step-down transformer (X1), two 1N4007 rectifier diodes (D1 and D2) and a 5V regulator 7805 (IC1).

The cube uses 64 green LEDs to make a 4 rows × 16 columns structure. All the LEDs are wired to 74HC154 decoder and AT89C2051 microcontroller. AT89C2051 is a 20-pin MCS-51 family controller having only two input/output ports.

To control individual LEDs for different display patterns, the 4 rows are controlled by BC547 transistors (T1 through T4). Port pins P1.0 through P1.3 control row transistors T4 through T1, respectively, and pins P1.4 through P1.7 control decoder IC3 with the help of the software program.

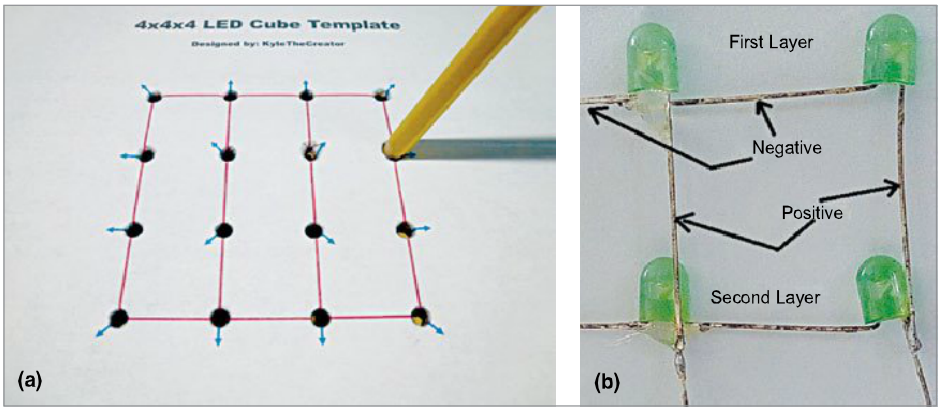

Fig. 3: Tips for soldering: (a) Placement of LEDs on the template, and (b) Bending/pulling the negative lead

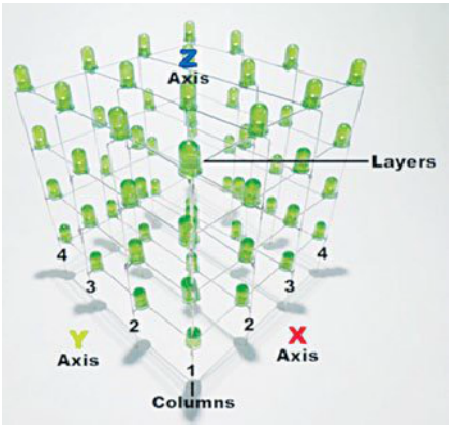

Fig. 4: Final structure of the 4x4x4 LED cube

First, using a button cell battery or multimeter in diode mode, check each LED for proper working. This may sound tedious but, in the end, it will safeguard your project!

Cube construction. Construct LED layers from the topmost layer (first layer) down towards the base layer (fourth layer) on the PCB. Take a template, preferably a cardboard with holes as shown in Fig. 3(a). Hole-to-hole distance is about 25.4mm. The cardboard helps in holding the LEDs during lead soldering.

Insert 16 LEDs into the holes and bend the negative (cathode/shorter) leads 90° outwards using needle-nose pliers. Solder negative leads of all the LEDs in the first layer. Next, solder positive leads of all the LEDs in the first layer to the positive leads of the LEDs in the second layer as shown in Fig. 3(b). Connect the subsequent layers in this manner. Solder positive leads of all the LEDs in the fourth layer to the PCB board.

The final structure of the 4x4x4 LED cube is shown in Fig. 4.

Software

The circuit is controlled using the software program loaded into the internal 2kB memory of AT89C2051. The program implements all the required functionalities. It is written in embedded C programming language and compiled using Keil µvision 4 IDE.

The code has five loops (stage1,

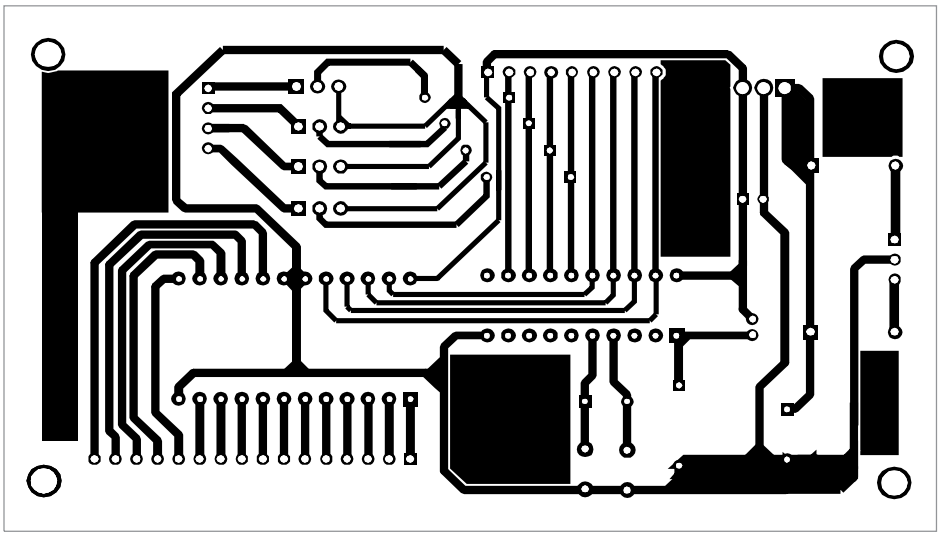

Fig. 5: Actual-size PCB layout of the 4x4x4 LED cube

PARTS LIST

Semiconductors:	
IC1	- 7805, 5V voltage regulator
IC2	- AT89C2051 microcontroller
IC3	- 74HC154 decoder
T1-T4	- BC547 npn transistor
D1, D2	- 1N4007 rectifier diode
LED1-LED64	- 5mm LED
Resistors (all 1/4-watt, ±5% carbon):	
R1-R4	- 10-kilo-ohm
R5	- 8.2-kilo-ohm
RNW1	- 10-kilo-ohm resistor network
Capacitors:	
C1	- 1000µF, 35V electrolytic
C2	- 100µF, 16V electrolytic
C3	- 10µF, 16V electrolytic
C4, C5	- 33pF ceramic disk
Miscellaneous:	
X1	- 230V AC primary to 12V-0-12V, 500mA secondary transformer
CON1	- 3-pin connector
CON2	- 16-pin connector
CON3	- 4-pin connector
XTAL1	- 11.0592MHz
	- 230V AC mains
	- 20-pin IC socket
	- 24-pin IC socket
	- Head-sink for IC1

EFY Note
The source code of this project is included in this month's EFY DVD and is also available for free download at *source.efymag.com*

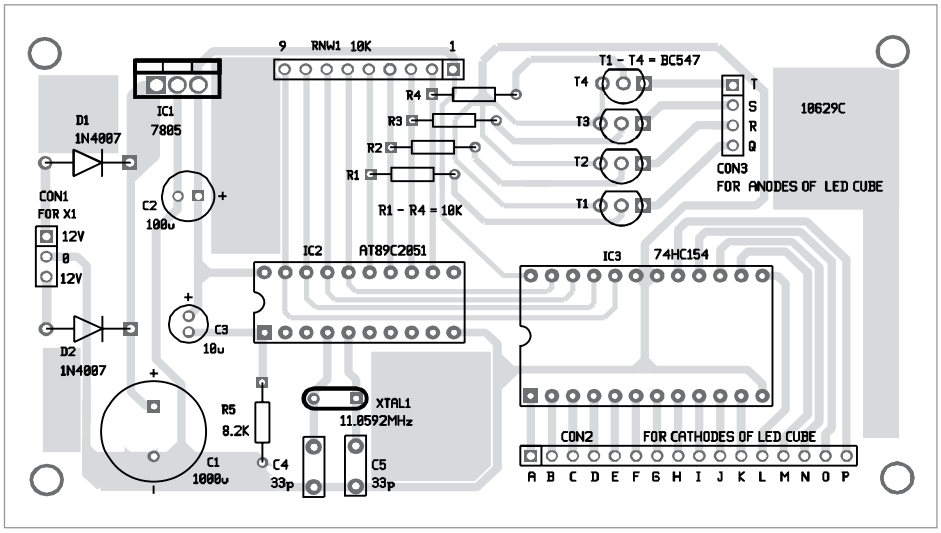

Fig. 6: Components layout for the PCB

stage2, stage3, stage4 and stage5) for demo purpose to show how you can control the 4x4x4 LED cube. You can include many more loops to create amazing lighting effects and patterns.

The hex code generated by the compiler is programmed into the microcontroller. At EFY Lab, ProgISP programmer was used to program the IC.

Construction and testing

An actual-size, single-side PCB for the 4x4x4 LED cube using AT89C2051 is shown in Fig. 5 and its components layout in Fig. 6.

After assembling the circuit on the PCB, connect CON2 to row LEDs and CON3 to column LEDs using external wires. Testing is relatively simple and user-friendly. When you connect 230V AC mains power supply to the circuit, the LED cube automatically starts glowing with lighting effects. EFY

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