Ambient Lights

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A project on developing an ambient visual display connected via serial port (or USB) to a computer. Part of the Interactive Spaces Course WS05/06 at >Neuroinformatics Group. These ambient displays are used e.g. for an ambient information service developed in the same course. Information on stock quotes and network traffic were routed through a tangible user interface and displayed on various displays such as the surrounding soundscape, the growing direction of (for now virtual) plants, or the lightscape (via these ambient lights).

Warning

Do not look directly into the ultra-bright LED-Lamps! This could cause damage to your eyes. The adapter is only tested with an supply voltage of 9V DC and two LED lamps serial per color. All suggestions of customize the adapter in this text come without any warranty.

Usage

It is possible to control the lamps by four characters, for example "A255". The first character determines the channel and might be either 'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', or 'I'. The next thee characters are used to define the saturation of the channel. Since the used PWM regulator has a resolution of eight bit the range of possible values is between "000" and "255".

Features

The Ambient-Lights are designed to meet the following features:

- **Ultra-low Price** We only use standard, mass production parts, which are cheap and easy to get. The PCB-Board was mixed assembly surface mounted and conventional to minimize the surface of the expansive custom made PCB-Board. Actually we re-

duced its size to 40x50 millimeters. The LED-Lights are mounted on external breadboards.

- **Easy to build** We renounce to integrate an USB-Interface onto the PCB-Board. The packages of USB-interface chips are not easy to solder and they needless increase the design complexity. It is much more easy (and also mostly cheaper) to use an external USB-to-RS232 interface, for example the DIGITUS DA-70146 device. If you use this device on mac OSX, you can get current and proper working drivers from the chip-set manufactory.
- **Stand alone** The PWM is calculated by an external micro-controller, using the adapter will only consume computing power of the host when the saturation of the lights are changed. It is even possible to switch of the host computer without any change to the ambient lights.
- **Low power consumption** To regulate the lamps, we use high efficient pulse width modulation. The current drain is less than 300mA at full saturation in a configuration with 18 lamps at 9V DC.
- **High flexibility** It can easy be customized for any supply voltage between 5V DC and ~24V DC. It drives up to 100mA, so it is possible to connect other devices than LED lights. The RS232 serial port can be found on most personal computers, if not you may use a Serial-to-USB adapter as the one described in the part list below.
- **Easy to Use** You just need to plug the power supply, configure your serial interface to 115kBaud and send the characters 'A' '2' '5' '5' to the serial port. For example this would light the first three channels to maximum:

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$ echo -n "A255B255C255" > /dev/ttyS0
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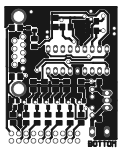
Technical Description



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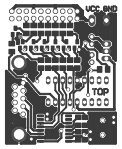
[Felix] IC1 stabilizes the supply voltage. V+ can lay between ~7V and 30V. But if you choose another supply voltage than 9V DC, you need to recalculate resistors R7-11, R16 - 20 and R26-30 because the LED lamps are directly connected to VCC to reduce power loss and avoid overheating of IC1. The resistors in the schematic are calculated for respectively two lamps switched to a serial at 9V DC. In this configuration the two channels of "blue" and "green" are redundant, you just have to connect the lamps to one of them. Actually it is also possible to use a stabilized voltage supply of 5V DC (For example from a internal power connector inside the PC or direct from the USB if you accordingly configure the USB). In this case you can leave IC1 and connect VCC direct to the 5V DC. 5V are to low to power two green or blue LEDs in serial, so you have to calculate the resistors on this channels fur just one LED lamp and use the redundant channels parallel. The operating voltage of the red LEDs is small enough to drive two LEDs in serial even at 5V, so this channel is implemented once.

The PIC-micro-controller is connected to an 20MHz crystal. The outcome of an operating frequency of 20MHz is an PWM switching frequency of 120Hz, far away from the maximum frequency that can be sensed by the human eye. Be sure to use the 20MHz version and not the cheaper 6MHz version, when you buy the adapter. The PCB-board does not provide in circuit programing, so you have to program the micro-controller in an external programming device. For later software changes, an IC-socket is provided to easy mount and unmount the chip.



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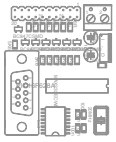
To rise the 5V signal level of the micro-controller to the high voltage level of the RS232 interface, we used the standard chip MAX232ACWE. We choose the "-A" version of the chip, because it provides smaller capacitors at high baud rate. Only use chips with the "ACWE" (or for extended temperature "AEWE") suffix. There are may versions of these chips which vary in package and capacitor value.



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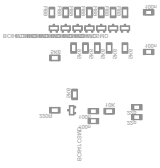
The lamp amplifiers are simple implemented by bipolar BC847 transistors. These parts can withstand voltages more than 30V and provide an maximum output current of 100mA. So it is possible to switch up to four or five LED lamps parallel on one channel or drive other sinks than LEW-Lamps. But do not forget to recalculate the resistors! Be aware of driving devices with a high inductance such as relays or motors. The inductance could produce high voltage spikes which can "kill" the adapter. To prevent the adapter from damage, you will need to add recovery diodes in that case.



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There are three connectors on the PCB-board:

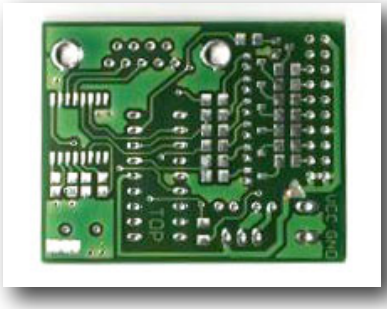
- 9-Pin D-SUB RS232. The pin-out suits to the RS232 standard.
- 2-pin screw terminal for V+ and GND. The pin-out is documented on the top-layer. Be warned to connect GND and V+ the wrong way! The temperature of IC1 would rise fast over the maximum temperature of this device, depending on the power of the voltage supply. So you may not have plenty of time to recognize the error before permanent damage.
- 20-pin ribbon cable terminal for the LED-Lamps. The connection is arranged that it is possible to split the ribbon cable into three parts, one for each configuration of two red, blue and green lamps. The pin-out is documented in the schematic.

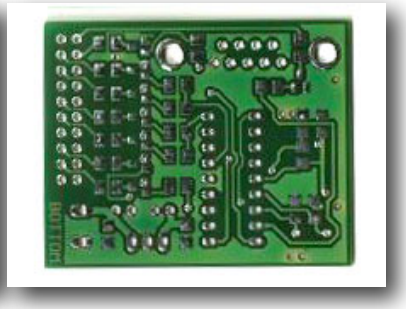
Part List

#	Serial Number	Description
1	D-SUB BU 09P	D-SUB-Connector, 9 pin, PCB-mounted
1	MAX 232 ACWE	RS232E Interface, SOL-16
1	µA 7805	Voltage-regulator, 1A positive, TO-220
1	PIC 16F628-20P	PIC-Controller, Dil-18 pin
15	BC 847C	SMD CHIP-Transistor, Code:1G
2	RAD 105 10u/63V	Electrolyte capacitor, 105°C, RM 2,5mm
8	X7R-G1206 100n	SMD-Capicator, 1206
1	20-HC49U-S	quartz crystal, 20,0 MHz, first harmonic
2	NPO-G1206 22p	SMD-Capicator, 1206
1	1/4W 10k	SMD-Chip-Resistor, 1206
15	1/4W 5,6k	SMD-Chip-Resistor, 1206
12	1/4W 68r	SMD-Chip-Resistor, 1206
3	1/4W 220r	SMD-Chip-Resistor, 1206
1	GS 18P	IC-Socket, 18-pin, super-flat, gold plated
1	2X10G 2,54	2x10 links strip, straight, RM 2,54
1	AK 2300	D-SUB cable, 1:1, 9-links., male/female, 1,8m
1	PFL 20	Ribbon cable connector, 20 pin, female
1	AKL 057-02	2-pole screw terminal, RM5,08
6	LED 5-6000 GN	LED, 5mm, ultra-bright, colorless, clear, green
6	LED 5-4500 RT	LED, 5mm, ultra-bright, colorless, clear, red
6	LED 5-3500 BL	LED, 5mm, ultra-bright, colorless, clear, blue
1-2	H25PR150	breadboard, 150x100mm, RM2.54
(1)	70146	USB 2.0 serial converter, manufacture:DIGITUS
1	MW 88V-GS/6	Power Supply, unstabilized, 300mA/9V
1	AWG 28-20G	Ribbon cable AWG28, 20-pin

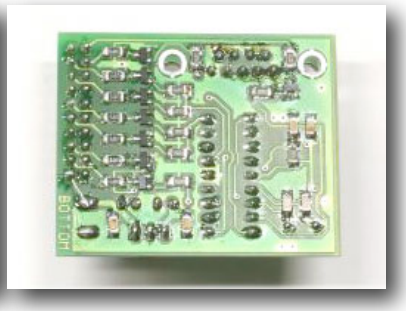
The Board

Plain board

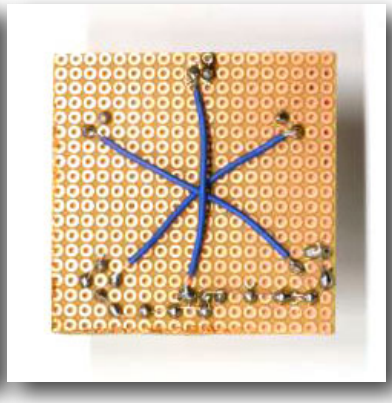


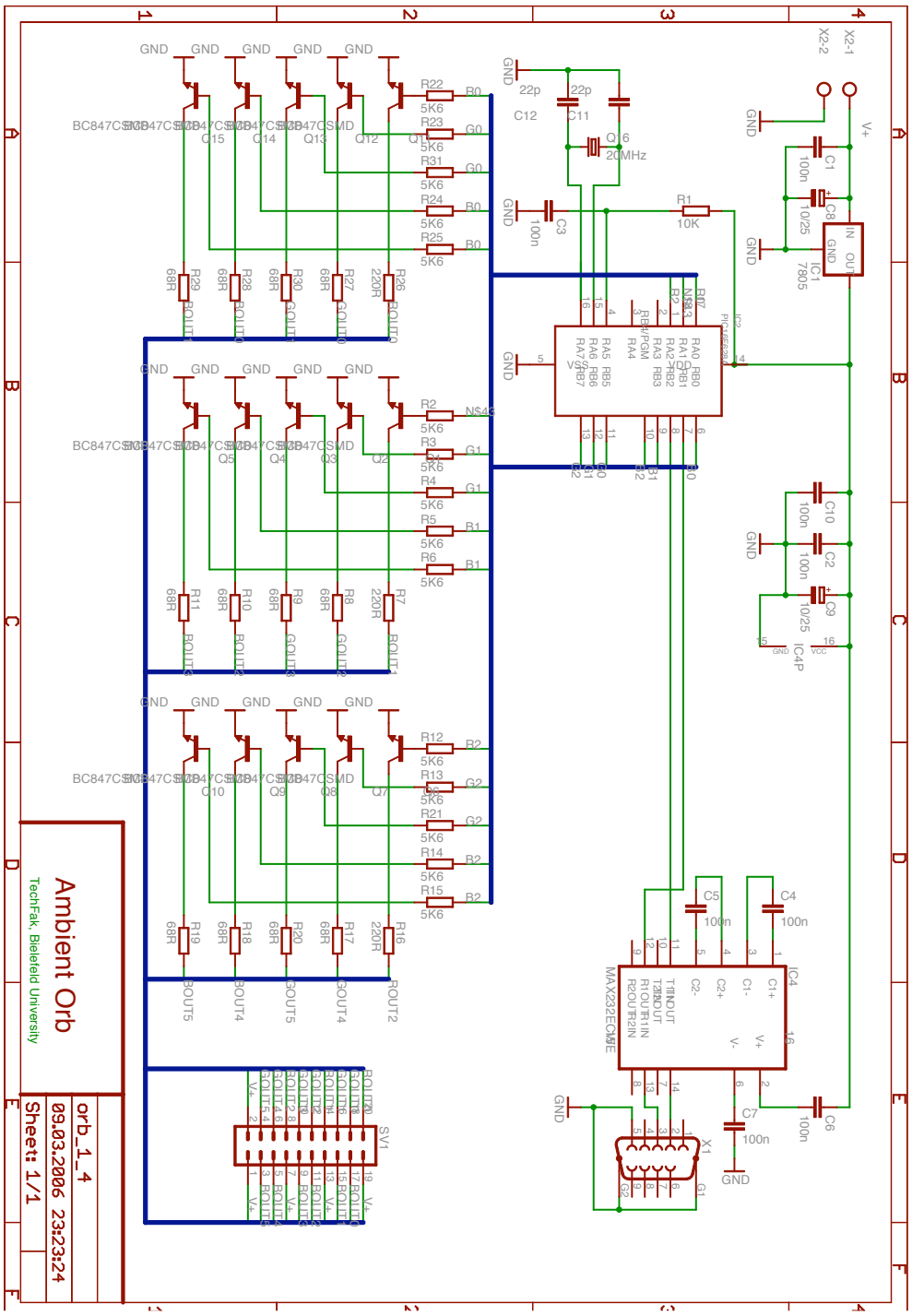


Equipped board



The Lights

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