

### Features

- Operating voltage: 4.5V~5.5V
- 4 SCR direct drive outputs
- 10 different groups of lighting patterns
- Up to 8 patterns for each group
- Demonstration function
- One key activation function
- Up to 23 patterns can be programmed inside
- Built-in PLL circuit
- 50Hz or 60Hz AC power supply applications
- Default 12 patterns for standard applications

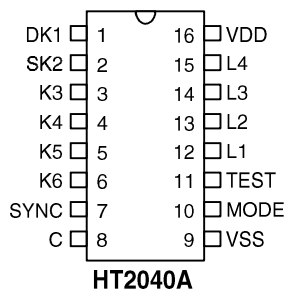
### General Description

The HT2040A is a low cost, low power CMOS LSI chip designed for use in Christmas lighting control products. It provides 4 SCR outputs to control the lamps. The lamps can display up to 10 different groups of lighting patterns, where each pattern or pattern group is chosen by appropriate input keys.

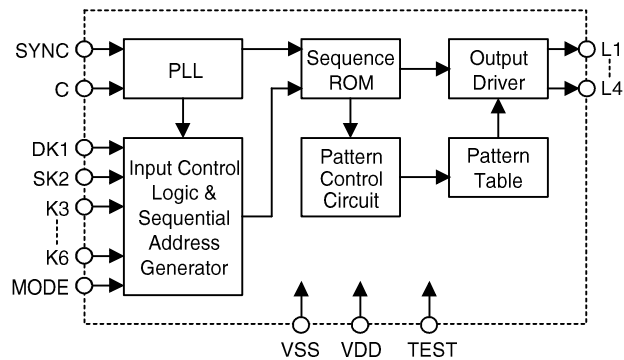
The available 10 groups of lighting patterns can all be displayed automatically or sequentially using a single key. (12 patterns and 10 pre-programmed groups are provided by default.)

The internal PLL circuit allows synchronized control of the SCRs at either 50Hz or 60Hz AC supply voltage.

### Pin Assignment

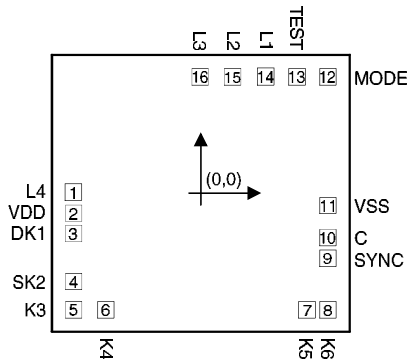


### Block Diagram



**Pad Coordinates**

Unit: mil



| Pad No. | X      | Y      | Pad No. | X     | Y      |
|---------|--------|--------|---------|-------|--------|
| 1       | -46.47 | -0.17  | 9       | 46.47 | -23.89 |
| 2       | -46.47 | -7.01  | 10      | 46.47 | -16.24 |
| 3       | -46.47 | -14.66 | 11      | 46.47 | -4.51  |
| 4       | -46.47 | -32.22 | 12      | 46.47 | 42.59  |
| 5       | -46.47 | -42.59 | 13      | 35.17 | 42.59  |
| 6       | -34.74 | -42.59 | 14      | 23.86 | 42.59  |
| 7       | 38.82  | -42.59 | 15      | 11.62 | 42.59  |
| 8       | 46.47  | -42.59 | 16      | -0.32 | 42.59  |

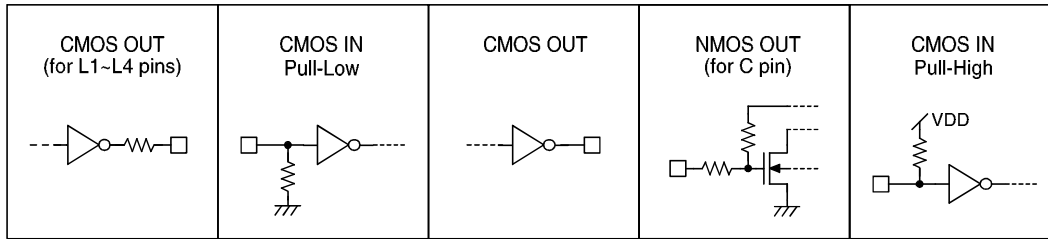
 Chip size:  $107 \times 99 \text{ (mil)}^2$ 

\* The IC substrate should be connected to VDD in the PCB layout artwork.

**Pad Description**

| Pad No. | Pad Name | I/O | Internal Connection | Description  |
|---------|----------|-----|---------------------|--|
| 1       | L4       | O   | CMOS                | Lamp driving signal<br>L4 generates a high SCR trigger signal to control the lamp intensity.   |
| 2       | VDD      | I   | —                   | Power supply (positive)  |
| 3       | DK1      | I   | CMOS Pull-Low       | Demo function or group-5 selection input<br>If MODE is connected to VSS or open, DK1 will enable the demo mode, i.e., show all the configurations (group-1 ~ group-10) by being momentarily connected to VDD. If MODE is connected to VDD, group-5 will be shown by connecting DK1 to VDD. |
| 4       | SK2      | I   | CMOS Pull-Low       | One key activated display or group-6 selection<br>If MODE is connected to VSS or floating, SK2 will display the next group by being momentarily pressed. If MODE is connected to VDD, group-6 will be shown by connecting SK2 to VDD.  |
| 5~8     | K3~K6    | I   | CMOS Pull-Low       | Group1 ~ Group4 selection<br>If MODE is connected to VSS or floating, group-7~group-10 will be shown by connecting MODE to VDD.  |
| 9       | SYNC     | I   | CMOS                | PLL synchronous signal input<br>The PLL circuit is synchronized to the AC power supply. The system can operate with a 60Hz or 50Hz AC power supply system.   |
| 10      | C        | I   | NMOS                | For low pass PLL filters   |

| Pad No. | Pad Name | I/O | Internal Connection | Description  |
|---------|----------|-----|---------------------|--|
| 11      | VSS      | I   | —                   | Power supply (ground)  |
| 12      | MODE     | I   | CMOS Pull-Low       | MODE defines the operating functions of DK1, SK2, and K3~K6 (refer to the functional description). |
| 13      | TEST     | I   | CMOS Pull-High      | For IC test only   |
| 14~16   | L1~L3    | O   | CMOS                | Lamp driving signals<br>L1~L3 generate high SCR trigger signals to control the lamp intensity.     |

**Approximate internal connection circuit**

**Absolute Maximum Ratings**

|                      |  |                            |                |
|----------------------|--|----------------------------|----------------|
| Supply Voltage ..... | -0.3V to 5.5V                                  | Storage Temperature.....   | -50°C to 125°C |
| Input Voltage.....   | V <sub>SS</sub> -0.3V to V <sub>DD</sub> +0.3V | Operating Temperature..... | -20°C to 75°C  |

**Electrical Characteristics**

(Ta=25°C)

| Symbol           | Parameter                   | Test Condition  |                       | Min.               | Typ.  | Max.               | Unit |
|------------------|-----------------------------|-----------------|-----------------------|--------------------|-------|--------------------|------|
|                  |                             | V <sub>DD</sub> | Condition             |                    |       |                    |      |
| V <sub>DD</sub>  | Supply Voltage              | —               | —                     | 4.5                | 5.0   | 5.5                | V    |
| I <sub>DD</sub>  | Operating Current           | 5V              | No load               | —                  | 300   | 600                | μA   |
| I <sub>OL</sub>  | L1~L4 Output Sink Current   | 5V              | V <sub>OL</sub> =0.5V | 2.0                | 4.0   | —                  | mA   |
| I <sub>OH</sub>  | L1~L4 Output Source Current | 5V              | V <sub>OH</sub> =4.5V | -15                | -22   | —                  | μA   |
| V <sub>IH</sub>  | “H” Input Voltage           | —               | —                     | 0.8V <sub>DD</sub> | —     | —                  | V    |
| V <sub>IL</sub>  | “L” Input Voltage           | —               | —                     | —                  | —     | 0.2V <sub>DD</sub> | V    |
| F <sub>OSC</sub> | Internal System Frequency   | —               | AC 60Hz               | —                  | 122.9 | —                  | KHz  |
|                  |                             |                 | AC 50Hz               | —                  | 102.4 | —                  |      |

**Functional Description**

The HT2040A provides 10 different lighting configurations. Each lighting configuration is called a group. A group is divided into sections (up to 8 sections maximum) where each section contains exactly one pattern. The patterns and the corresponding sections can be programmed into a group from a repository of up to 23 different patterns. The default option for the chip is 12 patterns with 10 pre-programmed groups.

The groups can be individually selected by using the DK1, SK2, and K3-K6 pins, where each pin has 2 functions that are decided by the status of the MODE pin. All groups will be displayed by momentarily connecting SK2 to VDD with the MODE pin being connected to VSS. Given this, the HT2040A provides a very versatile and easy way of controlling lamps.

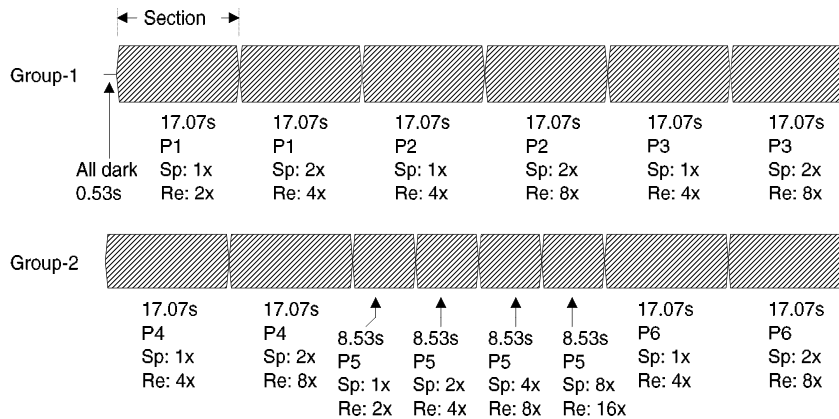
If the MODE pin is not connected to VDD and power is turned on, the system will enable the DEMO mode. But if the MODE pin is connected to VDD, the system will show the group assignment of each pin as shown in the following table.

| Selected Pin     |             | MODE          |               |
|------------------|-------------|---------------|---------------|
|                  |             | Open or VSS   | VDD           |
| DK1              | active high | —             | Show Group-5  |
|                  | momentarily | Demo function | —             |
| SK2              | active high | —             | Show Group-6  |
|                  | momentarily | One key show  | —             |
| K3 (active high) |             | Show Group-1  | Show Group-7  |
| K4 (active high) |             | Show Group-2  | Show Group-8  |
| K5 (active high) |             | Show Group-3  | Show Group-9  |
| K6 (active high) |             | Show Group-4  | Show Group-10 |

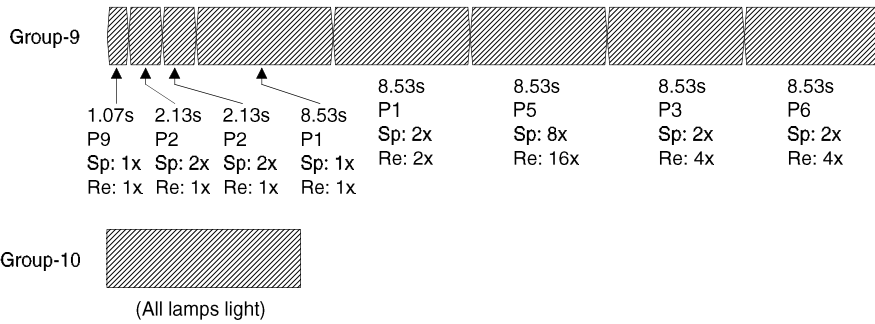
**Group List**

The available 10 groups in which the lamps can be displayed are illustrated in the following diagram. Each group is comprised by sections

where each section contains only one pattern. The approximate time of each section is based upon the 60Hz AC power frequency.



|         |        |        |         |         |         |         |         |
|---------|--------|--------|---------|---------|---------|---------|---------|
| Group-3 |        |        |         |         |         |         |         |
|         | 4.27s  | 4.27s  | 4.27s   | 4.27s   | 4.27s   | 4.27s   | 4.27s   |
|         | P8     | P8     | P8      | P8      | P8      | P8      | P8      |
|         | Sp: 1x | Sp: 2x | Sp: 4x  | Sp: 8x  | Sp: 4x  | Sp: 2x  | Sp: 1x  |
|         | Re: 2x | Re: 4x | Re: 8x  | Re: 16x | Re: 8x  | Re: 4x  | Re: 2x  |
| Group-4 |        |        |         |         |         |         |         |
|         | 4.27s  | 4.27s  | 4.27s   | 4.27s   | 4.27s   | 4.27s   | 4.27s   |
|         | P8     | P8     | P7      | P8      | P7      | P7      | P7      |
|         | Sp: 2x | Sp: 4x | Sp: 2x  | Sp: 8x  | Sp: 4x  | Sp: 2x  | Sp: 1x  |
|         | Re: 4x | Re: 8x | Re: 8x  | Re: 16x | Re: 16x | Re: 8x  | Re: 4x  |
| Group-5 |        |        |         |         |         |         |         |
|         | 0.53s  | 0.53s  | 0.53s   | 0.53s   | 0.53s   | 0.53s   | 0.53s   |
|         | P10    | P7     | P10     | P10     | P8      | P8      | P8      |
|         | Sp: 1x | Sp: 4x | Sp: 1x  | Sp: 1x  | Sp: 8x  | Sp: 8x  | Sp: 8x  |
|         | Re: 1x | Re: 2x | Re: 1x  | Re: 1x  | Re: 2x  | Re: 2x  | Re: 2x  |
| Group-6 |        |        |         |         |         |         |         |
|         | 4.27s  | 4.27s  | 4.27s   | 4.27s   | 4.27s   | 4.27s   | 4.27s   |
|         | P12    | P12    | P12     | P12     | P12     | P12     | P12     |
|         | Sp: 1x | Sp: 2x | Sp: 2x  | Sp: 2x  | Sp: 4x  | Sp: 4x  | Sp: 4x  |
|         | Re: 4x | Re: 8x | Re: 8x  | Re: 8x  | Re: 16x | Re: 16x | Re: 16x |
| Group-7 |        |        |         |         |         |         |         |
|         | 4.27s  | 4.27s  | 4.27s   | 4.27s   | 4.27s   | 4.27s   | 4.27s   |
|         | P12    | P12    | P12     | P11     | P11     | P11     | P11     |
|         | Sp: 1x | Sp: 2x | Sp: 4x  | Sp: 4x  | Sp: 2x  | Sp: 2x  | Sp: 1x  |
|         | Re: 4x | Re: 8x | Re: 16x | Re: 16x | Re: 8x  | Re: 8x  | Re: 4x  |
| Group-8 |        |        |         |         |         |         |         |
|         | 1.07s  | 4.27s  | 4.27s   | 4.27s   | 4.27s   | 4.27s   | 4.27s   |
|         | P9     | P8     | P7      | P7      | P12     | P11     | P12     |
|         | Sp: 1x | Sp: 4x | Sp: 2x  | Sp: 4x  | Sp: 2x  | Sp: 2x  | Sp: 4x  |
|         | Re: 1x | Re: 8x | Re: 8x  | Re: 16x | Re: 8x  | Re: 8x  | Re: 16x |

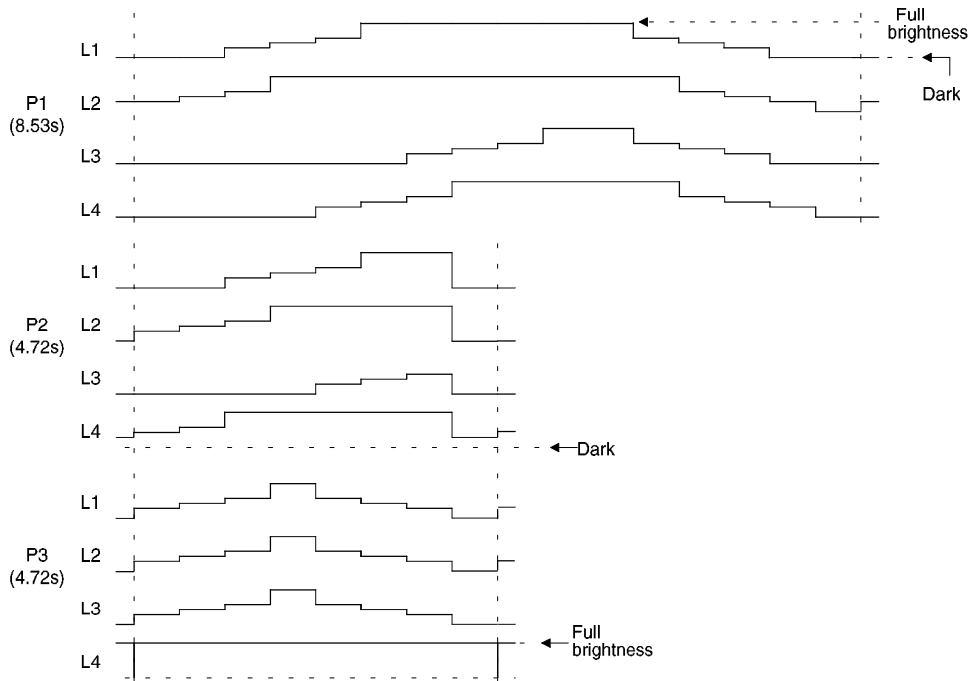


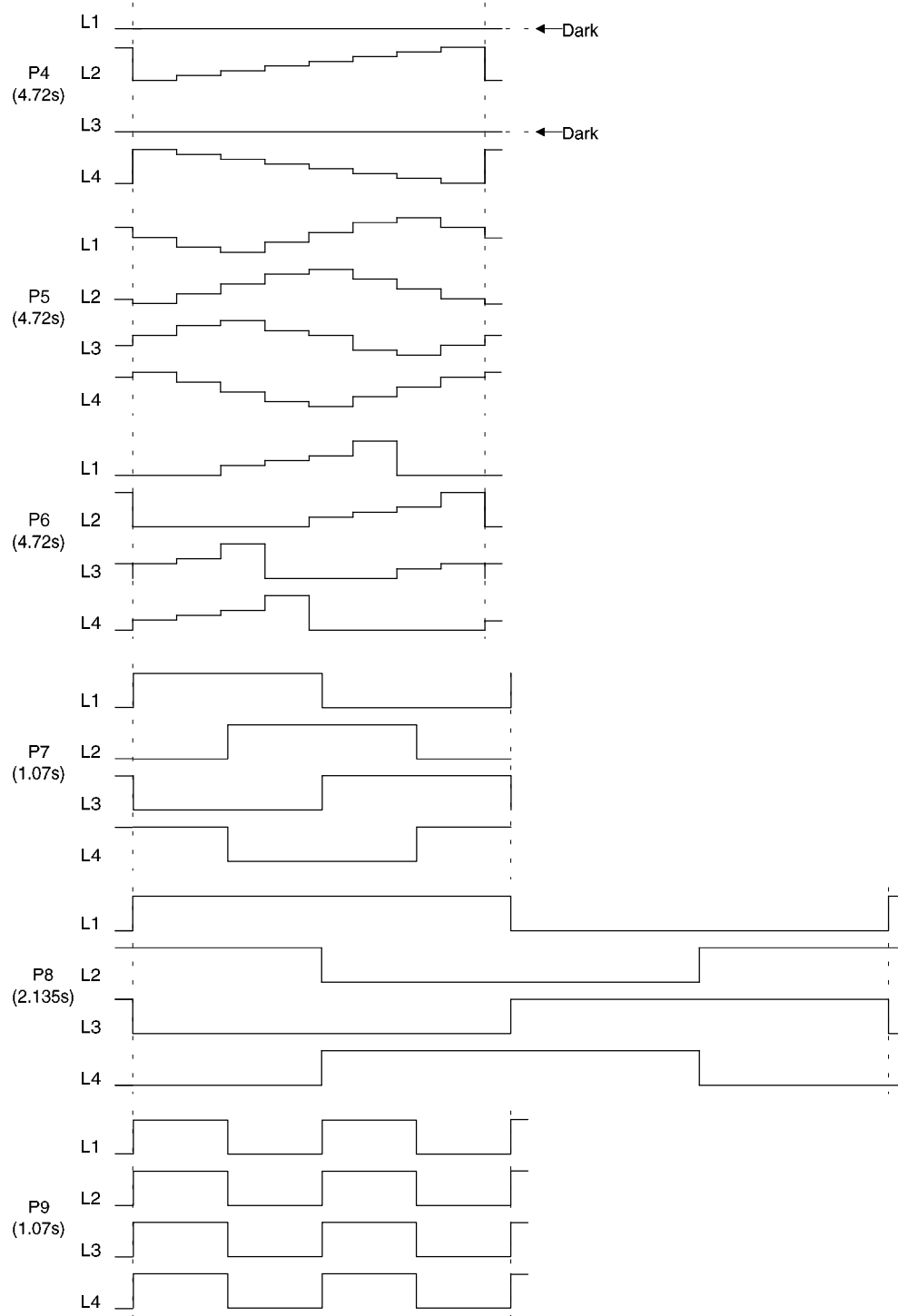
\*Note: Sp denotes the display speed of a pattern, and Re denotes the repeating number.  
 For example, Sp: 1x means normal speed.  
 Sp: 2x means double speed.  
 Re: 1x shows a pattern once.  
 Re: 2x shows a pattern twice.

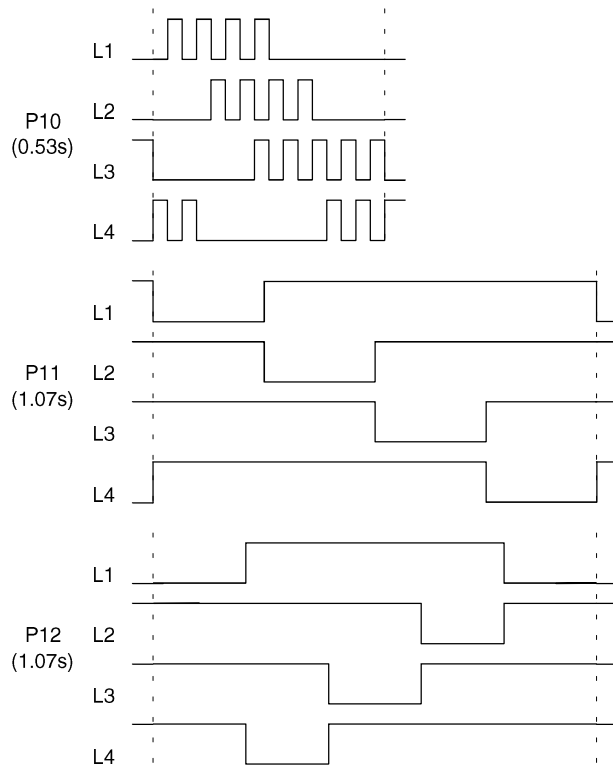
**Lamp Pattern**

Lamp patterns determine the way that each lamp is controlled. There are totally 12 patterns by default. Patterns P1 to P6 decide various

degrees of lamp brightness from fully on to fully off whereas patterns P7~P12 can only turn the lamps either fully on or fully off.



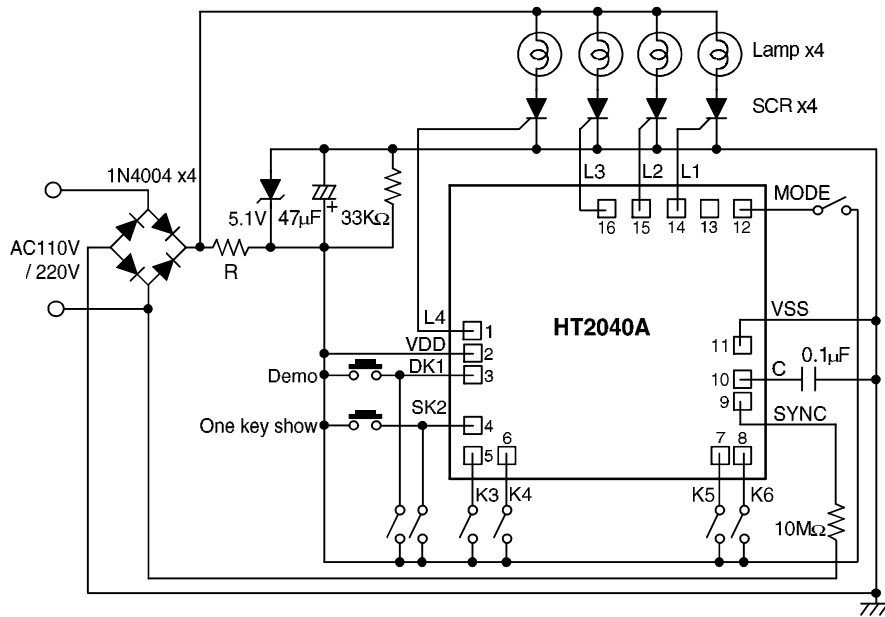






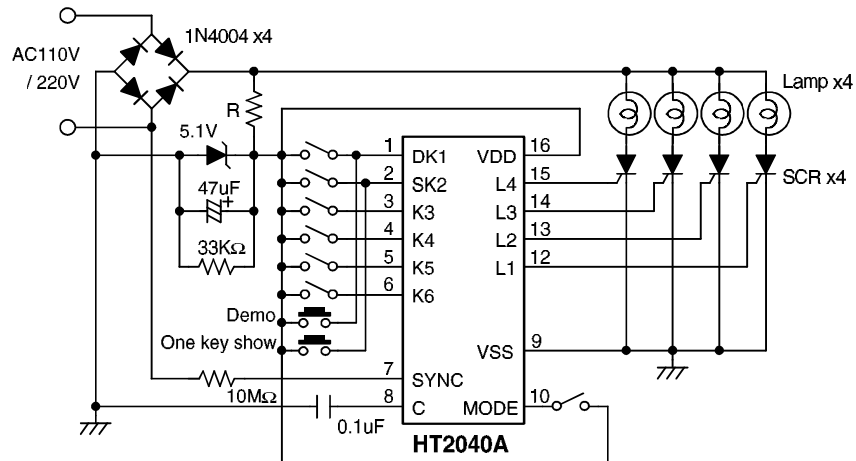
Application Circuit

Chip form



- \*Note: 1. The IC substrate should be connected to VDD in the PCB layout artwork.
- 2.  $R = 47K\Omega/0.5W$  when the AC power supply is 110V
- $R = 91K\Omega/1W$  when the AC power supply is 220V.

Package form



- \*Note:  $R = 47K\Omega/0.5W$  when the AC power supply is 110V
- $R = 91K\Omega/1W$  when the AC power supply is 220V.