PC utilizing USB or RS232 connection. All the parts of the equipment are galvanically isolated to the loop circuit.

1. INTRODUCTION

The aim of this work was to design universal equipment for testing of fire sensors. Communication with the sensors on a loop is initiated by voltage waveforms, devices on the loop answer by specific changes in current and/or voltage. This response is processed and temporarily stored by the device and sent via USB or RS232 to a PC. Power supply can be connected externally or directly from the USB port in the limited functionality mode of the device. A device attached to the bus or a fire detector is galvanically isolated from the main communication unit as well as the connected PC.

This work was submitted by Tyco Fire & Integrated Solutions in Brno, represented by Petr Pfeifer.

2. ANALYSIS

The entire device consists of several parts. Hardware can be divided into analog and digital part. In term of software, development consists of firmware for both microcontrollers and PC software development.

2.1. Requirements

The main requirements put on the device's functionality are: voltage range from 0 to 40 V, current up to 150 mA. In order to ensure proper functionality of all protocols, the analog part bandwidth should be up to 100 kHz, resolution of both A/D and D/A converters at least 10bits and for both generated voltage and voltage and current measurement. The digital part has to be fast enough. The galvanic isolation is necessary.

2.2. HARDWARE

Figure 1 shows the basic idea and functionality of both the microcontrollers. The first one is a 32-bit ATMEL ARM7 microprocessor (AT91SAM7S512) with large memory, which provides all the communication with the PC and stores data, including various measurement tasks, tables and control at higher levels. The second one is a 16-bit microcontroller (MSP430F2618), from Texas Instruments, ensuring complete control of the analog part while generating output voltage through integrated 12bit DAC, followed by a power amplifier, and 12bit ADC utilized for measurement of voltage and current on the bus or loop. The speed of both converters is up to 200 ksps. Processors communicate through a galvanically isolated SPI interface. It is also why the task was split into two microprocessors, simply connected just only by few digital signals.

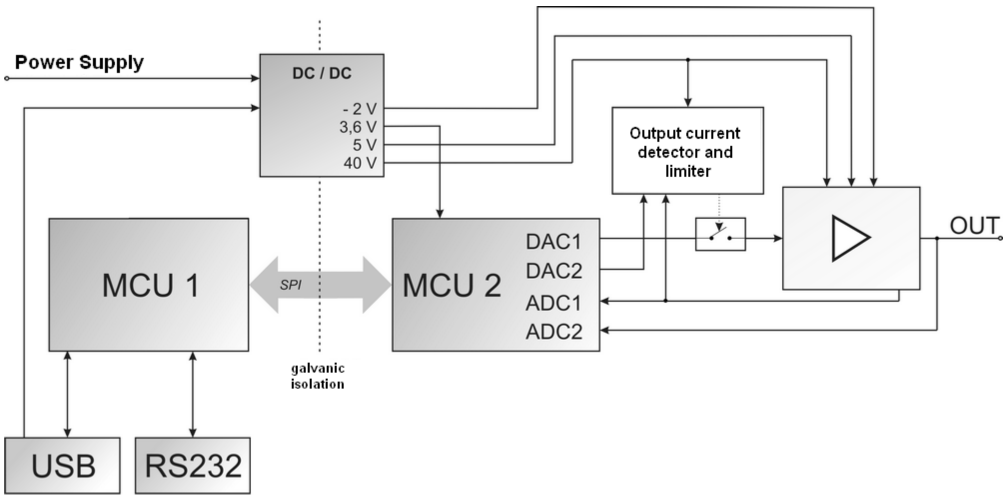

Figure 1: Block diagram.

The output stage consists of two operational amplifiers OPA2604 that meet the requirements put on the high-voltage input and high slew rate. The desired output current goes via high-frequency power transistor 2SC3346. In order to ensure output voltage generation of from the 0V, it is necessary to use a negative voltage source required in the output section, MAX1044 in our case. Furthermore, we needed to measure the output current. This is achieved by measurement of voltage at serially connected resistors in the power transistor's emitter through the differential amplifier connected to the input of A/D converter. This signal is also connected to the voltage comparator, comparing the value of the measured current with the voltage from the second D/A converter, monitoring current flowing through the output stage and generating overcurrent signal.

2.3. TESTING BOARD

As mentioned above, the entire design was divided into several parts. First, it was necessary to develop and validate proper functionality of the analog part, including the 16-bit microcontroller, the output, the measurement circuits and communication over the galvanically isolated SPI interface. The developed board is connected to ATMEL ARM7 development kit. The partition of the project was useful for additional adjustments in the circuits. It was also expected the output stage would run close to its limits, hence additional interventions and optimizations were expected here. The test board was designed preferring through-hole technology of components in order to make easy any the implementation of any change, the final design will utilize SMD components.

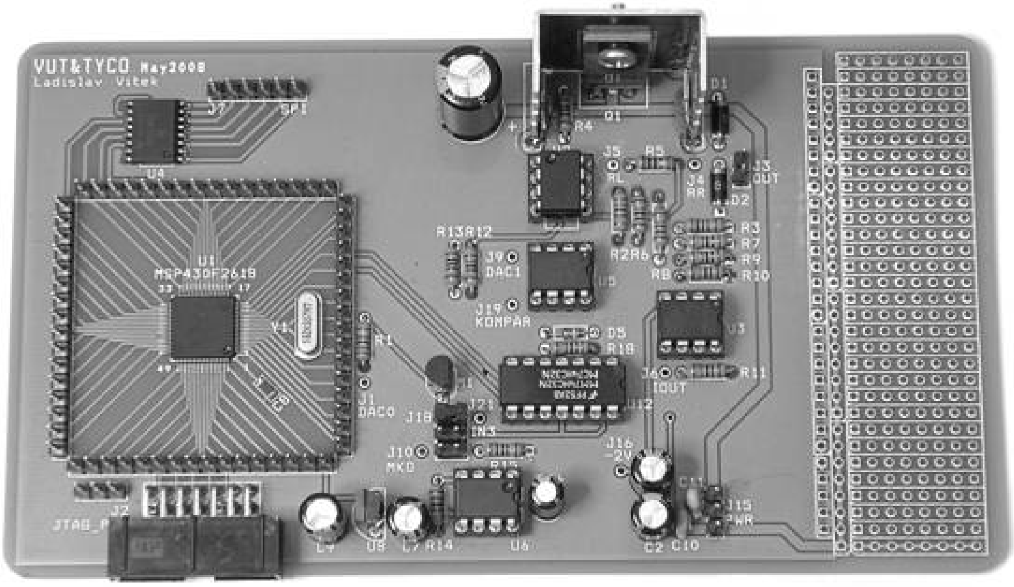

Figure 2: Developed test board

2.4. Firmware

It was decided to write bootloaders for both microcontrollers. This small piece of software resides at the lower layers and any other or new software can be written into the FLASH memory without the need of compilation of the entire code. Parts of the code or various tables can be recorded separately utilizing USB or RS232 only, without the need of any special programmers for both processors. This makes the job easier in terms of speeding-up of the firmware development, parallel programming of individual parts and also increases the code clarity.

2.5. PC Software development

This part of the project is being created by colleague Martin Smetana. Therefore, I will mention only the basic requirements. Devices are controlled with the program written in C# language (using MS Visual Studio). It communicates with the measuring board, defining the desired actions, acquiring and storing the measured data and their subsequent processing, displaying and saving to output files.

3. CONCLUSION

The presented functional prototype for communication with various components of fire detection system, panel and sensors has been developed and successfully tested. When completed as a single board, it will replace the old solution while offering full galvanic isolation, much better parameters and the possibility of further extensions.

REFERENCES

[1] datasheet MSP430F2618. [cit. 2008-02-15]. Available from WWW: <http://focus.ti.com/docs/prod/folders/print/msp430f2618.html>

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