

## **GENERAL DESCRIPTION**

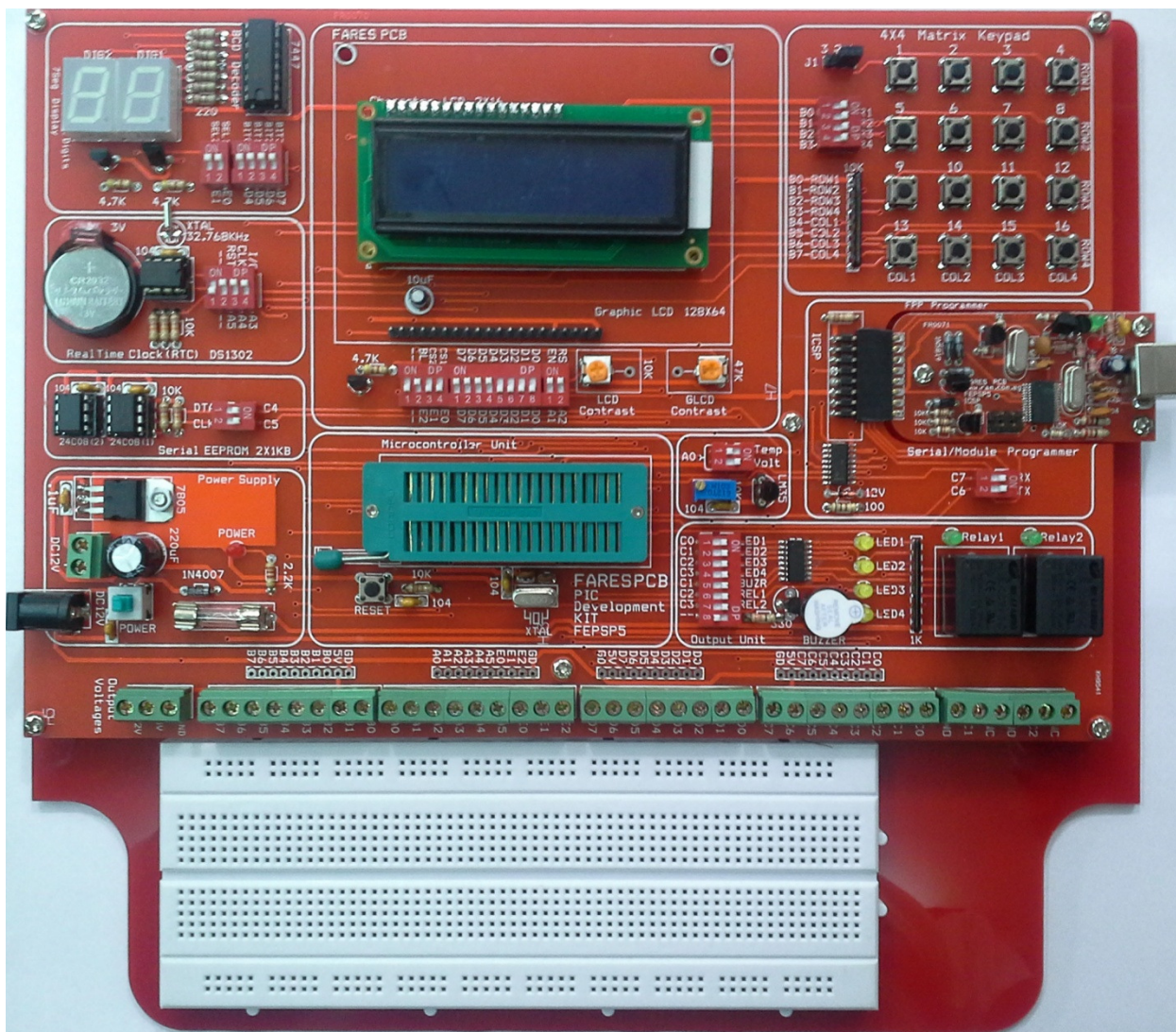
FEPS5 is an enhanced version of FEPS5 kit. FEPS5 kit is still simple designed particularly for students, beginners and recent graduated engineers to provide easily development PIC microcontroller projects.

FEPS5 supports many PIC microcontroller chips, such as 16F877A, 18F452 and more. All microcontroller I/O pins are brought out via pin header and screw clamp connector allow flexibility for direct port accessing, while provides the most common primary devices and circuits, such as LCD, 7SEG, KEYPAD, analog voltage, serial interface , and more. Thus, it saves most of the wasted time and efforts in hardware design and test, hence, the user can forward his efforts to software development.

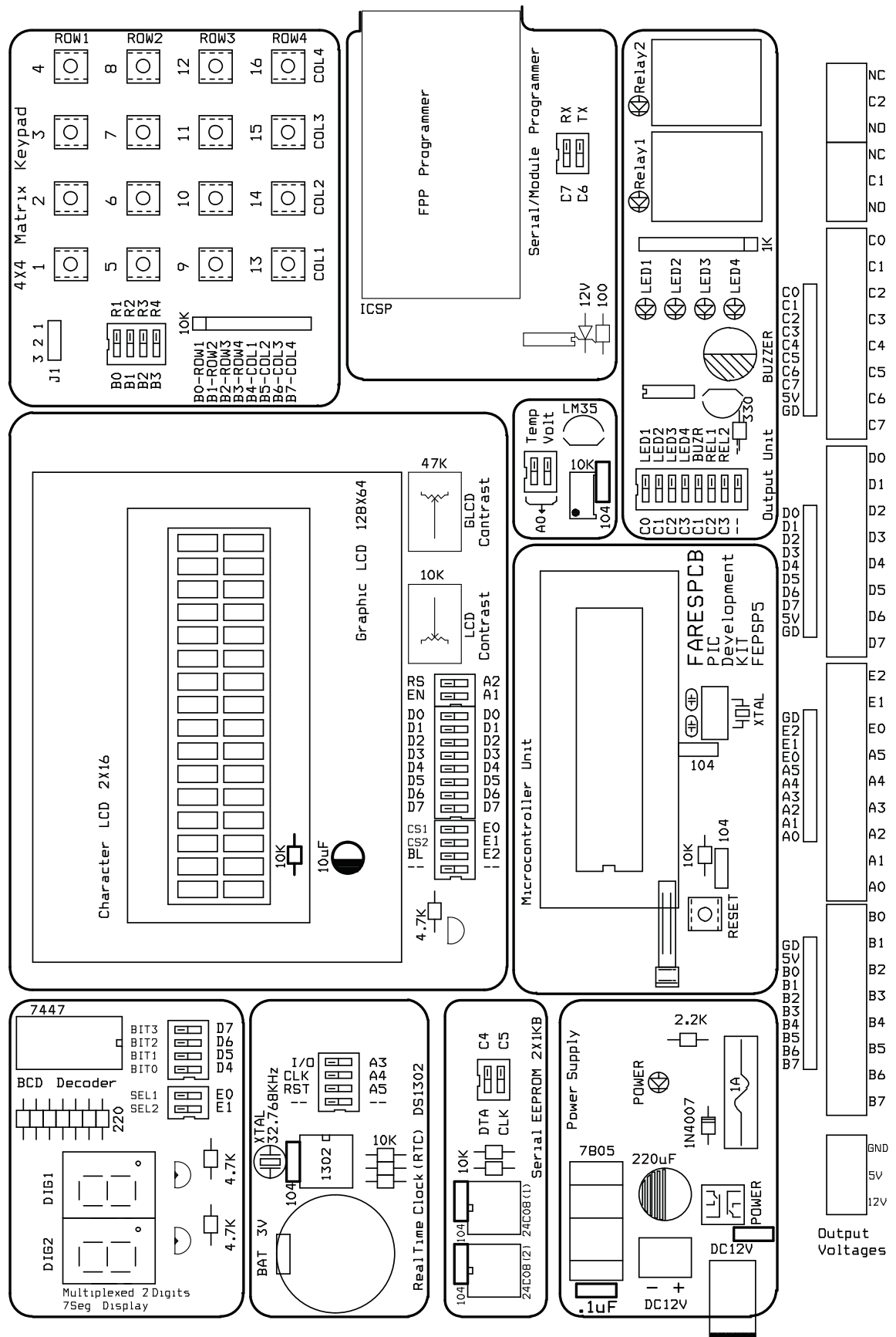
FEPS5 kit also still includes ICSP circuit. This circuit make the programming of chip is so easy, because you don't need to plug the chip out during programming. Only press one switch to change between program and run mode.

FEPS5 kit includes standard breadboard for other circuit extensions.

**Figure 1. FEPS5 kit real PCB view**



**Figure 3. FEPSP5 kit layout view**





## **FEPSP5 key features**

1. Power supply unit.
2. Microcontroller unit with reset circuit and pluggable crystal oscillator.
3. 4X4 matrix keypad unit.
4. Output unit involves four output LEDs, two output relays and one output buzzer.
5. Multiplexed two digits 7 segments display unit.
6. 2X16 LCD display unit.
7. 128X64 graphical LCD (optional).
8. Analog unit involved variable analog input using high accuracy multi-turn resistor and temperature sensor.
9. Serial EEPROM unit includes two memory chips (24C08).
10. Real time clock (RTC) unit with backup battery.
11. ICSP and virtual COM port via USB.
12. All microcontroller I/O pins are brought out via pin header and screw clamp connector.



## Power Supply Unit

### Power may be supplied from

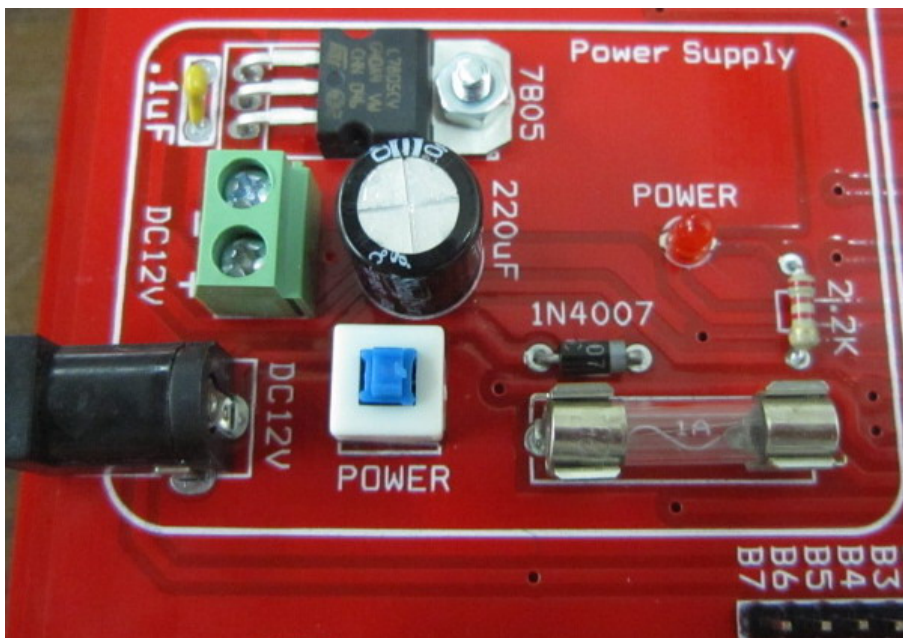
- 1- DC wall wart power supply adaptor via DC power socket (12V - 20V).
- 2- Any other source of DC power (12V – 20V) via screw clamp terminals.

### The power supply unit includes

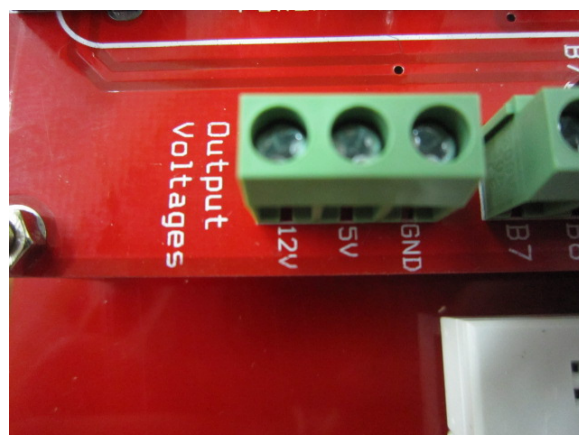
- Power supply on-off switch.
- LED for power indication.
- 7805 (5V regulator IC with 5% tolerance).
- 1A Fuse for over current protection.

**Note** 1- **FEPSP5** kit is protected against reversed polarity of power.  
2- The input voltage and the 5V regulated output voltage are redirected to external Screw clamp terminals labeled (output voltage) for external using.

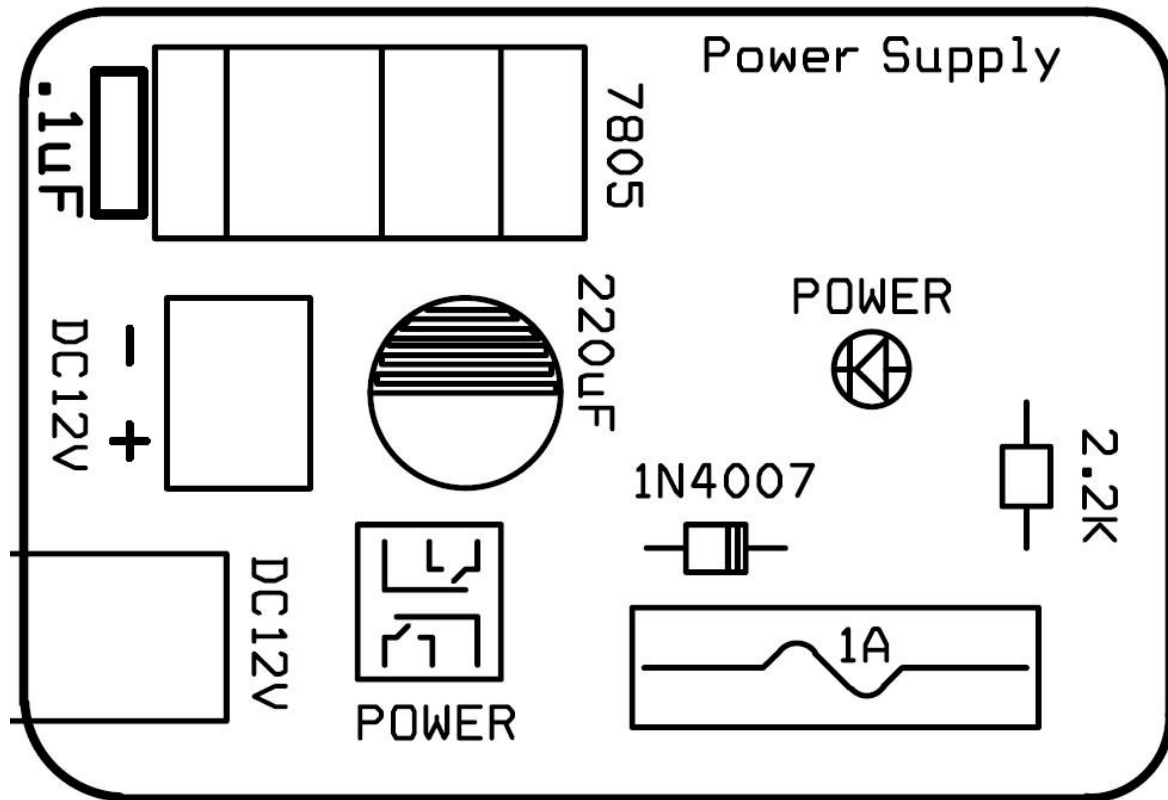
**Figure 4. Power supply unit real PCB view**



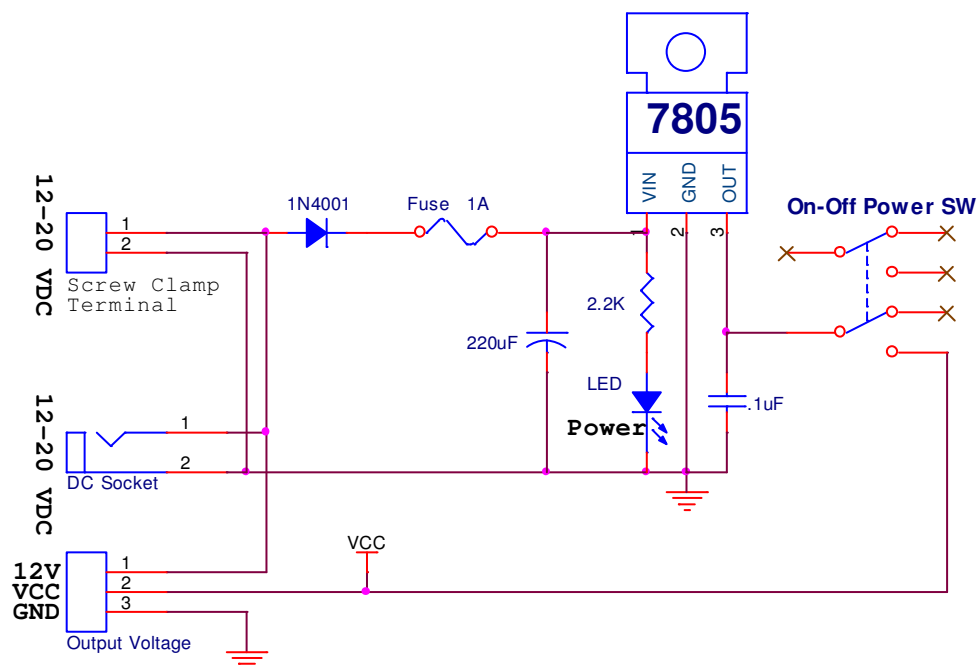
**Figure 5. Output Voltage (5V, 12V) for external using**



**Figure 6. Power supply unit layout view**



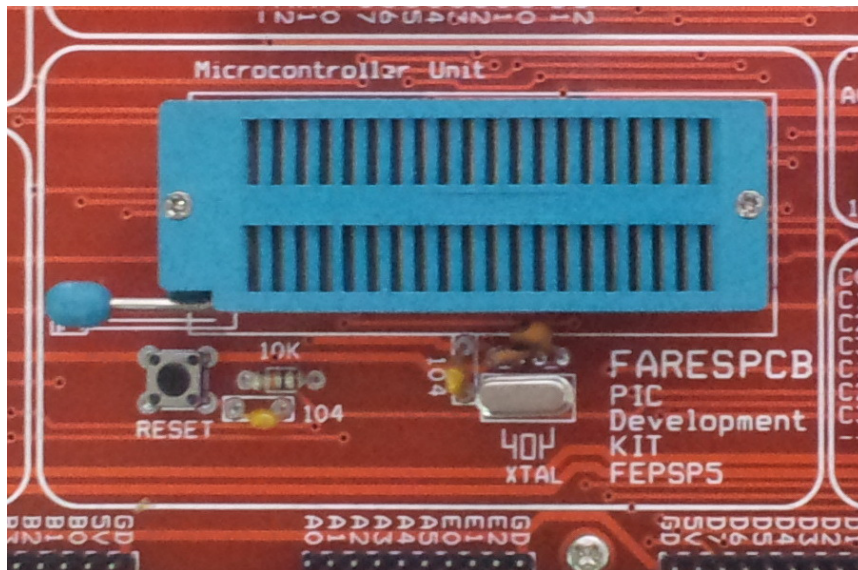
**Figure 7. Power supply unit schematic view**



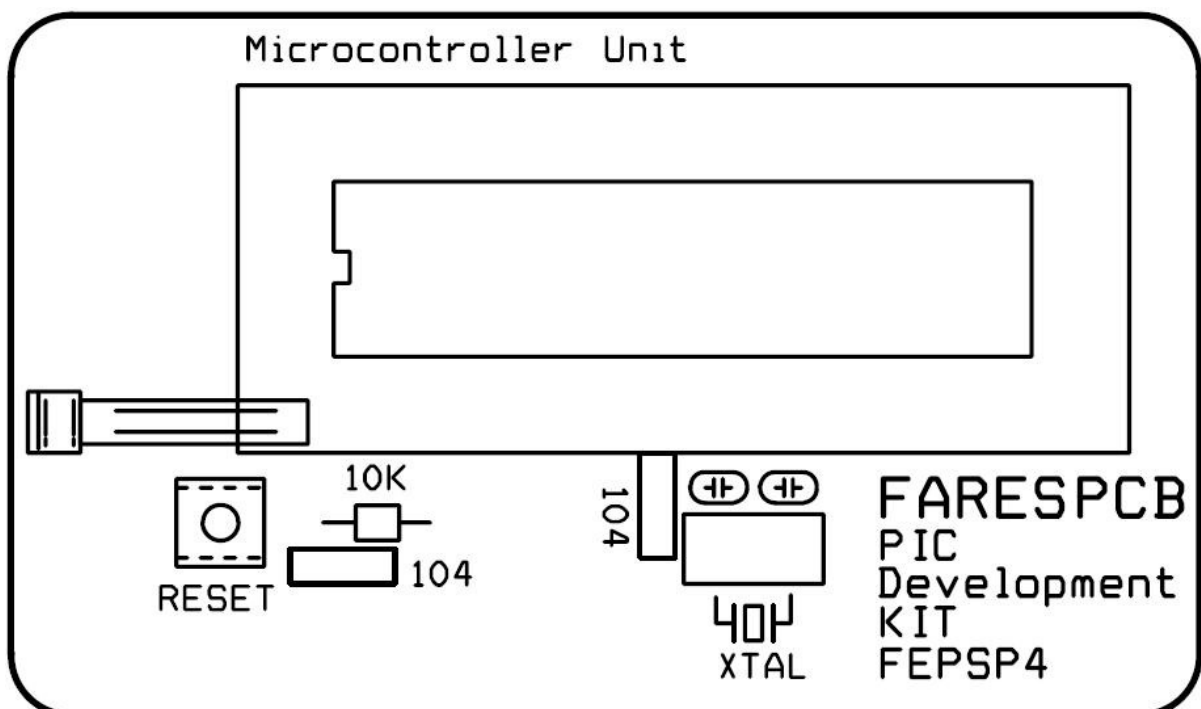
## Microcontroller Unit

- 40 pin DIP ZIF socket for microcontroller chip. Table 1 shows all supported microcontroller chips.
- 4 MHz crystal oscillator fixed on pluggable socket for flexibility.
- Power on reset circuit with push button reset switch.

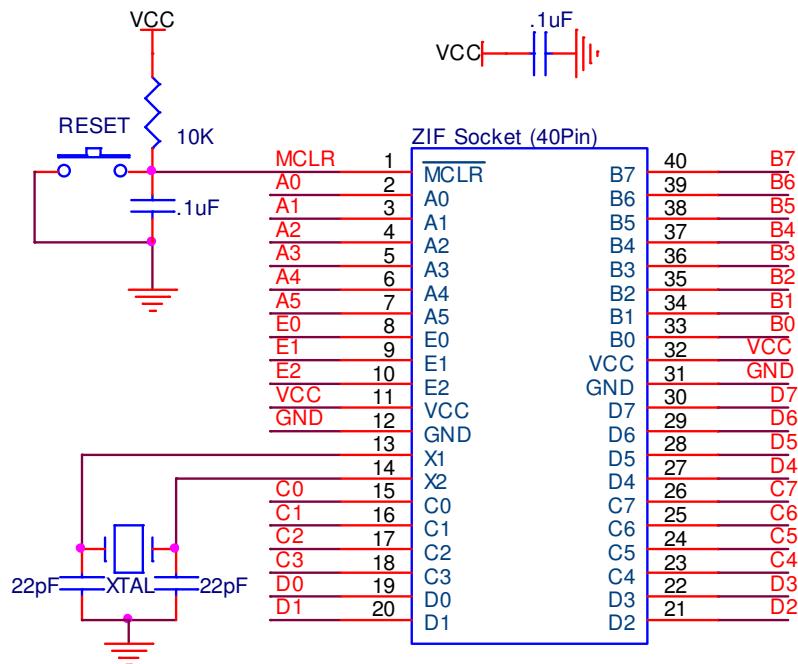
**Figure 8. Microcontroller unit real PCB view**



**Figure 9. Microcontroller unit layout view**



**Figure 10. Microcontroller unit schematic view**



**Table 1. List of chips supported by FEPS5**

Supported Chips
16F877A
18F442
18F448
18F452
18F458
18F4321
18F4520
18F4550



## 4X4 Matrix Keypad Unit

FEPS4 KIT includes 16 input switches attached to port **B**. Switches are configured as 4 rows intersected by four columns. Each intersection creates switch position. Four row lines are connected to low nipple of port **B** as follows.

ROW1	B.0
ROW2	B.1
ROW3	B.2
ROW4	B.3

Four column lines are connected to low nipple of port B as follows.

COL1	B.4
COL2	B.5
COL3	B.6
COL4	B.7

			COLUMN			
			COL1	COL2	COL3	COL4
			B4	B5	B6	B7
ROW	ROW1	B0	SW1	SW2	SW3	SW4
	ROW2	B1	SW5	SW6	SW7	SW8
	ROW3	B2	SW9	SW10	SW11	SW12
	ROW4	B3	SW13	SW14	SW15	SW16

- ✓ Each row can be enabled/disabled individually via DIP switch. If user doesn't intend to use the keypad absolutely, you must disable all rows.
- ✓ You can use the first row i.e. (SW1, SW2, SW3, SW4) as a direct input switches (not in matrix mode) by setting jumper J1 to (1-2). Otherwise set it to (2-3) to use it in matrix mode.

**Note:** Port **B** is pulled up by a 10KΩ resistor. i.e. (microcontroller port pin reads high if no switch is pressed).

**Table 2.** This table indicates the setting of jumper J1 and DIP switch to configure keypad in matrix mode.

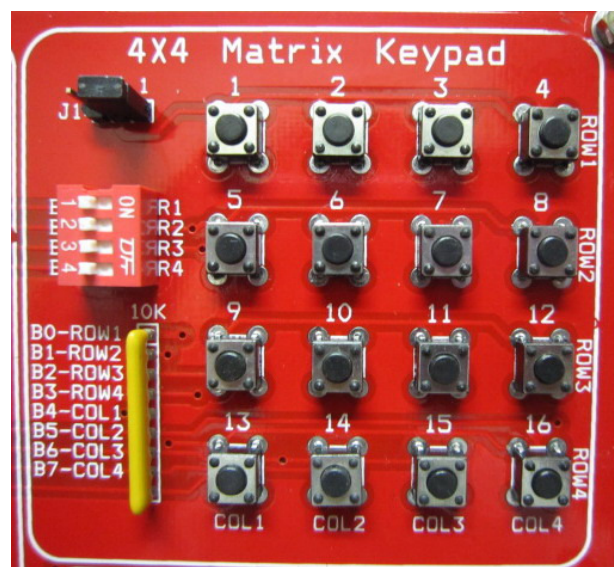
DIP switch setting	J1(1-2)
	Matrix mode
<b>B0-R1 (ON)</b>	B0 X B4 ----> SW1
	B0 X B5 ----> SW2
	B0 X B6 ----> SW3
	B0 X B7 ----> SW4
<b>B1-R2 (ON)</b>	B1 X B4 ----> SW5
	B1 X B5 ----> SW6
	B1 X B6 ----> SW7
	B1 X B7 ----> SW8
<b>B2-R3 (ON)</b>	B2 X B4 ----> SW9
	B2 X B5 ----> SW10
	B2 X B6 ----> SW11
	B2 X B7 ----> SW12
<b>B3-R4 (ON)</b>	B3 X B4 ----> SW13
	B3 X B5 ----> SW14
	B3 X B6 ----> SW15
	B3 X B7 ----> SW16

To set the keypad in direct mode just set jumper 1 to (2-3) position and set all DIP switch pins(**R1, R2, R3, R4**) to off position, up on this setting the first four switches (**SW1, SW2, SW3, SW4**) only connected to port pins (**B4,B5,B6,B7**) as shown in table 3.

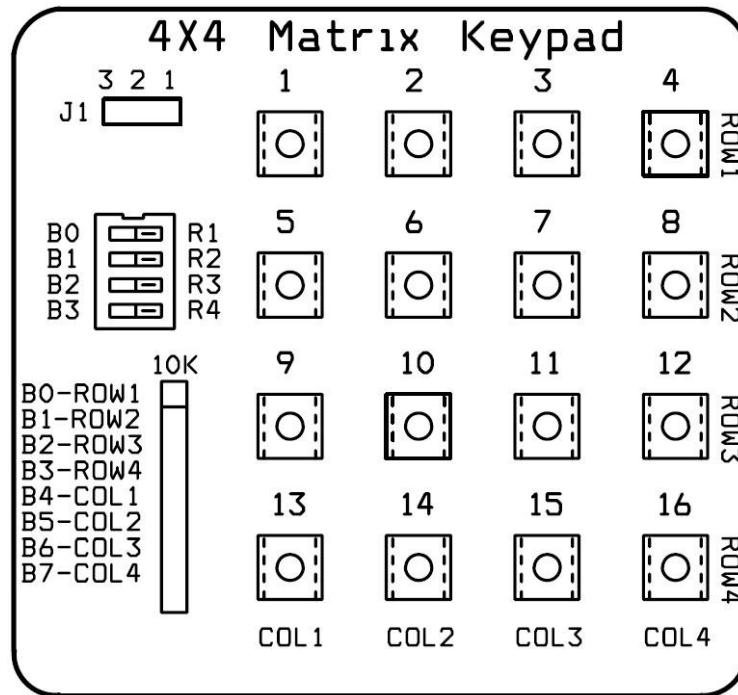
**Table 3.** This table indicates the setting of jumper J1 and to configure keypad in direct mode and the enabled switches.

J1(2-3)
Direct mode
B4 ----> SW1
B5 ----> SW2
B6 ----> SW3
B7 ----> SW4

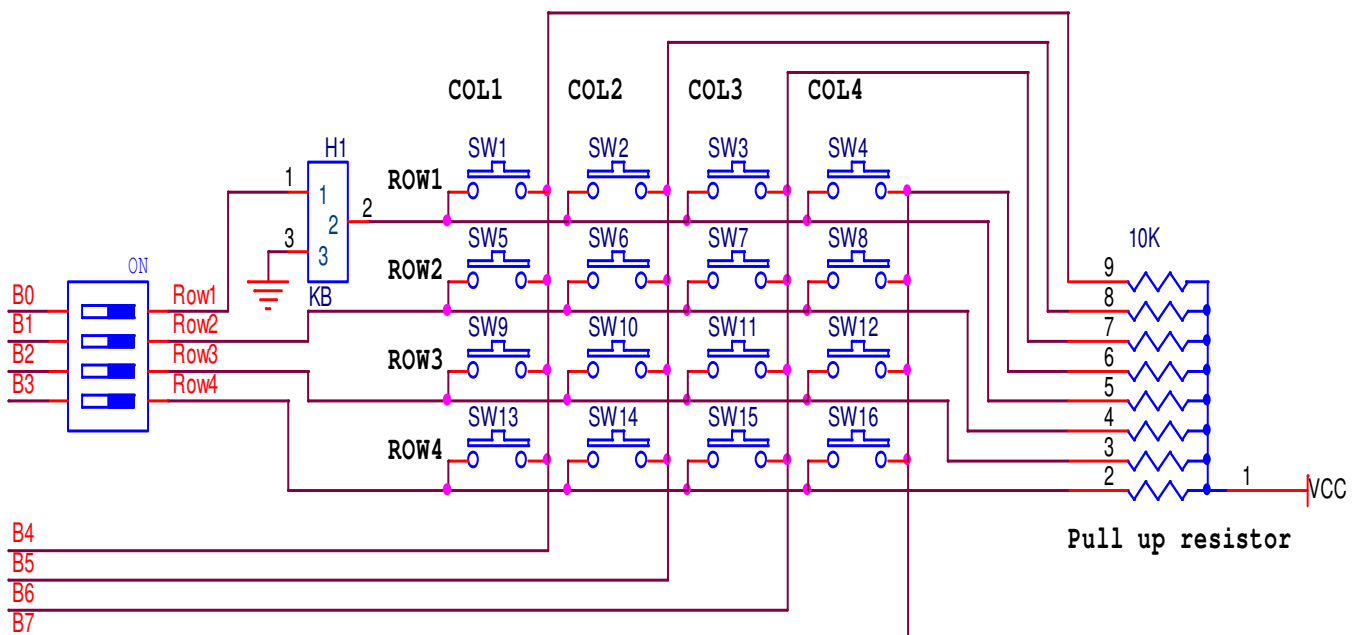
**Figure 11.** 4X4 matrix keypad unit real PCB view



**Figure 12. 4X4 matrix keypad unit layout view**



**Figure 13. 4X4 matrix keypad unit schematic view**



## Output Unit

This unit contains seven outputs distributed as four LEDs, two relays and Buzzer. However, four outputs only could be connected to microcontroller via port pins (**C0, C1, C2 and C3**) at a time. It's important to mention that the microcontroller outputs are connected to transistor driver IC ULN2003 which drives all loads.

### 1) Four output LEDs

Four red LEDs 12V biased with 1K $\Omega$  current limiting resistors are connected to port pins (**C0, C1, C2 and C3**). Each LED can be individually enabled or disabled via eight line DIP switch. LEDs are active high. I.e. output high turn LED on and output low turn it off.

### 2) Two output relays

Two output relays are embedded in FEPS4 kit to allow dry contact switches which is suitable for AC or DC switching applications.

Each relay has its own related LED for status indication and can be individually enabled via DIP switch. Relay1 attached to port pin **C2** and relay2 attached to port pin **C3**. Relays are rated to 12V coil and 3A contacts (resistive load).

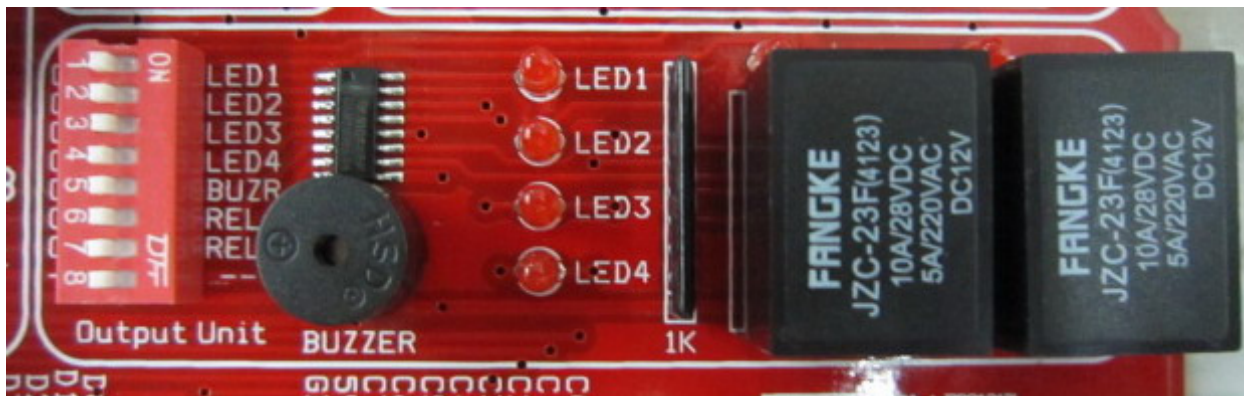
The freewheeling diodes are embedded in driving IC ULN2003.

Normally open and normally closed contacts are brought out via screw clamp terminals.

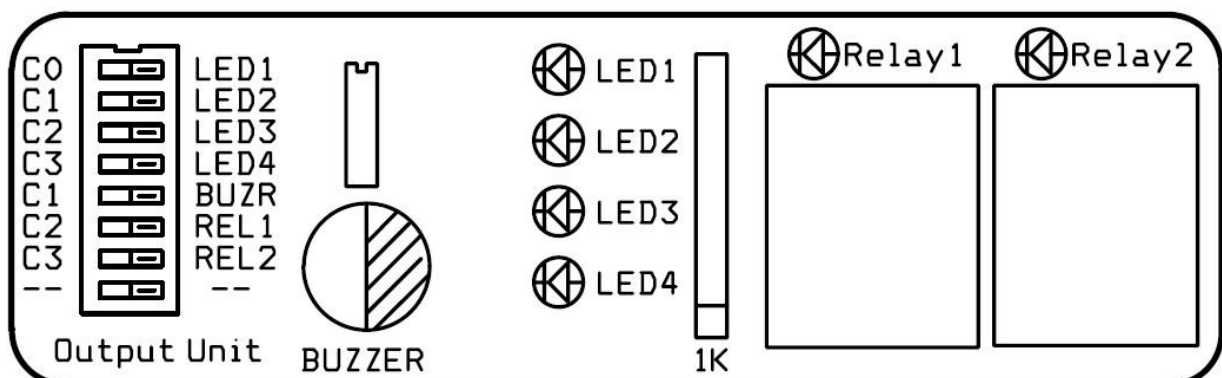
### 3) One output buzzer

One output buzzer (6VDC) is included in output unit to port pin **C1**. Again, it may be enabled using DIP switch.

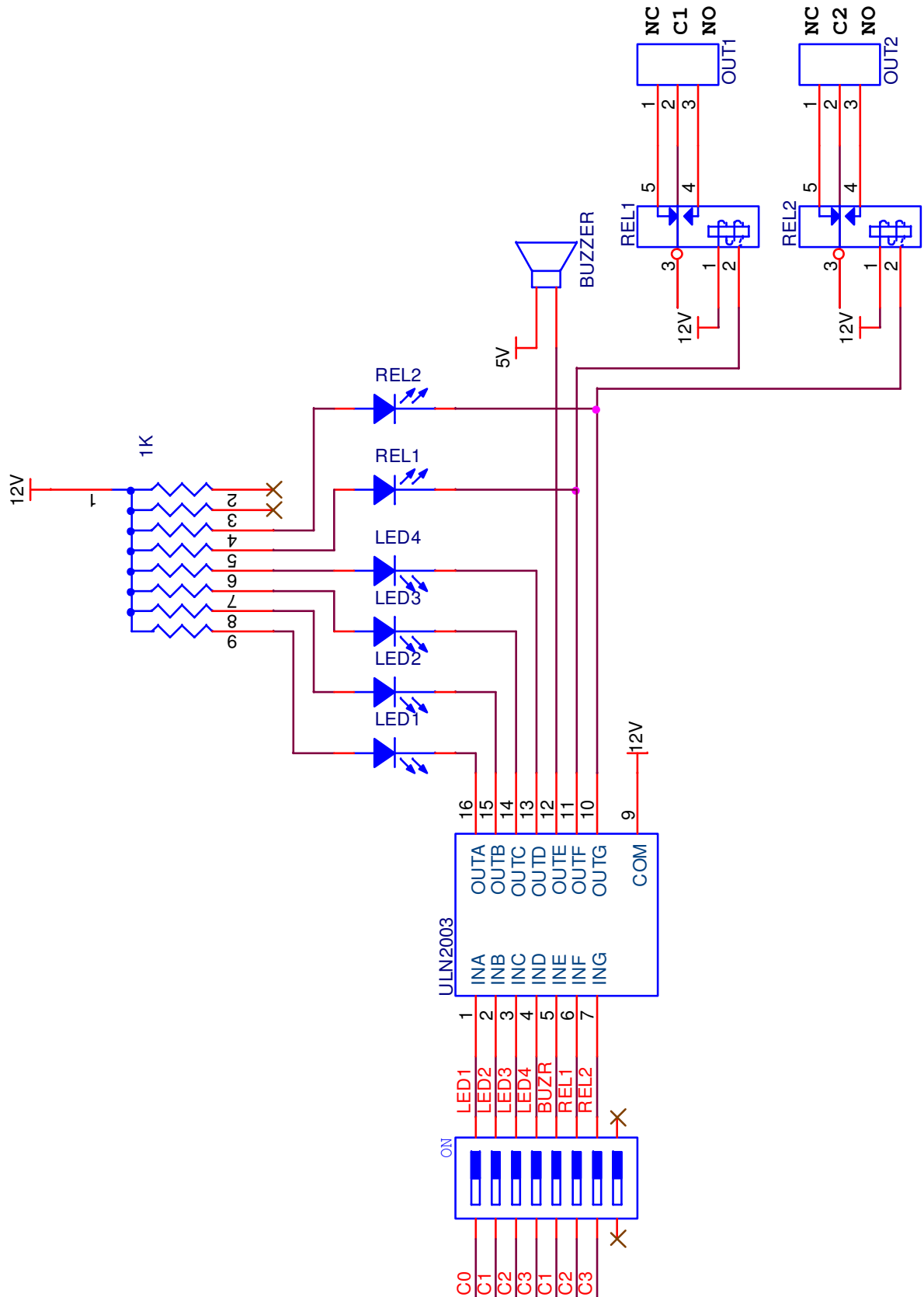
**Figure 14. Four LEDs display unit real PCB view.**



**Figure 15. Four LEDs display unit layout view.**



**Figure 16. Four LEDs display unit schematic view.**





## Multiplexed Two Digits 7seg Display Unit

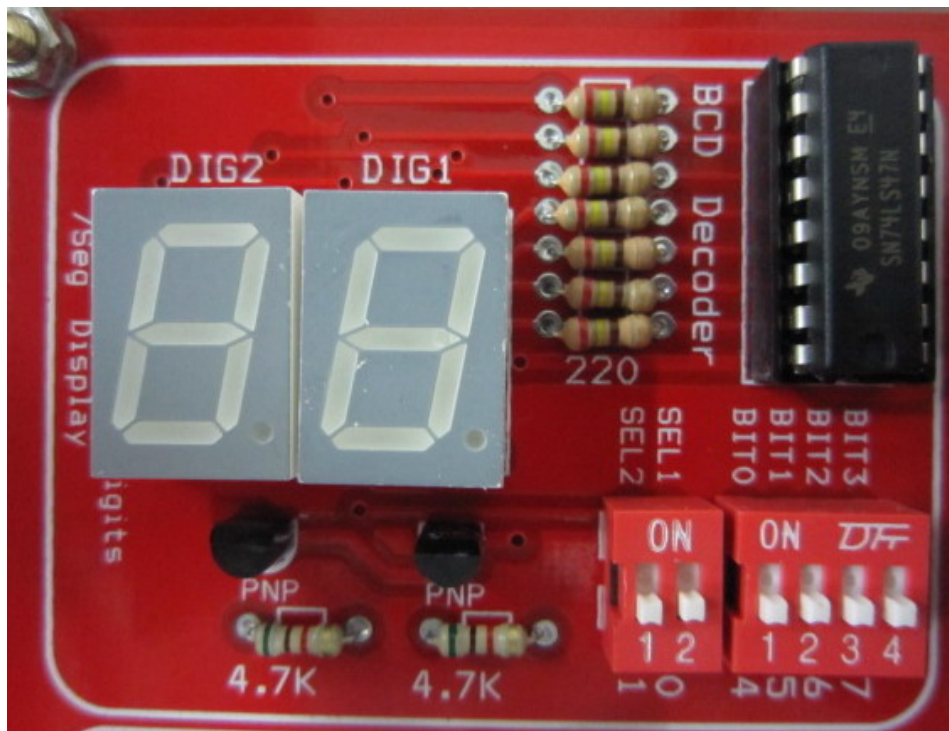
Two multiplexed 7seg digits with TTL BCD decoder (7447). The decoder inputs are connected to microcontroller pins **D4** (BIT0), **D5** (BIT1), **D6** (BIT2), and **D7** (BIT3) via four line DIP switch. The selection inputs may be connected to microcontroller pins D2 (digit1 selection) and D3 (digit2 selection). Each 7seg digit can be enabled or disabled individually using two line DIP switch.

- Note** 1 - Enable signal is active low i.e. a low output enables the required 7SEG.  
2 - 7seg module, 2X16LCD and 128X64 GLCD share the same port. So, it's not allowed to enable more than one module at the same time.

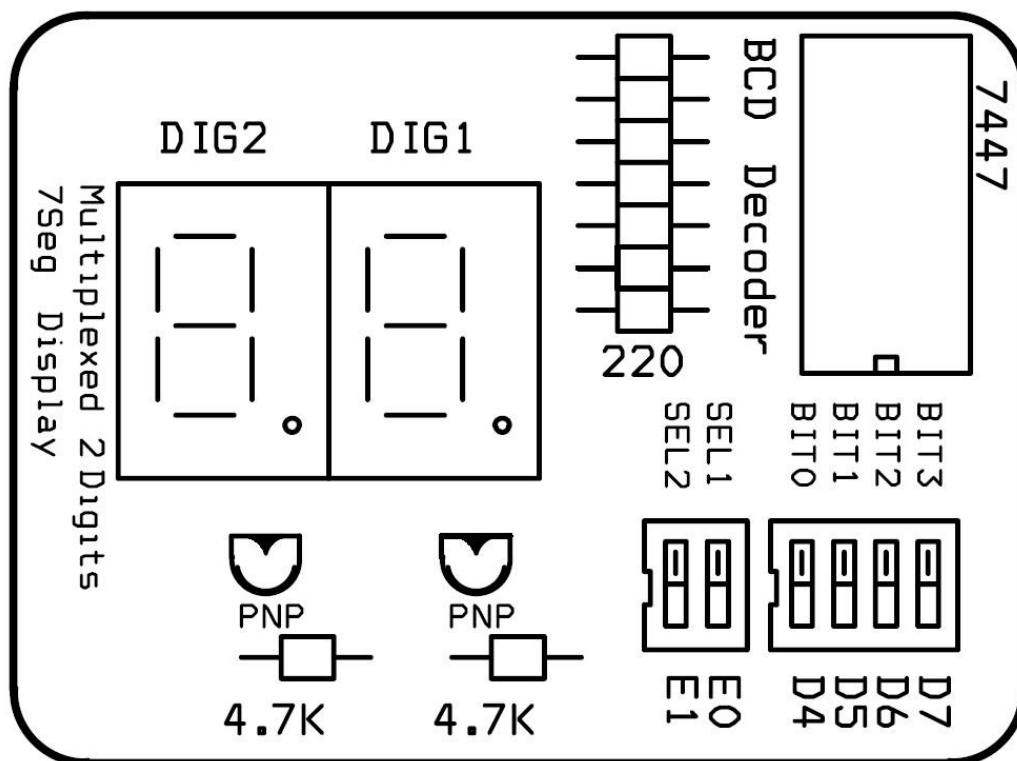
**Table 4. The following table shows the required decoder input to display the numbers from 0 to 9.**

Digit	Decoder inputs			
	Bit3	Bit2	Bit1	Bit0
	D7	D6	D5	D4
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

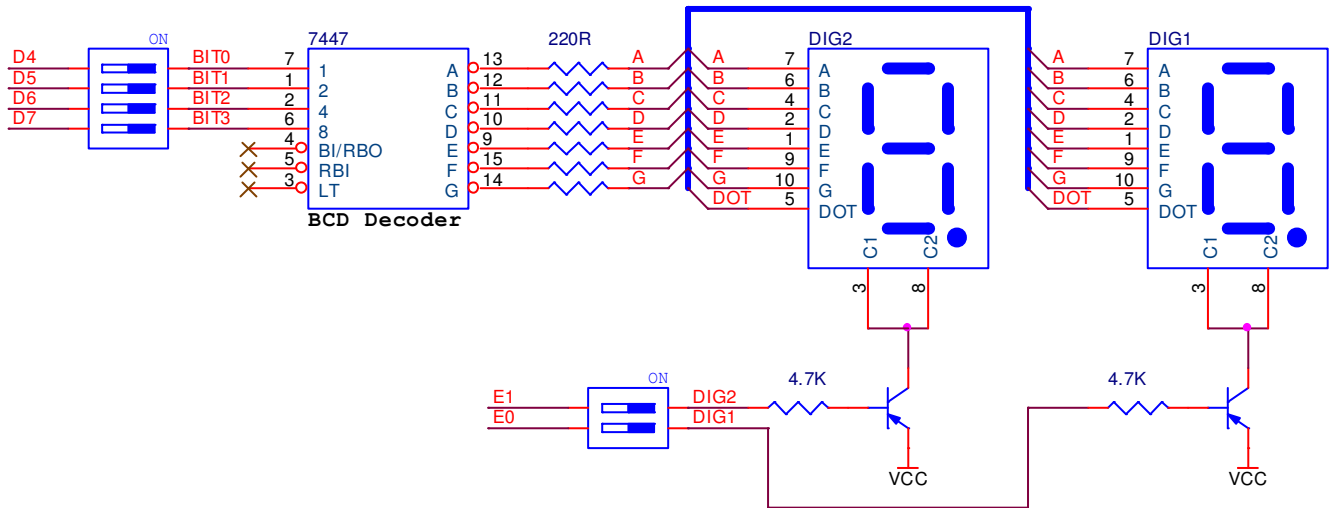
**Figure 17. Multiplexed two digits 7seg display unit real PCB view.**



**Figure 18. Multiplexed two digits 7seg display unit layout view.**



**Figure 19. Multiplexed two digits 7eg display unit schematic view.**



## 2X16 LCD Display Unit

2X16 alphabetic LCD with backlight and contrast control configured in 4bit mode is connected to port D via DIP switch as follows,

Port **D.7** is connected to Bit 7 of LCD

Port **D.6** is connected to Bit 6 of LCD

Port **D.5** is connected to Bit 5 of LCD

Port **D.4** is connected to Bit 4 of LCD

Port **E.2** is connected to backlight control, Output high on this pin turn backlight on.

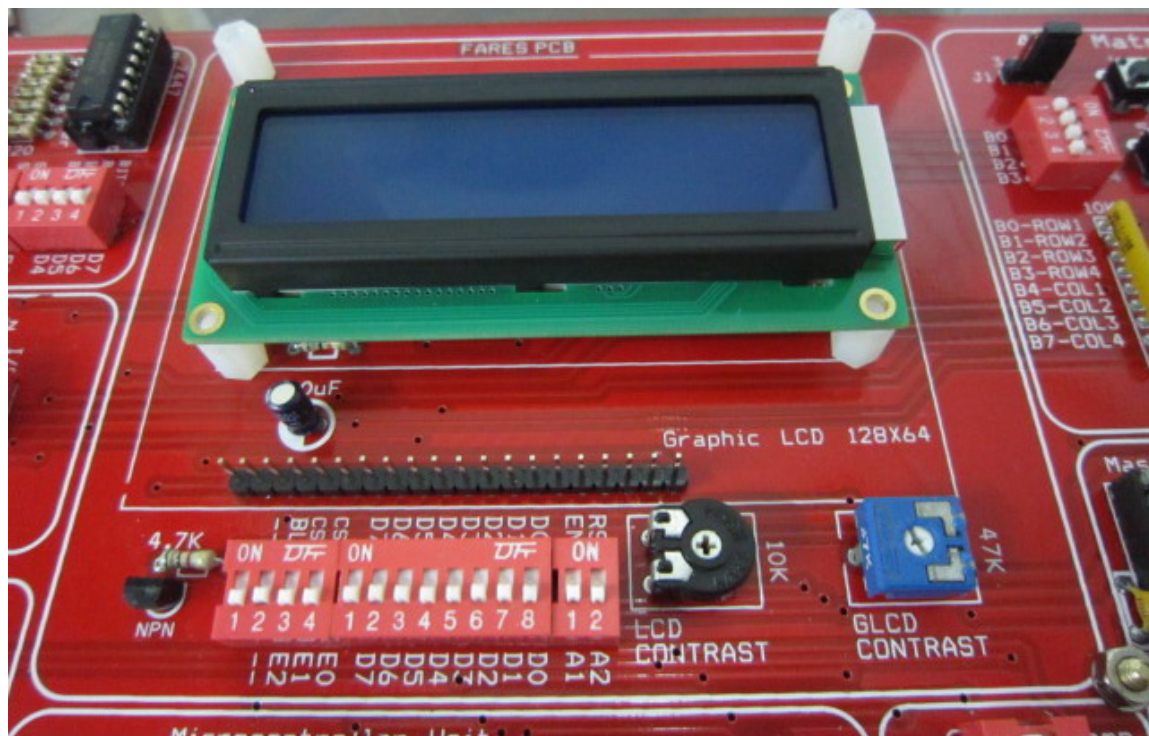
Port **A.1** is connected to EN of LCD

Port **A.2** is connected to RS of LCD

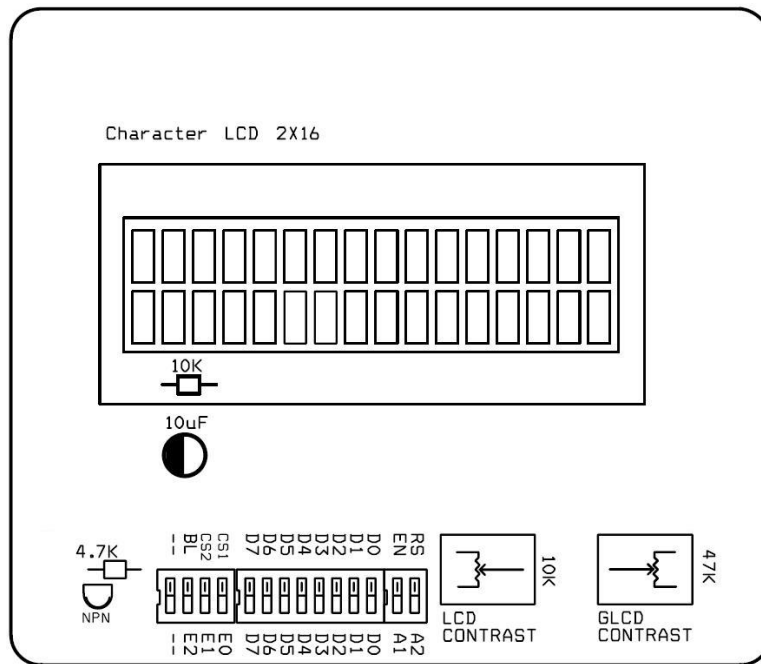
10K $\Omega$  variable resistor labeled "LCD CONTRAST" is adjusted to control the LCD contrast.

**Note** Remind to disable all DIP switches related to 128X16 GLCD and 7seg modules before using 2X16 LCD module.

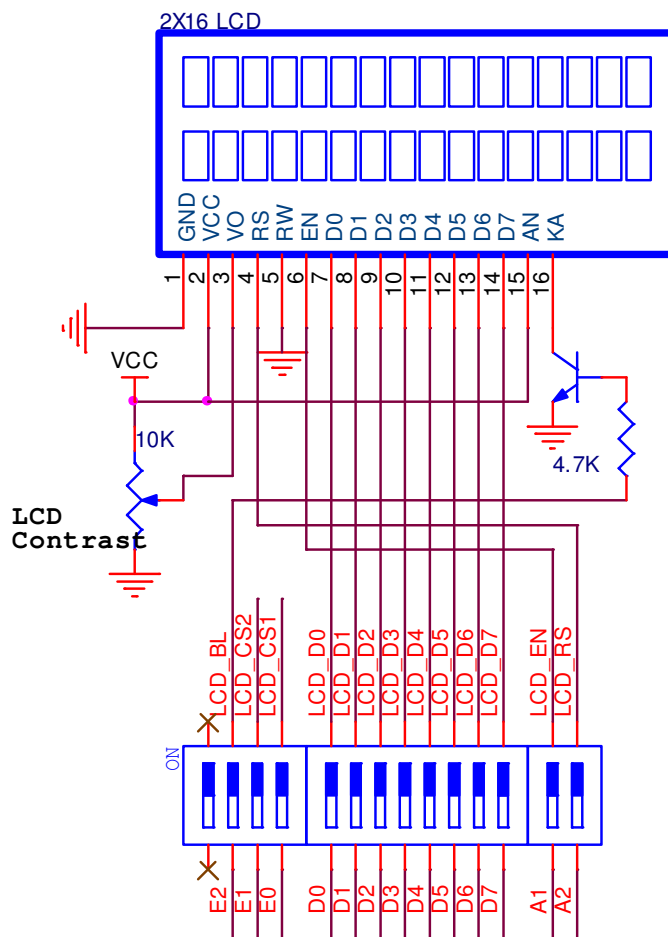
**Figure 20. 2X16 LCD display unit real PCB view.**



**Figure 21. 2X16 LCD display unit layout view.**



**Figure 22. 2X16 LCD display unit schematic view.**





## 128X64 Graphical LCD Unit

128X64 graphical LCD with backlight and contrast control is connected to port D via DIP switch as follows,

Port **D.7** is connected to Bit 7 of LCD

Port **D.6** is connected to Bit 6 of LCD

Port **D.5** is connected to Bit 5 of LCD

Port **D.4** is connected to Bit 4 of LCD

Port **D.3** is connected to Bit 3 of LCD

Port **D.2** is connected to Bit 2 of LCD

Port **D.1** is connected to Bit 1 of LCD

Port **D.0** is connected to Bit 0 of LCD

Port **E.2** is connected to backlight control, Output high on this pin turn backlight on.

Port **A.1** is connected to EN of LCD

Port **A.2** is connected to RS of LCD

Port **E.0** is connected to CS1 of LCD

Port **E.1** is connected to CS2 of LCD

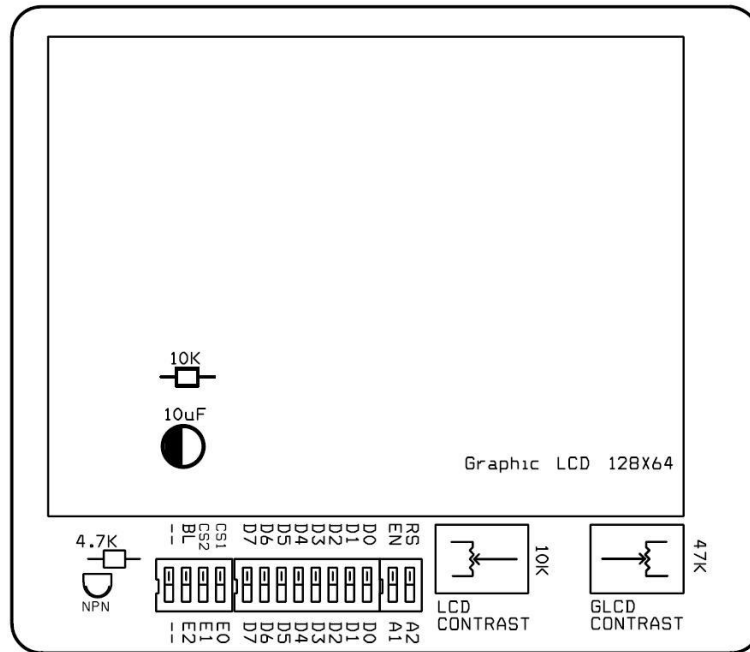
47K $\Omega$  variable resistor labeled "GLCD CONTRAST" is adjusted to control the LCD contrast.

**Note** Remind to disable all DIP switches related to 2X16 LCD and 7seg modules before using 128X64 GLCD module.

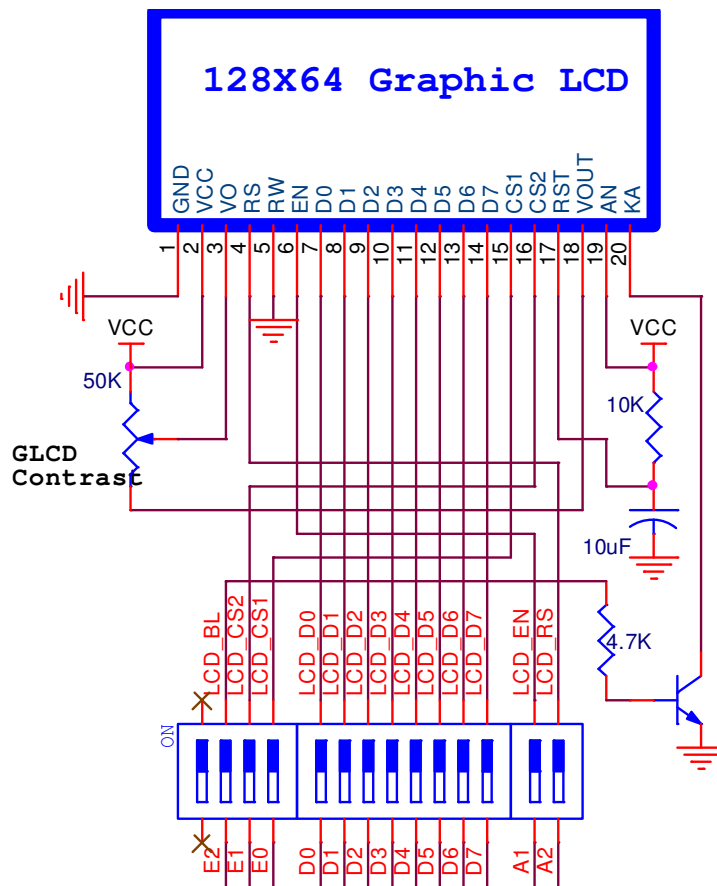
**Figure 23. 128X64 GLCD display unit real PCB view.**



**Figure 24. 128X64 GLCD LCD display unit layout view.**



**Figure 25. 128X64 GLCD LCD display unit schematic view.**



## Analog Input Unit

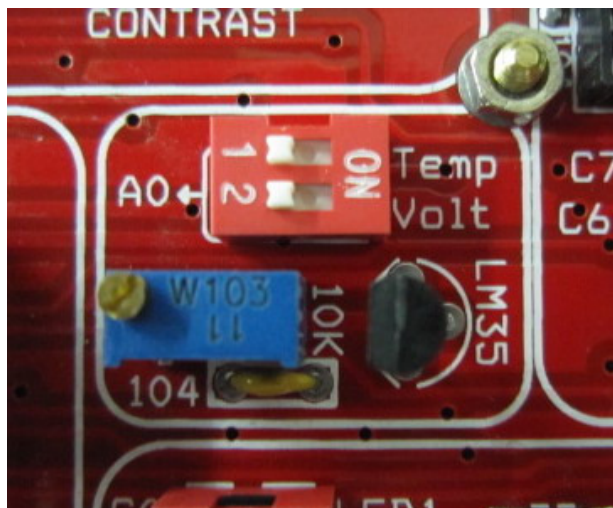
It consists of two sources of analog signals share the same analog input Port pin **A0** of the microcontroller. So, it's must to enable one analog source only.

The first analog source is multi-turn variable resistors. The fixed terminals biased (0V and 5VDC), while the variable terminal connected to port pin **A0** via DIP switch. The resistor may be adjusted precisely to the required voltage (0.00V to 5.00V).

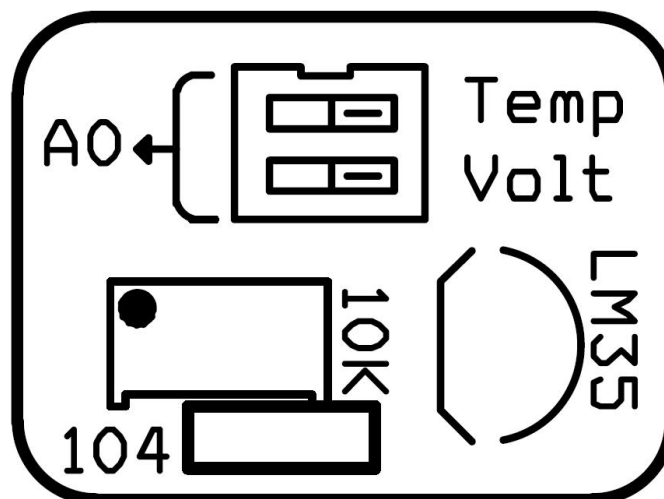
The second analog source is the temperature sensor LM35. This sensor is biased 5V and its output is connected directly to the port pin **A0** via DIP switch without any signal conditioning circuits. The output voltage of LM35 is directly proportional to the temperature in Celsius degree  $10\text{mV}/^{\circ}\text{C}$ . The operating temperature range is from  $0^{\circ}\text{C}$  to  $150^{\circ}\text{C}$ . So, the output voltage range is (0V to 1.5V).

**Note** For any more information about the Temperature sensor LM35 and its operation please refer to the datasheet included in the CD in package.

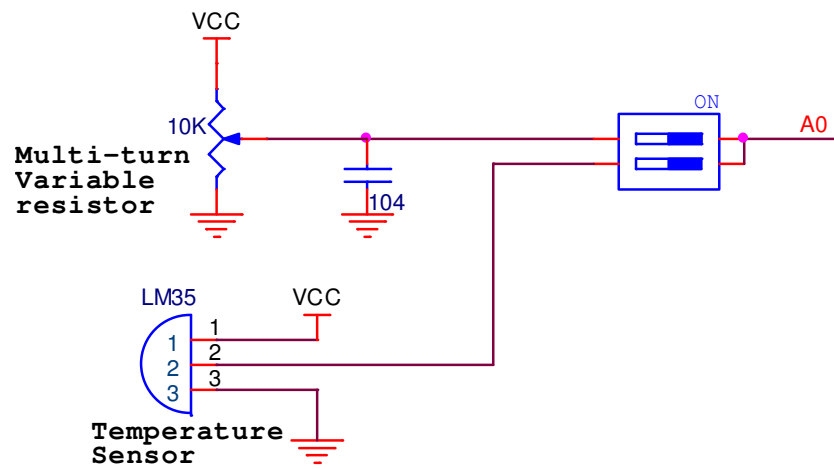
**Figure 26. Analog input unit real PCB view.**



**Figure 27. Analog input unit layout view.**



**Figure 28. Analog input unit schematic view.**



## Serial EEPROM Unit

This unit involves two serial EEPROM memory chips 24C08 (1KB each). The interface protocol is IIC. This interface requires two I/O port pins to transfer data between memory and microcontroller. One line is the clock (labeled CLK) which synchronizes the data transfer. While the other line is the data line (labeled DTA).these two lines are common for the two chips. Control lines are connected to port pins **E0** (Clock) and **E1** (Data) via two channels DIP switch.

The device address bits of the first chip 24C08 (1) is ( $A_2 = 0, A_1 = 0, A_0 = 0$ ) so the device address byte is (1010000X).

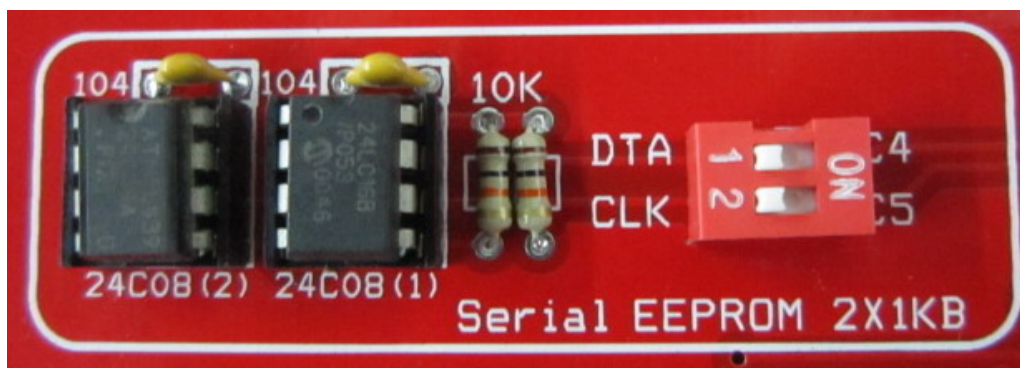
The device address bits of the second chip 24C08 (2) is ( $A_2 = 1, A_1 = 1, A_0 = 1$ ) so the device address byte is (1010111X).

Where X is "0" for write operation and "1" for read operation.

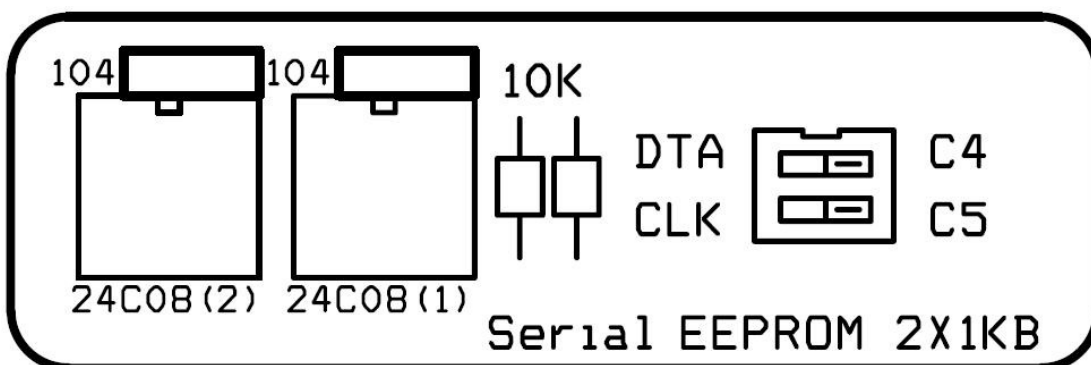
**Note** It's capable to plug any other serial EEPROM that have more size such as 24C16, 24C128, 24C256.

For any other information about the serial EEPROM 24Cxx please refer to the datasheet included in the CD in package.

**Figure 29. Serial EEPROM unit real PCB view.**

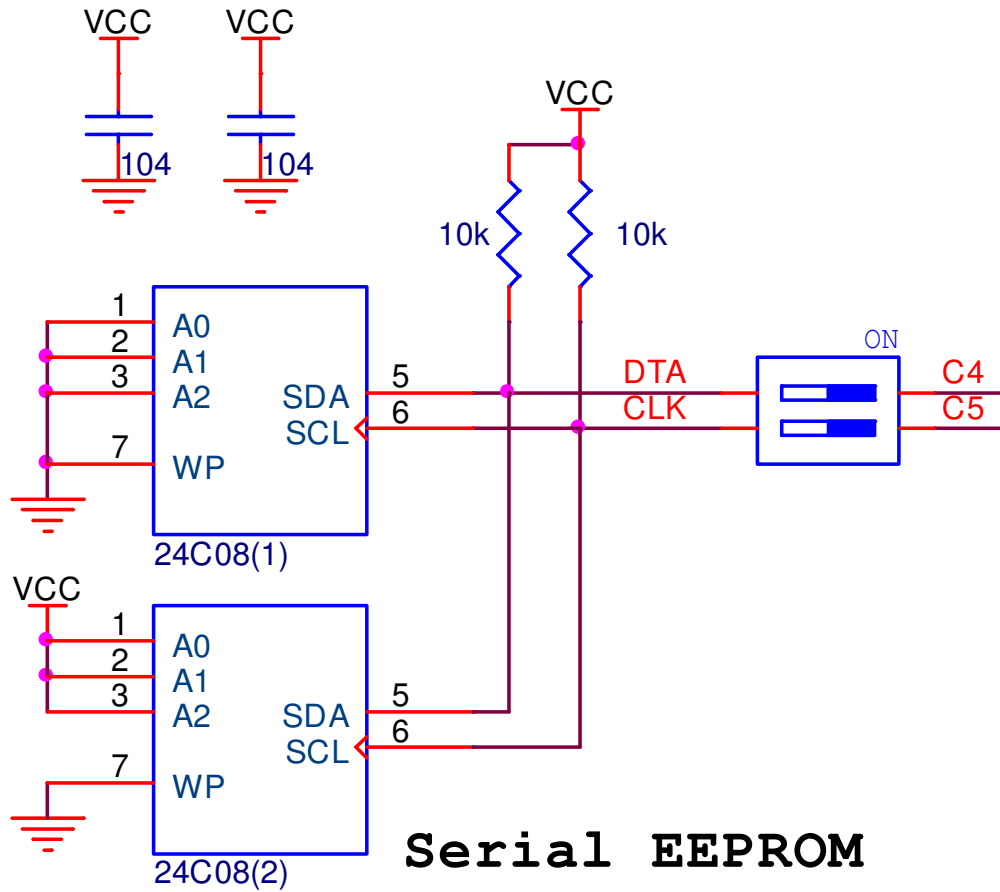


**Figure 30. Serial EEPROM unit layout view.**





**Figure 31. Serial EEPROM unit schematic view.**

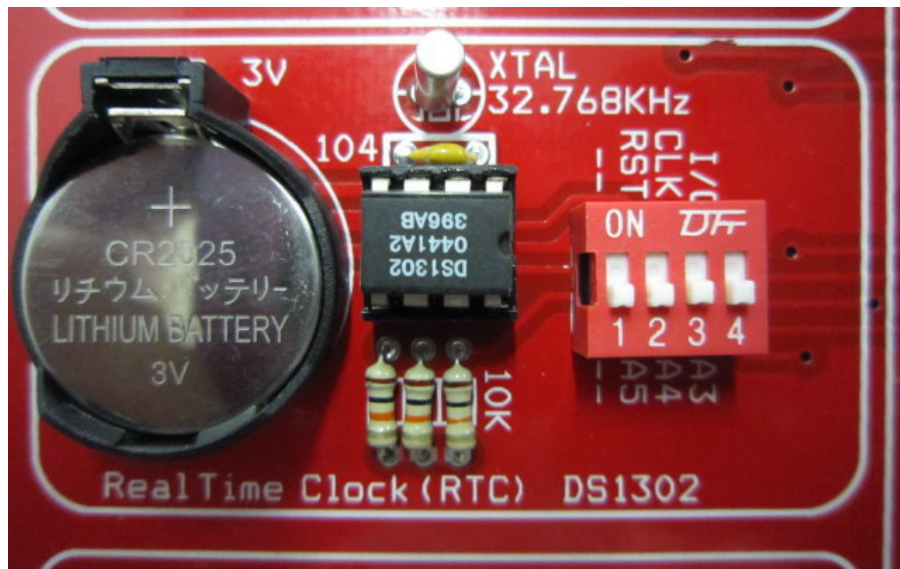


## Real Time Clock RTC Unit

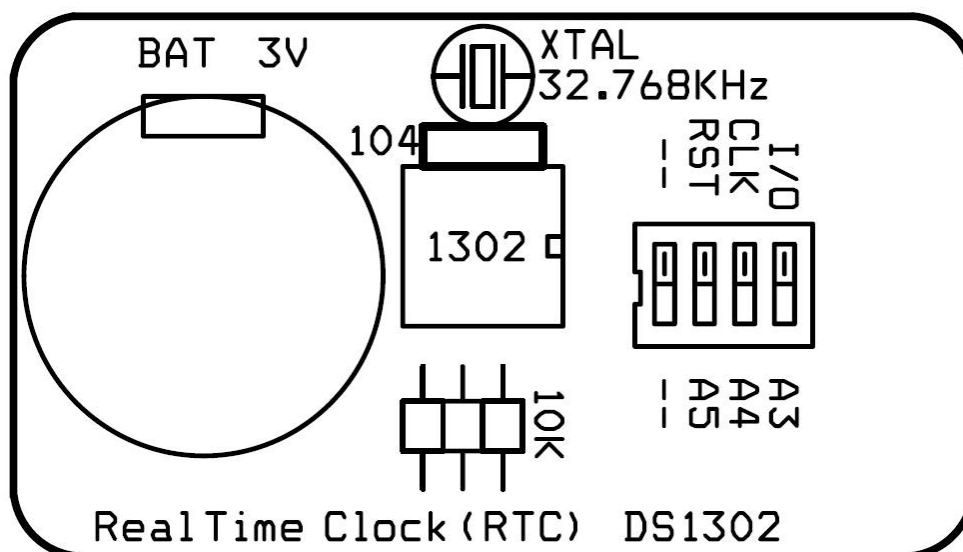
Many microcontrollers haven't embedded real time feature. So this unit provides simple way to add real time clock module to your system without any external components. The RTC used is DS1302 IC, which requires three I/O ports to interface to microcontroller. Reset, Clock and Data (I/O) are connected to port pins (**A5, A4 and A3**) respectively via DIP switch.

**Note** For any other information about the real time clock chip DS1302 please refer to the datasheet included in the CD in package.

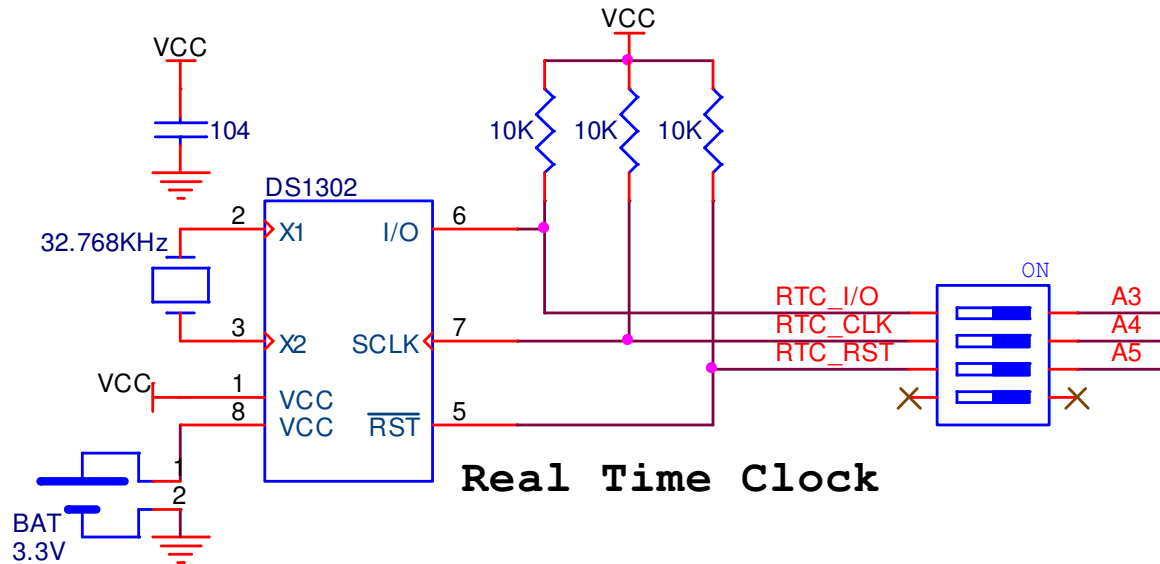
**Figure 32. RTC unit real PCB view.**



**Figure 33. RTC unit layout view.**



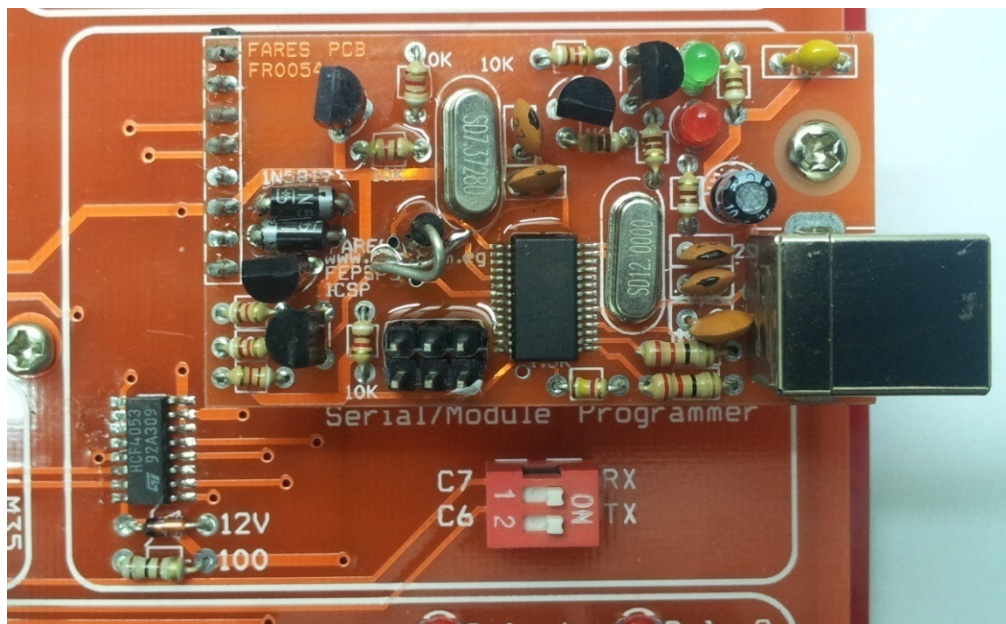
**Figure 34. RTC unit schematic view.**



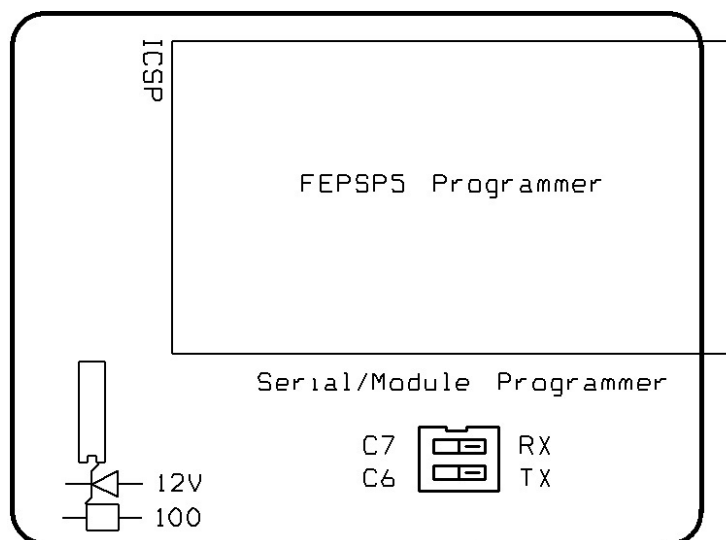
## ICSP AND SERIAL UNIT

Serial unit include USB-TTL logic converter using PL2303 converter IC, and provides USB-B connector for PC serial communication. After installing PL2303 Driver PC can be connected to **FEPS5** as a virtual COM port .Serial interface circuit can be enabled or disabled using DIP switch labeled Rx, Tx. If this unit is enabled, you can't use the two port pins **C6**, **C7** from external connectors. FEPS5 software Program make auto switching between run mode and programming mode and performs reset after programming chip. The green LED is an indicator for USB power connection and the red LED is an indicator for programming activity.

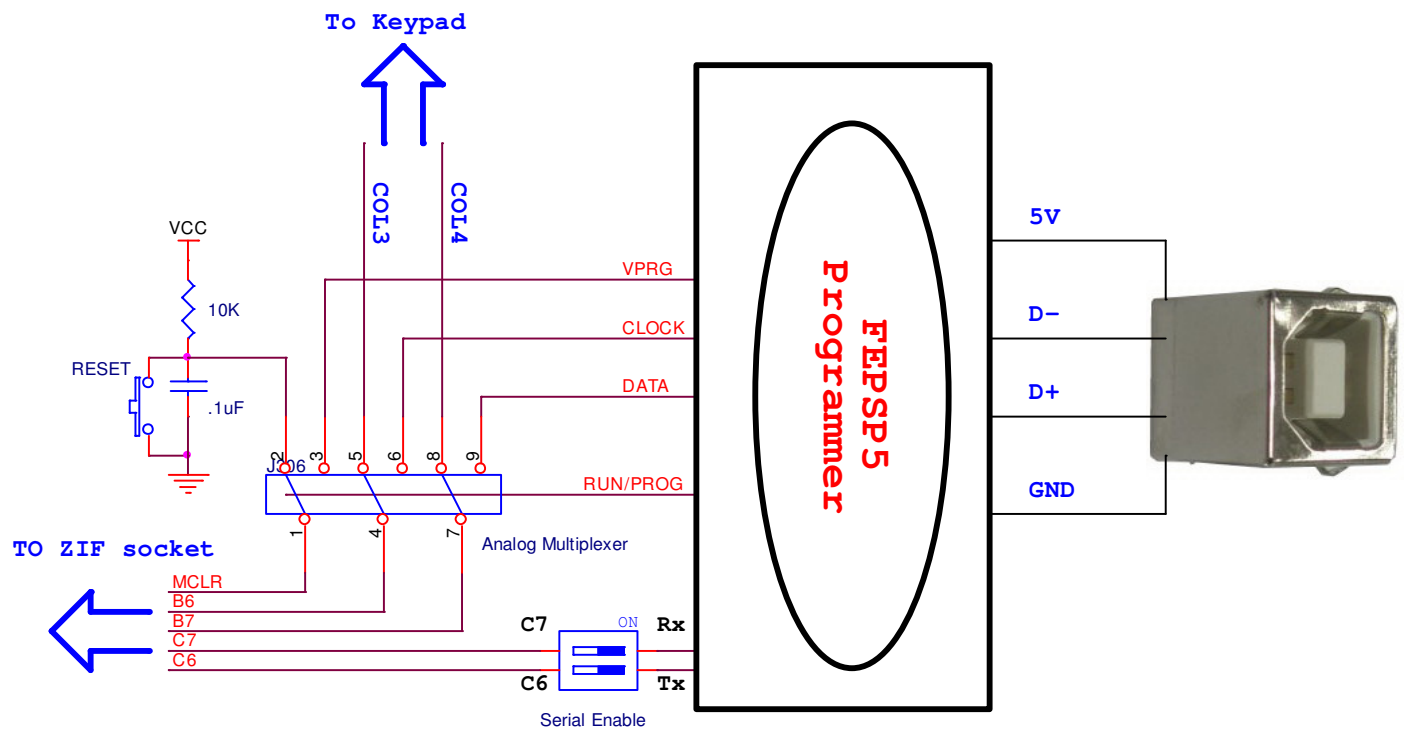
**Figure 35. ICSP and serial unit real PCB view**



**Figure 36. ICSP and serial unit layout view**



**Figure 37. RS232 serial interface unit schematic view**





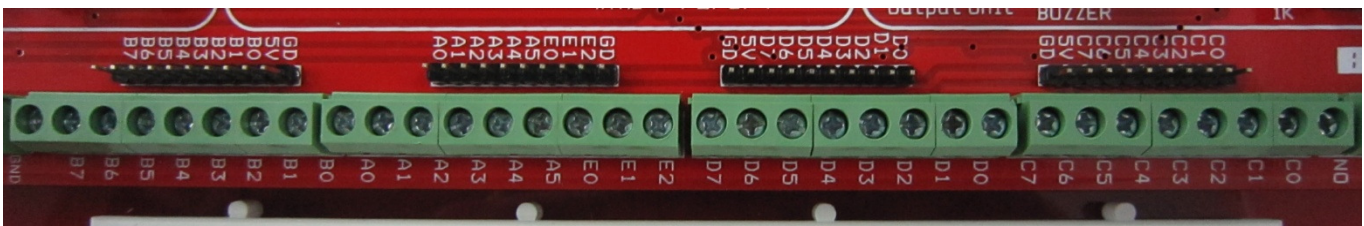
## PORT CONNECTORS

Although FEPS5 Kit has a very popular built in circuits and devices (switches, LEDs, 7seg, LCD and other), but any circuit can be enabled or disabled via DIP switches setting. And so the associated port pins are allowed to any other applications through screw clamp terminals.

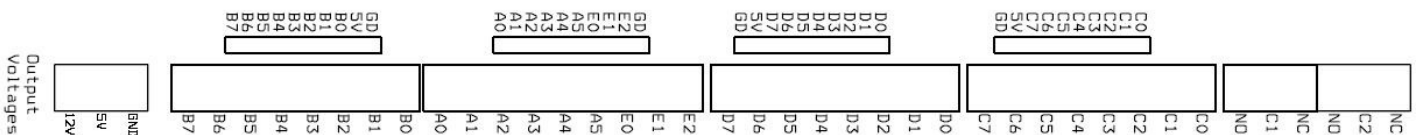
**Note** Please insure to disconnect the built in circuits which is connected to the port pins which decide to use.

The external connectors are grouped into 4 units each represents one microcontroller port (8 I/O) except one group has 9 I/O pins.

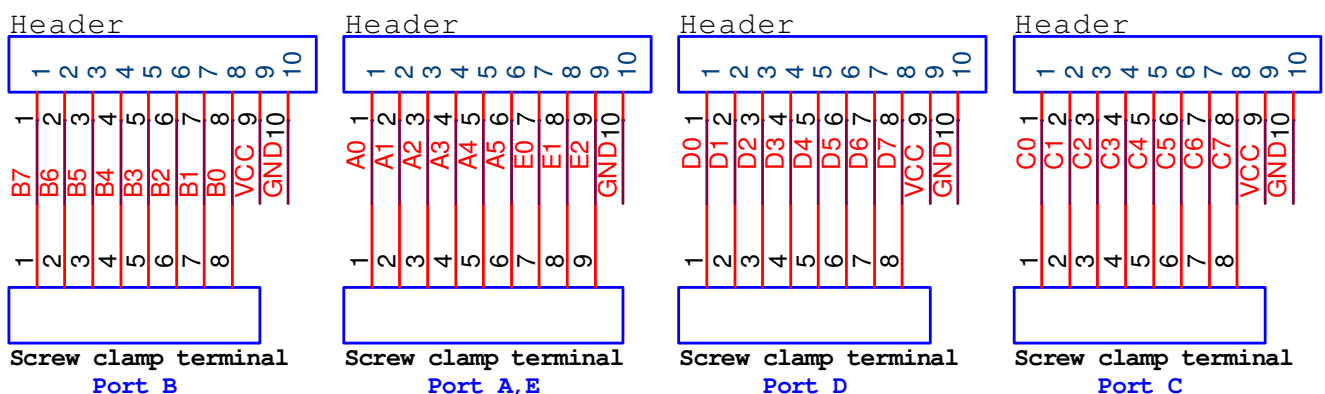
**Figure 38. Microcontroller port pins real PCB view**



**Figure 39. Microcontroller port pins layout view**



**Figure 40. Microcontroller port pins schematic view**



**FEPS5 involves standard 2.5" X 6.75" breadboard for easy circuit making and extensions.**

## HOW TO START?

**We recommend few tests before begin to use FEPSP5 KIT.**

If it is the first time to use FEPSP5 kit, user should perform test operation on kit before start using it. The CD included with package contains the firmware code required for testing any module on kit. So, it's recommended to apply this test code before applying your own application firmware to guarantee system readiness.

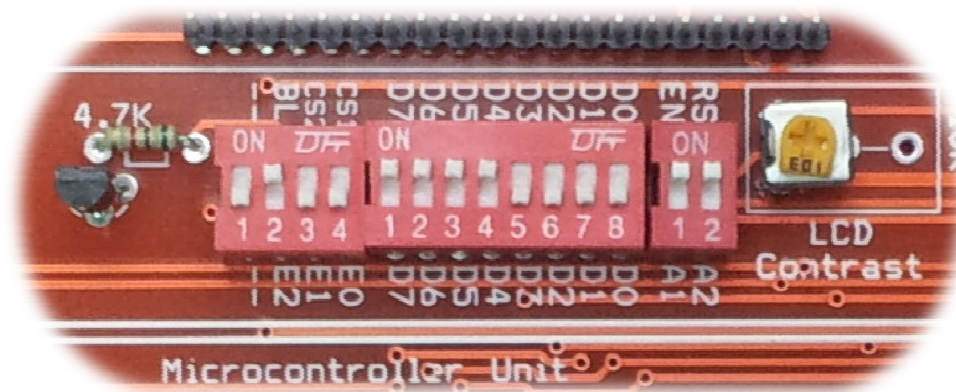
## Test

Upon burning this hex code user could test

- Keypad in matrix mode.
- 2X16 LCD.
- Output unit.
- Seven segment module.
- UART Serial operation.
- Real Time Clock (RTC) module.
- Analog module.
- Serial EEPROM module.

1. Enable all DIP switches of all modules on kit except GLCD, Set DIP switch of GLCD as seen in figure

**Figure 41. DIP switch position to enable LCD only**



2. Set keypad to matrix mode (J1 to 1-2 position).
3. Plug in serial cable.
4. Turn power switch on.
5. Open the software program (**FEPSP5.exe**).
6. The software will detect the Kit automatically.
7. Chose the **PIC16F877A** chip from chip selector.
8. Load the test code included in CD (**Test.hex**).
9. Click program button.
10. After programming is completed the microcontroller is reset automatically.

### After power on or reset operation the test sequence is

- 1 - Serial module transmits "FARES PCB: PIC Development Kit (FEPS5)". (User may receive this statement by HyperTerminal program or any other serial monitor software.
- 2 - LCD displays the message below for about 3 seconds then clear screen.



\*\*\* FARESPCB \*\*\*  
FEPS5 KIT

- 3 - If any switch is pressed the LCD displays a message show the switch number as



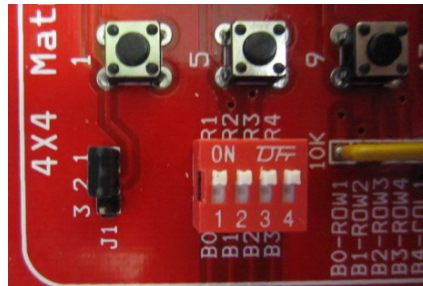
SW 9 is pressed.

In addition to the message displays the number of pressed switch some switches performs a test for specified modules on kit. These tests are listed in table below

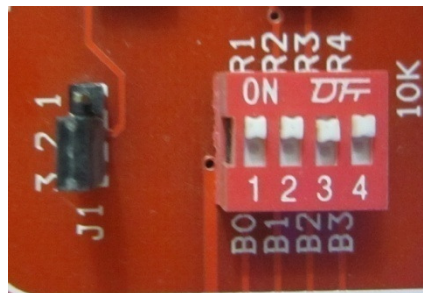
Switch	Function	
	LCD and serial port message	Test
SW1	"SW 1 is pressed."	Toggle LED1
SW2	"SW 2 is pressed."	Toggle LCD Backlight
SW3	"SW 3 is pressed."	Toggle LED3
SW4	"SW 4 is pressed."	Toggle LED4
SW5	"SW 5 is pressed."	-
SW6	"SW 6 is pressed."	-
SW7	"SW 7 is pressed."	-
SW8	"SW 8 is pressed."	-
SW9	"SW 9 is pressed."	-
SW10	"SW10 is pressed."	-
SW11	"SW11 is pressed."	-
SW12	"SW12 is pressed."	Digit1 counts from 0 to 9 then Digit2 counts from 0 to 9 repeatedly
SW13	"SW13 is pressed."	Serial EEPROM Chip1 is tested then Chip2 is tested
SW14	"SW14 is pressed."	LCD displays full time and date information and updates it continuously
SW15	"SW15 is pressed."	LCD displays the analog volt on pin A0
SW16	"SW16 is pressed."	The LCD

**The following figures show the setting of DIP switches to set all modules in FEPSP5 kit.**

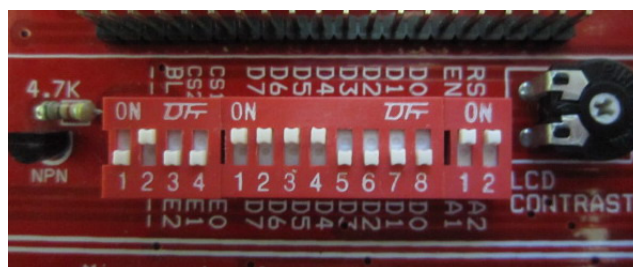
**Figure 42. Setting switches in matrix mode**



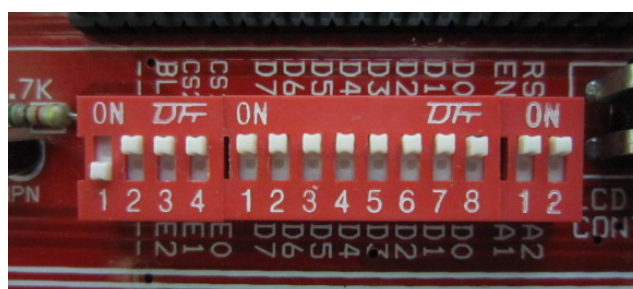
**Figure 43. Setting switches in direct mode**



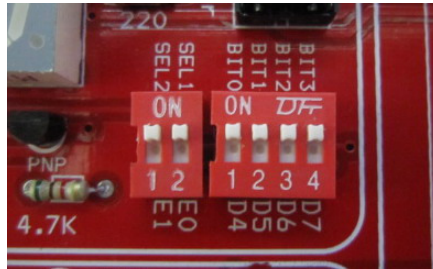
**Figure 44. Setting LCD DIP switch (character LCD)**



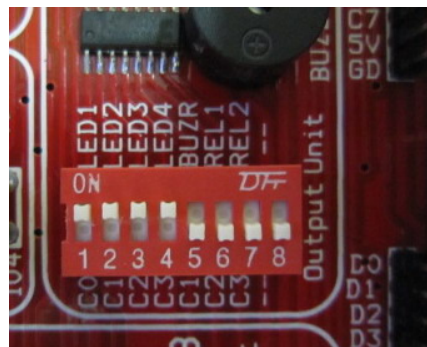
**Figure 45. Setting LCD DIP switch (graphic LCD)**



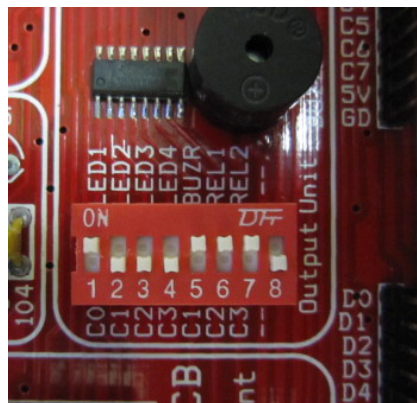
**Figure 46. Setting seven segment DIP switch**



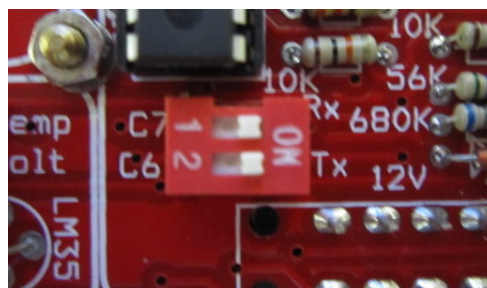
**Figure 47. Enable four output LEDs**



**Figure 48. Enable one LED(LED1), two relays(REL1,REL2) and buzzer(BUZR)**

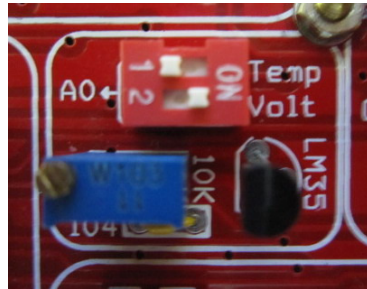


**Figure 49. Enable serial transmission**

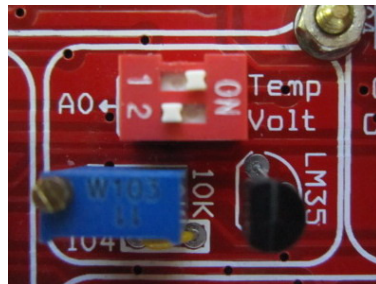




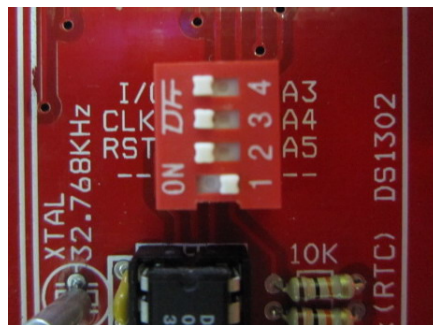
**Figure 50. Enable analog voltage input(variable resistor)**



**Figure 51. Enable temperature sensor input (LM35)**



**Figure 52. Enable real time clock (RTC)**



**Figure 53. Enable serial EEPROM (24Cxx)**





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