USB MIDI Lights device

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Abstract: - This article describes coordination between computer made music and stage lights device. At the input this device communicates via MIDI and USB protocols. At the output is managing tension. Its value is affected by pulse-width modulation. This modulation value is given to value of the third byte in MIDI message. This value is sound power of control note. There is device is connected as one of USB interfaces at the input. There is device is connected to power transformation device on output. There are lights and fountains are connected to power transformation device as ending equipment.

Key-Words: - USB, MIDI, pulse width modulation, Microchip, power transformation, MIDI message

1 Introduction

Usage of computers in music is standard how for live performance so for music recording. MIDI protocol is the most used for the live performance. It is basic for some setting of musical instruments on the stage. For other equipments, e.g. sound effects too. Some musicians can use MIDI and use it. Some musicians don't know MIDI, but use MIDI too, because MIDI is standard in electronic musical instruments. MIDI is often one of inner components in keyboards, electrical string instruments or wind MIDI instruments. These MIDI components don't need human control.

Today, MIDI is a part of effects units for all music instruments. Whether are electric guitars, keyboards or some effects for singers or acoustical instruments. MIDI protocol is part of other stage equipment. Consequently MIDI is part of stage lights and artificial smokes. Current development and usage of this protocol especially focuses to music instruments settings and other equipment on stage. Thus, time coordination with other visual effects without human control. In this development, the MIDI protocol is used in combination with the most modern technologies. Very often is used with USB protocol and devices.

Research target was to design simple, the most inexpensive, simply programmable high variable device. Variability was intended for various lights systems. Important for design was real-time application. Accordingly zero MIDI USB transfer delay for live music performance. Simply put, visual effect must correspondence music performance in real-time. From the begging was evident that it will be one chip device with small requirements for voltage, maintenance and space. There is also a small percentage of failure as an additional criterion for the development of the equipment described below.

2 Avalaible solutions

Between existing solutions in this area at present belongs to the following applications

2.1 Harvey Twyman device

Harvey Twyman hardware module consists of an integrated circuit HC11, produced by Motorola. This circuit sends MIDI messages to another device, which is Altera 8254 FPGA (Field Programmable Gate Array). This module provides a total of 12 channels. Rated power of each channel can be up to 300W. Thus conceived control provides 128 levels of light for each light. Setting these levels can then be carried out directly from the editing programs such as Cubase. This setting can be used specifically Key Graphics Editor, List Editor, or Mixer Maps Editor. Author uses the last of the editors. The editors are part of the music software Cubase.

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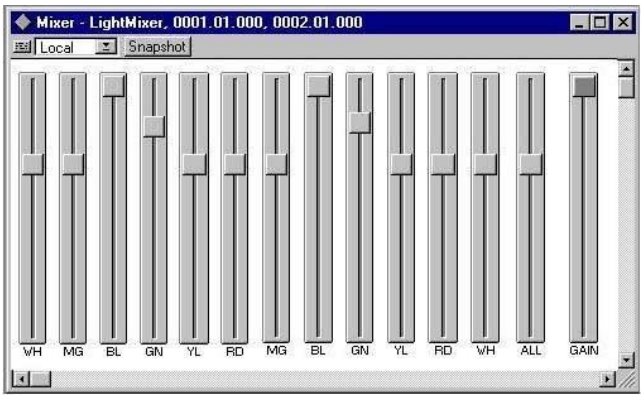

Fig. 1. Setting the color intensity MixerMaps editor in Cubase

Each light channel has three parameters, which can control the channel. There are the level of the channel (channel level), channel gain (Gain channel) and the overall level (Master Gain):
Channel Level - the range is from zero up to 127. Settings this parameter but the parameter is closely related to the overall level (see below).
Gain Channel - serves as the setting of the luminance channel, as they are, according to the author, often seems lighter than it should be.
Master Gain - to adjust the overall brightness of all channels.

2.2 BOTEX company and its solution

Other devices that use the MIDI protocol to control stage lighting equipment is of Botex company. These devices are combining MIDI with DMX512 protocol. The MIDI protocol is used primarily by Note On event and Note Off event. As a demonstration model I picked a four-channel dimmer Botex MPX – 405. Among its features include:

- Control via MIDI and DMX
- infrared remote control
- 4 channel output for dimming
- the possibility of linking multiple units (Link Up)
- Last setting memory.

Fig. 2. Botex MP-405

2.3 Tom Scarff MIDI hardware

The author of this design comes from Dublin, where he works in Dublin Institute of Technology. The board is equipped with a chip, MIDI connectors, necessary LEDs, and the connector for the nine-volt battery, which serves as the power supply. The PIC16C84 microcontroller is centre of this module, along with the option to select those channels. Then select the output signal from the MIDI channel is not resolved through programmed utilities, but is dealt with firmly, hardware. This is the simplest case for lights, extension of other electrical equipment, using only the Note On command, respectively On, Off command. Controlled lights are only switched. Intensity is not controlled.

3 Own solution

This device consists of a CPU, which is in this case, the PIC 18F2550 by Microchip company, 8 LEDs, crystal and necessary stabilizing capacitors. An integral part is a USB type B connector, for connection to a PC.

3.1 Microchip PIC 18F2550

Heart of this module is microcontroller by Microchip company with type signature PIC 18F2550. It is single chip, which is compatible with USB protocol version 2.0. It also supports both USB transfer types, both low speed (1.5 Mbps) and full speed at 12 Mbit / s. It allows all types of USB transfers, so to ensure all possible available functionality in the USB protocol. The processor supports full number of two-way endpoints.

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In Run mode is controller, when running the processor and peripherals. In Idle mode runs only the peripherals. Sleep mode is set, even when is not running CPU or peripherals. The device can be connected to two external oscillator frequency of up to 48 MHz. The controller has its internal oscillator too. The user can choose from a total of eight oscillation frequencies between 31 kHz to 8 MHz.

The device is also possible to change the polarity, which has used during creation the final project. The first in a series of devices have switching diodes in a logical 1, and then there was a reversal of values taken by the Velocity parameter, which is contained in the third byte of MIDI message. The processor has 100 000x rewritable memory for program and 1000 000x rewritable EEPROM. It also includes 32 tier stack and instruction set, which contains 105 of system instructions. Function Code Protection prevents entry into selected areas of memory. There is also support for ICSP programming that allows you to program the processor embedded in the PCB. There are of the CPU PIC18F2550 16 - bit comparator (SPI - Serial Interface Peripherial) and last but not least, EUSART. The serial communication module, based on the standard RS-232 protocol provides support for the LIN bus standard. EUSART also includes automatic detection of baud rate and 16-bit baud rate generator. If the microcontroller used in the internal oscillatory block EUSART is used in place of communication, where nurses access to unused external oscillator, avoiding mistakes in the requirements for induction.

3.2 USB MIDI Lights Device

USB MIDI Lights Device plate was designed as a versatile development board for PIC18F2550 microcontroller applications with emphasis on the use of USB microcontrollers.
Power board is done via the USB port, which provides a stable 5V. To filter this voltage is added inductance (ferrite seed) and 100μF electrolytic capacitor. Microcontroller itself also contains a stabilizer 3.3V, which is used to stabilize the output 1μF ceramic capacitor. The power supply also connected blocking capacitor 100nF located between GND (ground) and VCC pin microcontroller.
The source for generating the clock signal is 20MHz XTAL with two 15pF ceramic capacitors. The value of the crystal was chosen because of its availability, the actual microcontroller allows the use of crystal in the values (4, 8, 12, 16, 20, 24, 40, 48 MHz). Microcontroller is also equipped with an internal RC oscillator, but using the USB connection you must use the exact source of the clock frequency - crystal.
The connectors J2, J3 and J5 are connected input / output pins of the microcontroller. The J2 connector pins are connected RC6 and RC7 - microcontroller serial port and ground. The J3 connector pins are connected to gate B (RB0 - RB7), which are parallel connected to 5V LED series resistor.
J5 connector includes pins Gate A (RA0-RA5) and GND. Other connectors on the board's jumper, which is used to activate the bootloader in the normal mode is disconnected, the short-circuited in bootloader mode. The basic program board loader - bootloader has been programmed into the board using an external programmer connected to connector J4, which is represented on the board pads for soldering programmer wires.
Reset the microcontroller is connected through resistor 10 k ohms or the power supply. The device has a total of eight functional outputs (channels).

4 MIDI Protocol

This text part will be describes the MIDI protocol and USB. The basis of the MIDI communication is called a MIDI message, which consists of three bytes. Each MIDI message (event) is therefore presented as three eight-digit binary values, which are made up of zeros and ones. Each MIDI message can then contain in the each byte value from 0 to 255, for a total of 256 different values. MIDI messages are divided into two basic categories: Status messages and Data messages. Status message determines the type of information that is sent via MIDI. Indicates a device that receives a message that the event belongs to which channel the MIDI event belongs and what it is. It may be an event: Note On, pitch change, Program Change (patch change) and after touch (the last event occurs when it is developed further pressure on already depressed note). Data bytes contained in the device again informed about what values are assigned to events, which carries the status byte.

4.1 USB MIDI Event packet

MIDI data is transmitted via USB using 32 - bit MIDI Event Packet. Data transmission is performed using the standard reports of four bytes. With this USB MIDI Event Packet is to create a virtual connection between the endpoints USB host and USB MIDI devices. This method of connection is advantageous for its low, which does not require a

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large number of endpoints, like other types of USB devices. Each MIDI event has its own USB MIDI packet, which prevents creation of many mistakes.

Byte 0		Byte 1	Byte 2	Byte 3
CN cable number	CIN Code Index - Number. MIDI generic classifica -tion	MIDI First byte	MIDI Second byte	MIDI Third byte

Tab. 1. USB MIDI Event Packet structure

The first four bytes starting at the MSB position contains information on the number of virtual MIDI cable, which it is transmitted by a given MIDI information. The value of CN is an indication of the range 0x0 through 0xF indicates the number of the embedded jack, through which there is a link with appropriate MIDI functionality. Second nibl LSB has ended, then identification of the MIDI message. Table 1 shows how different byte write MIDI messages from the USB MIDI packet, which must be submitted if it will be to communicate and receive MIDI information via the USB protocol.

CIN	**MIDI_x Size**	**Description**
0x0	1, 2 or 3	Vacant value, reserved for others enlargement.
0x1	1, 2 or 3	Vacant value, reserved for others enlargement.
0x2	2	Two bytes MIDI messages. E.g. Time Clock or SongSelect
0x3	3	Three bytes MIDI messages
0x4	3	MIDI messages System Exclusive
		type run or continue
0x5	1	One byte System common or SysEx messages with command end and next one byte information.
0x6	2	SysEx messages with nex two bytes information
0x7	3	SysEx messages with nex three bytes information
0x8	3	Nota off
0x9	3	Nota On
0xA	3	Common pressure sensitivity
0xB	3	MIDI Control Change
0xC	2	Program change
0xD	2	Pressure sensitivity
0xE	3	Tune change
0xF	1	Single Byte

Tab. 2. Code Index Number and corresponding MIDI messages

USB MIDI Event Packet is the final part MIDI and USB communication. In the beginning it is necessary that the device is configured and programmed especially visible as a USB interface for the system. Individual sub-categories for this USB device as USB Audio and USB Audio sub-MIDI interface. Various communication interfaces, therefore must be programmed according to these standards.

5 Conclusion

The proposal USB MIDI Lights Device was to create a financially optimized, the cheapest possible, programmable robust equipment. The basic advantage of the device is that of the manufacturing cost. This cost is very low. The

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device will be available only to the USB connector and a jumper or switch for easy re-programming the application itself for changes in light assembly. An important benefit is the ability to exploit any effect devices, regardless of which protocol is or is not in their software toolkit. The only one prerequisite is to manage the output of the light kit with inductors for large wattage because of reasons of intensity control by pulse width modulation. In this time is developed other new version of hardware device and its management software.

References:

[1] *MIDI review* [available online]
<http://www.midi.cz>

[2] *Harveye Twymana MIDI hardware* [available online]
<http://www.twyman.org.uk/midilite.htm>

[3] *Botex MPX405* [available online]:
<http://eshop.prodance.cz/Files/MPX405%20MultiPak%20cz.pdf>

[4] *MIDI lights settings* [online]. [cit. 2008-05-05]:
<http://tomscarff.tripod.com>

[5] *Universal Serial Bus specification.pdf* [available online] <http://www.usb.org>

[6] *Universal Serial Bus Device Class Definition for MIDI Devices.pdf* [available online]. <http://www.usb.org>

[7] *Universal Serial Bus Device Class Definition for Audio Devices.pdf* [available online]. <http://www.usb.org>

[8] *Universal Serial Bus Class Definition for Communication Devices.pdf* [available online]. <http://www.usb.org>

[9] *PIC18F2455/2550/4455/4550 Data Sheet.pdf* [available online].
<http://www.microchip.com>

[10] *MPLAB C18 C Compiler User's guide.pdf* [available online].
<http://www.microchip.com>

[11] *MPLAB C18 C Compiler Libraries.pdf* [available online].
<http://www.microchip.com>

[12] Slovák, D. *Protocol MIDI and stage equipment: Tomas Bata University*, Faculty of Applied Informatics, Department of Applied Infomatics, 2008, 64 p. Thesis supervisor prof. Ing. Vladimír Vašek, CSc.