Intelligent Light Effects' Controller for Entertainment Systems.

Abstract

The controller is intended for creating visual effects during various entertainment performances: concert shows, discotheques, varieties, presentations. As opposed to existing pre-programmed or manually/sound controlled lighting systems, the novel approach for generation of visual effects is proposed. The participants' movements are used to create visual effects in developed system. The Doppler Effect on ultrasound frequency is used for obtaining participants' movement information. The controller is performing Doppler frequency spectrum analysis to determine performance participants' movements speed, rhythm and create corresponding visual effects.

The controller works in following way: the piezoelectric transmitter **TR** radiates ultrasound waves in surrounding space. These waves are reaching the acting participants and reflect from them. Part of reflected waves is reaching the receiver **RS** and converting to electric signals which are amplified by low-noise preamplifier **LNA**. The amplifier signal is being filtered by band-pass filter $\mathbf{BPF_1}$, in which central filter frequency is equal to generator **GEN** frequency. The filtered signal is being brought to signal input of **MIXER**, and the reference mixer input is connected to generator output. The mixer is forming Doppler frequency difference signal, which is separated from other mixer products by low-pas filter **LPF**.

The filter output is connected with input of tunable selective filter $\mathbf{BPF_2}$, which is intended to select narrow band spectrum from Doppler signal. The filter signal is sampled by analog-to-digital converter **ADC**, the output data stream is processed by central processor **CPU**. The processor controls the sweep frequency of band-pass filter, which, together with **ADC,** is forming spectrum analyzer. The spectrum of Doppler signal is used for obtaining information concerning participants' moving speeds, which is being processed via dedicated algorithms for loads controlling. For Doppler signal analysis and off-line testing of proposed Doppler signal processing algorithms the dedicated PC-based software has been developed too.

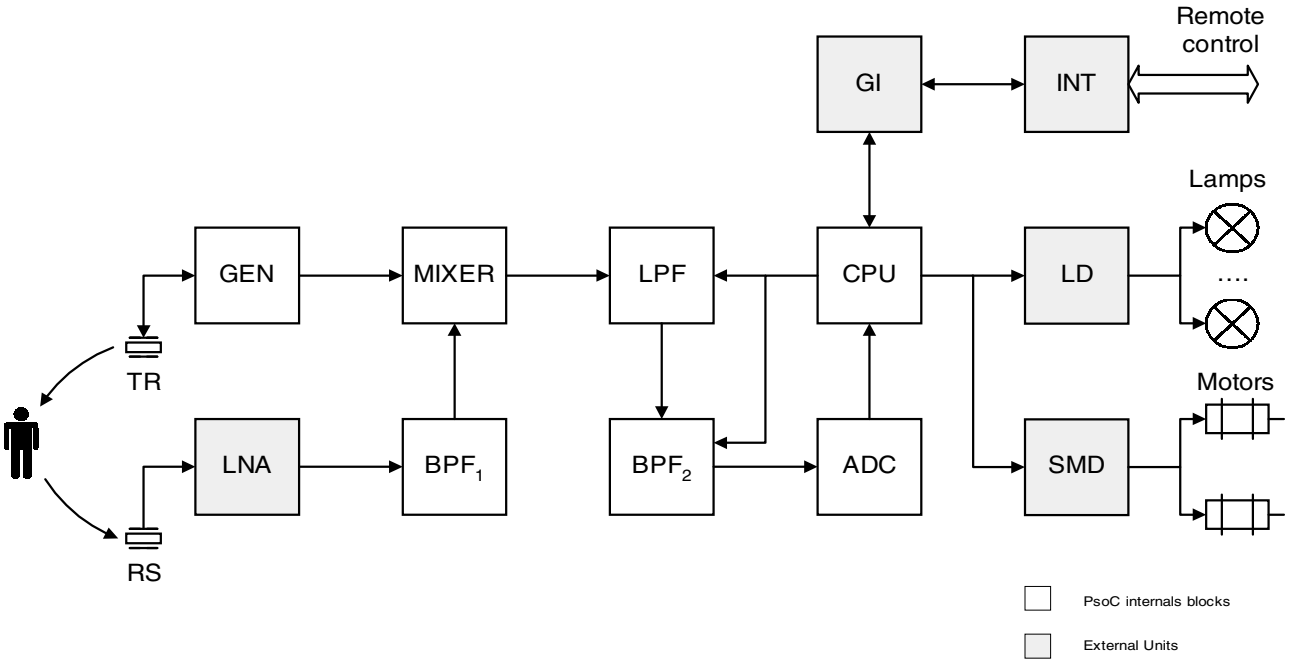
The controller supports both popular types of loads concurrently: projector lamps and stepper motors. Note the stepper motors are widely used in modern light effects generators for rotating mirrors, gobos, light filters and diaphragms. These devices are driven by lamp driver **LD** and stepper motor driver **SMD** correspondingly.

For data exchange and remote control the full galvanic isolated RS485 interface under DMX protocol is implemented. This interface type is commonly used for controlling various lighting systems in entertainment, concert and theatre systems.

The proposed controller can be easily used for modernization of existing lighting systems because the several most popular load types are supported as well. A commercial lighting effects generator modernization project is presented. The device can be controlled remotely via standard in lighting systems RS485 interface or can serve as master for controlling existing, already preinstalled lighting equipment, which allows a rapid retrofit of present systems with minimal cost and time.

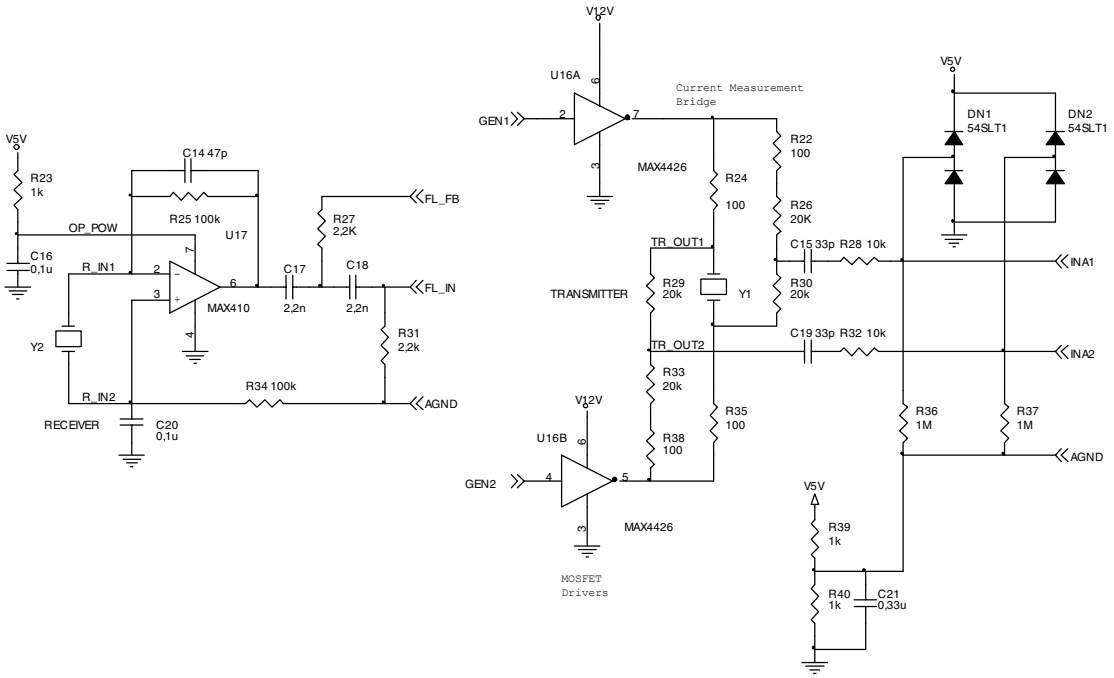
The examples of using the proposed controller in discotheques and varieties are described, showing correlation between generated visual effects and participants' dancing movements. As result, the increasing participants' interest to performance action is observed. The other possible applications of developed system are considered too.

The lighting controller flowchart.

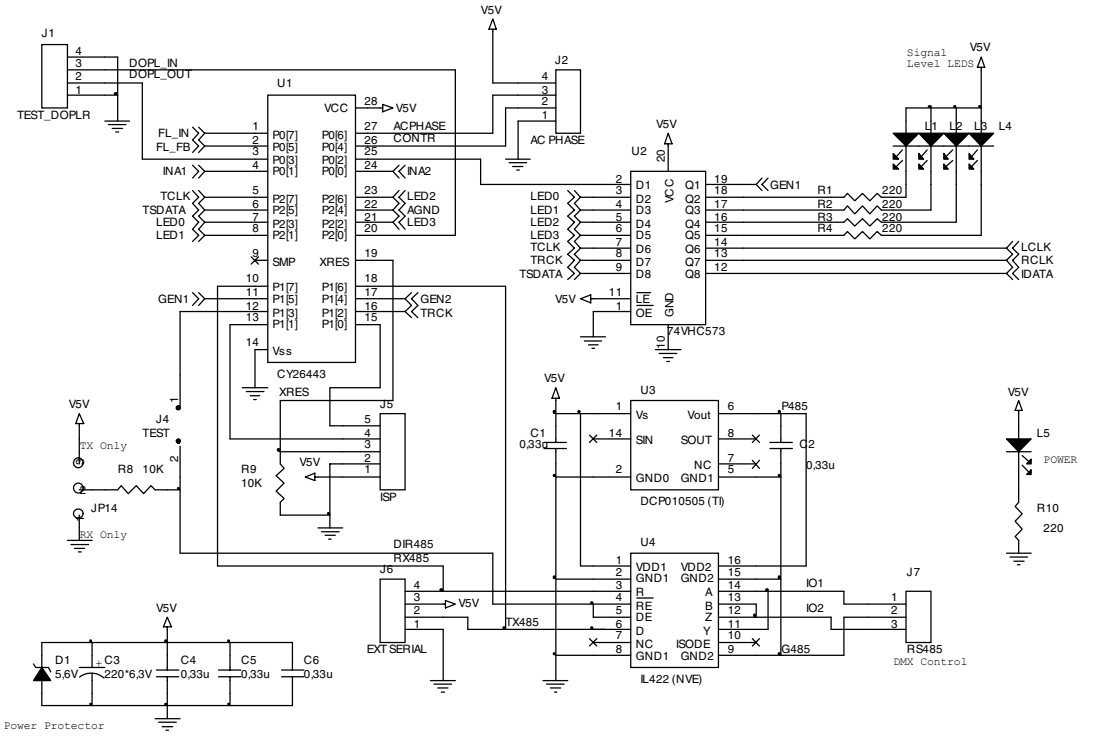


The lighting controller consists of the following main modules:

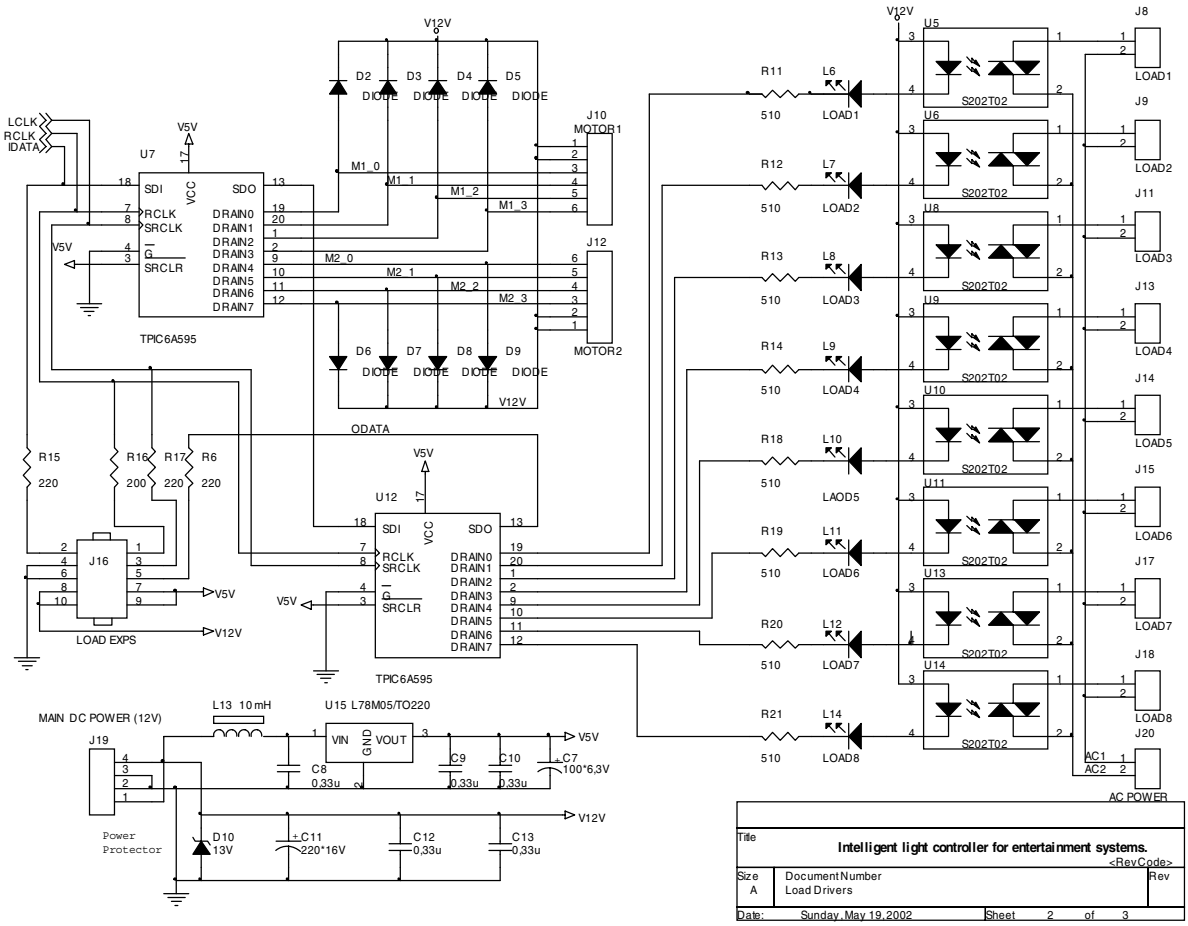
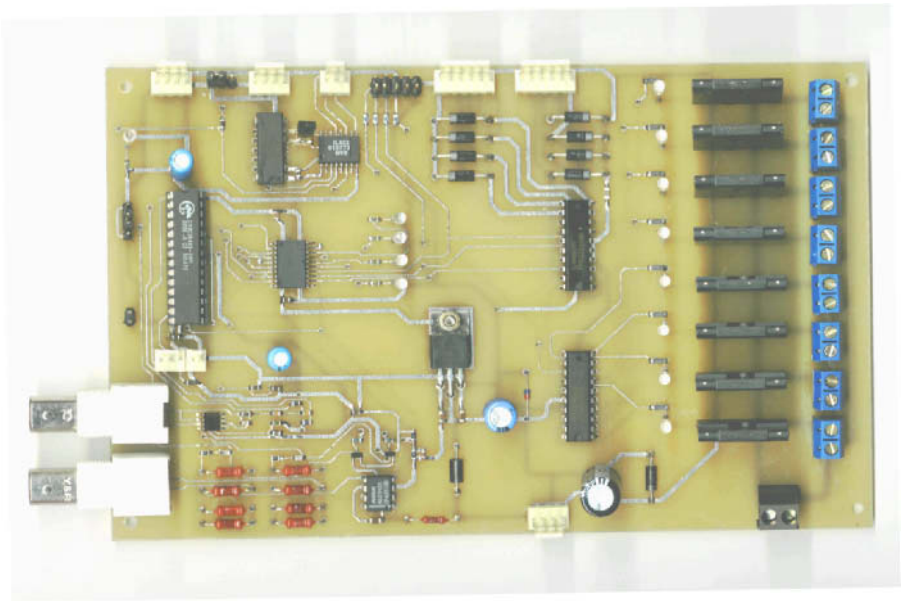
1. **GEN** – resonant generator of continuous ultrasound signal.
2. **TR** – piezoelectric transmitter of ultrasound waves.
3. **RS** – piezoelectric receiver of reflected signal.
4. **LNA** – low-noise preamplifier.
5. **MIXER,** selects Doppler effect frequency shift.
6. **LPF** – low-pass filter.
7. **BPF_1,** is intended to suppress off-band received signals.
8. **BPF_2** – tunable band-pass filter.
9. **ADC** – analog to digital converter.
10. **CPU** – central processing unit.
11. **LD** – lamps driver.
12. **SMD** – stepper motors driver.
13. **GI** – galvanic isolation circuit.
14. **INR** – interface level translator.
15. **Lamps** – lighting lamps: projectors, etc, which are external to system.
16. **Motors -** stepper motors for rotating mirrors, gobos and light color filters.



Title	**Intelligent light controller for entertainment systems.**	
Size A	DocumentNumber Ultrasound Subsystem	Rev <RevCode>
Date: Monday, May 27, 2002	Sheet 3 of 3	



Title	**Intelligent light controller for entertainment systems.**	
Size A	DocumentNumber CPU	Rev <RevCode>
Date: Sunday, May 19, 2002	Sheet 1 of 3	


V12V
LCLK
RCLK
IDATA
V5V
U7
TPIC6A595
SDI
SDO
RCLK
SRCLK
SRCLR
VCC
DRAIN0
DRAIN1
DRAIN2
DRAIN3
DRAIN4
DRAIN5
DRAIN6
DRAIN7
M1_0
M1_1
M1_2
M1_3
M2_0
M2_1
M2_2
M2_3
D2
D3
D4
D5
D6
D7
D8
D9
DIODE
J10
MOTOR1
J12
MOTOR2
ODATA
U12
R15
R16
R17
R6
220
200
J16
LOAD EXPS
R11
R12
R13
R14
R18
R19
R20
R21
510
L6
L7
L8
L9
L10
L11
L12
L14
LOAD1
LOAD2
LOAD3
LOAD4
LAOD5
LOAD6
LOAD7
LOAD8
U5
U6
U8
U9
U10
U11
U13
U14
S202T02
J8
J9
J11
J13
J14
J15
J17
J18
J20
AC1
AC2
AC POWER
MAIN DC POWER (12V)
J19
L13 10mH
U15 L78M05/TO220
VIN
GND
VOUT
C8
0,33u
C9
C10
C7
100*6,3V
Power
Protector
D10
13V
C11
220*16V
C12
C13
Title
Intelligent light controller for entertainment systems.
<RevCode>
Size
A
Document Number
Load Drivers
Rev
Date: Sunday, May 19, 2002
Sheet 2 of 3