

GENERAL DESCRIPTION

FEPSV4 kit is an AVR development board that is simple designed particularly for students, beginners and recent graduated engineers to provide easy developing of AVR microcontroller projects.

FEPSV4 supports all 40DIP AVR microcontroller chips. 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 developer can focus his efforts to software development.

FEPSV4 kit also 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.

FEPSV4 kit includes standard breadboard for other circuit extensions.

Figure 1. FEPSV4 kit real PCB view

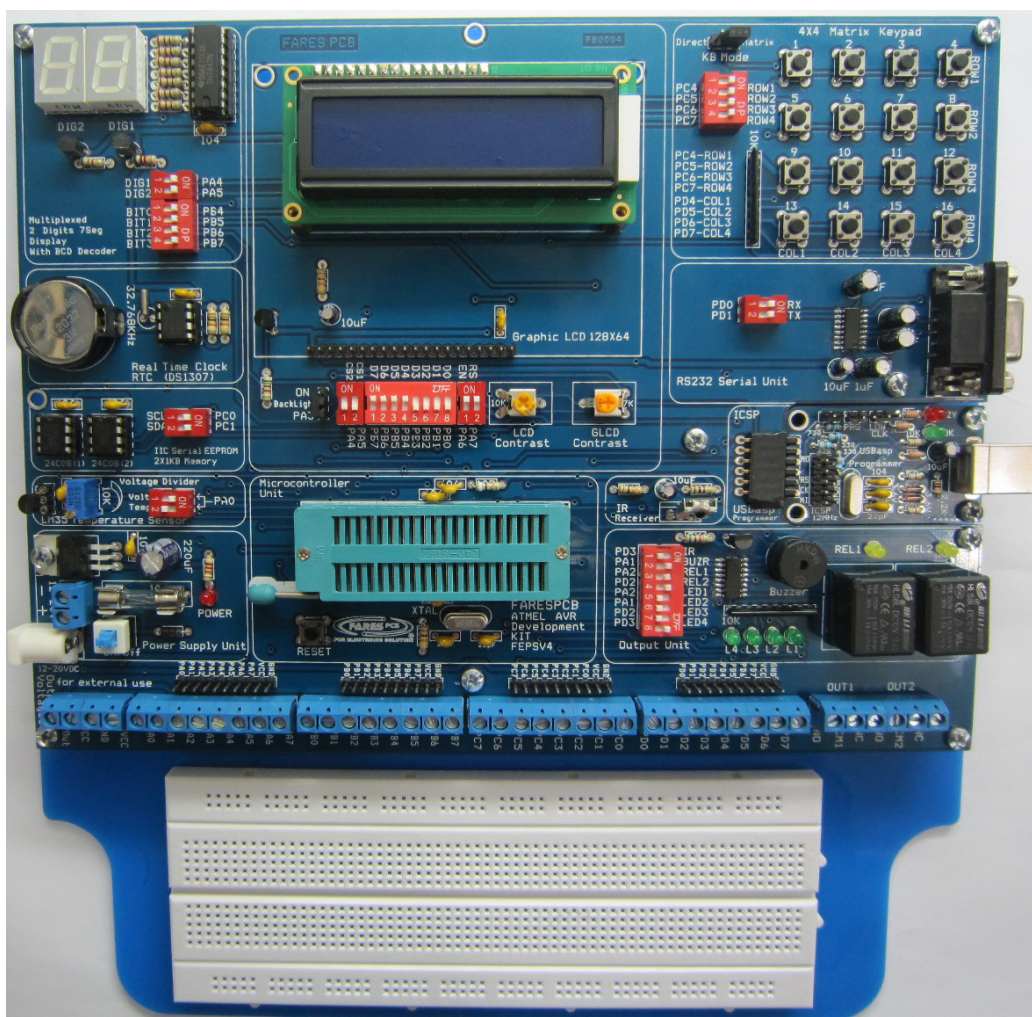


Figure 2. FEPSV4 kit layout view

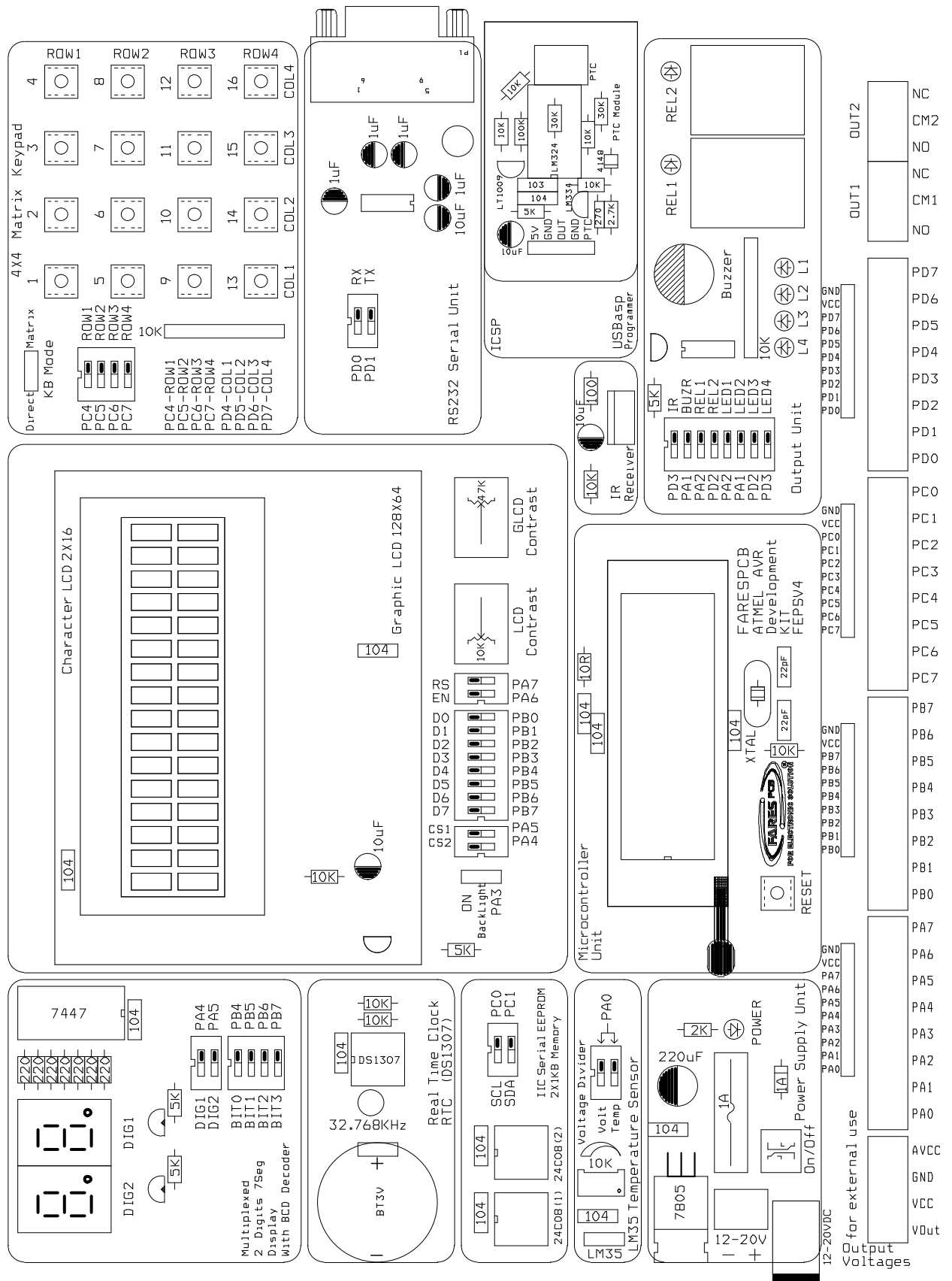
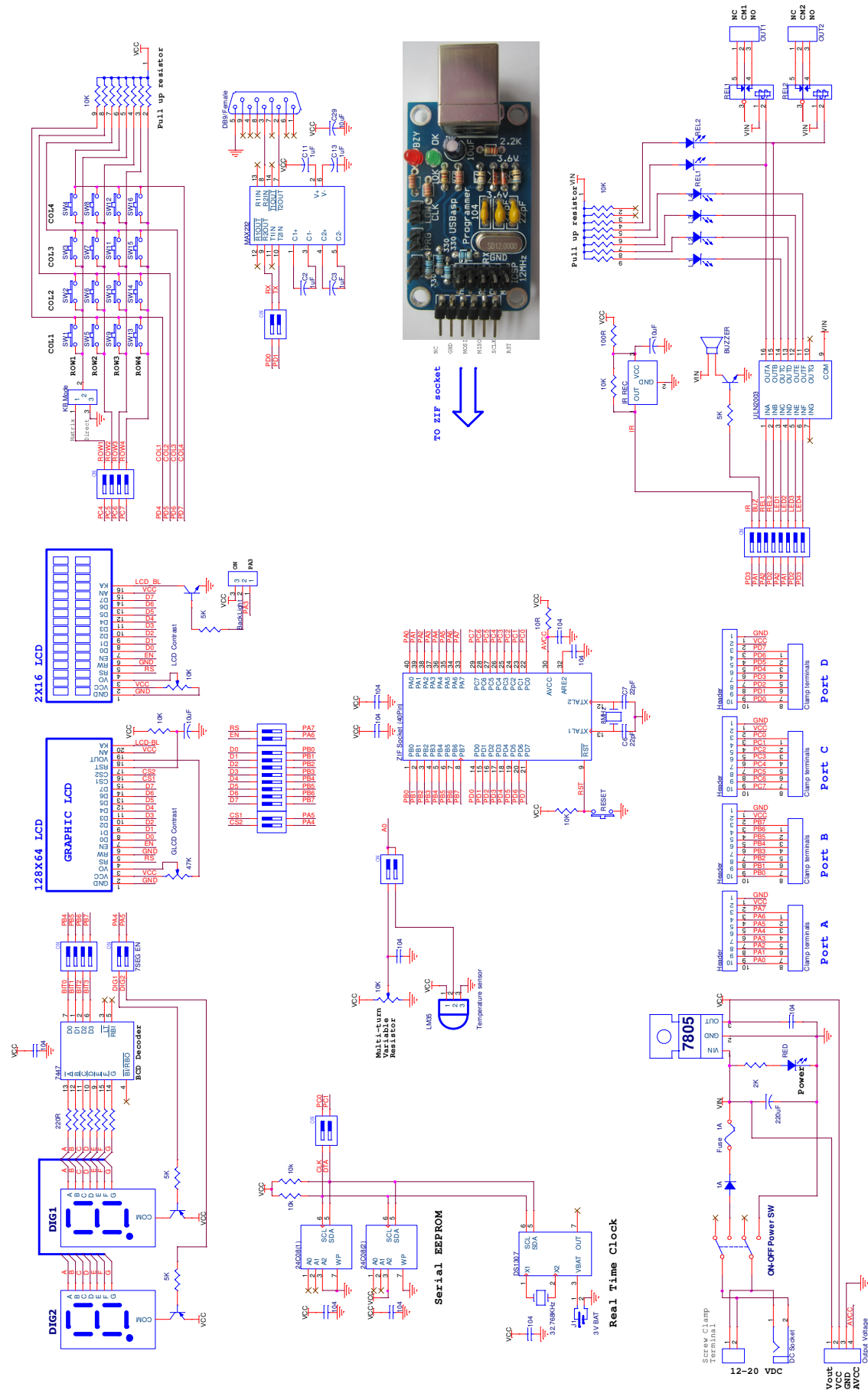


Figure 3. FEPSV4 kit schematic view



FEPSV4 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.

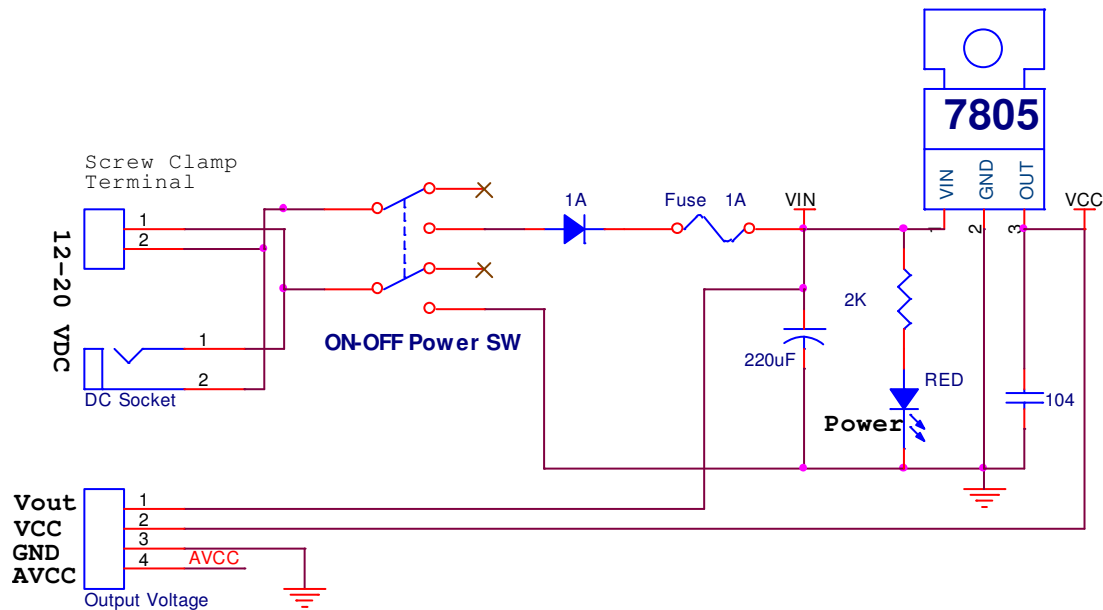
Note 1- FEPSV4 kit is protected against reversed polarity of power.
2- The input voltage and the 5V regulated output voltage are redirected to external Screw clamp terminals labeled (output voltage) for external using.

Figure 4. Power supply unit real PCB view



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



Figure 6. Power supply unit schematic view

Microcontroller Unit

40 pin DIP ZIF socket for microcontroller chip. Table 1 shows all supported microcontroller chips.

8 MHz crystal oscillator fixed on pluggable socket for flexibility.

Power on reset circuit with push button reset switch.

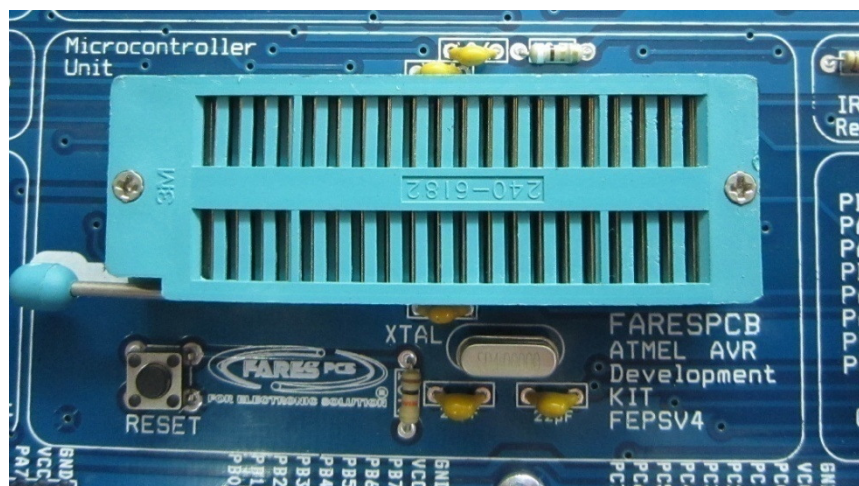
Figure 7. Microcontroller unit real PCB view

Figure 8. Microcontroller unit schematic view

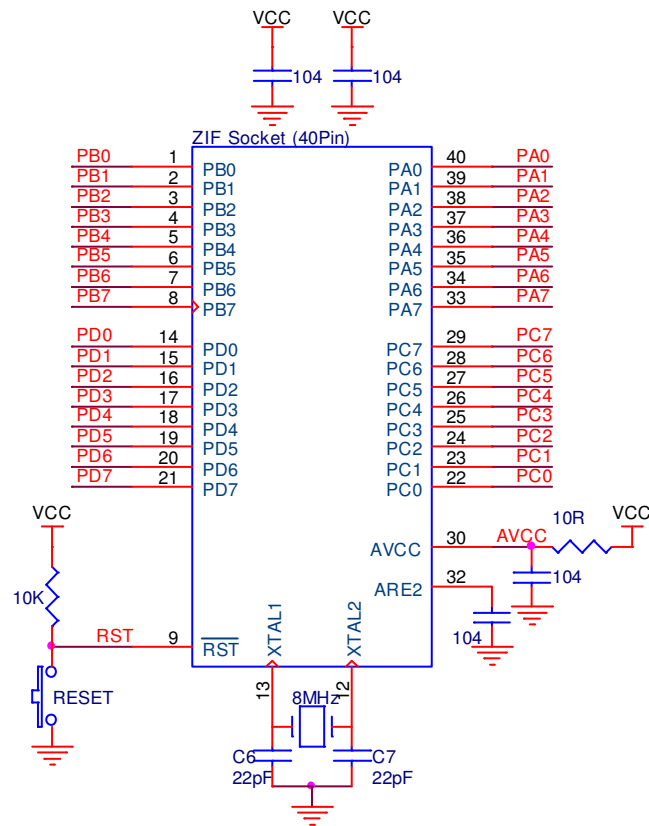


Table 1. List of chips supported by FEPSV4

Supported Chips
AT90S8535
ATMEGA8535
ATMEGA16
ATMEGA161
ATMEGA162
ATMEGA163
ATMEGA164
ATMEGA1284
ATMEGA644
ATMEGA324
ATMEGA32

4X4 Matrix Keypad Unit

FEPSV4 KIT includes 16 input switches attached to the upper nibble of **PortC** and **PortD**. Switches are configured as 4 rows intersected by four columns. Each intersection creates a switch position.

Four row lines are connected to high nibble of **PortC** as following.

ROW1	PC4
ROW2	PC5
ROW3	PC6
ROW4	PC7

Four column lines are connected to high nibble of **PortD** as following.

COL1	PD4
COL2	PD5
COL3	PD6
COL4	PD7

			COLUMNS			
			COL1	COL2	COL3	COL4
			PD4	PD5	PD6	PD7
ROWS	ROW1	PC4	SW1	SW2	SW3	SW4
	ROW2	PC5	SW5	SW6	SW7	SW8
	ROW3	PC6	SW9	SW10	SW11	SW12
	ROW4	PC7	SW13	SW14	SW15	SW16

- Each row can be enabled/disabled individually via DIP switch. In case of needn't to use the keypad absolutely, all rows should be disabled.
- You can use the first row i.e. (SW1, SW2, SW3, SW4) as a direct input switches (not in matrix mode) by setting KB Mode jumper to (Direct). Otherwise set it to (Matrix) to use it in matrix mode.

Note

- All rows and columns are pulled up by a 10K Ω resistor. i.e. (microcontroller port pin reads high if no switch is pressed).

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

DIP switch setting	KB Mode
	Matrix mode
PC4 - ROW1 (ON)	PC4 X PD4 ----> SW1
	PC4 X PD5 ----> SW2
	PC4 X PD6 ----> SW3
	PC4 X PD7 ----> SW4
PC5 - ROW2 (ON)	PC5 X PD4 ----> SW5
	PC5 X PD5 ----> SW6
	PC5 X PD6 ----> SW7
	PC5 X PD7 ----> SW8
PC6 - ROW3 (ON)	PC6 X PD4 ----> SW9
	PC6 X PD5 ----> SW10
	PC6 X PD6 ----> SW11
	PC6 X PD7 ----> SW12
PC7 - ROW4 (ON)	PC7 X PD4 ----> SW13
	PC7 X PD5 ----> SW14
	PC7 X PD6 ----> SW15
	PC7 X PD7 ----> SW16

To set the keypad in direct mode just set **KB Mode** jumper to (Direct) position and set all DIP switch pins(**ROW1, ROW2, ROW3, ROW4**) to ON position, up on this setting the first four switches (**SW1, SW2, SW3, SW4**) only connected to port pins (**PD4,PD5,PD6,PD7**) as shown in table 3.

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

KB Mode	
Direct mode	
PD4	----> SW1
PD5	----> SW2
PD6	----> SW3
PD7	----> SW4

Figure 9. 4X4 matrix keypad unit real PCB view

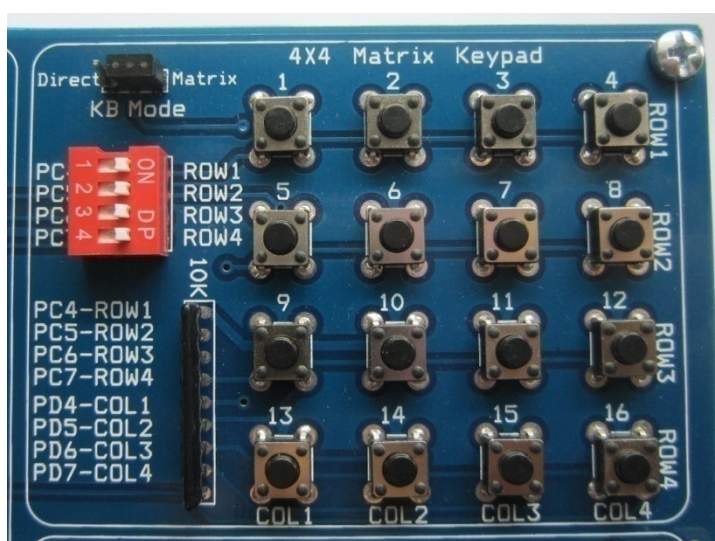
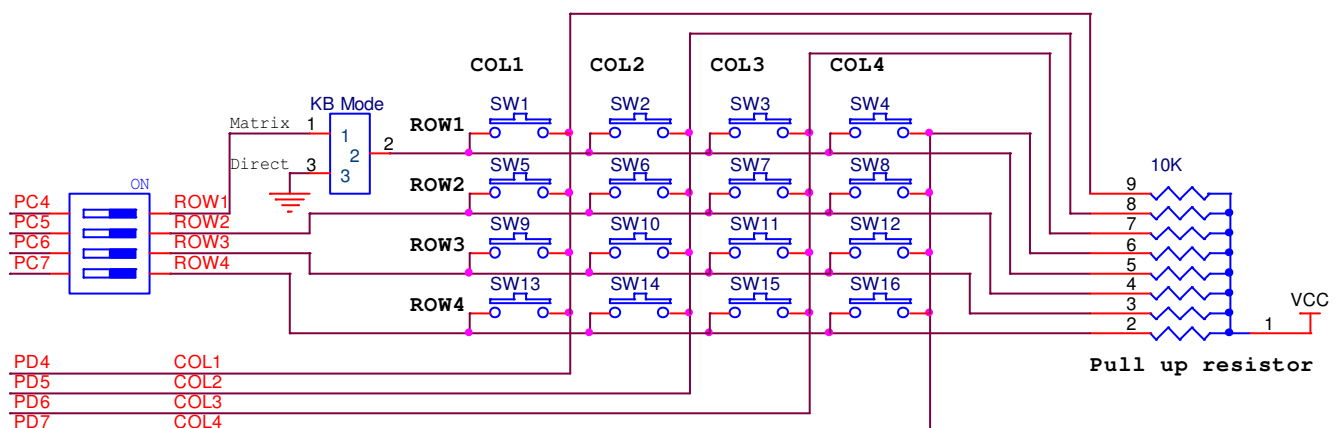


Figure 10. 4X4 matrix keypad unit schematic view



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 (**PA1, PA2, PD2 and PD3**) at a time. It's important to mention that the microcontroller outputs are connected to transistor driver IC (ULN2003) which drives all loads except Buzzer which is derived from a discrete transistor.

1) Four output LEDs

Four green LEDs 12V biased with 1K Ω current limiting resistors are connected to port pins (**PA2, PA1, PD2 and PD3**). 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 **FEPSV4** 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 **PA2** and relay2 attached to port pin **PD2**. 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 (12VDC) is included in output unit to port pin **PA1**. Again, it may be enabled using DIP switch.

Figure 11. Four LEDs display unit real PCB view.

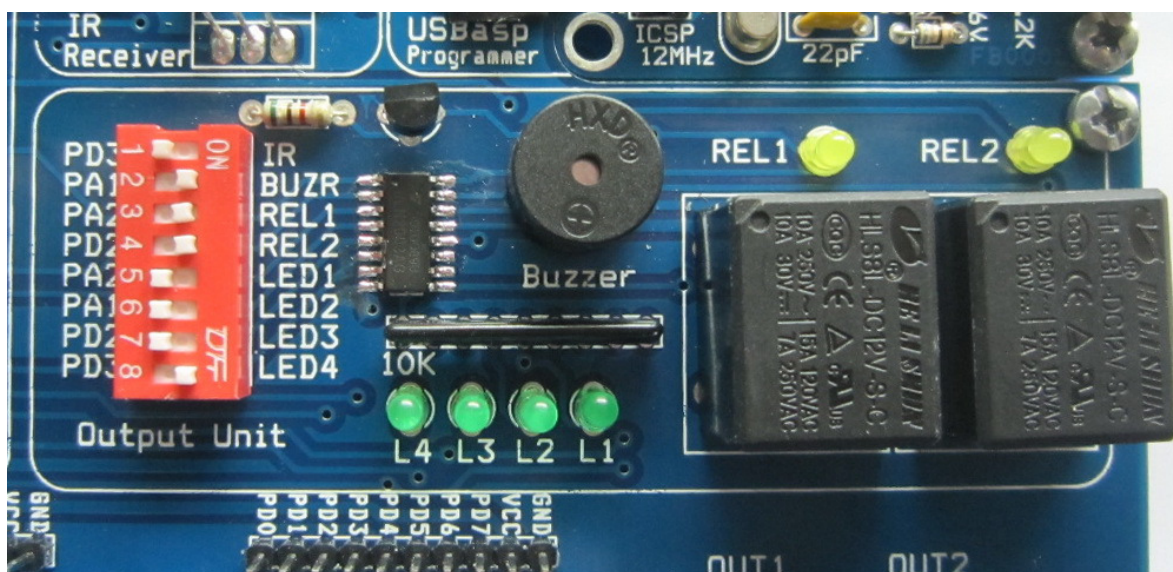
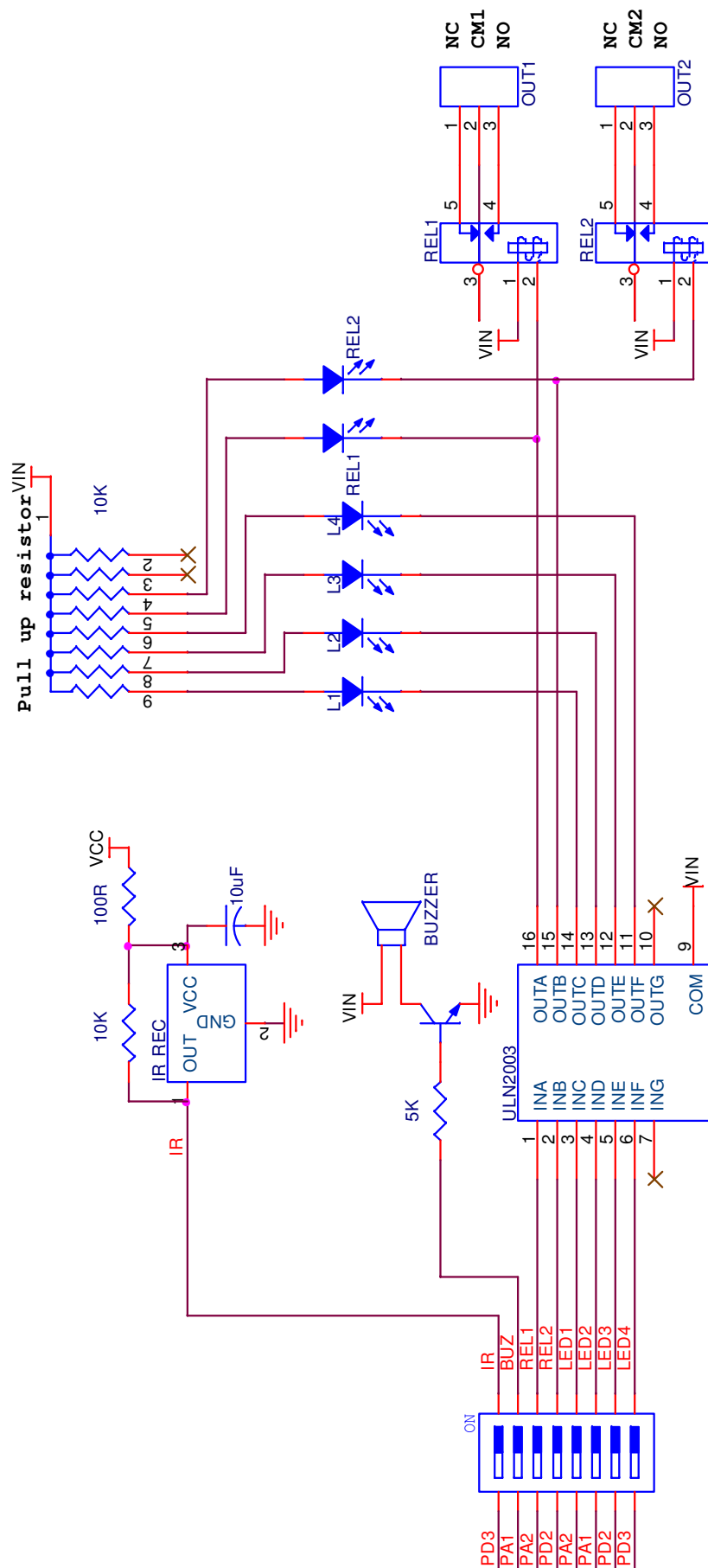


Figure 12. Four LEDs display unit schematic view.



IR Receiver Unit

This unit contains IR sensor input. IR receives the IR signal (40 KHz) and converts it to TTL level to be adequate for microcontroller operation. IR signal may be generated from any IR TV Remote control or simple mp3 player remote.

IR receiver is connected to port PD3 via DIP switch.

Figure 13. IR receiver unit real PCB view.

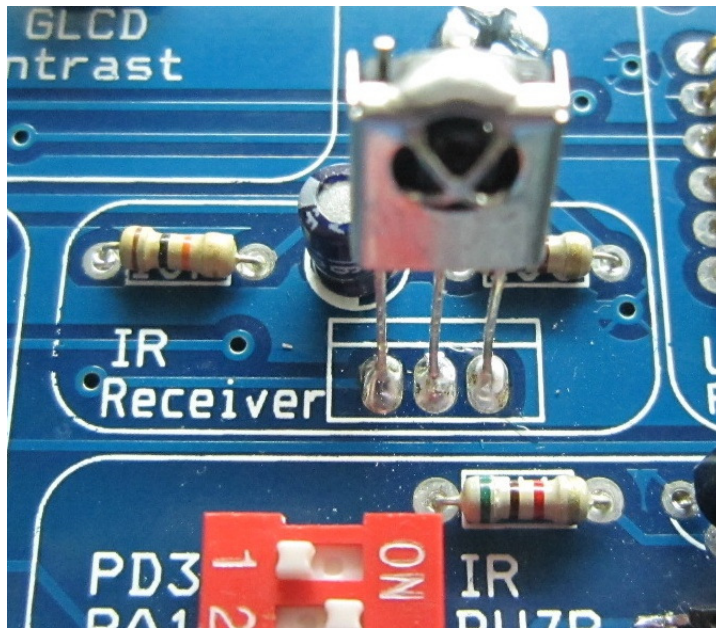
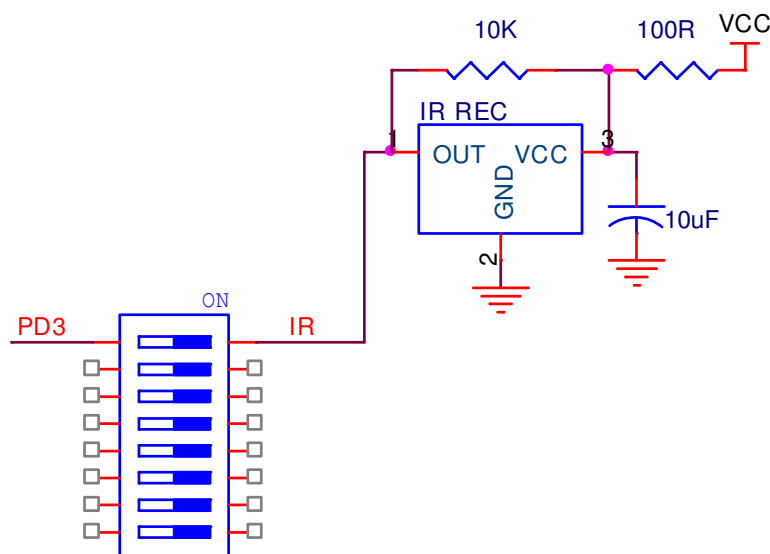


Figure 14. IR receiver unit schematic view.



Multiplexed Two Digits 7seg Display Unit

Two multiplexed 7seg digits with TTL BCD decoder (7447). The decoder inputs are connected to microcontroller pins **PB4** (BIT0), **PB 5** (BIT1), **PB 6** (BIT2), and **PB 7** (BIT3) via four line DIP switch. The selection inputs may be connected to microcontroller pins **PA4** (Digit1 selection) and **PA5** (Digit2 selection). Each 7seg digit can be enabled or disabled individually using two line DIP switch.

Note

- Enable signal is active low i.e. a low output enables the required 7SEG.
- 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
	PB7	PB6	PB5	PB4
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

Multiplexed
2 Digits 7Seg
Display
With BCD Decoder

DIG1
DIG2

104

DIG1
DIG2
BIT0
BIT1
BIT2
BIT3

PA4
PA5
PB4
PB5
PB6
PB7

2X16 LCD Display Unit

2X16 alphabetic LCD with backlight and contrast control configured in 8 or 4 bit mode is connected to **PortB** via DIP switch as following

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

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

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

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

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

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

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

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

Port **A.3** is connected to backlight control, Output high on this pin turn backlight on.

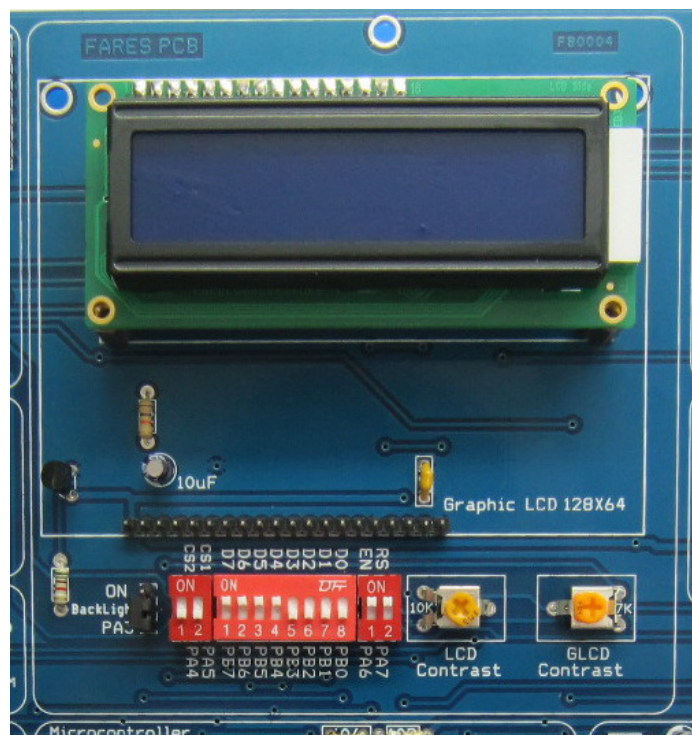
Port **A.6** is connected to EN of LCD

Port **A.7** is connected to RS of LCD

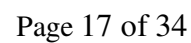
Note

- 10K Ω variable resistor labeled "LCD CONTRAST" is adjusted to control the LCD contrast.
- Remind to disable all DIP switches related to 128X16 GLCD and 7seg modules before using 2X16 LCD module.

Figure 17. 2X16 LCD display unit real PCB view.



2X16 LCD



128X64 Graphical LCD Unit (Optional)

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

Port **B.0** is connected to Bit 0 of GLCD

Port **B.1** is connected to Bit 1 of GLCD

Port **B.2** is connected to Bit 2 of GLCD

Port **B.3** is connected to Bit 3 of GLCD

Port **B.4** is connected to Bit 4 of GLCD

Port **B.5** is connected to Bit 5 of GLCD

Port **B.6** is connected to Bit 6 of GLCD

Port **B.7** is connected to Bit 7 of GLCD

Port **A.3** is connected to backlight control, Output high on this pin turn backlight on.

Port **A.6** is connected to EN of LCD

Port **A.7** is connected to RS of LCD

Port **A.5** is connected to CS1 of LCD

Port **A.4** is connected to CS2 of LCD

Note

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

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

Figure 19. 128X64 GLCD display unit real PCB view.

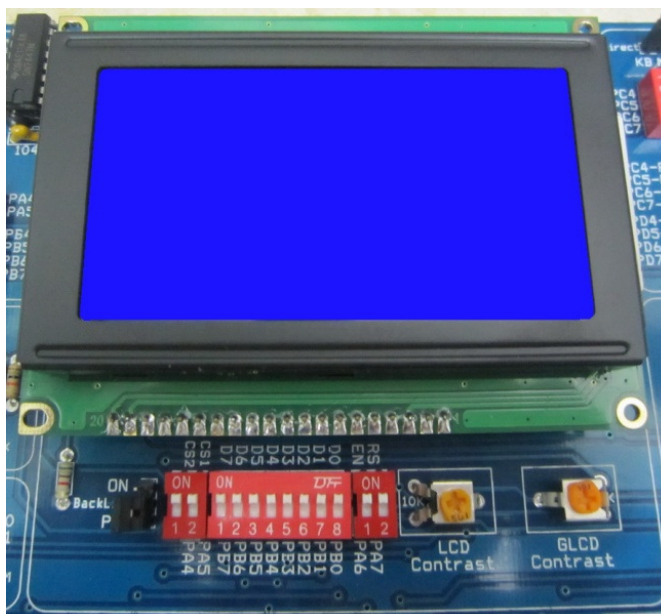
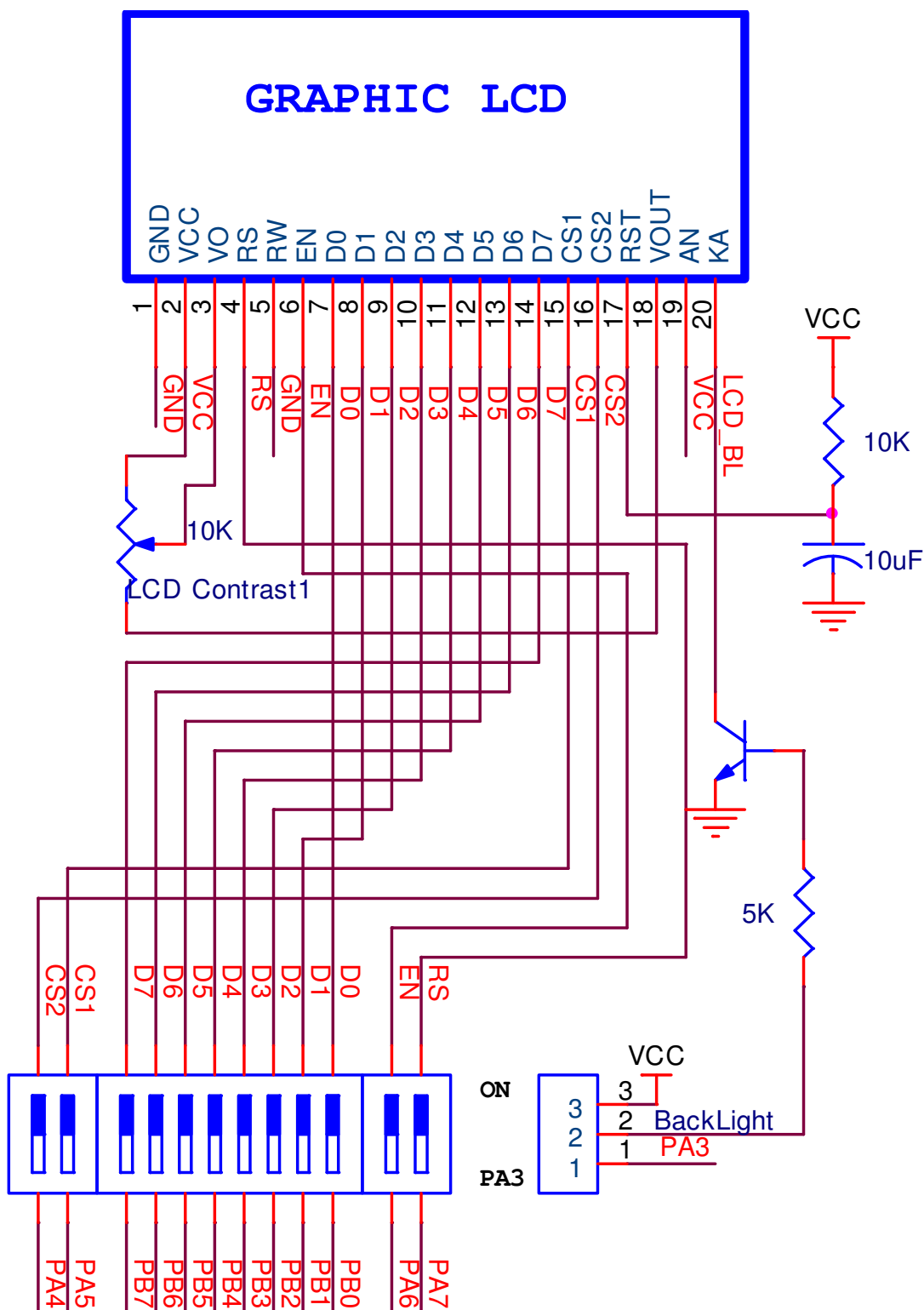


Figure 20. 128X64 GLCD LCD display unit schematic view.



Analog Input Unit

It consists of two sources of analog signals share the same analog input Port pin **PA0** 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 **PA0** 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 **PA0** 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°C to 150°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 21. Analog input unit real PCB view.

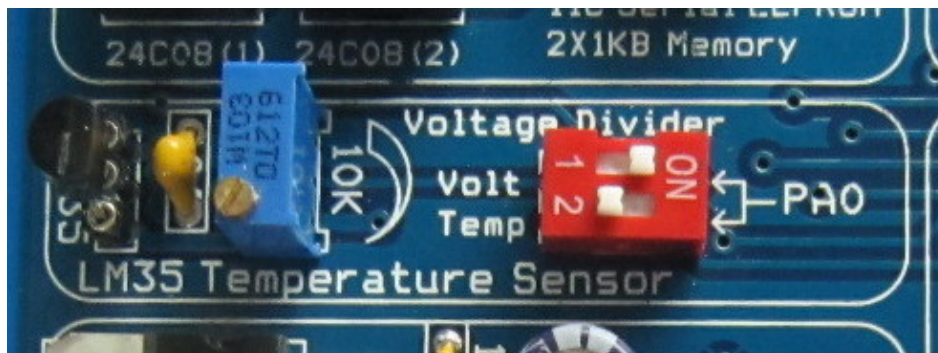
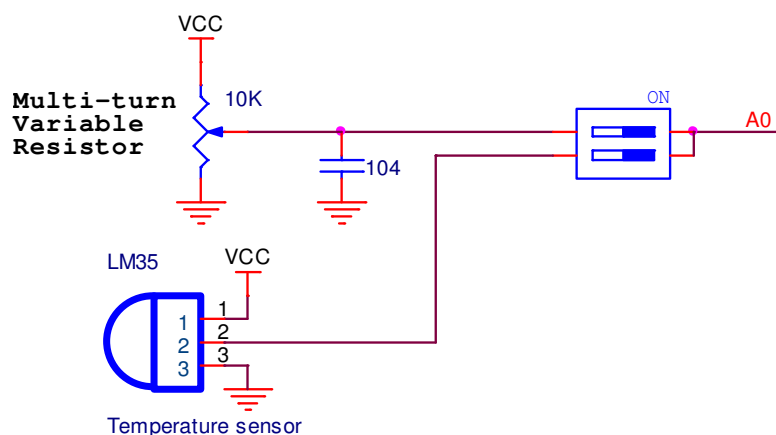


Figure 22. Analog input unit schematic view.



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 PC0 (Clock) and PC1 (Data) via two channels DIP switch. The device address bits of the first chip 24C08 is

1	0	1	0	A2	P1	P0	R/W
---	---	---	---	----	----	----	-----

Where A2 is the device address bit (Pin 3). P0, P1 is the page address in the chip. R/W is the read write select bit.

The device address bits of the first chip 24C08 (1) is

1	0	1	0	0	P1	P0	R/W
---	---	---	---	---	----	----	-----

The device address bits of the first chip 24C08 (2) is

1	0	1	1	0	P1	P0	R/W
---	---	---	---	---	----	----	-----

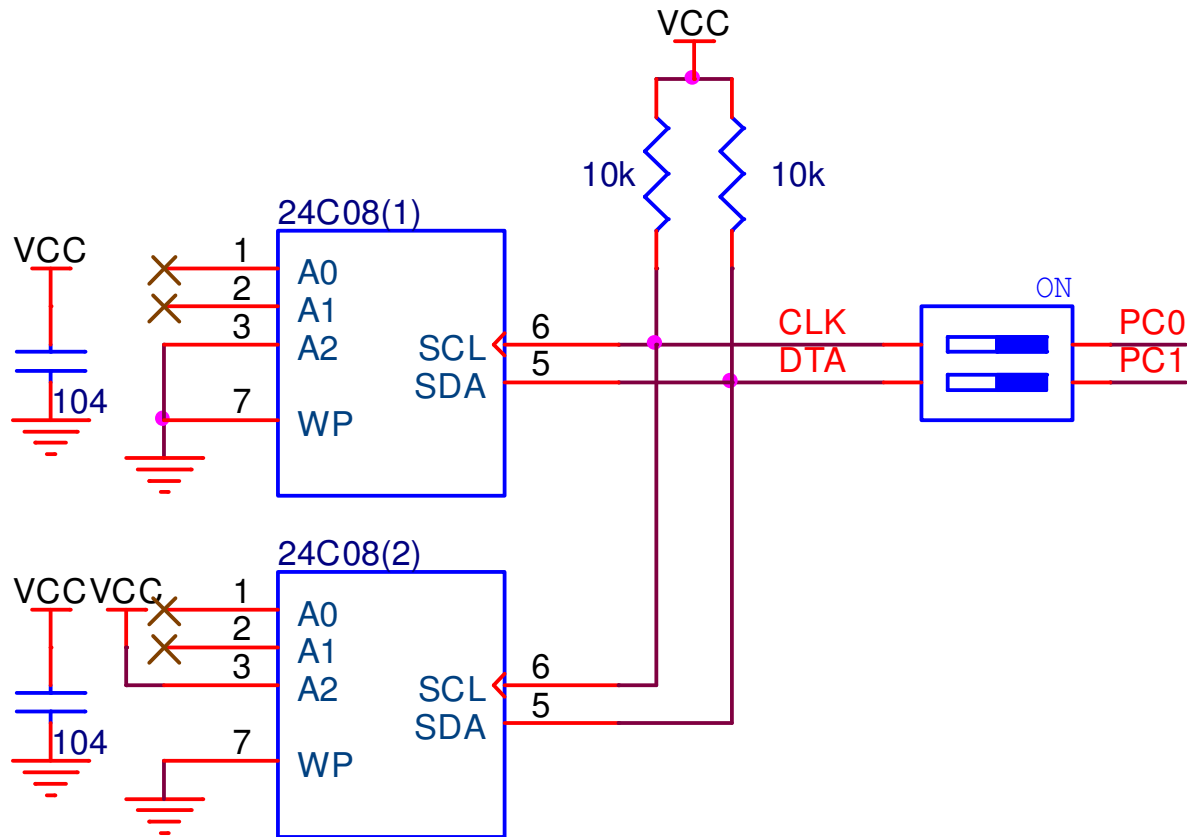
Note

- It's capable to plug other serial EEPROMs 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 23. Serial EEPROM unit real PCB view.



Figure 24. Serial EEPROM unit schematic view.



Serial EEPROM

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 DS1307 IC, which requires two I/O lines to interface to microcontroller. It operates as a slave on the serial IIC bus and shares the same lines with 24C08 serial EEPROM.

Clock and Data are connected to port pins (**PC0 and PC1**) respectively via DIP switch.

Note

For any other information about the real time clock chip DS1307 please refer to the datasheet included in the CD in package.

Figure 25. RTC unit real PCB view.

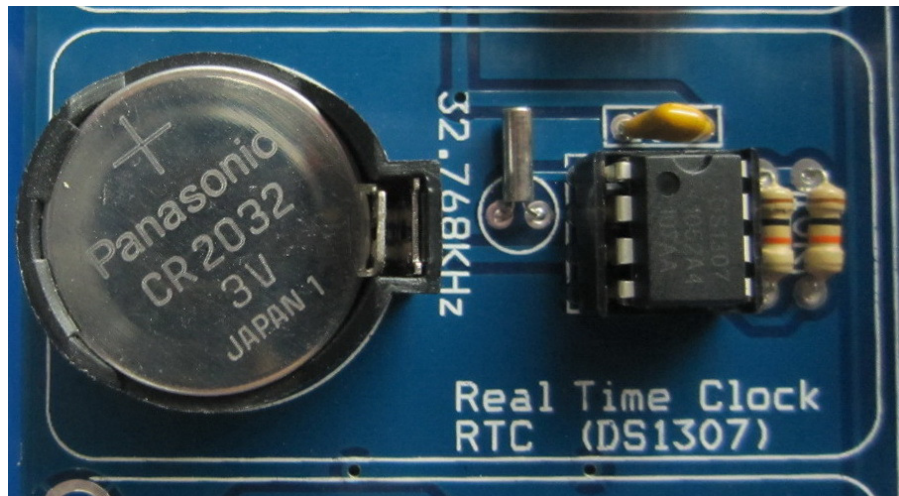
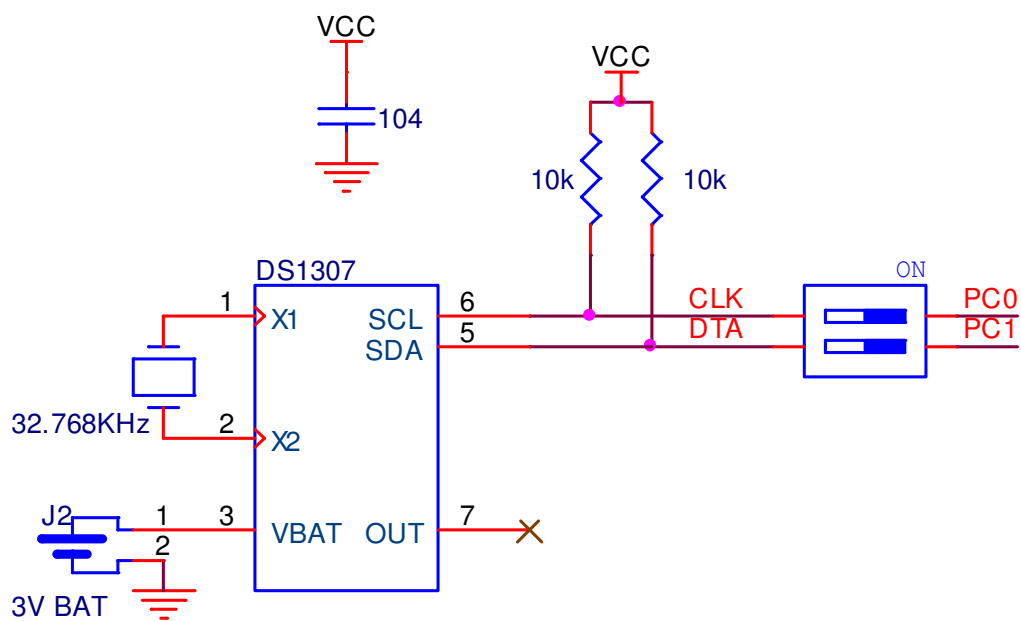


Figure 26. RTC unit schematic view.



Real Time Clock

RS232 Serial Unit

This unit includes RS232-TTL logic converter using MAX232 IC, and provides DB9 Female socket for PC serial communication. Serial interface circuit can be enabled or disabled using DIP switch (see figure 25). The RS232/TTL Converter IC is connected to hardware UART embedded in AVR microcontroller on **PD0** and **PD1** if this unit is enabled.

Figure 27. RS232 Serial unit real PCB view.

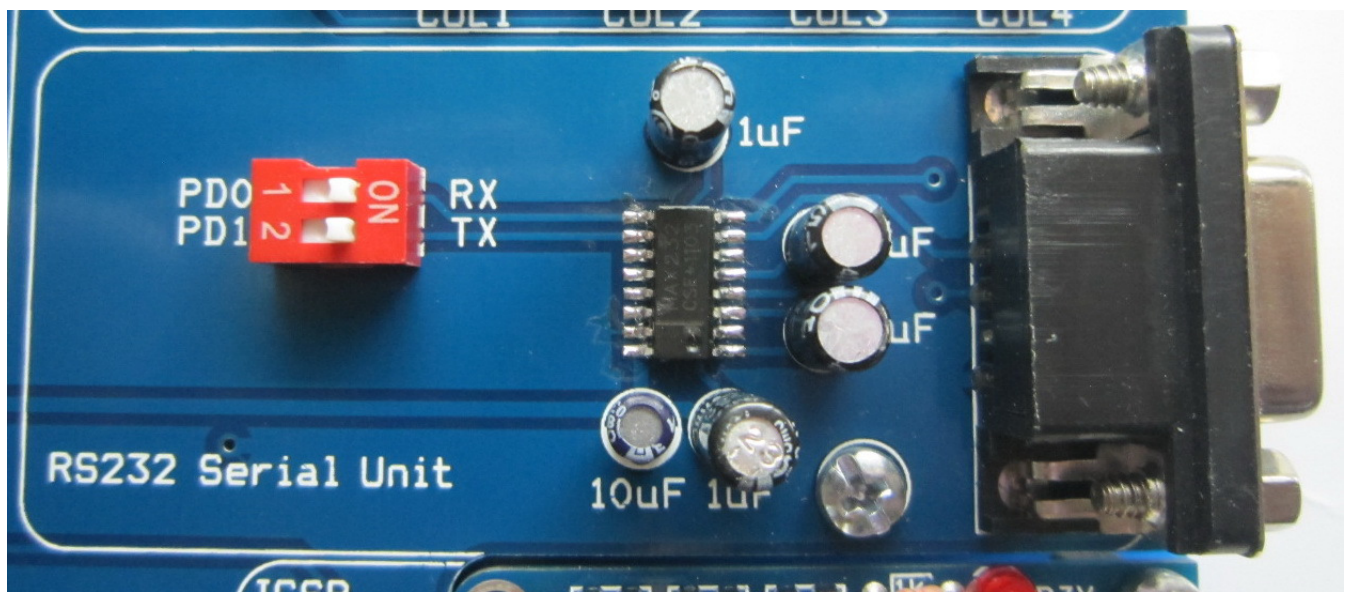
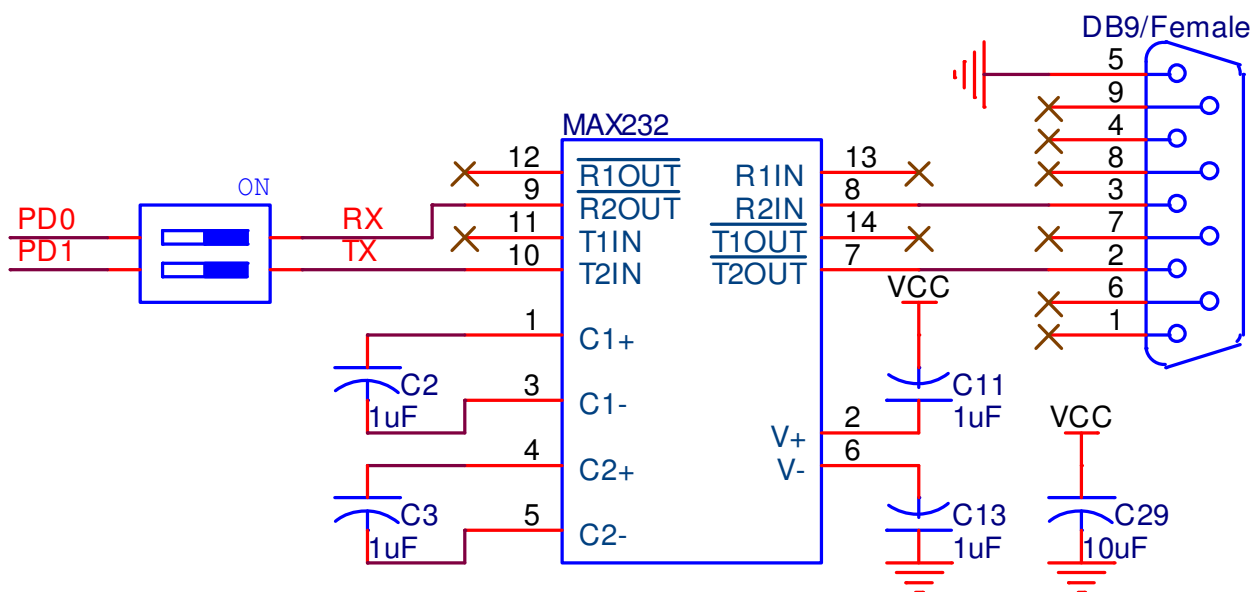


Figure 28. RS232 Serial unit schematic view.



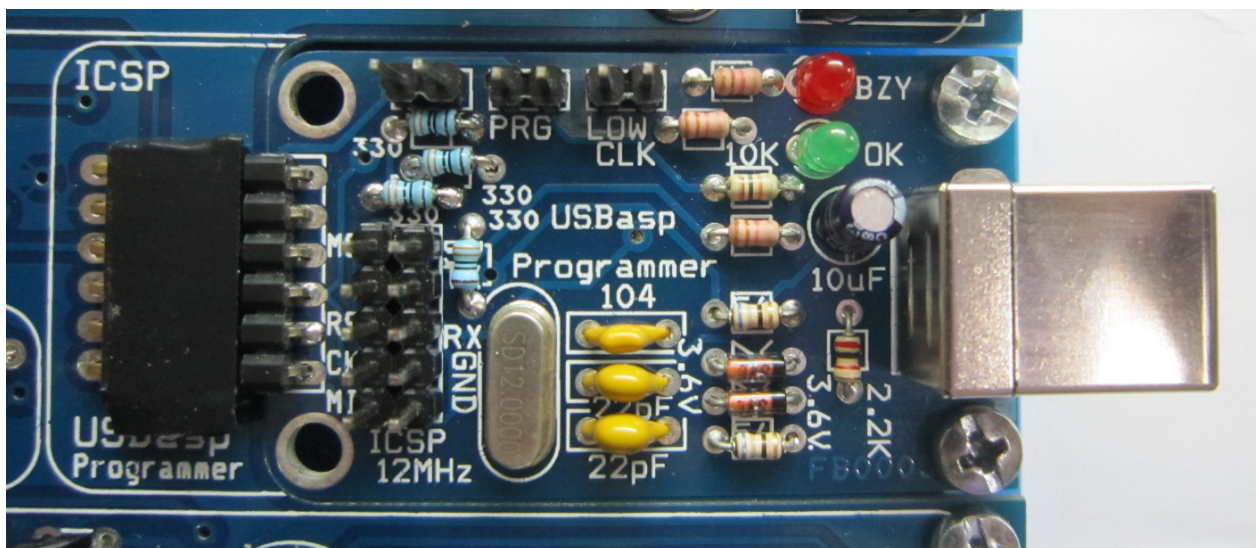
USBasp Programmer UNIT

USBasp is an open source USB in-circuit programmer for Atmel AVR microcontrollers. It's embedded in [FEPSV4](#) kit. USBasp programmer allows Read/write the microcontroller Program memory, EEPROM data, fuse bits and lock bits. It has two LEDs for normal and activity operation. There are two software programs implied in CD package to burn your hex code. After the programming of target is completed a reset operation is performed to ensure right operation.

Note

For any other information about the USBasp programmer please refer to the datasheet included in the CD in package.

Figure 29. USBasp programmer unit real PCB view



PORT CONNECTORS

Although FEPSV4 Kit has a very popular built in circuits and devices (switches, LEDs, 7seg, LCD and other), 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).

Figure 30. Microcontroller port pins real PCB view

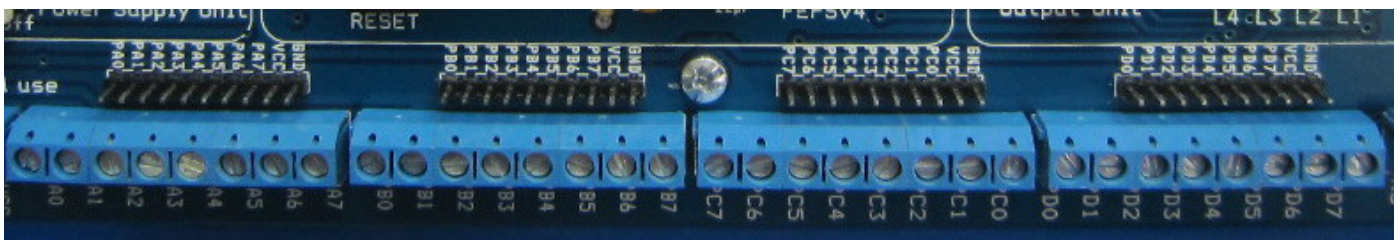
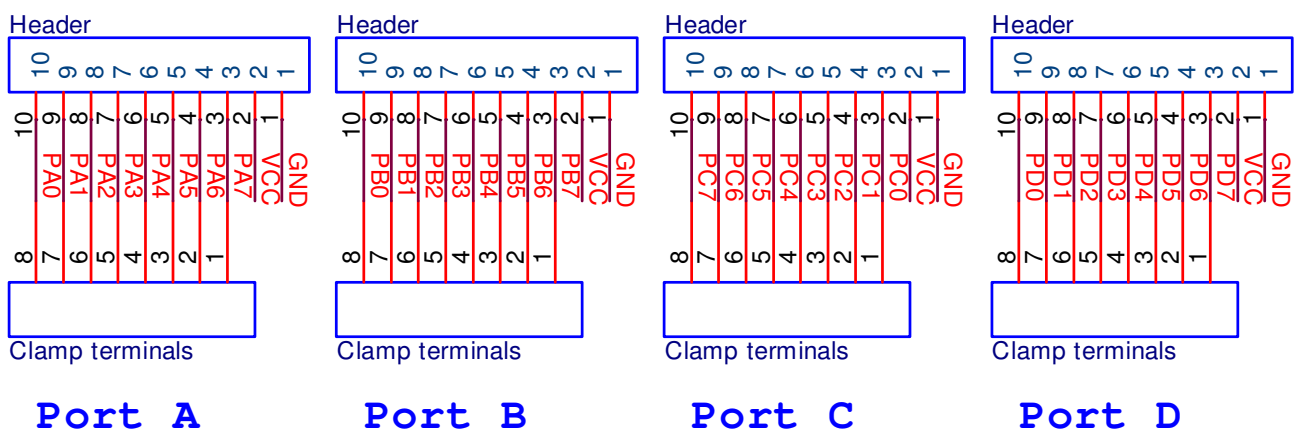


Figure 31. Microcontroller port pins schematic view



FEPSV4 involves standard 2.5" X 6.75" breadboard for easy circuit making and extensions.

HOW TO START?

Step1

First of all USBasp programmer driver must be installed.

Start Windows and connect USB cable to the kit. When Windows asks for a driver, choose "usbasp-windriver\libusb_0.1.12.1". Windows XP may warn that the driver is not 'digitally signed'. Ignore this message and continue with the installation.

For Linux and Mac OS X no kernel driver is required.

Step2

Install your preferred programming software (Khazama AVR Programmer or eXtreme Burner). Both software programs include the driver of USBasp programmer, so you needn't to perform the first step.

Step3

If it is the first time to use [FEPSV4](#) kit, you should perform some test operations on kit before start using it. The CD included with package contains the firmware code required for testing all modules in kit. So, it's recommended to apply this test code before going to your own application firmware to guarantee system readiness.

Upon burning "**FEPSV4_Test.hex**" code user could test

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

- Enable DIP switches of all modules on kit except IR and Analog module where only the volt DIP switch is enabled.
- Set backlight jumper to PA3.
- Set keypad to matrix mode (Set KB Mode to Matrix position).
- Ensure 8MHz crystal is used.
- Plug in serial cable.
- Plug in power cable.
- Turn power switch on.
- Open the software program (**eXtreme or Khazama**).
- Chose “**ATMEGA16**” chip from chip selector.
- Load the test code included in CD (**FEPSV4_Test.hex**).
- Click Write button.
- After programming is completed the microcontroller is reset automatically.

After power on or reset operation the test sequence is

1 - Serial module transmits this message to serial port

"FARESPCB: ATMEL AVR Development Kit (FEPSV4)".

(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 ***
AVR Kit (FEPSV4)
```

3 - If any switch is pressed the microcontroller sends a message to serial port contains the pressed switch number and the LCD displays the same message such 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 port pin (PA2) LED1/REL1
SW2	"SW 2 is pressed."	Toggle port pin (PD2) LED3/REL2
SW3	"SW 3 is pressed."	Toggle port pin (PD3) LED4
SW4	"SW 4 is pressed."	---
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 port pin (PA0)
SW16	"SW16 is pressed."	LCD displays any received text from the serial port in the second line.

If no switch is pressed for about one Minute, the backlight of LCD will be turned off.

The following figures show the setting of DIP switches to set each modules in FEPSV4 kit.

Figure 32. Setting switches in matrix mode

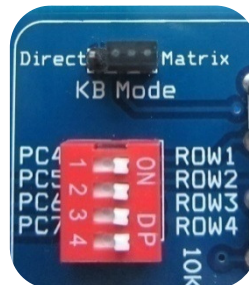


Figure 33. Setting switches in direct mode



Figure 34. Setting LCD DIP switch (character LCD) in 4 Bit mode

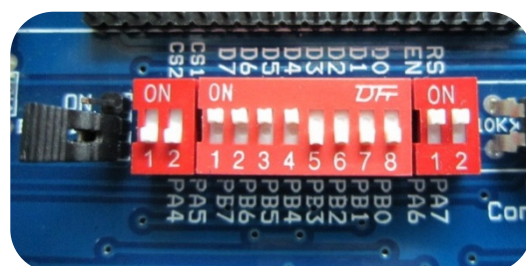


Figure 35. Setting LCD DIP switch (character LCD) in 8 Bit mode

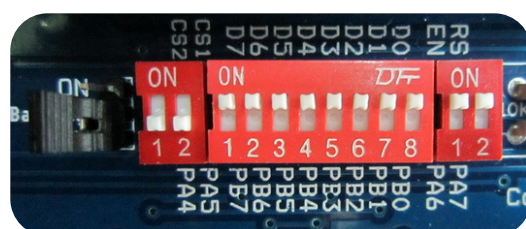
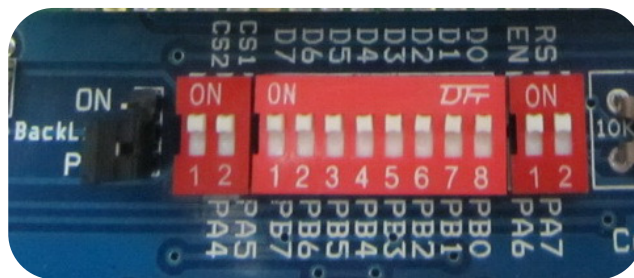
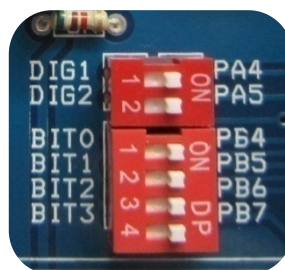
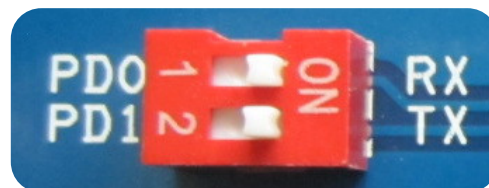
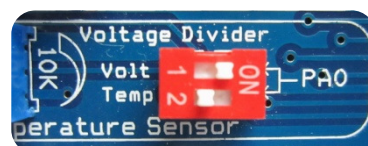
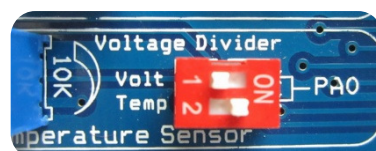
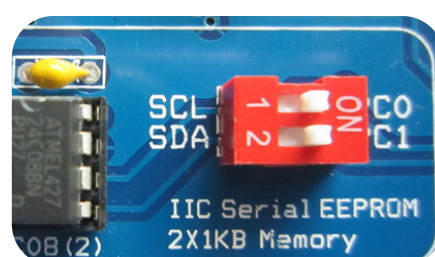
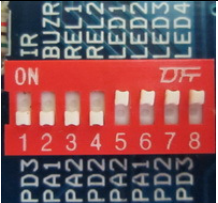
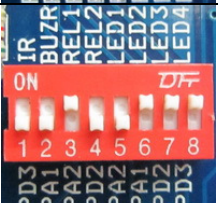
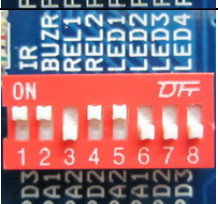
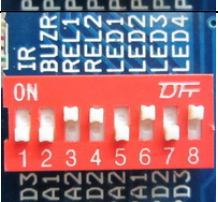
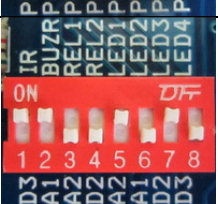
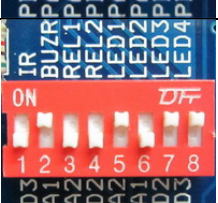
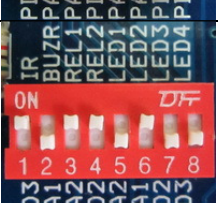


Figure 36. Setting LCD DIP switch (graphic LCD)**Figure 37. Setting seven segment DIP switch****Figure 38. Enable serial transmission****Figure 39. Enable analog voltage input(variable resistor)****Figure 40. Enable temperature sensor input (LM35)****Figure 41. Enable IIC for real time clock (RTC) and serial EEPROM (24Cxx)**

Output unit configuration options

Configuration	IR PD3	Buzzer PA1	Relay		LED			
			REL1 PA2	REL2 PD2	LED1 PA2	LED2 PA1	LED3 PD2	LED4 PD3
	X	X	X	X	✓	✓	✓	✓
	✓	✓	✓	✓	X	X	X	X
	X	X	✓	X	X	✓	✓	✓
	✓	✓	X	✓	✓	X	X	X
	X	X	✓	✓	X	✓	X	✓
	✓	✓	X	X	✓	X	✓	X
	X	✓	X	X	✓	X	✓	✓
	✓	X	✓	✓	X	✓	X	X

	X	✓	✓	X	X	X	✓	✓
	✓	X	X	✓	✓	✓	X	X
	X	✓	✓	✓	X	X	X	✓
	✓	X	X	X	✓	✓	✓	X
	X	✓	X	✓	✓	X	X	✓
	✓	X	✓	X	X	✓	✓	X
	X	X	X	✓	✓	✓	X	✓
	✓	✓	✓	X	X	X	✓	X

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