

第二届中华人民共和国职业技能大赛 江苏省选拔赛

电子技术项目样卷

模块ID	模块名称	时间分配	配分
一	电子电路设计与装调（电子电路原理设计+电子电路PCB设计+电子电路安装与调试）	6小时 (2+2+2)	45
二	故障查找与检修	3小时	30
三	电子技术程序设计	3小时	25
	总 计	12小时	100分

注：根据第一届中华人民共和国职业技能大赛电子技术项目（国赛精选）的命题方式，本项目试题采用封闭式命题，即所有题目信息在比赛现场公开。本样题仅提供竞赛时间、分数比例、比赛技术要求和竞赛文档格式的参照，**样题所有内容与本次选拔赛试题内容没有联系**，仅做技术准备和训练参考！！！！

第二届中华人民共和国职业技能大赛江苏省选拔赛样题

一 . 电子电路设计与装调

电子技术

工位号： _____

1. DESCRIPTION OF THE PROJECT

项目描述

This project is a traffic light with a countdown timer with function of generating an audio signal.

这是一个带倒计时器及音频信号发生功能的交通灯电路

To complete this task, you need:

要完成这个任务，你需要：

- Complete the five electrical circuits provided below. Complete and submit to the experts answers sheets #1, #2, #3, #4, #5.

-完成下面五个电路的设计，完成后将答题纸交给裁判。

- Design a traffic light board with a countdown timer using Altium Designer, prepare files for manufacturing and assembling your PCB. If the files are not suitable for manufacturing a PCB, then the points for the PCB layout will be reduced by approximately 60%.

-用 Altium Designer 软件设计一个带倒计时的交通灯电路板，为加工和组装你的 PCB 板准备相关的文件，如果设计的文件不能够加工，那么 PCB 的设计分将直接扣除约 60%。

You have 2 hours to design the electrical circuits. After all this time, hand over the completed answer sheets to the experts. After 1 hours competitor could submit all the answer sheet to expert for the schematic answer PDF. At this time routing of the PCB and any preparatory work is prohibited.

你有 2 个小时设计电路图，之后将所有的答题纸交给裁判，开始后 1 个小时，选手可以申请原理图答案(pdf 打印文档)，领取答案时需要上交答题纸，这个时间内禁止一切 PCB 的布线工作。

注意：在答题纸页眉处填写上你的工位号，请将答题纸的“工位号+姓名”修改成你的工位号和姓名。例如：上交答题纸文件名为：'A 模块答题纸-08-张三.docx'

Design of the PCB must be completed in 2 hours. After completing the design, give to the experts the necessary project files. There is could be missed a components inside the provided library. You need to finalize the library.

用 2 个小时完成 PCB 布线，完成设计后向裁判递交相关的工程文件，在提供的库文件里可能缺失一个元件你需要将它补齐。

2. FUNCTIONAL DESCRIPTION OF ELECTRONIC DEVICES "TRAFFIC LIGHT WITH COUNTDOWN TIMER" “带倒计时器的交通灯”电路功能描述

A traffic light with a countdown timer is a digital discrete state machine based on standard logic ICs. The device repeats the functionality of traffic lights designed to regulate the traffic of vehicles, and generates signals of three colors: red, yellow and green. The countdown is displayed using two groups of seven-segment indicators, respectively red and green.

这个带倒计时器的交通灯电路是一个基于标准逻辑IC的数字离散状态机。设备会循环运行设计好的交通灯功能来达到规范车辆行驶的目的，电路产生3种颜色信号，红/黄/绿。倒计时器是通过两组7段数码管显示(显示红灯和绿灯)

The duration of the red and green signals is determined by the position of the DIP switches in the BCD format. The block diagram of the device is shown on Figure 2.

红灯和绿灯信号的持续时间是由DIP开关的BCD格式码位决定的，电路原理框图以图2所示。

The traffic light implements the following algorithm of operation, illustrated by a graph of its output signals in Figure 1.

交通灯实现下面的运算算法，如图1中的输出信号的图形所示。

After switching on the power supply, the traffic signal switching unit generates a signal for loading the operating time of the red traffic light signal. The value of the time determined by the position of the switches in the unit for setting the duration of the activation of the red signal is recorded in the up - down counter.

当上电后，交通信号开关单元产生一个读取红灯工作时间的信号，时间的值是由红灯信号持续时间设置开关单元决定，并由倒计时器记录。

At each clock pulse from the generator with a frequency of 1Hz occurs a counter decrement.

发生器生成的1Hz时钟脉冲产生一个倒计数。

The output signals of units and tens of seconds received to the decoder, from the outputs of which the seven-segment code is amplified in current and inverted by the driver of the seven segment display. The amplified signal includes a combination of indicator bits corresponding to the binary state of the up - down counter.

单元个位和十秒位信号发送到译码器，由七段译码显示驱动器进行译码。再进行了反相和电流放大，被放大的信号包含了一组与二进制计数器对应的段码信号。

At the moment when counter is switching from one to zero value, a signal is generated to turn on the yellow traffic light signal and turn off the red time indication unit and green signal.

与此同时当计数器的某一位值从1到0时，产生一个信号，将开启黄灯信号并且关闭红灯时间指示单元和绿灯信号。

At the end of the countdown traffic lights switching unit switches its state. As a result, the up-down counter is loaded with the green light signal turn-on time, red and yellow lights are turned off, and the green traffic light turns on.

在交通灯开关设置的红灯倒计时结束时，加减计数器伴随着绿灯信号启动开始工作，红灯和黄灯关闭，绿灯开始工作。

Marking Scheme 配分

Circuit Design 15 p (电子电路原理设计)

PCB layout Design 15 p (电子电路PCB 设计)

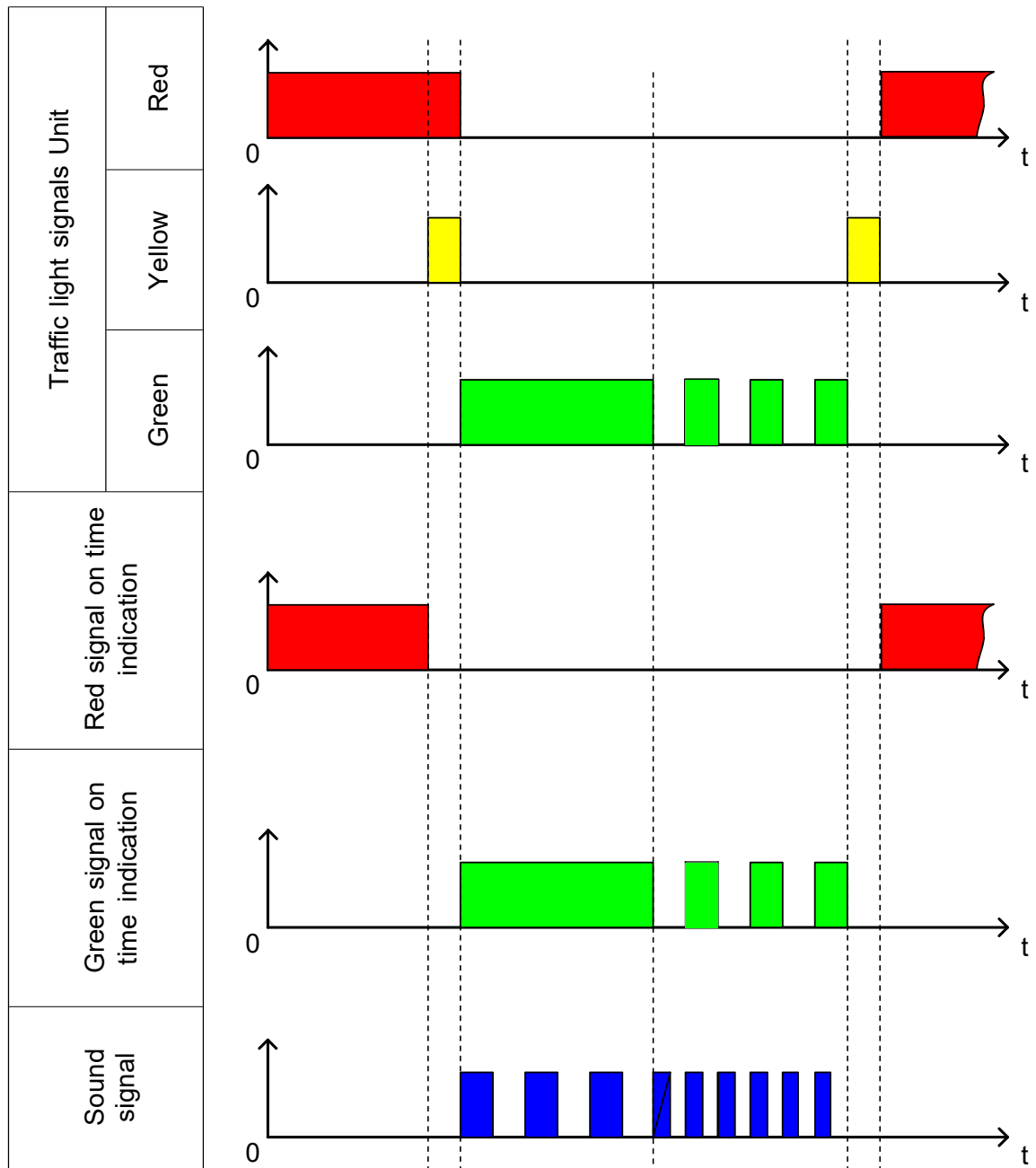


Figure 1 – Graph of traffic light output signals

图1-交通灯输出信号图表

When the time of the green signal is reduced to three seconds, the green blinking enable circuit will connect the clock signal to the green control line, which will cause it to switch three times at a frequency of 1Hz.

当绿灯信号的时间减到3秒钟时，绿灯闪烁使能电路将连接到时钟信号并到绿灯控制线上，这样可以产生了3次频率为1Hz的闪烁。

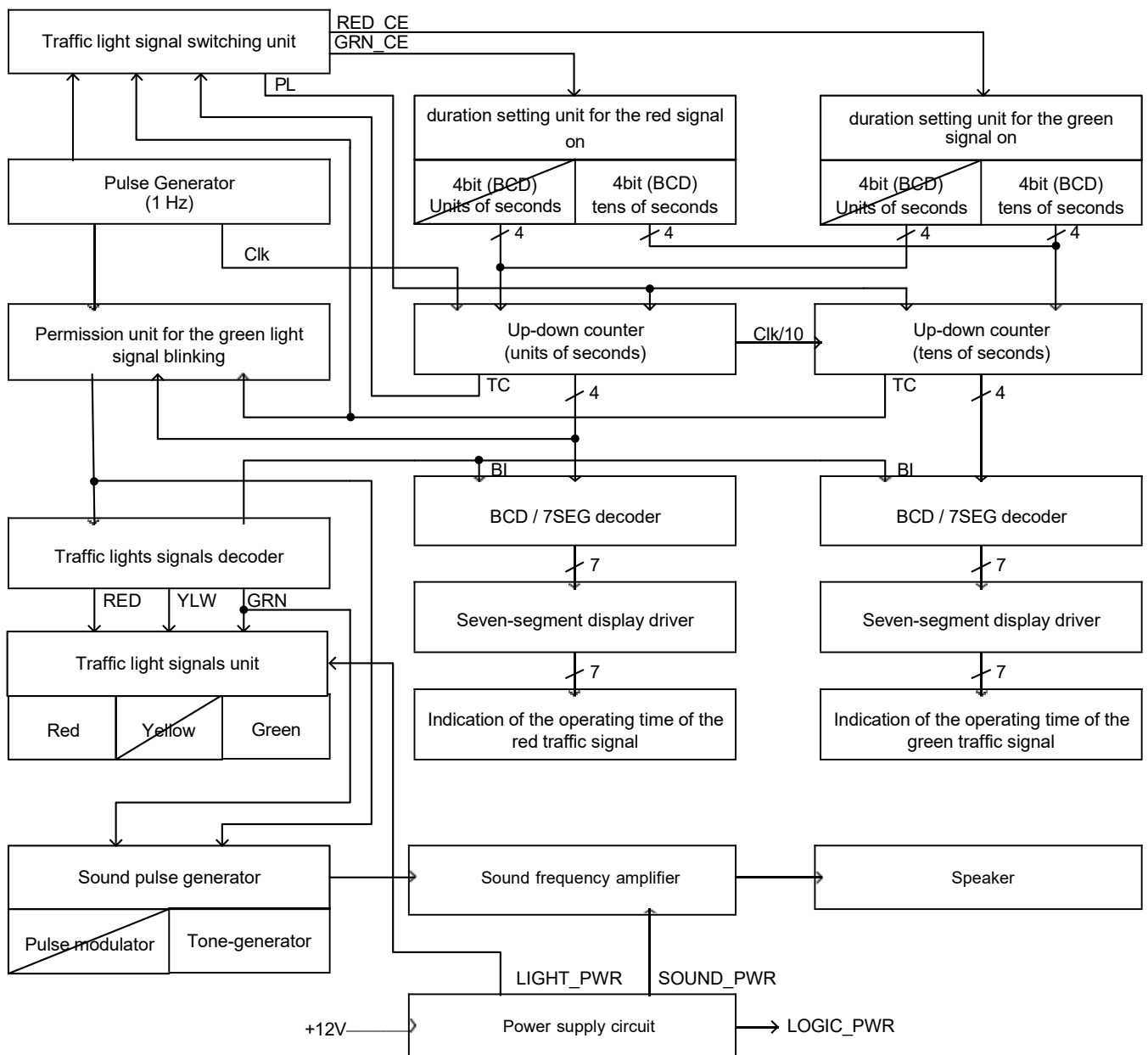


Figure 2 - Block diagram of a traffic light with a countdown timer

图2-带倒计时计数器交通灯电路框图

After the green operation time has elapsed, a short-time switch-on for one clock pulse of a yellow color occurs. After that, the whole cycle of traffic lights is repeated again.

当绿灯工作时间结束，会有一个短暂的黄灯开启时钟脉冲，之后，整个交通灯开始循环工作。

The traffic light decoder receives a combination of signals from other units and generates traffic light control output signals and switches the red and green pair of indicators.

交通灯译码器接收一组来自其他单元的信号，并且产生交通灯控制输出信号和“开关”红绿灯两位指示器信号。

Synchronous to activation of the green traffic light signal activates the audio signal generator at a frequency of 2.5KHz. The audio signal is generated at a frequency of 1Hz packets and amplified by an audio amplifier for output to the speaker. When the green traffic light flashes, the frequency of the sound pulses increases. The pulses of the audio frequency generated by the tone generator, and the parameters of the sound pulses determined by the pulse modulator.

绿灯信号工作的同时，激活频率为2.5KHz的音频信号发生器，音频信号是由1Hz的信号控制的，并且经过音频放大器放大输出给扬声器。当绿灯闪烁时，声音脉冲的频率增加，音频频率的脉冲是由音调发生器 (tone generator) 产生，并且声音脉冲的参数是由脉冲调制器 (pulse modulator) 决定。

Power supply 5V. The power circuit generates three voltages: + 5V for supplying the digital control circuit; adjustable voltage in the range 0V-8V for supplying the circuit of the sound signal generation; supply voltage of traffic light signals with current stabilization.

输入电源是5V，电源电路产生三种电压：+5V给数字控制电路供电；0-8V范围可调电压是给声音发生器电路供电；交通灯信号的电源是带恒流的电压供电。

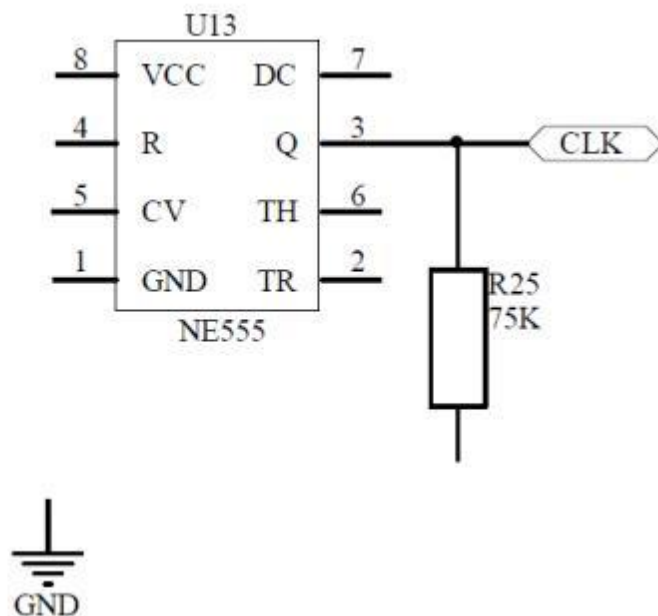
3. TASK FOR COMPETITORS

选手的任务

3.1 PULSE GENERATOR 1 HZ 1HZ 脉冲发生器

Using the NE555 timer in the multivibrator mode, design a pulse generator for an output signal with a frequency of 1 Hz and a duty cycle of 0.5. Calculate the values of the passive components and fill out the results table. Passive components must be used from the list of components. Determine the deviation of the frequency generated by the circuit with the components selected from the list to the specified value. Complete the diagram and show the results of calculations in the answer sheet # 1.

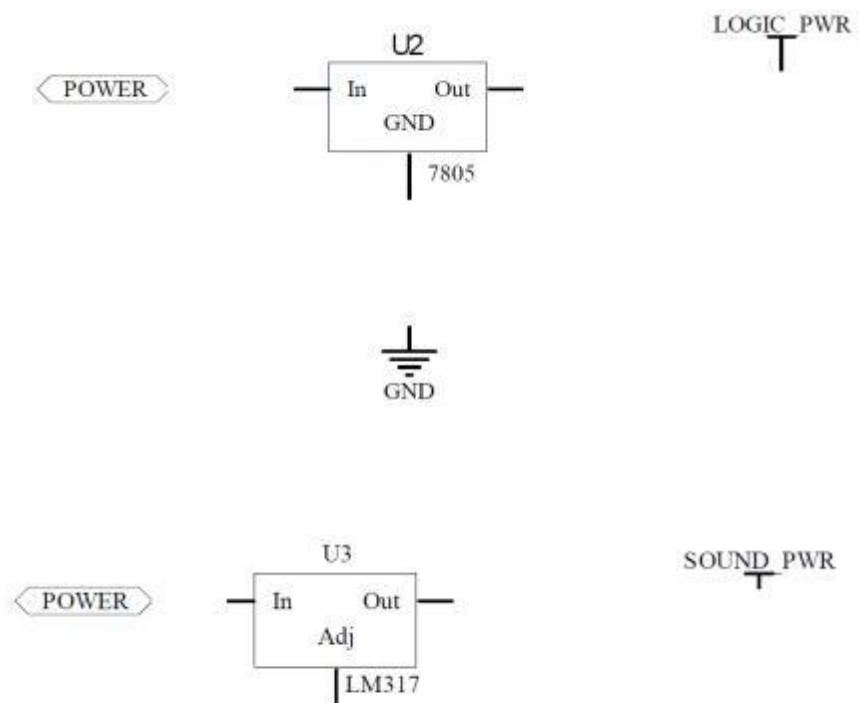
使用NE555定时器的多谐振荡器模式，设计输出一个占空比为50%，频率为1Hz的脉冲发生器，计算无源元件的值并将结果填入表格，必须使用元件清单里的无源元件。从元件清单里选择合适的值来确定电路产生的频率偏差，完成原理图并将计算结果填写在答题纸中。



3.2 POWER SUPPLY CIRCUIT 电源电路

Develop a traffic light power supply circuit with a countdown timer and calculate the nominal values of its blocks. The circuit should provide the following output voltages: LOGIC_PWR - +5V; SOUND_PWR – 0V – 8V; Place the bypass capacitors of 0.1 μF for each digital IC. Additional items must be used from the component list. The input voltage to the circuit is supplied by the POWER connection and is equal to + 9V. Complete the diagram and show the results of calculations in the answer sheet #2.

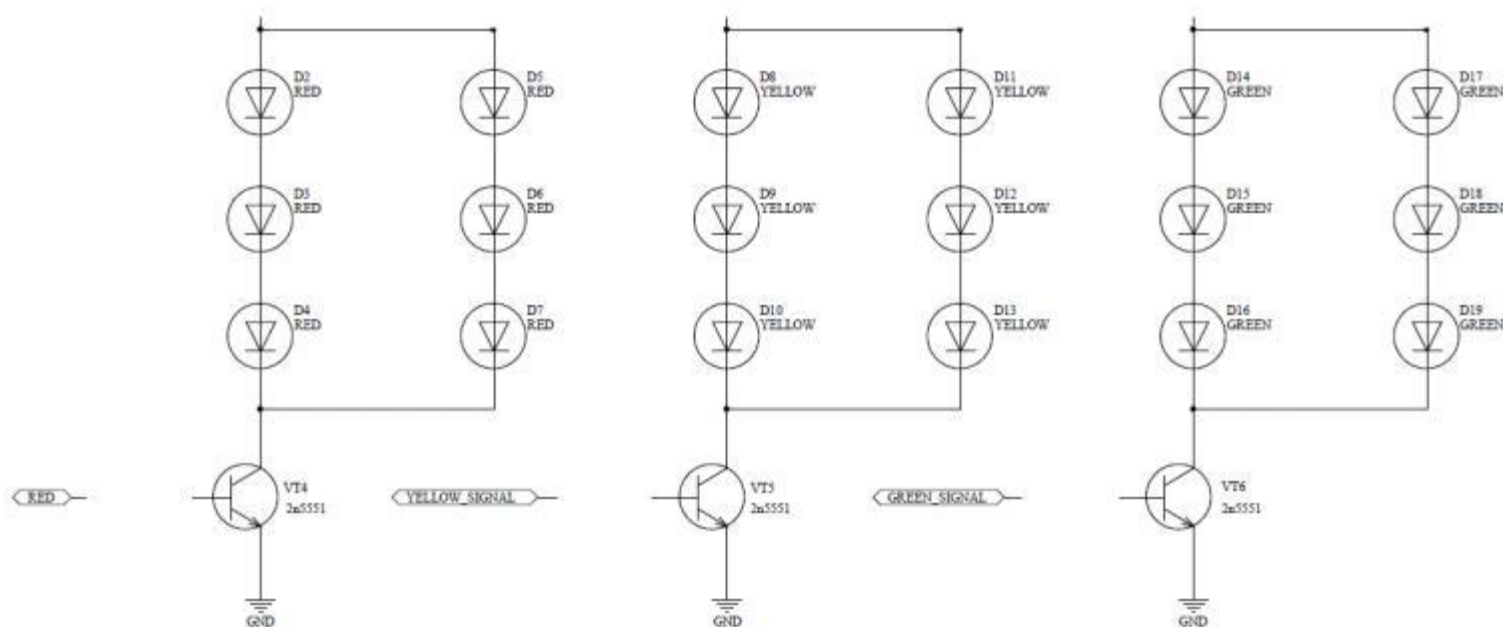
设计一个带倒计时器的交通灯电源电路并且计算该部分的标称值， 电路需要提供以下输出电压： LOGIC_PWR - +5V; SOUND_PWR – 0V~ 8V;为每个IC放置0.1 μF 的旁路电容， 额外的元件必须从元件清单里挑选， 电路的输入电压是从POWER端连入电压为+9V。完成电路图并将计算结果填入答题纸中



3.3 TRAFFIC LIGHTS SIGNALS UNIT 交通灯信号单元

Develop a LED block indicator for traffic light with a countdown timer. The circuit should power and switch red, yellow and green light. Power LED indication of traffic lights should be carried out with a stabilized current of 40 mA for each control channel. You can use additional components from the list of elements. Complete the diagram and show the results of calculations in the answer sheet #3.

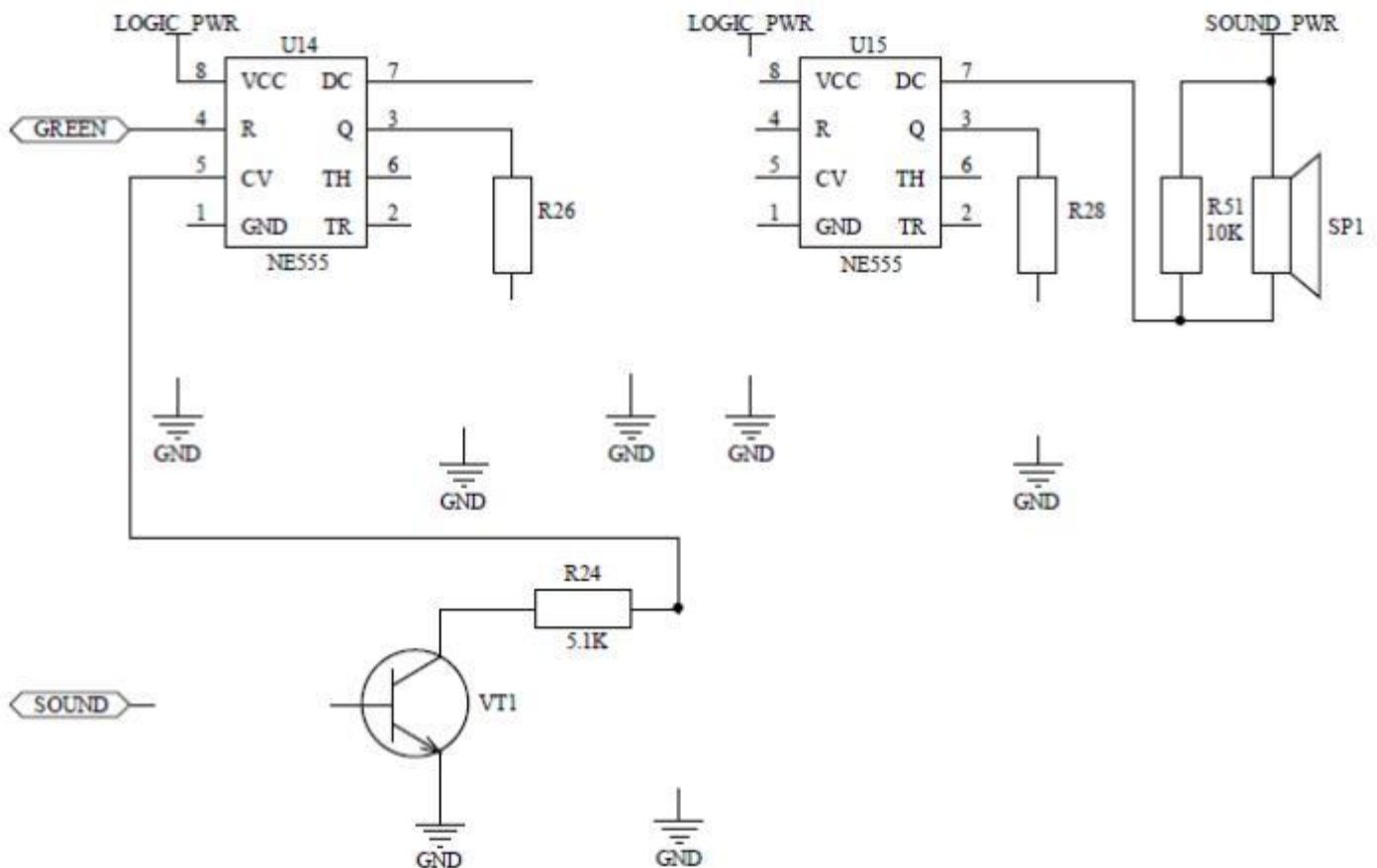
设计开发一个带倒计时的交通灯LED指示器组，电路需要控制红黄绿灯的开关，交通灯LED指示器的功率需要在每个控制通道过40mA的恒定电流，你可以使用清单中的额外元件来完成电路图并将计算结果填写到答题纸中



3.4 SOUND SIGNAL GENERATION UNIT 声音信号发生单元

Develop the circuit for generating an audio signal based on the NE555 chips. The audio signal must have a frequency of 2.5 kHz and be received to the amplifier by packets with a frequency of 1 Hz only when the green traffic light is switched on. During blinking of the green light the frequency of sound pulse packets should be increased twice. The duration of the packet of sound pulses should be equal to the pause between them. The high electrical level on the GREEN pin must turn on the sound signal, and the high electrical signal at the SOUND input should increase the frequency of the sound pulses. Additional ICs must be used from the component list. Complete the diagram and show the results of calculations in the answer sheet #4.

基于NE555设计一个音频信号发生电路。当绿灯亮的时候，音频信号是一个2.5kHz的信号并且由1Hz的信号控制。当绿灯信号闪烁时声音脉冲包的频率应该增加两倍，声音脉冲包的持续时间应该与暂停时间相等。GREEN端的高电平来开启声音信号，并且SOUND端的高电平信号可以增加声音脉冲的频率。额外元件必须从元件清单里选，完成设计并将设计结果填入答题纸中

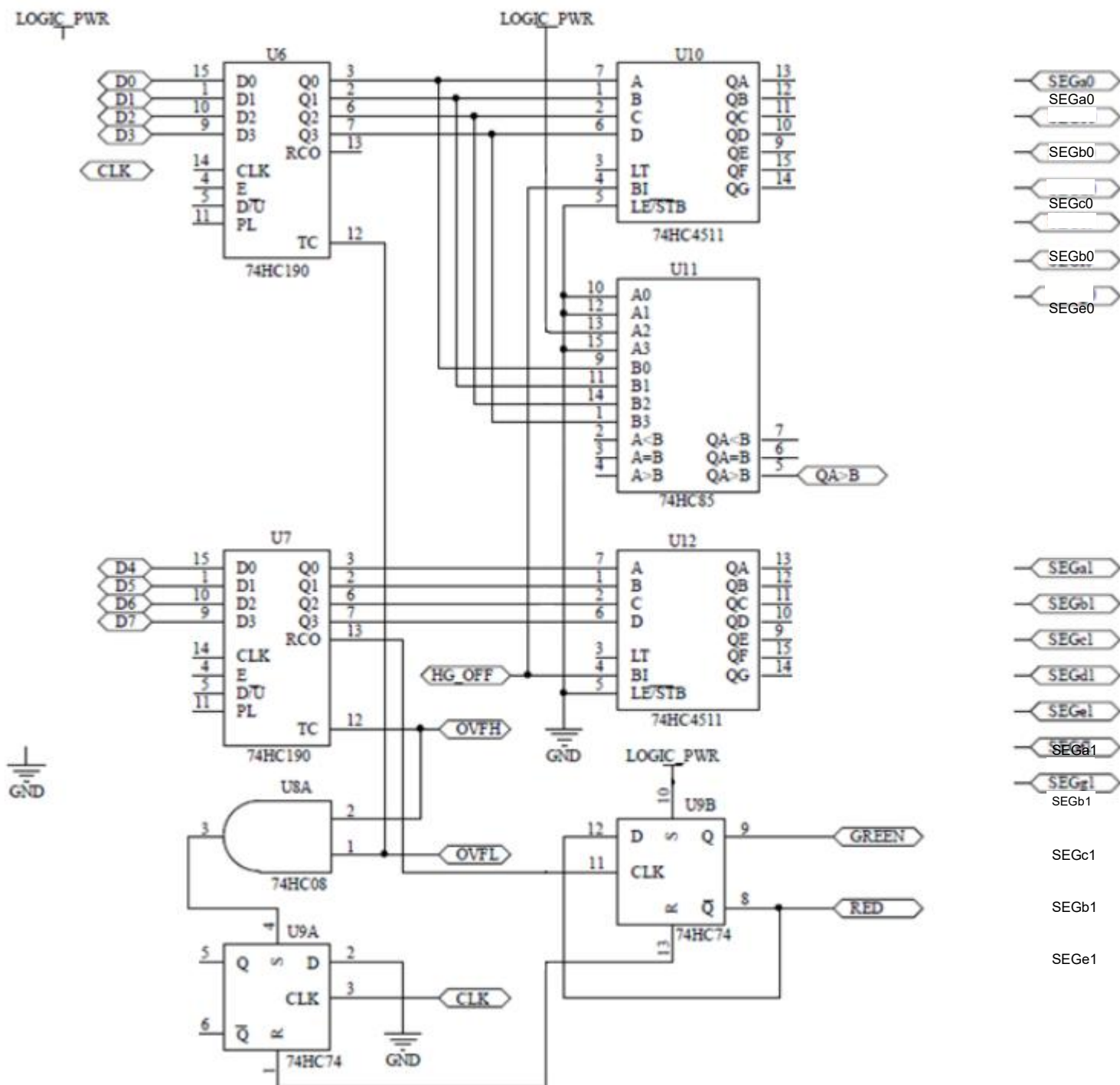


3.5 SETTING THE DURATION OF THE TRAFFIC LIGHTS SIGNALS UNIT

交通灯信号持续时间设置单元

Finalize the up-down counting scheme, which provides a countdown the time of the red and green signals of the traffic light. Switch the inputs of the 74HC190 to the BCD format counts down. Complete the diagram in the answer sheet #5.

完成为红绿灯信号提供倒计时的加减计数器原理图，通过改变74HC190的输入开关进行BCD格式的递减。完成原理图并填入答题纸



The PCB should be 150x120mm in size. Mounting holes, display components and connectors must correspond to the component layout. Use the minimum number of jumpers. The PCB must have one layer of printed conductors.

PCB尺寸在150×120mm以内，安装孔、显示元件和接口必须参照元件布局要求，使用最少数量的跳线(不多于25条)

It's necessary to covered the blank spaces by a polygon and connect to GND. Rub Out must be added during the manufacturing process.

线路板空白区域需要覆铜并且与GND相连，删除无网络死铜(方便焊接)。

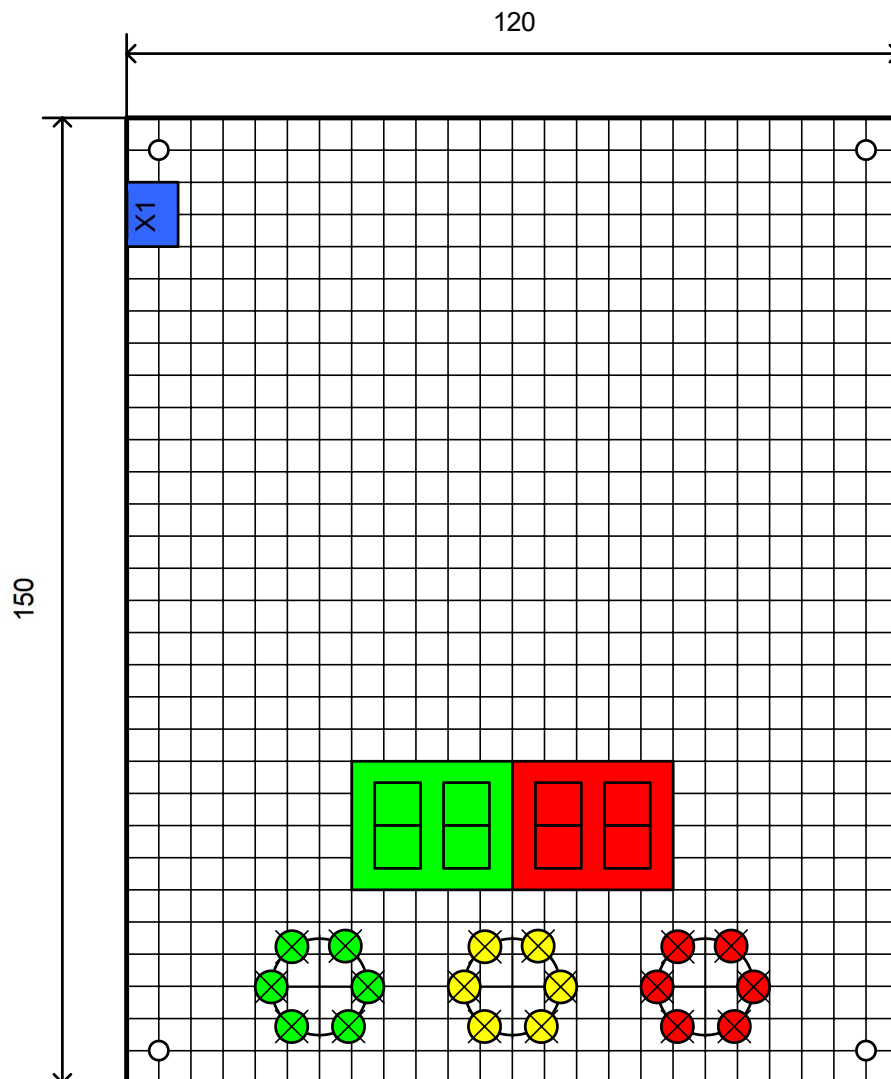


Figure 3 - PCB layout requirements (unit: mm, Grid=5mm)

图3-PCB布局要求(单位: mm, 每个栅格5mm)

All components must be arranged in strict accordance with the layout requirements shown in Figure 3. To determine the position of the components of the printed circuit board, a grid with a pitch of 5 mm is shown in the figure. Connector X1 and seven segment indicators must be placed strictly as shown in Figure 3. The LEDs should be placed evenly around the circumference with a diameter of 15mm according to figure 3. Also on the perimeter of the PCB, it is required to place 4 mounting holes, 3.24mm in diameter, as shown in Figure 3, with the clearance from the edge of the board 5mm.

所有元件必须严格按照图3要求布局，通过图中5mm的栅格块来定位元件在PCB板上的位置。X1接头和七段数码管必须严格按照图3位置放置，LED组按图3要均匀的围绕直径为15mm的圆周放置。在PCB的周边要放置4个安装孔，直径3.24mm，距离板边缘间距为5mm。

The PCB may contain wire jumpers. The jumpers must be straight and can not bend. Jumpers should be parallel the boundaries of the printed circuit board. It is forbidden to place jumpers under the bodies of components and cross each other, and forbidden to place jumpers on the GND connection.

PCB会用到跳线，填写必须是直的不是弯，跳线应该平行与PCB的边，跳线禁止在元件下方及交叉，禁止在GND使用跳线。

Design the PCB footprint of SP1 (speaker) component according the size diagram below

根据下面的外形尺寸图设计SP1(蜂鸣器)元件的PCB封装。

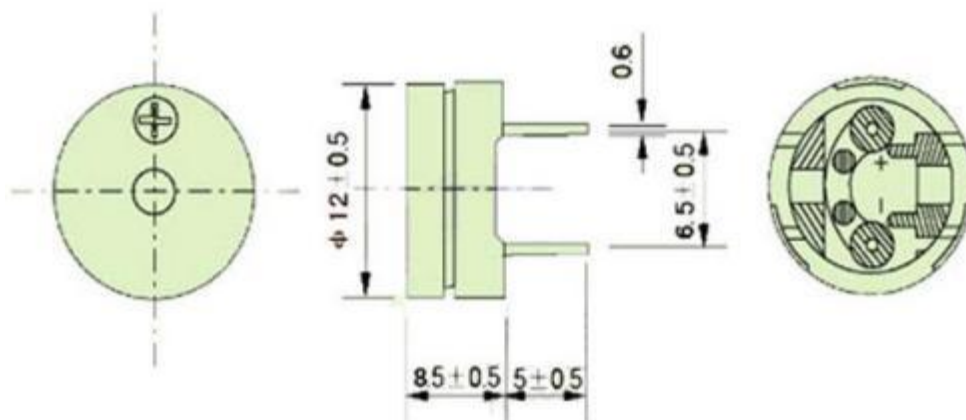


Figure 4 – Dimension and footprint of SP1 (unit: mm)

图4-SP1元件尺寸封装图(单位mm)

To verify the operation, it is necessary to prepare output GERBER files for the production of a printed circuit board in accordance with the RS-274-X standard. It is also necessary to generate BOM and pdf files with assembly information. In the TrafficLight.PDF file , the location of the components in the TOP layer, the mirror arrangement of the components in the BOTTOM layer, and the mirror image of the printed conductors in the BOTTOM layer. The file names are listed in Table 1.

为了验证操作， 需要依据RS-274-x标准准备输出GERBER文件来生产加工PCB， 同样需要生成带有安装信息的BOM和PDF文件， 元件的布置在Top Layer， 元件在Bottom Layer底层镜像布局同时镜像丝印层指示。文件清单见表1

Table 1 - Requirements for output files 需要输出的文件需求

Название файла 文件名称	Описание 描述
TrafficLightPCB.GBL	Bottom layer
TrafficLightPCB.GKO	Board outline
TrafficLightPCB.TXT	Drill

GERBER board files for production and the design of the printed circuit board made in Altium Designer are provided to the experts.

Gerber板文件用于生产， Altium Designer设计的印制电路板文件提供给裁判评分。

1.DESCRPTION OF THE PROJECT

项目描述

This project is a traffic light with a countdown timer with function of generating an audio signal.

这是一个带倒计时器及音频信号发生功能的交通灯电路

To complete this task, you need:

要完成这个任务，你需要：

The assembly of a traffic light prototype with a countdown timer takes 2 hours. After completing the time allotted for assembly, demonstrate to the experts the functionality of the device and complete the acceptance list on page12.

在 2 个小时内完成交通灯原型板的安装，完成安装后向裁判演示电路板功能，同时完成 12 页上的功能确认单。

2.FUNCTIONAL DESCRIPTION OF ELECTRONIC DEVICES "TRAFFIC LIGHT WITH COUNTDOWN TIMER"

“带倒计时器的交通灯”电路功能描述

A traffic light with a countdown timer is a digital discrete state machine based on standard logic ICs. The device repeats the functionality of traffic lights designed to regulate the traffic of vehicles, and generates signals of three colors: red, yellow and green. The countdown is displayed using two groups of seven-segment indicators, respectively red and green.

这个带倒计时器的交通灯电路是一个基于标准逻辑IC的数字离散状态机。设备会循环运行设计好的交通灯功能来达到规范车辆行驶的目的，电路产生3种颜色信号，红/黄/绿。倒计时器是通过两组7段数码管显示（显示红灯和绿灯）

The duration of the red and green signals is determined by the position of the DIP switches in the BCD format. The block diagram of the device is shown on Figure 2.

红灯和绿灯信号的持续时间是由DIP开关的BCD格式码位决定的，电路原理框图以图2所示。

The traffic light implements the following algorithm of operation, illustrated by a graph of its output signals in Figure 1.

交通灯实现下面的运算算法，如图1中的输出信号的图形所示。

After switching on the power supply, the traffic signal switching unit generates a signal for loading the operating time of the red traffic light signal. The value of the time determined by the position of the switches in the unit for setting the duration of the activation of the red signal is recorded in the up - down counter.

当上电后，交通信号开关单元产生一个读取红灯工作时间的信号，时间的值是由红灯信号持续时间设置开关单元决定，并由倒计时器记录。

At each clock pulse from the generator with a frequency of 1Hz occurs a counter decrement.

发生器生成的1Hz时钟脉冲产生一个倒计数。

The output signals of units and tens of seconds received to the decoder, from the outputs of which the seven-segment code is amplified in current and inverted by the driver of the seven segment display. The amplified signal includes a combination of indicator bits corresponding to the binary state of the up - down counter.

单元个位和十秒位信号发送到译码器，由七段译码显示驱动器进行译码。再进行了反相和电流放大，被放大的信号包含了一组与二进制计数器对应的段码信号。

At the moment when counter is switching from one to zero value, a signal is generated to turn on the yellow traffic light signal and turn off the red time indication unit and green signal.

与此同时当计数器的某一位值从1到0时，产生一个信号，将开启黄灯信号并且关闭红灯时间指示单元和绿灯信号。

At the end of the countdown traffic lights switching unit switches its state. As a result, the up-down counter is loaded with the green light signal turn-on time, red and yellow lights are turned off, and the green traffic light turns on.

在交通灯开关设置的红灯倒计时结束时，加减计数器伴随着绿灯信号启动开始工作，红灯和黄灯关闭，绿灯开始工作。

Marking Scheme 配分

Circuit Functionality	10p	(电路功能)
Assembly Quality	5 p	(安装质量)

1.TASK FOR COMPETITORS

选手的任务

ASSEMBLY THE PROTOTYPE BROAD 电子电路安装与调试

Perform the assembly of PCB according to the task, using the necessary tools, equipment and documentation. Assembly PCB in accordance with IPC A-610F.

根据任务要求实施PCB组装，使用必要的工具、仪器和文档，装配依据IPC A-610F标准。

Perform a function check of all units and the necessary presetting to perform the functions of the electronic device "Traffic light with a countdown timer".

实施检查所有单元的功能，需要展示出“带倒计时交通灯”设备的功能。

ATTENTION! The power supply voltage of the traffic light board with a countdown timer is 3.5 - 5V. Before turning on the traffic light, it is necessary to set the time for activating the red and green traffic lights in BCD format. When the device is started for the first time, the on-time load may not be correct, to evaluate the circuit's functionality it is necessary to wait for the end of first switching of traffic light signals.

注意：带倒计时交通灯电路板的工作电压是3.5-5V，在打开交通灯之前，要先设置好BCD格式的红灯和绿灯启动的时间。当设备第一次启动时，实时读取信号不一定正确，要评估电路的功能最好是等到第一个交通灯信号转换之后。

2.LIST OF COMPONENTS

元件清单

Component	Disignator	Amount
100uF		1
0. 1uF		4
1uF		2
1500pF		1
330uF		1
0. 1uF		13
10uF		1
10uF		1
100n		1
1uF		1
TMBYV10-40FILM	D1	1
BL-L513LRD (RED)	D2, D3, D4, D5, D6, D7	6
BL-L513UYD (Yellow)	D8, D9, D10, D11, D12, D13	6
L- 1503GT (Green)	D14, D15, D16, D17, D18, D19	6
SA05- 11EWA	HG1, HG3	2
SA05- 11GWA	HG2, HG4	2
ELC10D221E 170mH 1,1A	L1	1
DG301-5.0	P1	1
0.22		1
180		1
1K		1
6K2		1
240		1
10K		1
ЧИП 0. 125Вт 0805 100K		16
2.7K		6
5K1		1

75K		1
75K		1
10K		2
270		1
270		14
33		3
SPEAKER	SP1	1
DS1040-08	SW1, SW2	2
MC34063	U1	1
7805	U2	1
LM317	U3	1
74HC245	U4, U5	2
74HC190	U6, U7	2
74HC08	U8	1
74HC74	U9	1
74HC4511	U10, U12	2
74HC85	U11	1
NE555	U13	1
NE555	U14, U15	2
74HC00	U16	1
LM317	U17, U18, U19	3
2n5551	VT1, VT2, VT3, VT4, VT5, VT6	6

3.线路板装配要求

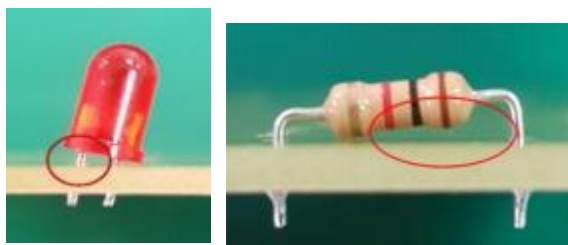
1) 元件摆放方向一致，要求色环电阻、 SMD 元件识读方向一致，测量针环方向一致。

以下情形将被扣分：



2) 元件安装需要对称美观，不能倾斜、歪翘。

以下情形将被扣分：



3) 元件安装位置要居中，SMD 元件置于焊盘并对称居中。

以下情形将被扣分：



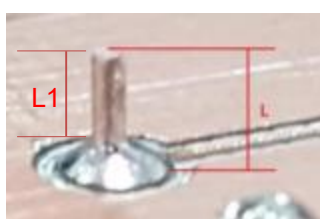
4) 圆柱形过孔器件(电解电容、 LED 等)立式安装需要与线路板之间留有 0.5mm-1.0mm 的间距，瓷片电容、钽电容等元件间距控制在 1.2mm。

以下情形将被扣分：

- 紧贴在 PCB 上，无任何间距；
- 安装过高并且大于 1.2mm

5) 直插电阻、电容、LED、二极管等元件引脚剪脚留长控制在 1.0-1.5mm。

以下情形将被扣分：



$L1 > 1.5\text{mm}$

6) LED 颜色正确，按下表要求安装 LED。

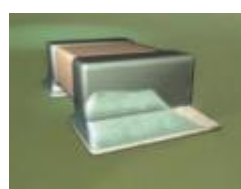
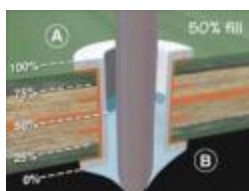
- LED1-绿色， LED2-蓝色， LED3-红色， LED4-黄色

7) 焊料覆盖大于焊盘 75%，过孔中焊料需要填充超过 75%

以下情形将被扣分：



$< 270^\circ$



8) 焊点浸润良好，焊料使用量适当，无短路、漏焊、虚焊、球状、拉尖、气孔等现象。

以下情形将被扣分：



9) 元件完好，无破损或表面烫伤的元件。

下列情形将被扣分：



10) 板面清洁，无飞溅焊渣，无过多的助焊剂残留。

4.ACCEPTANCE LIST

电路功能确认表

No	The parameter to be checked 检查的参数	Competitor Check 选手检查	Expert Confirmation 专家确认
1	When power is ON, SEG or any LED could be turn on(No short occur) 板通电后数码管或任何一个LED会亮(没有短路)		
2	Countdown timer could work correctly 数码管能够正确倒计时		
3	RED/YELLOW/GREEN switched correctly 红、黄、绿灯可以正确切换		
4	RED signal duration presenting time is correct 红灯预置倒计时时间显示正确		
5	GREEN signal duration presenting time is correct 绿灯预置倒计时时间显示正确		
6	green signal is reduced to three seconds could blink (1HZ) 绿灯信号倒计时最后3秒可以闪烁(1Hz)		
7	Speaker made sound correct according to the design 蜂鸣器工作正确(绿灯亮和最后3秒两种模式)		
8	SEG and LEDs are indication integrity 数码管和LED显示正确(无缺段和不亮)		

注：打 √或×

第二届中华人民共和国职业技能大赛江苏省选拔赛样题

二 . 故障查找与检修

电子技术

工位号： _____

以上内容仅为本文档的试下载部分，为可阅读页数的一半内容。如要下载或阅读全文，请访问：<https://d.book118.com/356053032050010100>