RK Electronics

Vivarium/Aquarium Lights Controller

Design Manual for Engineers and Hobbyists

Russell Kelly,

E: russell.kelly@rkelectronics.org

W: www.rkelectronics.org

CONTENTS

Welcome

First of all I would like to thank you for your interest in this project and my work. It is my hope that you will find this project useful and may decide to build yourself, or at least be a good read.

Design Brief

This project will be the design of a mains powered controller unit, for activation and deactivation of a series lamps used in reptile vivariums or fish aquariums. A typical reptile vivarium or fish aquarium contains two sets of lamps; day lamps (white fluorescent) and heat lamps (for vivariums) / sunset lamps (blue fluorescent for aquariums). The controller will be designed to maintain a 24 hour clock, and allow the user to pre-set sunrise and sunset times. These times are used to trigger the beginning and end of the day, and the control of the electric lamps.

At sunrise the heat lamps/blue lamps shall be activated. One hour later (microprocessor software can be changed) the day lamps shall be activated. At sunset the day lamps shall be deactivated, followed by the heat/blue lamps one hour later (again microprocessor software can be changed).

The controller will have an alphanumeric display to display the time, and the period of the day which can be either; sunrise, daytime, sunset and night time. The controller will also have a series of status indication LEDs which indicate which lamps are or should be active.

The controller will have a series of push buttons, such that the time, sunset and sunrise times can be adjusted using the following options; Menu/Enter, Increase and Decrease.

The power output to the lamps will be provided by the controller, via 3 pin 'kettle' lead connections, and power controlled via solid state relays.

Safety

This project is designed to operate from mains electricity. I **cannot** emphasize enough about the **dangers** of using and or building a circuit which operates from mains power. Incorrect use or incompetence (including but not limited to touching transformer primary side connections) **can kill you!** If you do not have experience or do not feel comfortable using mains power, this project may not be for you.

Please note that I do not take any responsibility for any loss, damage or harm caused by the building of this project. This project book comes 'as is'. I have built this project and can confirm it works, and to the best of my ability is safe to use.

Assumptions

This project assumes that you have basic knowledge of electronics and have worked with mains electricity. This report also assumes that you have some experience with using PIC microcontrollers.

Principle of Design

General Operation

The principle of the lights controller is to provide an automated function; of activating and deactivating specific lamps used in reptile vivariums and fish aquariums. The controller maintains a 24 hour clock, and stores the hour and minutes values for sunrise and sunset. When the clock reaches either sunrise, sunset or one hour past these times, a series of triggers are initiated to 'switch on' or 'switch off' specific lamps.

To improve reliability and simplicity, the use of solid state relays are used to control the mains power to various lamps. These relays can also be driven direct from the microcontroller.

The microcontroller used is the Microchip PIC18F14k22 microprocessor running at 5v. Internal processor clock is 8 MHz, and Timer1 (auto incrementing register used to maintain the clock) is controlled via an external 32.768 kHz quartz crystal. This microcontroller provides all the control functions of the unit. The microprocessor outputs the time and day period to a backlit 8 column, 2 row alphanumeric display (HD44780) , reads the user input buttons (Menu/Enter, Increase and Decrease), drive a series of status LEDs (Day lamps and heat/blue lamps active as green and yellow respectively) and provide a 3 - 5v control signal for the solid state relays.

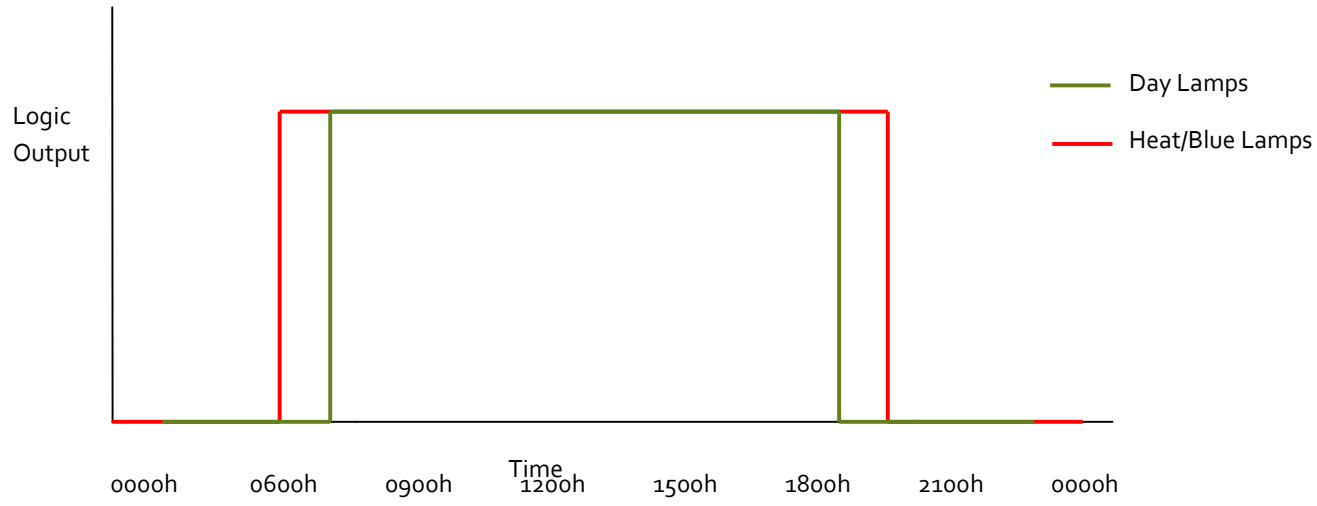


Figure 1 - Typical Controller Output Profile

Controller Architecture

The controller consists of a number of key components in order for the controller to function. Figure 2 below describes each component, and how each component is interfaced.

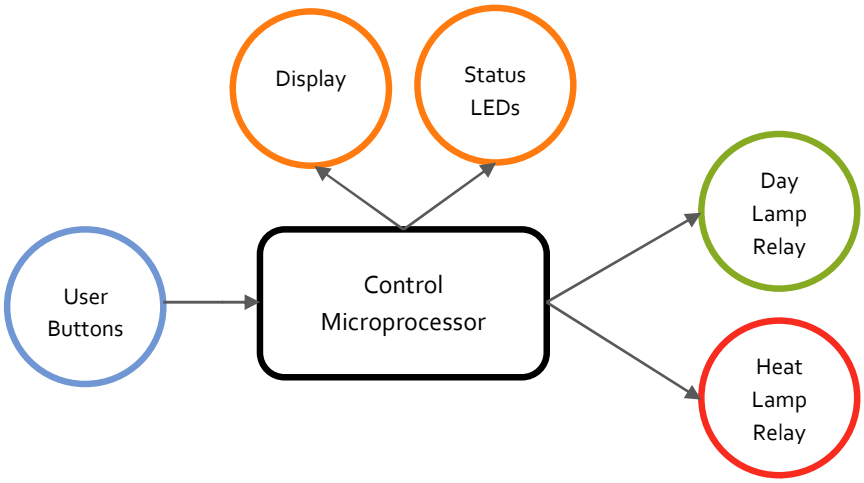


Figure 2 - Controller Architecture

User Buttons

The user buttons allow the user to set the time, and the hours and minutes of sunrise and sunset. There are three buttons; Menu/Enter button (normally closed), which triggers the programming mode and allows the advancement through the menu. The menu order is; time hours, time minutes, sunrise hours, sunrise minutes, sunset hours and sunset minutes. Increase button (normally open), which increments the hours or minutes values, and decrease button (normally open), which decreases the hours or minutes values.

Display

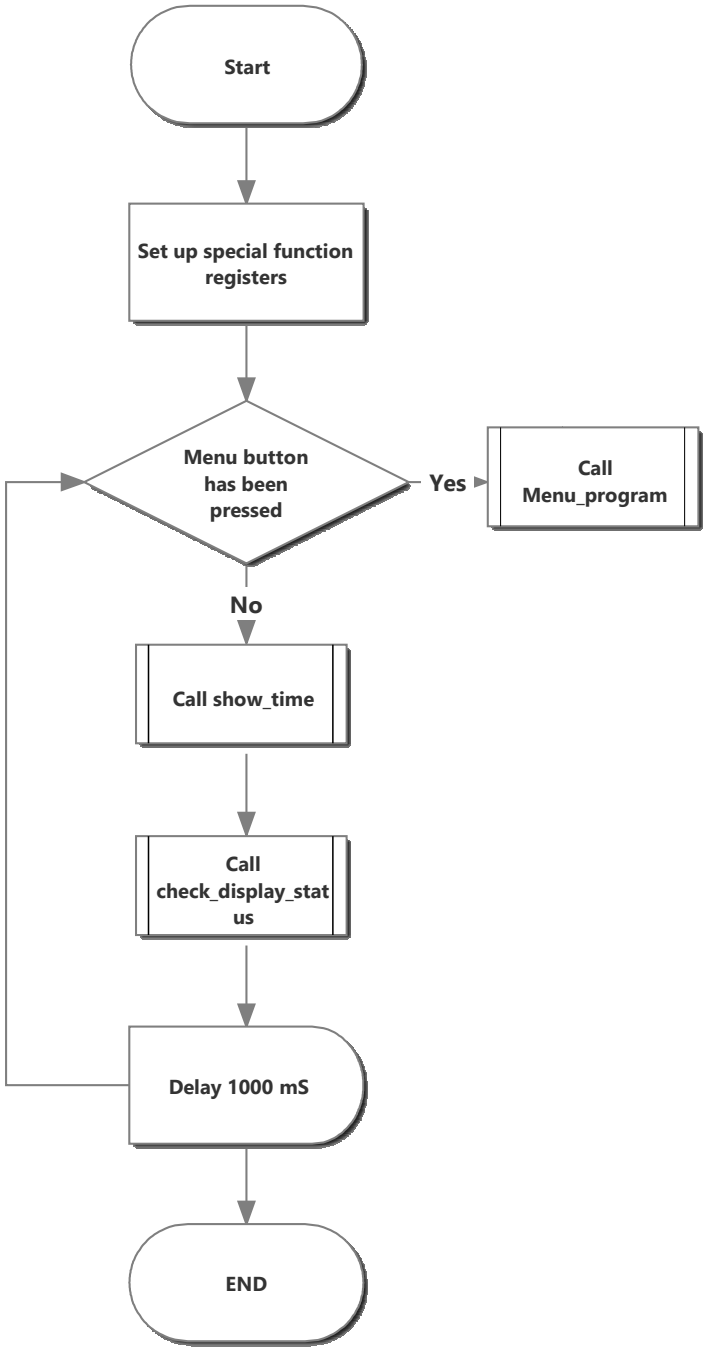
The display shows the current time, and the period of the day. The display required is an Hitachi HD44780; 2 row, 8 column display. Communication is via the standard 4 bit mode.

Day Lamp/Heat or Blue Lamp Relays

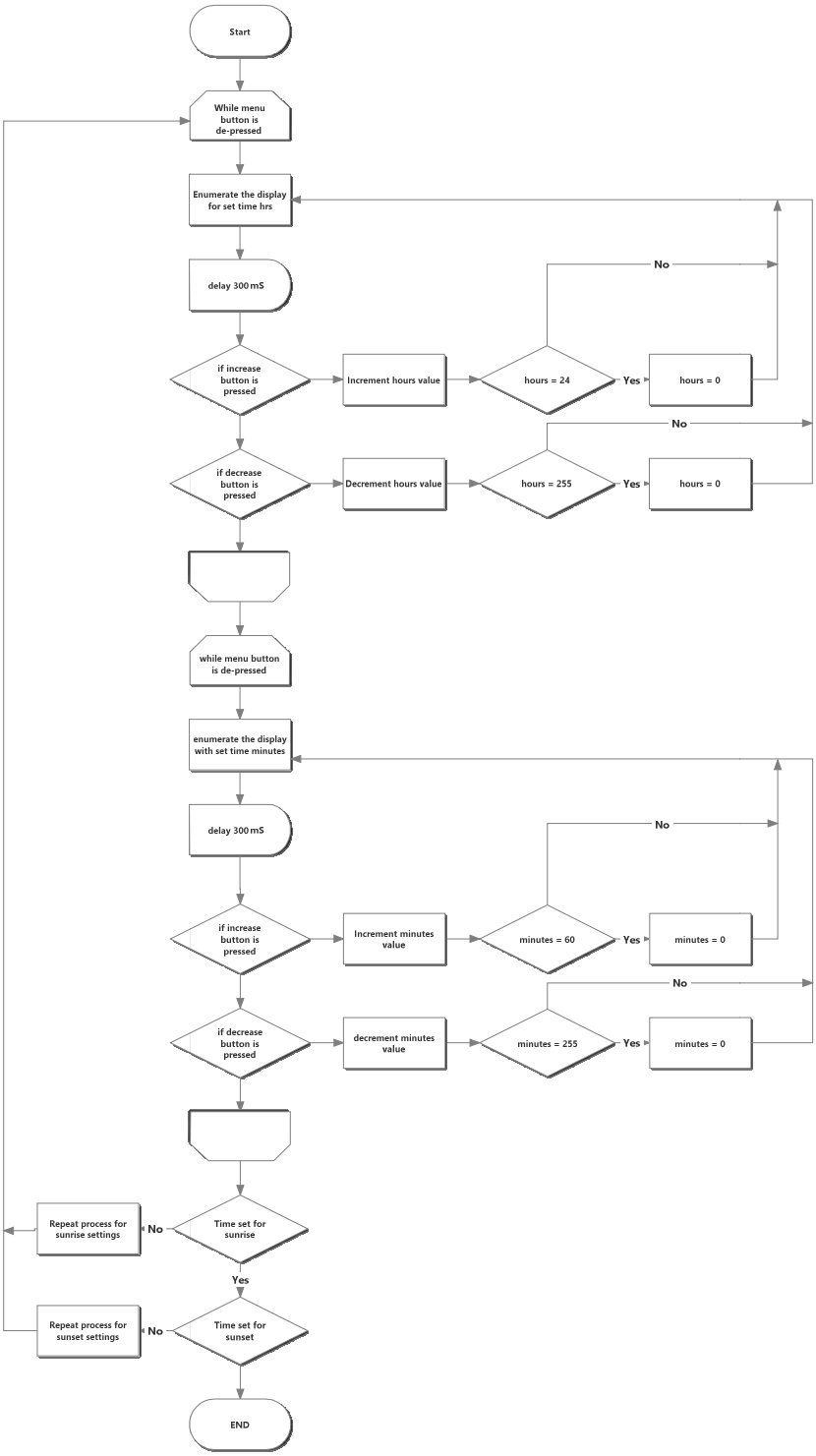
The lamp relays are solid state, opto-isolated TRIAC based switches, which are activated by supplying a 3 - 8v logic signal to the internal opto-isolated triggering LED, which optically activates the TRIAC switch. This method allows the microprocessor to directly control the mains switching of the day or heat/blue lamps.

Microcontroller code (Flow chart)

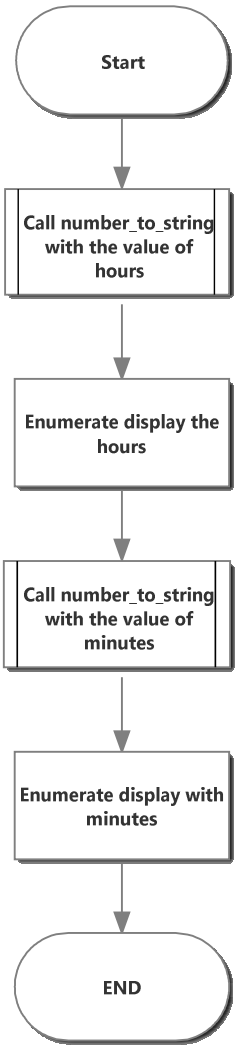
Main program



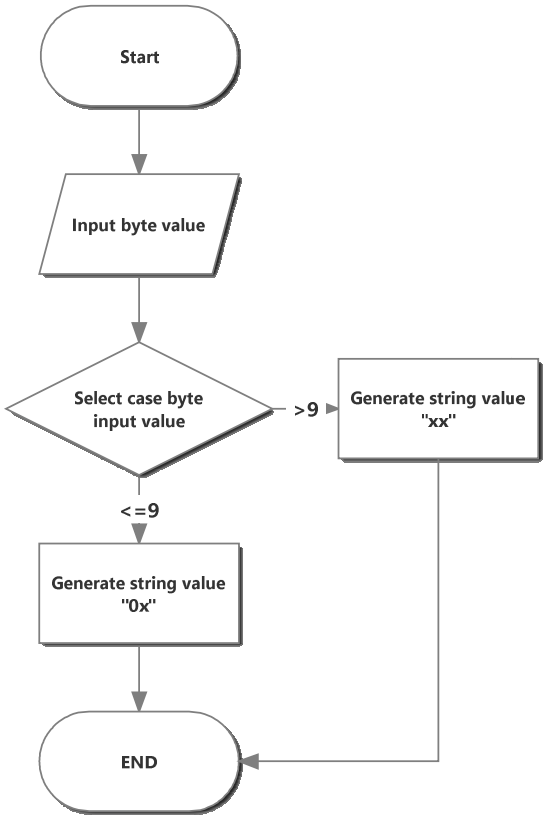
Call Menu_program



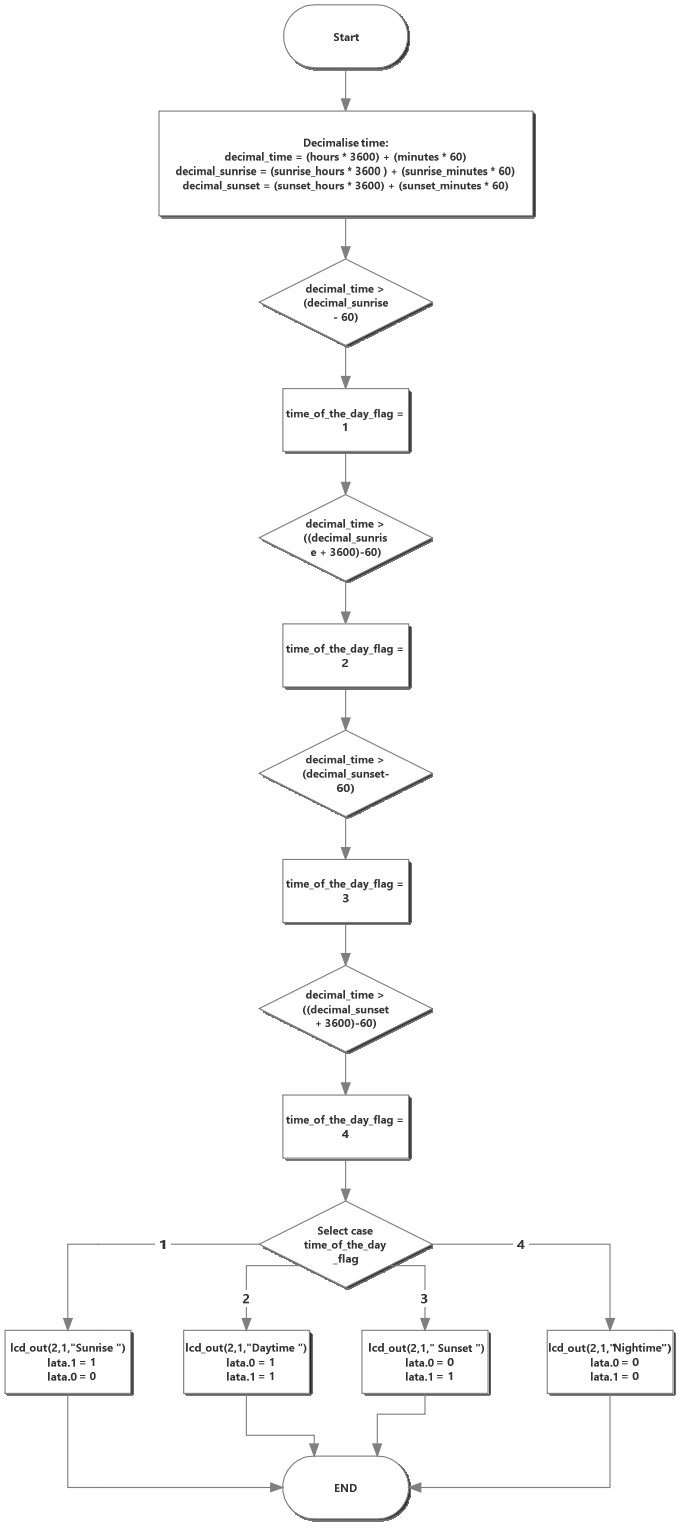
Show_time


Start
Call number_to_string with the value of hours
Enumerate display the hours
Call number_to_string with the value of minutes
Enumerate display with minutes
END

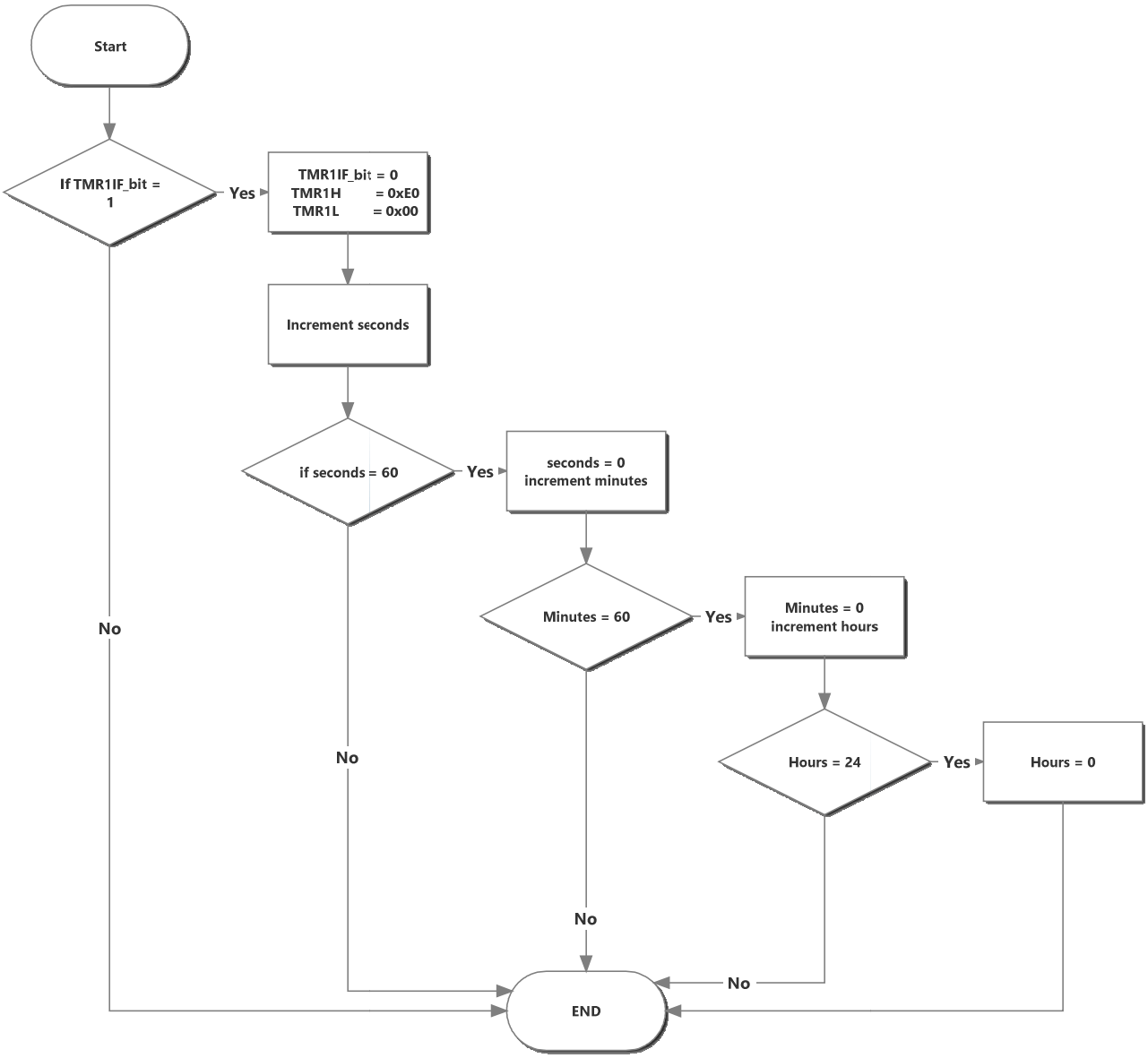
Number_to_string



Check_day_status



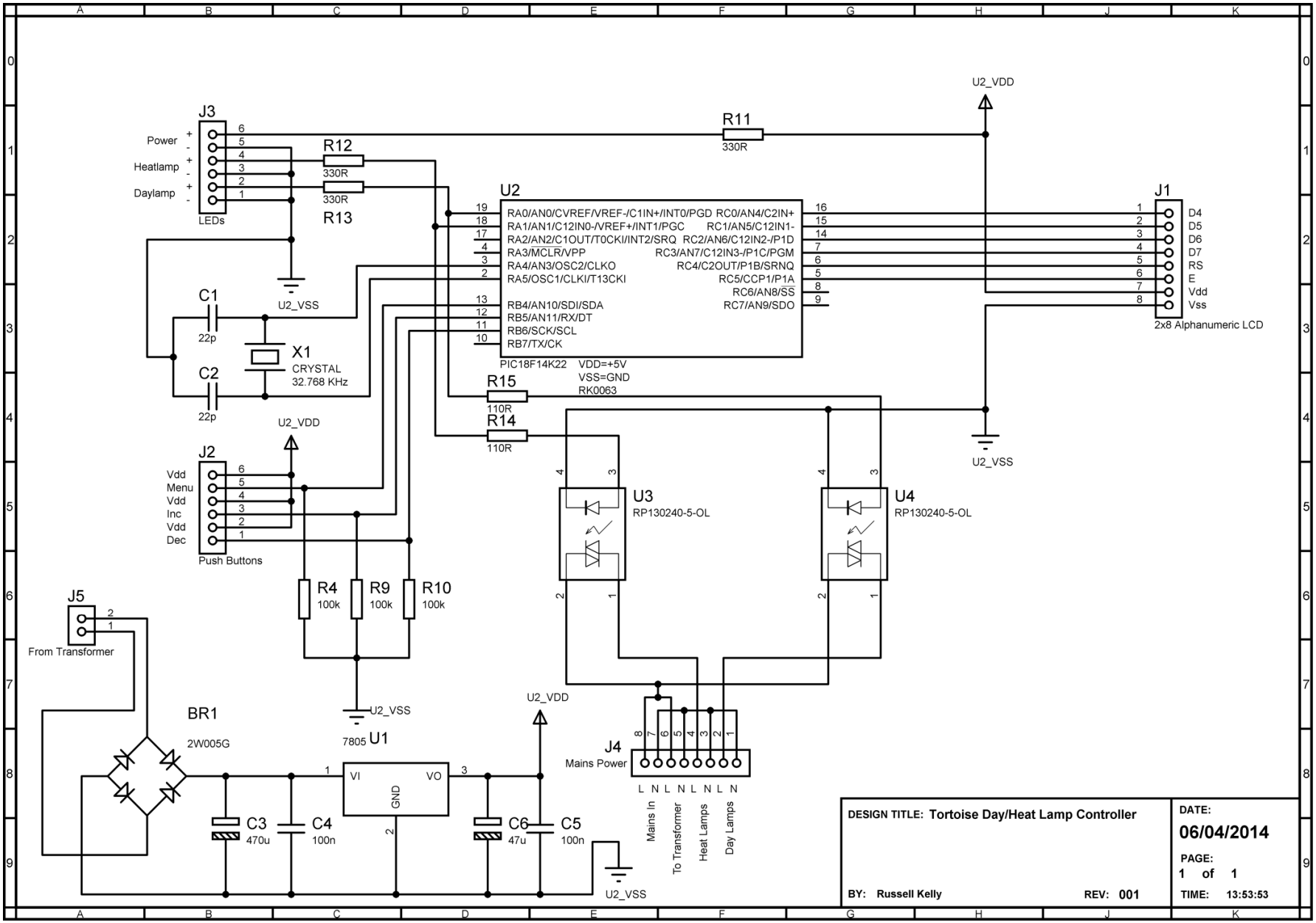
Timer_interrupt



Schematic Diagrams

Schematic diagrams are shown on the next landscape pages;

Schematic Diagram

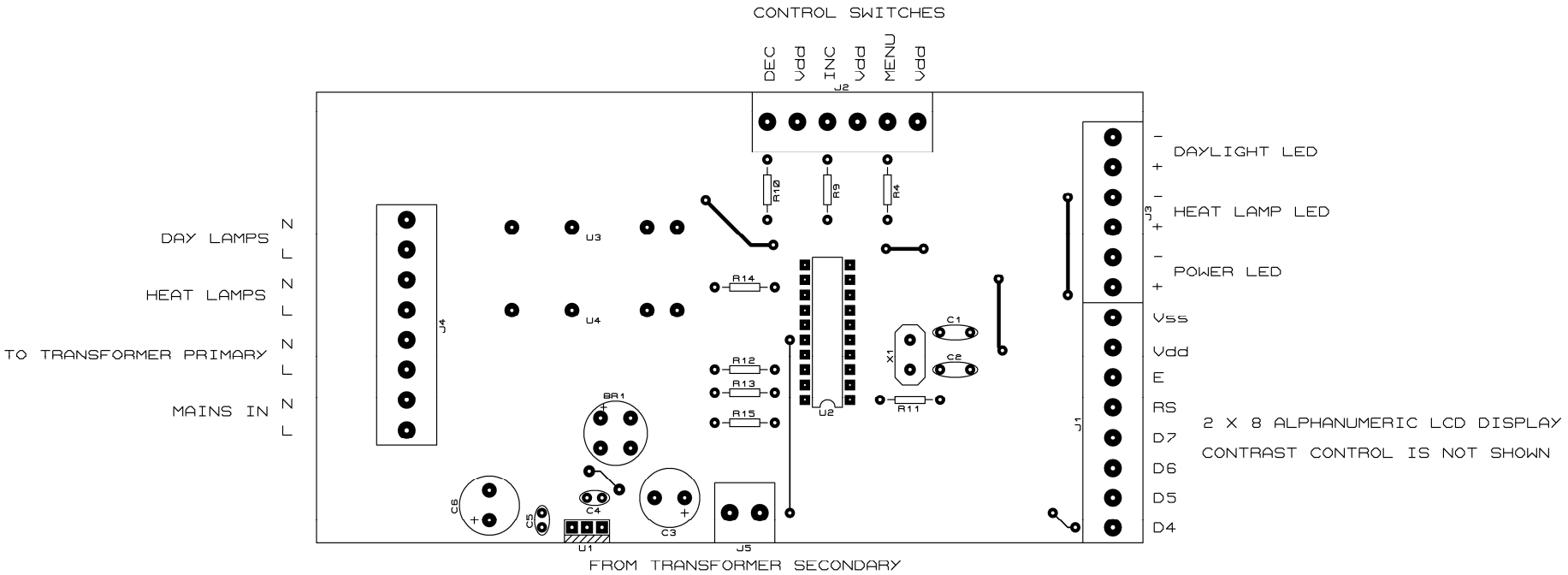


Circuit Boards

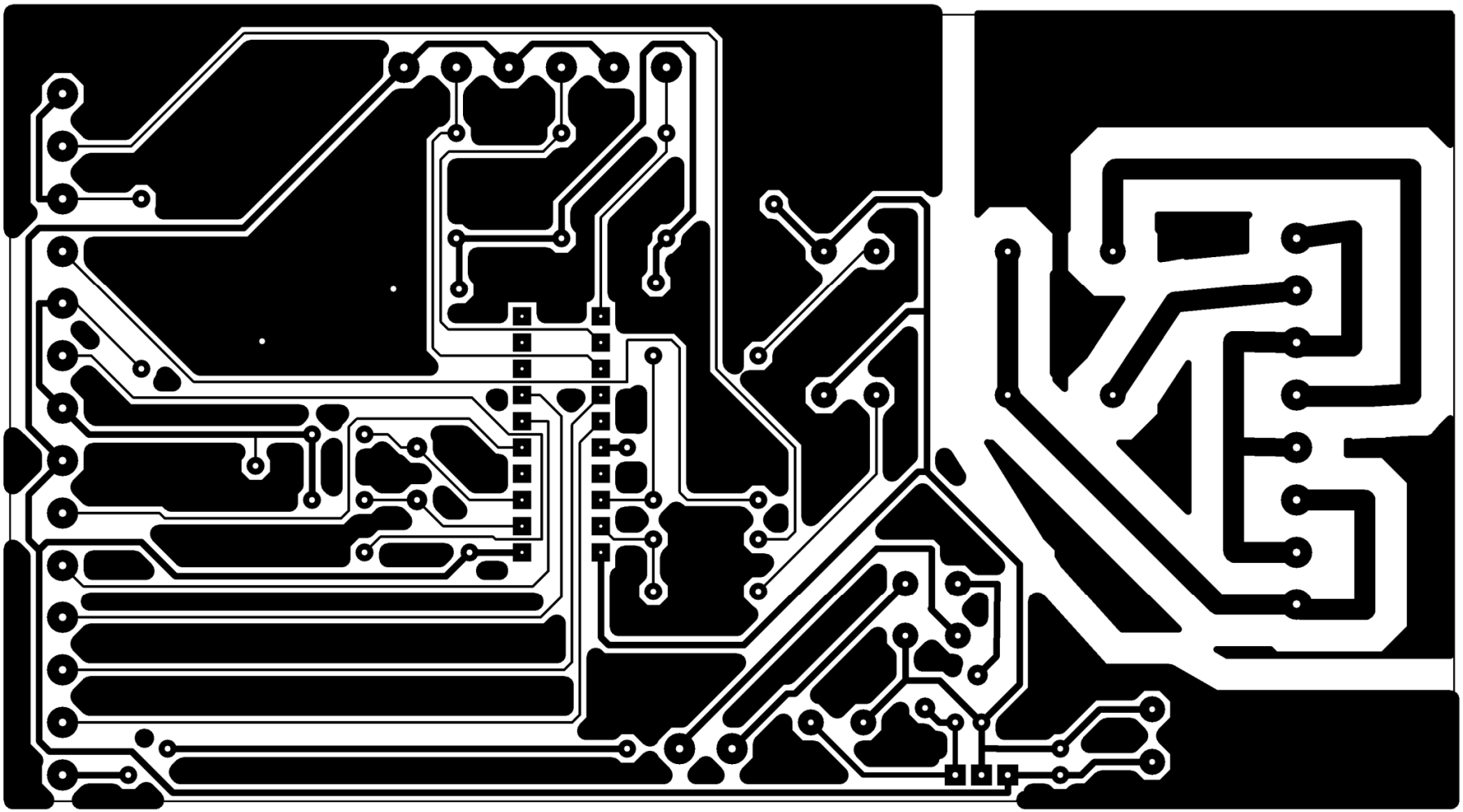
Circuit boards are displayed on the next few pages. For high resolution, correct scale toner print and UV print solder side art works, please refer to either the project folder supplied with this document. All art works may also be downloaded from my website;

www.rkelectronics.org

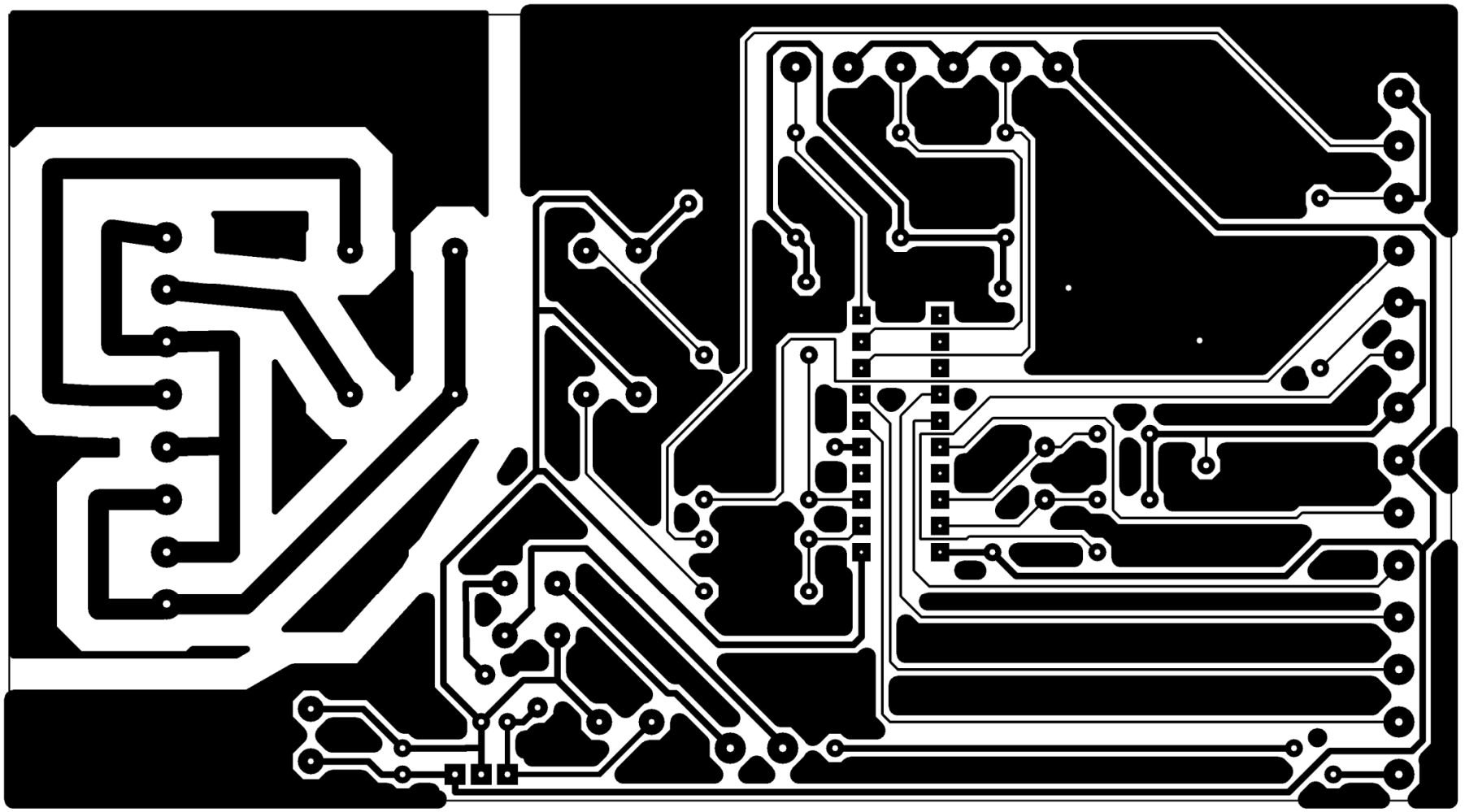
Circuit Board (Component Side)



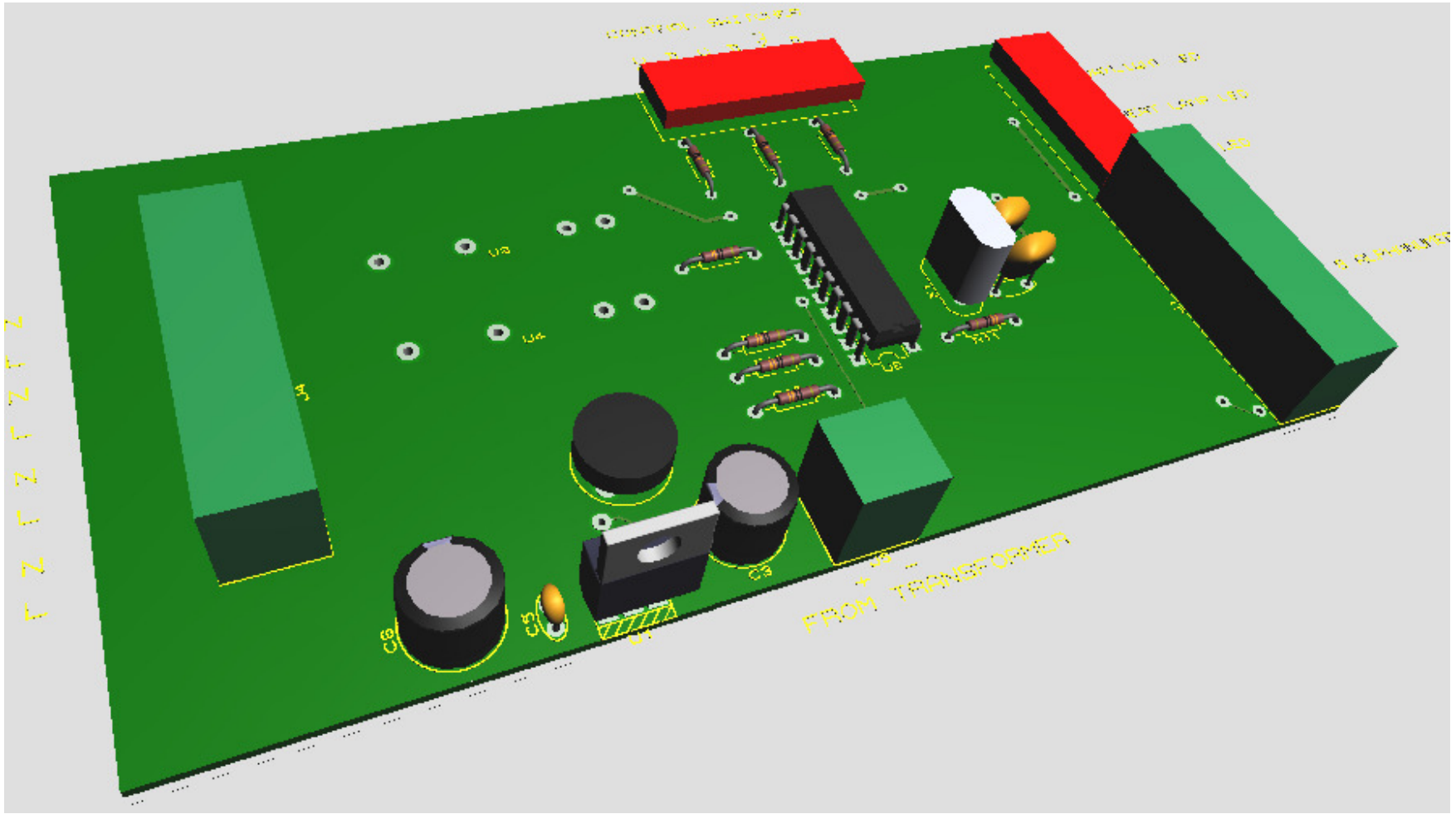
Circuit Board (Solder Side)



Solder Side [Toner Mask Transfer]



3D Circuit Board Estimate



Bill of Materials

Table 1 - Bill of Materials

6 Capacitors

Quantity	References	Value	PCB Package
2	C1-C2	22p	CAP20
1	C3	470u	ELEC-RAD20
2	C4-C5	100n	CAP10
1	C6	47u	ELEC-RAD20

8 Resistors

Quantity	References	Value	PCB Package
3	R4,R9-R10	100k	RES40
3	R11-R13	330R	RES40
2	R14-R15	110R	RES40

4 Integrated Circuits

Quantity	References	Value	PCB Package
1	U1	7805	P1
1	U2	PIC18F14K22	DIL20
2	U3-U4	RP130240-5-OL	OPTIORELAY (RP130240-5-0LC)

7 Miscellaneous

Quantity	References	Value	PCB Package
1	BR1	2W005G	BRIDGE2
1	J1	2x8 Alphanumeric LCD	TBLOCK-I8
1	J2	Push Buttons	6 WAY TERMINAL BLOCK_5.4MM
1	J3	LEDs	6 WAY TERMINAL BLOCK_5.4MM
1	J4	Mains Power	TBLOCK-I8
1	J5	From Transformer	TBLOCK-I2
1	X1	CRYSTAL	XTAL18