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Easy8051B

USER'S MANUAL

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Nebojša Matić
General Manager

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CONTENTS

Easy8051B KEY FEATURES	4
CONNECTING THE SYSTEM	5
INTRODUCTION	6
Switches	7
Jumpers	8
MCU Ports	9
Power Supply	10
On-board USB 2.0 Programmer	11
MCU Sockets	12
LEDs	13
Push-Buttons	15
7-segment LED Displays	17
2x16 Character LCD	18
Graphic LCD	19
RS-232 Communication	20
DS1820 Digital Thermometer	21
Oscillator	22
A/D Converter	23
D/A Converter	24
Direct Port Access	25
Circuit Details	27

SOFTWARE AND HARDWARE SOLUTIONS FOR EMBEDDED WORLD

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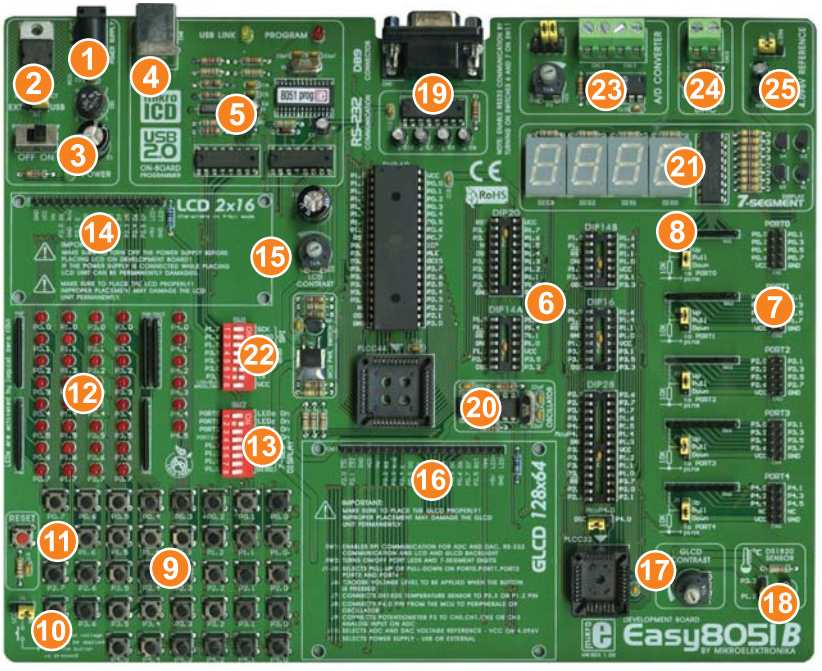
Easy8051B KEY FEATURES



1. External power supply of 8v to 16v AC/DC.
2. Selectable external and USB power supply. When using USB port, there is no need for external power supply.
3. Power on/off switch.
4. USB connector.
5. Very fast and flexible on-board USB 2.0 programmer. By downloading a new software, it will be possible to program new MCUs in coming years.
6. Easy8051B supports micro controllers in DIP14, DIP20, DIP28, DIP40, PLCC32 and PLCC44 package, which means that almost the entire range of Atmel 8051 microcontrollers can be used with it.
7. Direct port access connectors.
8. Jumpers to determine input pin performance in idle state (connected to pull-up or pull-down resistor).
9. 38 push-buttons allow control of all the microcontroller pins.
10. Jumper to select high or low state of pins on push-button press.
11. RESET push-button.
12. Each I/O pin corresponds to one LED.
13. Switch group SW2 allows all LEDs on ports P0, P1, P2, P3 and P4 to be connected to or disconnected from MCU pins. Four switches of the same group enable drivers for each 7-segment LED digit.
14. 2x16 characters LCD display connector.
15. Potentiometer for LCD contrast adjustment.
16. Graphic LCD display (GLCD) connector.
17. Potentiometer for GLCD contrast adjustment.
18. DS1820 temperature sensor allows temperature measurement with 0.5 C accuracy.
19. RS-232 communication port.
20. On-board clock oscillator circuit.
21. 7-segment LED displays in multiplex mode.
22. Switch group SW1 enables MOSI, MISO and SCK pins used for SPI communication. Also, it enables on-board A/D and D/A converters, RX/TX line of RS232 module and LCD/GLCD backlight.
23. 12-bit A/D converter.
24. 12-bit D/A converter.
25. Precise voltage reference 4.096V.

CONNECTING THE SYSTEM

Apart from this manual, development system box contains development system, product CD, USB cable, RS232 cable and user's manuals for *8051prog programmer,* and *Installing USB drivers*. In order to use Easy8051B properly, it is necessary to go through the following steps:

Step no.1 Take development system and product CD out of the box. First of all, insert the product CD into CD drive. Do not connect development system to PC yet.

Step no.2 Install *8051flash* programmer software to enable a program to be transferred from PC to the microcontroller chip. Installation instructions are contained in '*8051prog programmer*' manual.

Step no.3 Install USB drivers on your PC to enable programmer's hardware to operate properly on Easy8051B board. For detailed installation instructions refer to '*Installing USB drivers*' manual.

Step no.4 Connect Easy8051B to PC using USB cable. Please use one of USB ports on the back of the PC because they are directly connected to the computer motherboard.

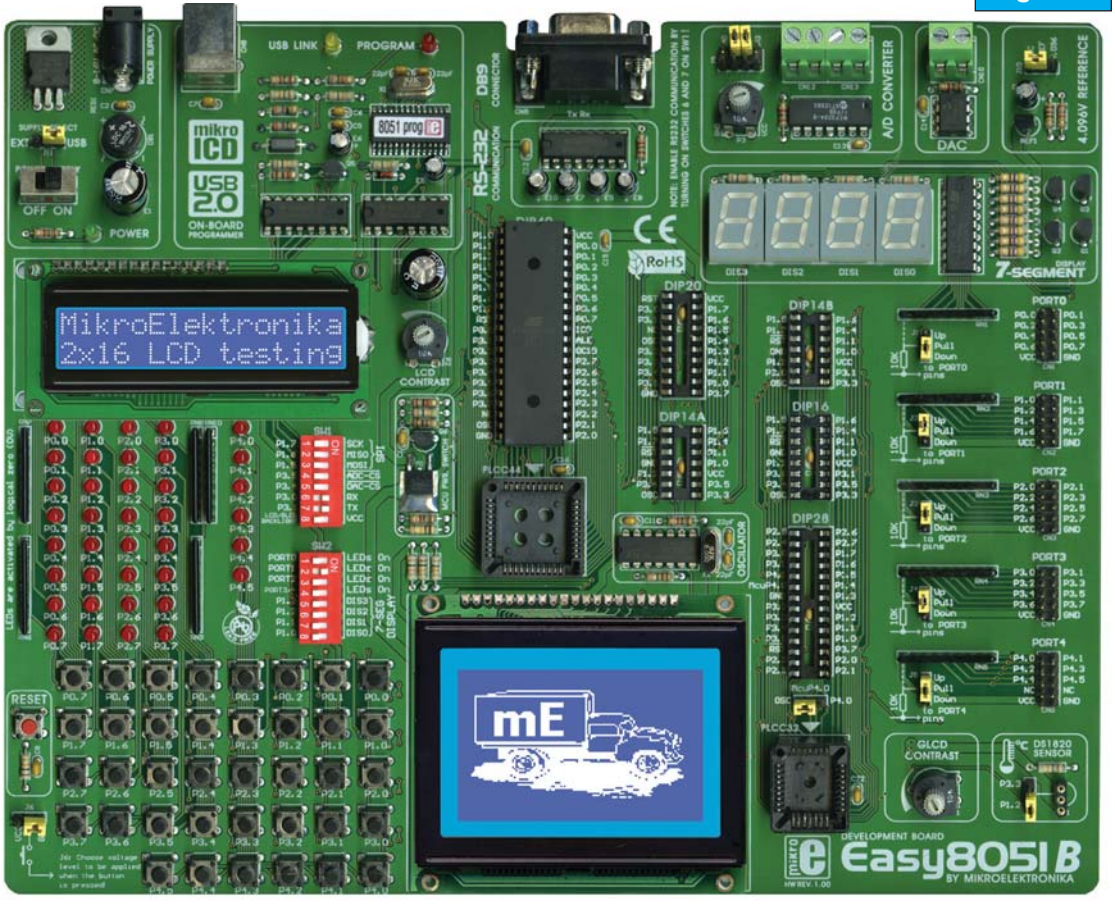
After these four steps, your Easy8051B is successfully installed and ready for use. You can read a program from the chip or write a new one into it. The product CD provides numerous simple program examples which will make your first steps Easy...

INTRODUCTION

The Easy8051B development system is a perfect tool for programming almost all Atmel 8051 microcontrollers. It allows students and engineers to easily test and explore the abilities of 8051 microcontrollers. Additionally, it allows 8051 microcontrollers to be interfaced with external circuits and a broad range of peripheral devices. The user can therefore concentrate on software development only.

Figure 1 illustrates the Easy8051B development system. As can be seen, there are identification marks next to each component on a silkscreen, both on the top and bottom. These marks describe connecting to the microcontroller, operation modes and provide additional useful information as well. In that way all relevant information is provided on the board so that there is almost no need for additional schematic.

Figure 1



SWITCHES

The Easy8051B development system features a number of peripheral devices. In order to enable them before programming, the appropriate jumpers or switches have to be properly set.

Switches are mechanical devices used to establish or break connection between two contacts. The Easy8051B development system has two groups of switches.

Switch group **SW1** is used to enable SPI communication lines, external on-board A/D and D/A converters, RS232 TX/RX lines and LCD/GLCD backlight.

Switch group **SW2** is used to enable/disable LEDs and 7-segment displays connected to the microcontroller ports. Each port has its own LEDs' on/off switch. Each digit driver has its own on/off switch too.

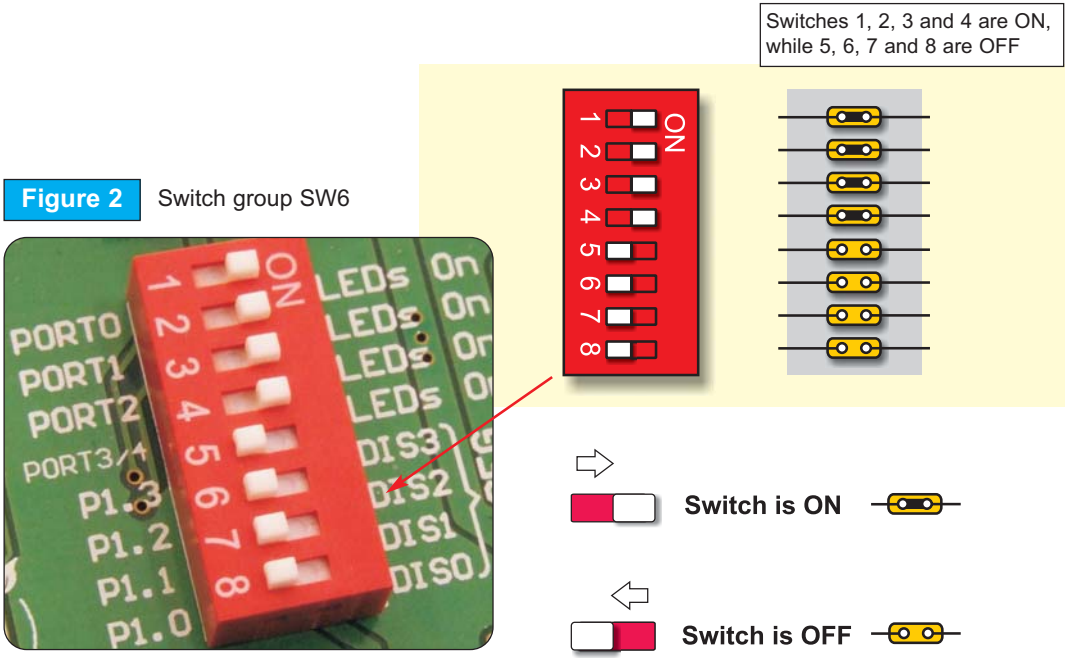


Figure 2 Switch group SW6

JUMPERS

Similar to switches, jumpers are used to break or establish connection between two points. Under the plastic cover of a jumper, there is a metal contact which establishes connection when the jumper is placed over two pins.

Jumper is commonly used as a selector between two possible connections on 3-pin connector. As illustrated in figure 3, the middle connector pin can be connected to the left or right pin, depending on the jumper's position.

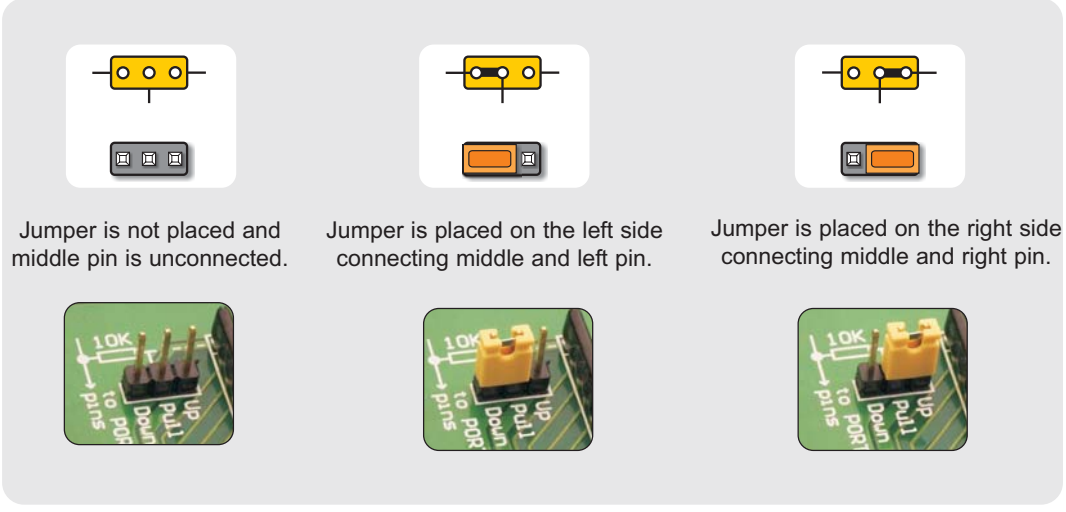


Figure 3 Jumper as a selector

MCU PORTS

Microcontroller pins are routed to various peripherals as illustrated in figure 4.

All MCU ports are directly connected to 2x5 direct port access connectors on the right side of the board. Such connectors are normally used for connecting external peripherals to the board or for digital logic probes for testing and measurement.

All ports are also connected to LEDs and push-buttons, which allows easy monitoring and testing digital pin state.

Some pins are connected to other peripherals such as DS1820 temperature sensor, RS-232 communication, LCD etc. which depends on MCU internal organization.

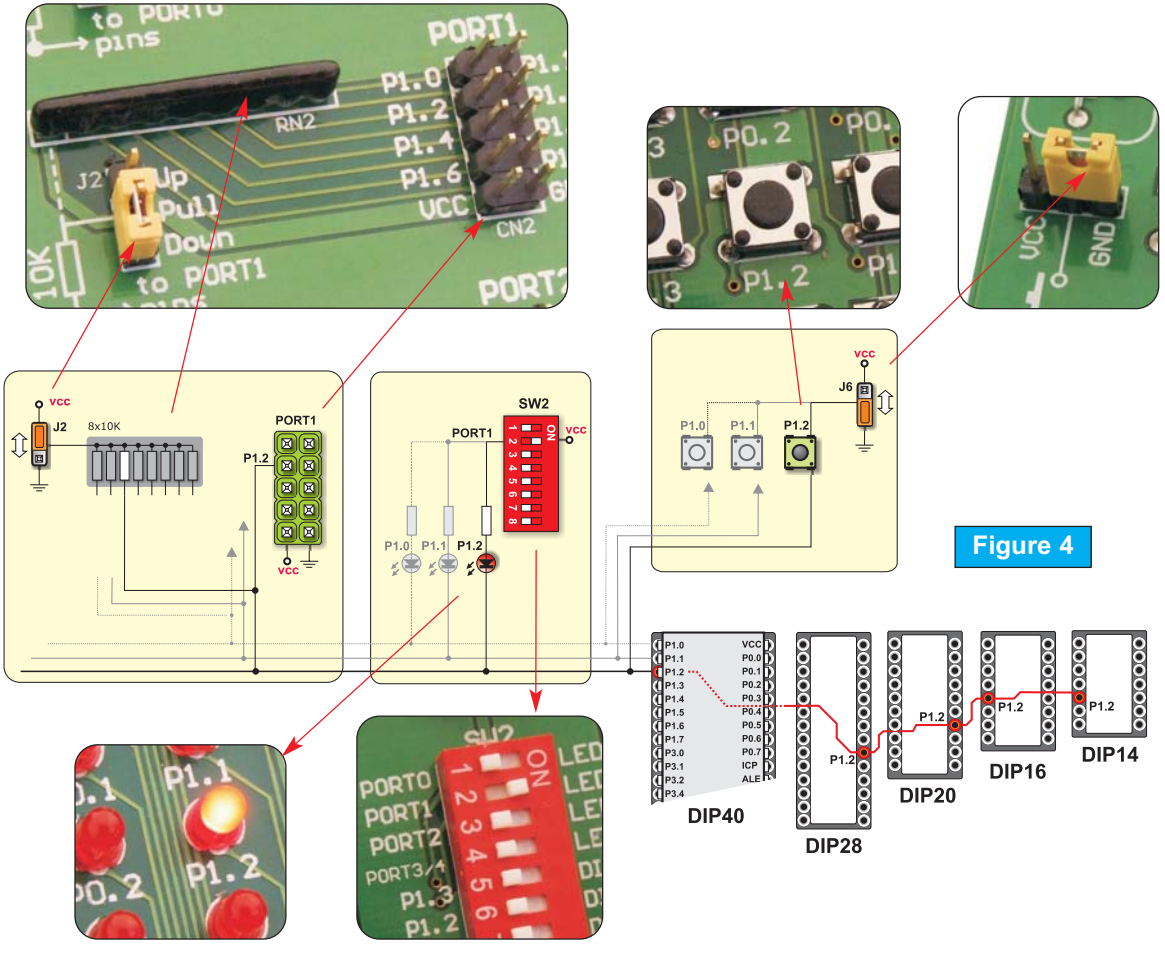


Figure 4

POWER SUPPLY

Easy8051B can use two power supply sources - PC power supply over USB cable (by default) and external power supply (external AC/DC power adapter). When power supply over USB is used, the system should be connected to PC over the USB programming cable, while the jumper J11 should be set in right-hand position.

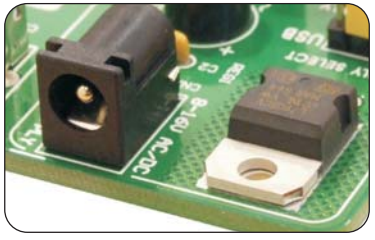


Figure 5 External power supply connector

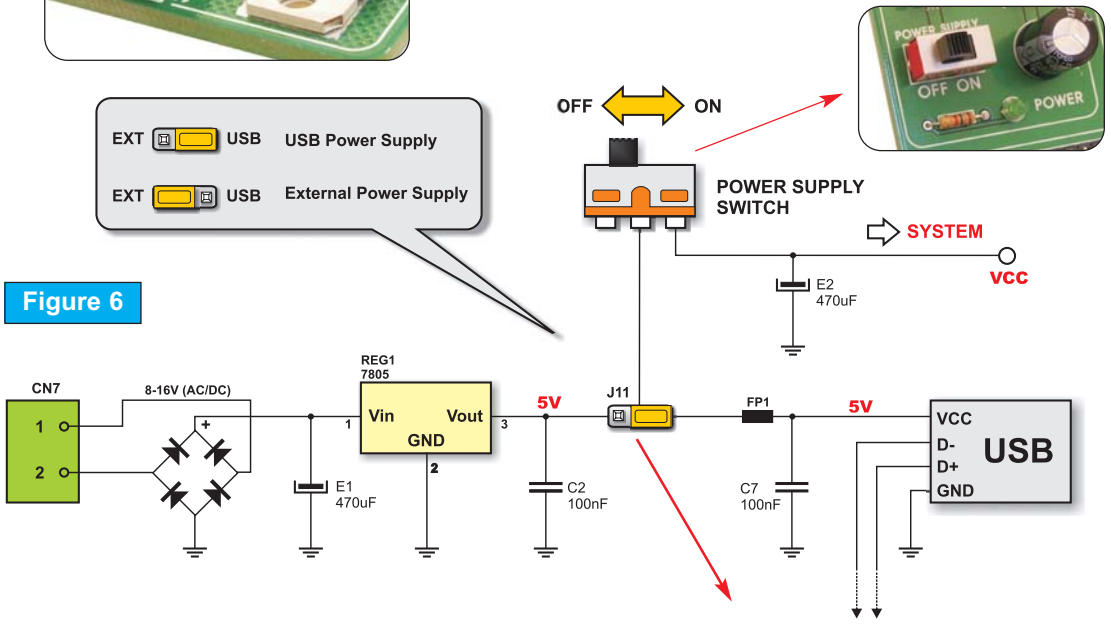


Figure 6

When external power supply is used, the Easy8051B board produces +5V by means of LM7805 voltage regulator. The external power supply can be AC or DC with the voltage range of 8 - 16V. The jumper J11 should be set in left-hand position. Figure 6 illustrates USB power supply over USB cable.

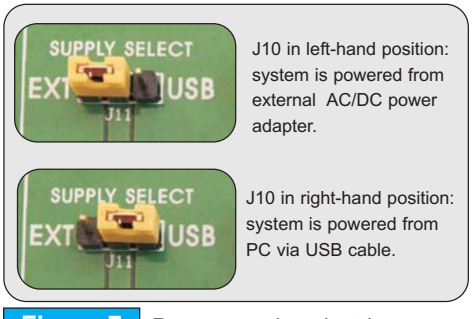


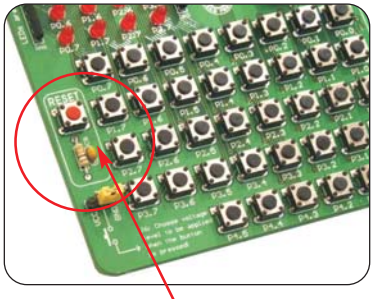
Figure 7 Power supply select jumper

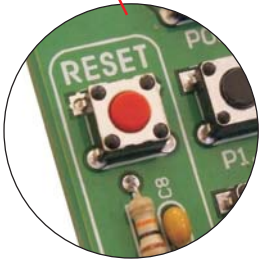
ON-BOARD USB 2.0 PROGRAMMER

Figure 8 USB 2.0 programmer

There is no need to use external equipment during programming since the Easy8051B development system contains on-board USB 2.0 programmer. It is only needed to connect the system to PC using the USB cable. Then, the program should be loaded into the microcontroller using the *8051flash* programming software supplied with Easy8051B development system. For more information, please refer to *8051prog* documentation.

Red button marked as RESET and placed in the bottom left corner is used for MCU reset.





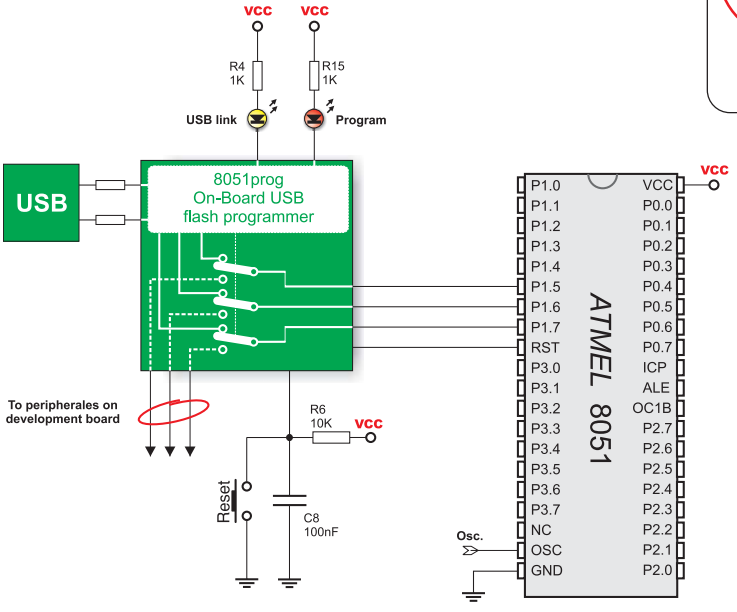


Figure 9 Reset button

Note: There is no need to reset MCU after programming because the programmer will reset the MCU automatically.

MCU SOCKETS

Easy8051B is delivered with 40-pin microcontroller AT89S8253. The user can replace this one with a different microcontrollers in DIP40, DIP28, DIP20, DIP16, DIP14, PLCC32 and PLCC44 package having an adequate pinout.

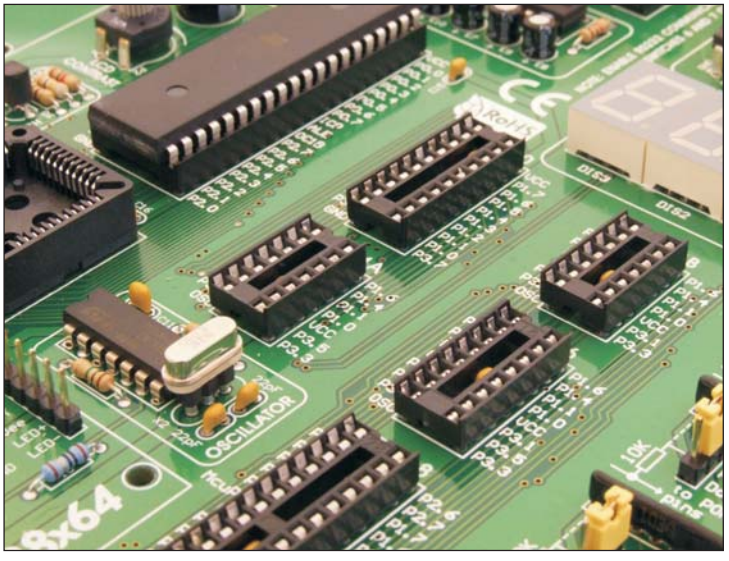


Figure 10 MCU sockets

Note: Since all packages have parallel connections, it is not allowed to have more than one microcontroller on the board at a time.

LEDs

Light Emitting Diodes (LEDs) are components most commonly used for displaying pin digital state. Easy8051B has 38 LEDs connected to the microcontroller ports P0, P1, P2, P3 and P4.

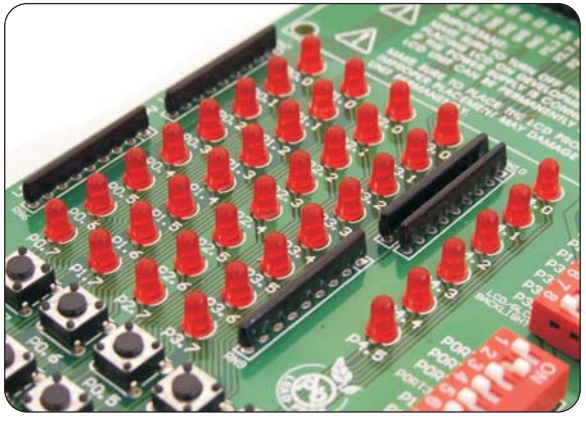


Figure 11 On-board LEDs

LEDs are arranged in five groups. Each group except leds belonging to P4 consists of eight LEDs and can be enabled or disabled using switches of the switch group SW2.

LEDs are enabled when the corresponding switch of the SW2 is on. When enabled, LEDs display the state of the corresponding microcontroller pin. Otherwise, the LEDs are always off, no matter what the port state is, since no current can flow through them.

Note: LEDs are activated by logic zero (0), which means that if LED is ON, appropriate microcontroller pin voltage is low (0). If LED is OFF, appropriate microcontroller pin voltage is high (1).

Figure 12 illustrates the connection between port P1 pins and the corresponding LEDs. A resistor is serially connected to LEDs in order to limit current through them. In this case the resistor value is 1K.

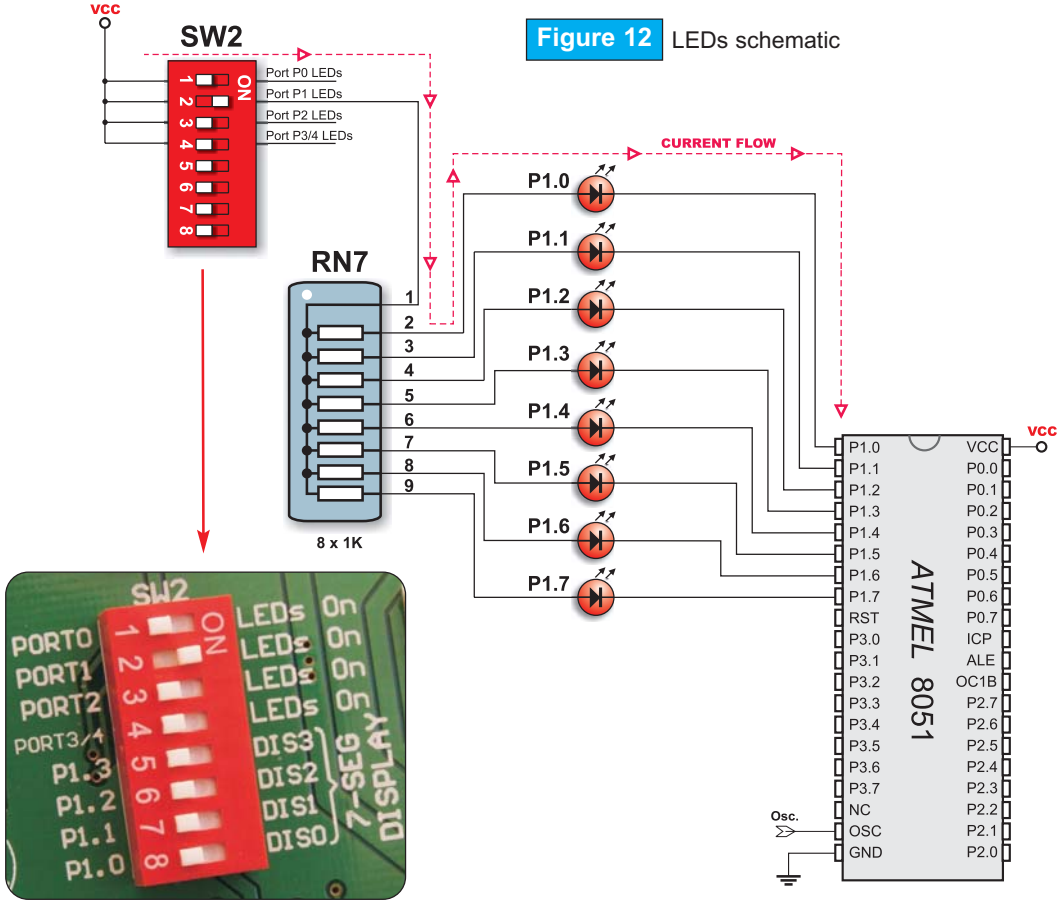


Figure 12 LEDs schematic

PUSH-BUTTONS

Easy8051B has 38 push-buttons used to change the state of digital inputs on the microcontroller ports. Figure 13 illustrates connection between push-buttons and the corresponding port pins. Jumper J6 determines whether a button press will bring logic zero (0) or logic one (1) to the appropriate pin. If button is released then pin state is determined by pull-up or pull-down resistor.

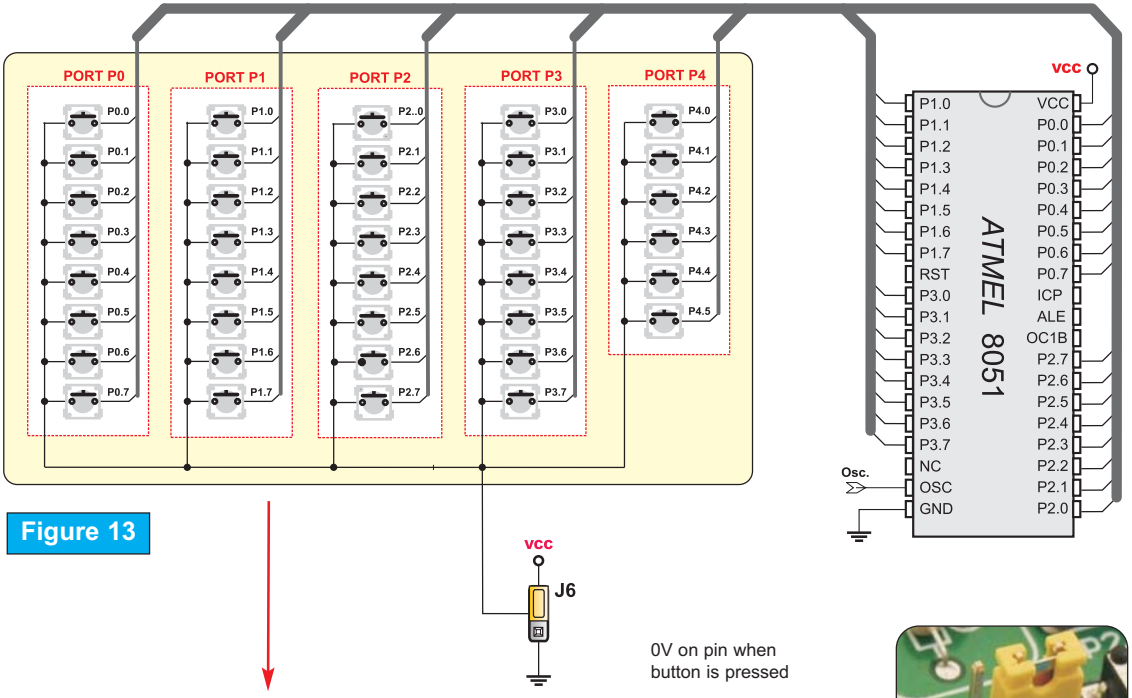


Figure 13

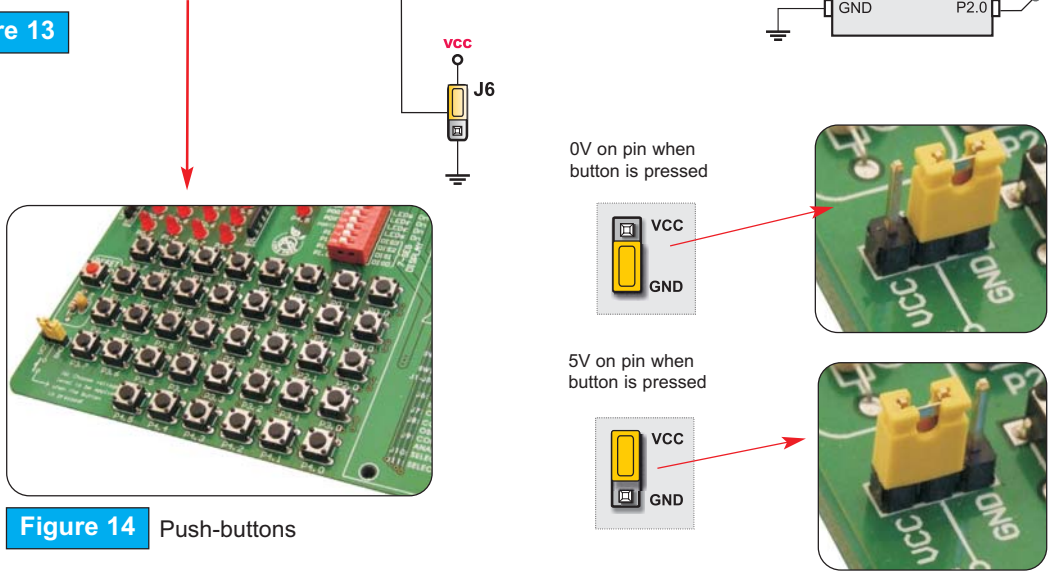
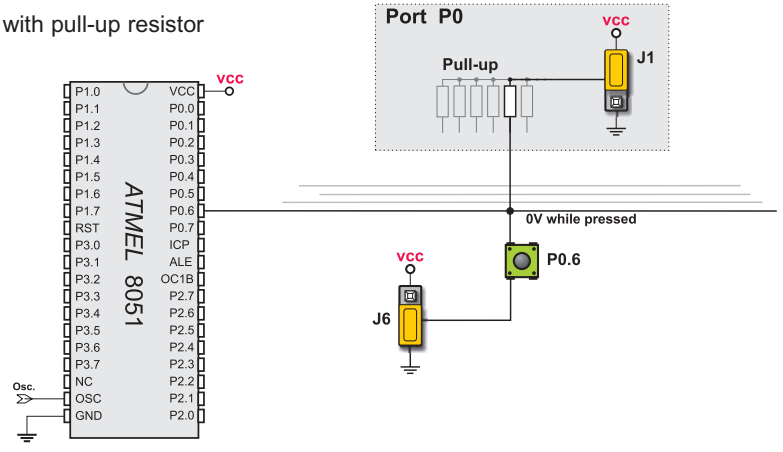


Figure 14 Push-buttons

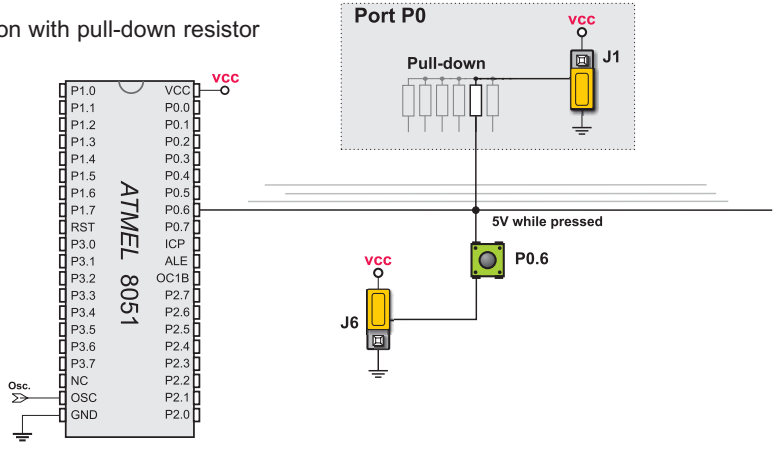
Referring to figure 15, jumper J1 is set in pull-up position, so that pull-up resistor pulls the microcontroller P0.6 pin to +5V. By pressing the button, the corresponding port pin is connected to ground (J6 is in lower position).
Accordingly, only in case the button is pressed the microcontroller senses a logic zero (0). Otherwise, the pin state will always be logic one (1).

Figure 15 Push-button with pull-up resistor



Referring to figure 16, jumper J1 is set in pull-down position, so that pull-down resistor pulls the microcontroller P0.6 pin to 0V.
By pressing the button, the corresponding port pin is connected to +5V (J6 is in higher position).
Accordingly, only in case the button is pressed the microcontroller senses a logic one (1). Otherwise, the pin state will always be logic zero (0).

Figure 16 Push-button with pull-down resistor



7-SEGMENT LED DISPLAYS

Easy8051B has four 7-segment displays in multiplex mode. Data lines are connected to port P0. Each display is enabled by switches 5, 6, 7 and 8 of the switch group SW2.

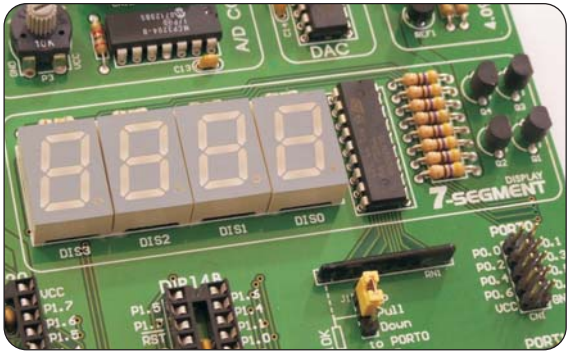
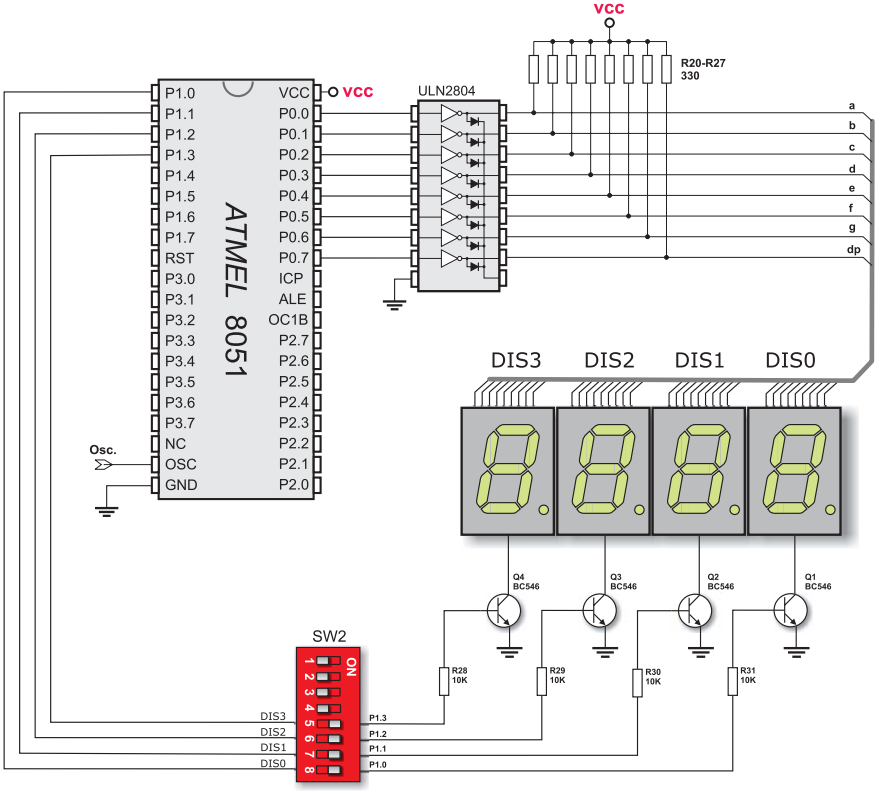


Figure 17 7-segment LED display module



2X16 CHARACTER LCD

A standard character LCD is probably the most frequently used data visualization component. It can display messages in two lines, each containing up to 16 alphanumeric characters. Characters are made up of 5x8 pixels. The character LCD communicates with the microcontroller via 4-bit data bus. Connecting to the microcontroller is shown in figure 19.

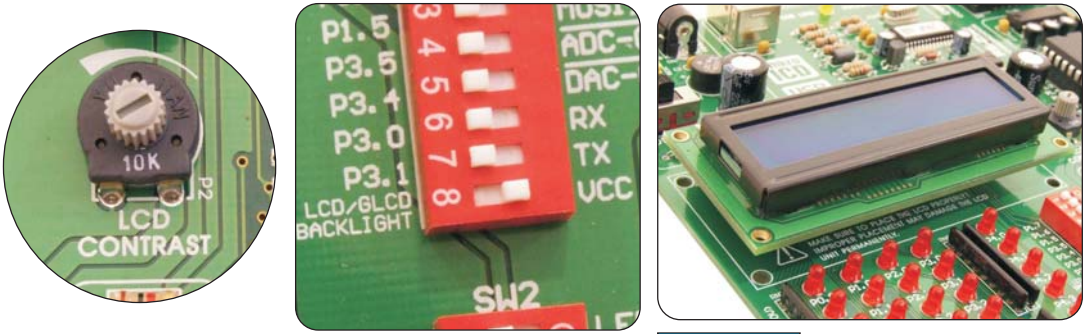


Figure 18 2x16 LCD in 4-bit mode

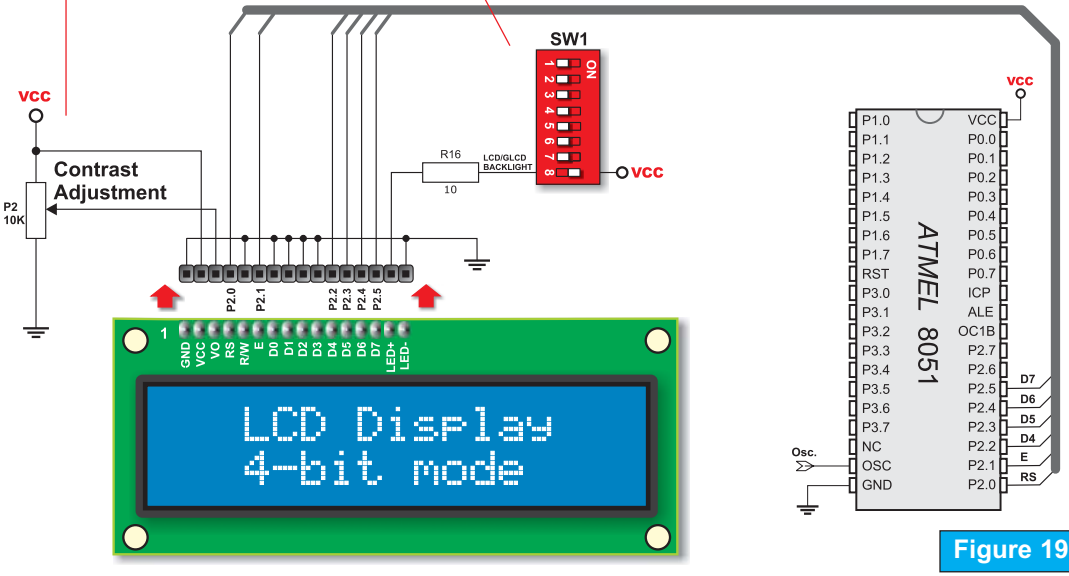


Figure 19

Note: It is important to have in mind that LCD should be placed on or removed from the Easy8051B development board only after the power supply is switched off.

GRAPHIC LCD

A graphic LCD (GLCD) provides an advanced method for displaying visual messages. While a character LCD can display only alphanumeric characters, a GLCD can display messages in the form of drawings and bitmaps. The most commonly used graphic LCD has 128x64 pixels screen resolution. The GLCD contrast can be adjusted using the potentiometer P1 placed on the right of the GLCD.

Figure 20 GLCD contrast adjustment potentiometer

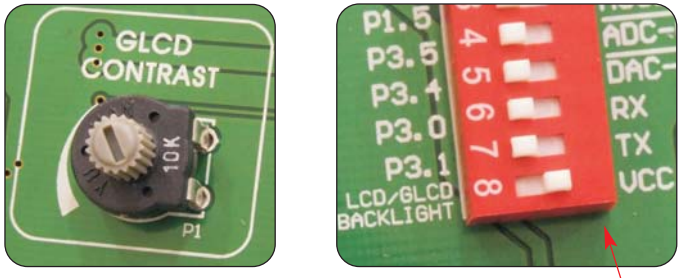
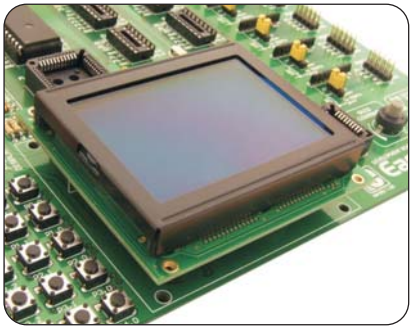


Figure 21 GLCD



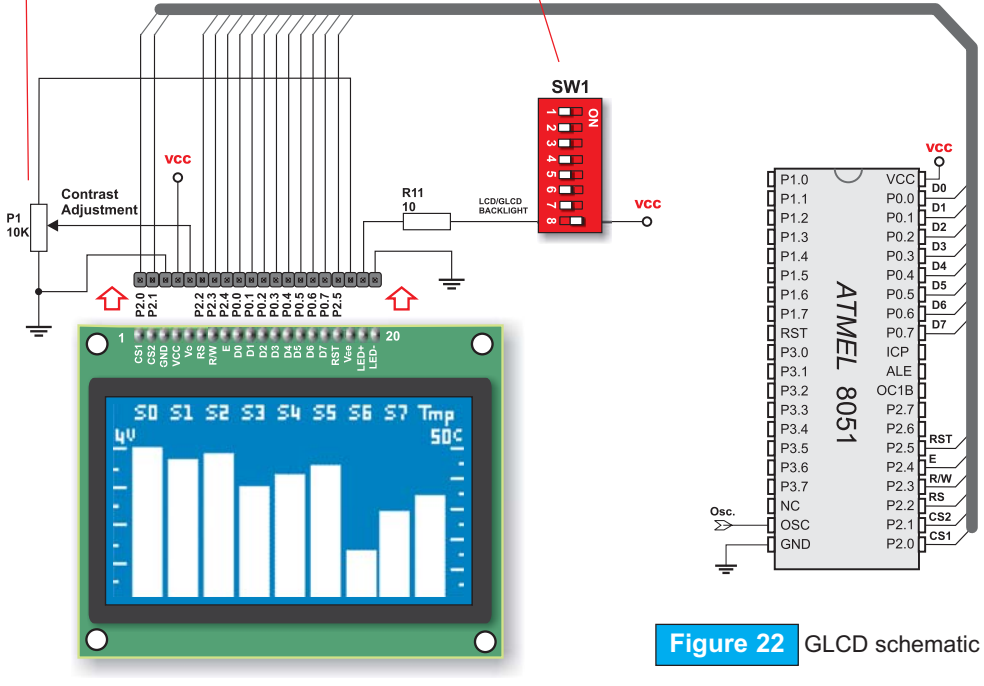
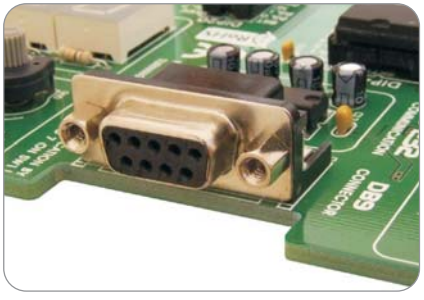


Figure 22 GLCD schematic

RS-232 COMMUNICATION

RS-232 communication enables point-to-point data transfer. It is commonly used in data acquisition applications to transfer data between the microcontroller and PC. Since the voltage levels of the microcontroller and PC are not directly compatible with each other, a level transition buffer such as the MAX232 must be used.



In order to provide a more flexible system, the microcontroller is connected to MAX232 chip through the switches of switch group SW1. The first one is used to connect MCU pin P3.0 to Rx line of RS-232, whereas the later one is used for connecting pin P3.1 to Tx line of RS-232.

Figure 23 RS232 connectors

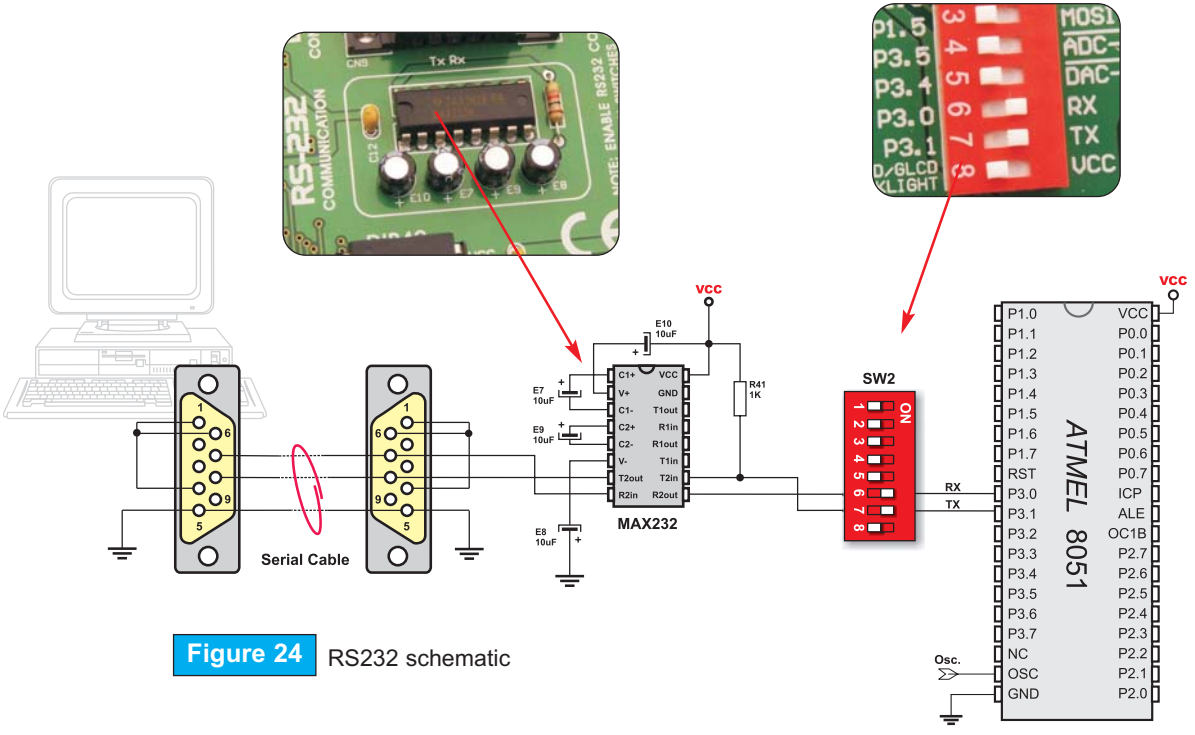


Figure 24 RS232 schematic

DS1820 DIGITAL THERMOMETER

DS1820 digital thermometer is convenient for temperature measurement in the range of -55°C to 125°C with +/-0.5°C accuracy. It must be properly placed in the 3-pin socket provided on the Easy8051B development board, with its rounded side oriented as marked on the board (see figure below). Otherwise the DS1820 could be permanently damaged. DS1820 data pin can be connected either to P3.3 or to P1.2. Selection is performed by jumper J7.

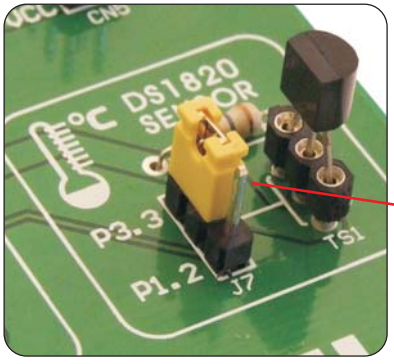
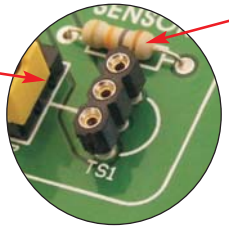
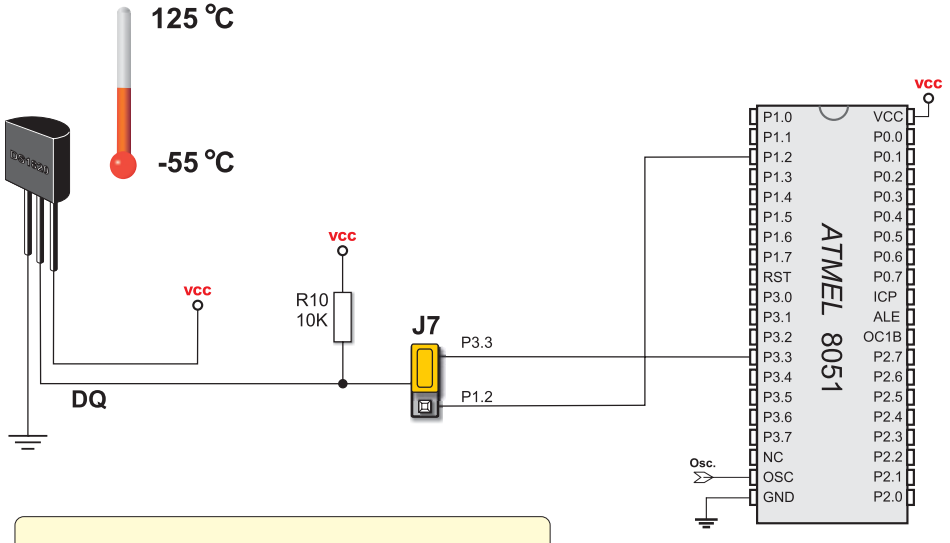


Figure 25 DS1820



There is a mark in the form of half-circle for proper orientation of DS1820 sensor.



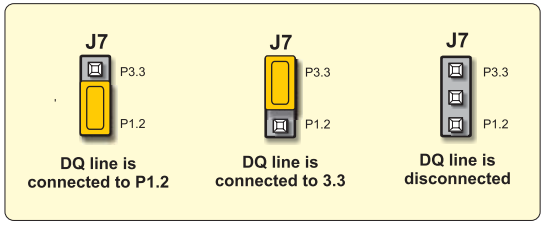


Figure 26 DS1820 sensor circuit

OSCILLATOR

Easy8051B development board has on-board oscillator circuit for generating microcontroller's clock signal. *8051flash* software enables you to choose between internal or external oscillator. The source of external clock is connected to the XTAL1 pin of the microcontroller. Some microcontrollers in DIP28 and PLCC32 package can use both internal and external oscillator. In that case, it is possible to choose clock source by means of jumper J8. When this jumper is in left position (OSC), the microcontroller uses clock signal from the external oscillator. Otherwise, if the jumper is in right position (P4.0), the microcontroller uses internal clock source and pin P4.0 is available as general purpose I/O pin.

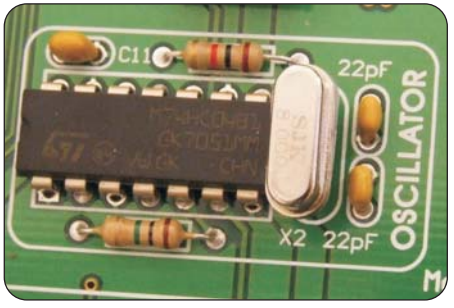


Figure 27 On-board oscillator

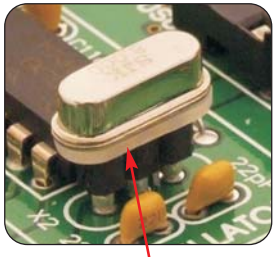
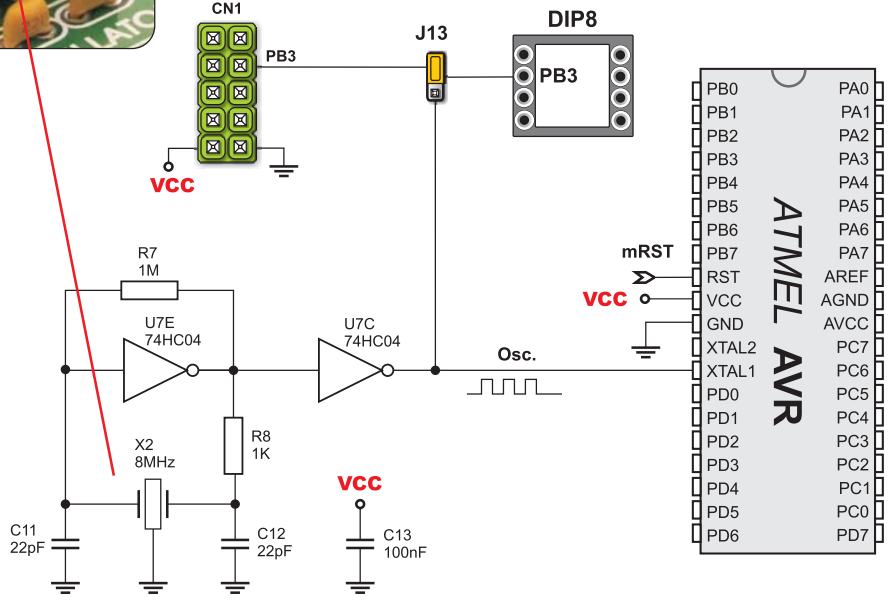


Figure 28 Oscillator schematic



A/D CONVERTER

Most 8051 microcontrollers do not have built-in A/D converter. In order that these microcontrollers can perform analog-to-digital conversion, 4-channel 12-bit A/D converter MCP3204 are added to the Easy8051B development system. Analog signal to be converted should be brought to one of four connectors placed in the upper right corner of development board. The A/D converter takes analog signal from its input pin and converts it into digital value. Basically, any analog signal that fits in the range acceptable by converter can be measured. That range is 0-5V. After conversion, the appropriate binary value is transferred to the microcontroller via SPI communication.

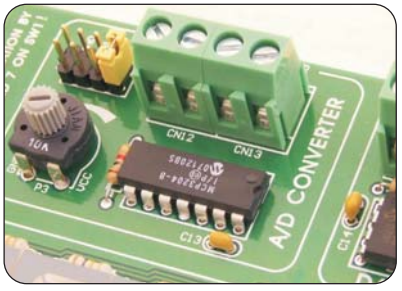
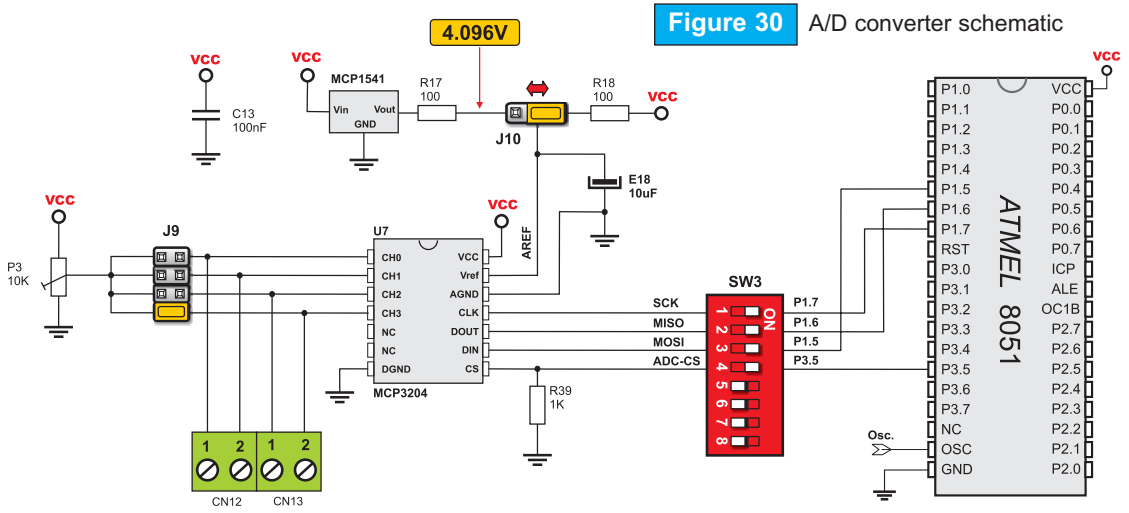


Figure 29 A/D converter

The Easy8051 enables reference voltage selection for the operation of converter. It can be power supply voltage (5V) or 4.096V provided by precise voltage source reference MCP1541. The appropriate voltage is selected using jumper J10. The operation of converter as well as its communication with the microcontroller is enabled by switches of the switch group SW1.

Figure 30 A/D converter schematic



In addition to A/D converter chip, the development board has potentiometer used to demonstrate its operation. Potentiometer's output is in the range of 0-5V and it's signals can be brought to four different converter pins simultaneously. The jumper group J9 enables connection between potentiometer P3 and one of the converter pins: CH0, CH1, CH2, or CH3.

D/A CONVERTER

To enable 8051 microcontrollers to use digital-to-analog conversion, the Easy8051B development system has on-board 12-bit D/A converter MCP4921. The microcontroller transfers data to be converted into analog signal via SPI communication. After conversion, the appropriate analog value appears on the connector placed in the upper-right corner of the development board, next to A/D connectors. As in A/D convertor unit, the Easy8051B enables reference voltage selection for the operation of MCP4921 converter. The appropriate voltage is selected using the same jumper J10. The operation of this converter as well as its communication with the microcontroller is enabled by switches of the switch group SW1.

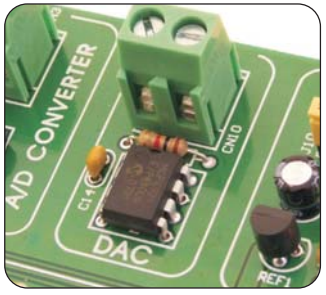


Figure 31 D/A converter

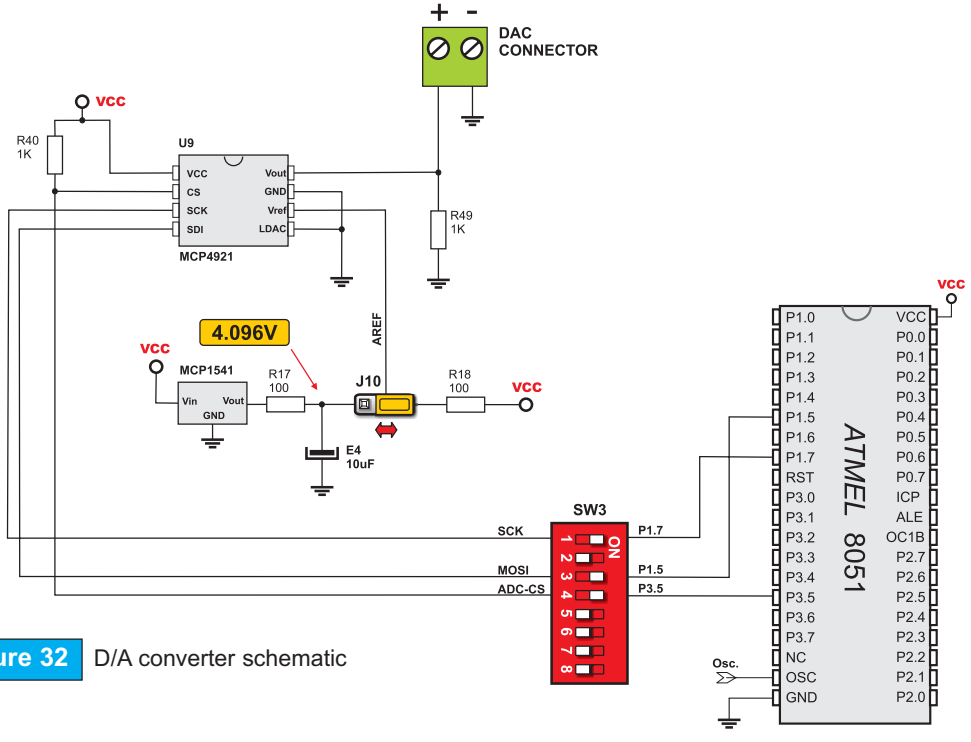


Figure 32 D/A converter schematic

DIRECT PORT ACCESS

All the microcontroller input/output pins can be accessed via 2x5 connectors placed along the right side of the board. For each microcontroller port, there is one 10-pin connector providing eight port pins and two additional pins connected to VCC and GND.

Connectors shown in figure below can be used to connect the system to external devices. On-board peripherals must be disconnected from the microcontroller using the appropriate jumpers /switches if external and on-board peripherals use the same pins. The connectors can be also used for attaching logic probes or other test equipment.

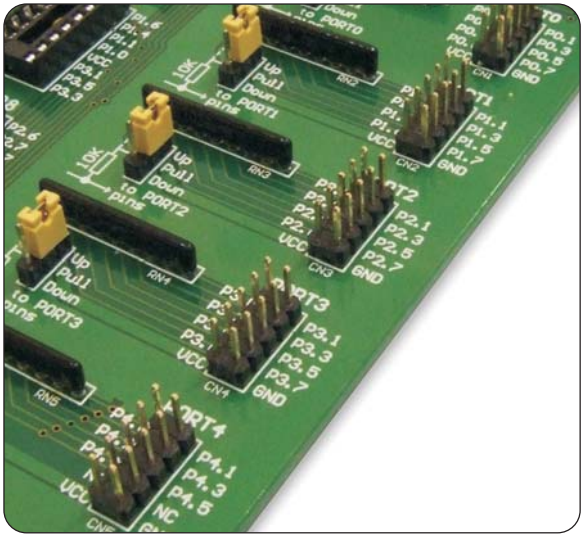


Figure 33 Direct port access connectors

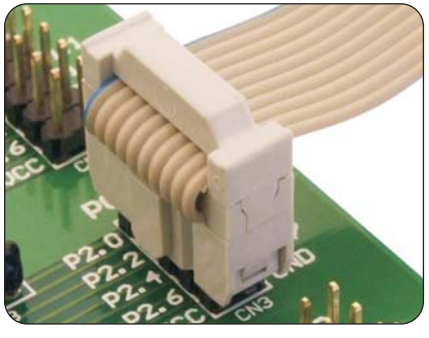


Figure 34 Flat cable connector

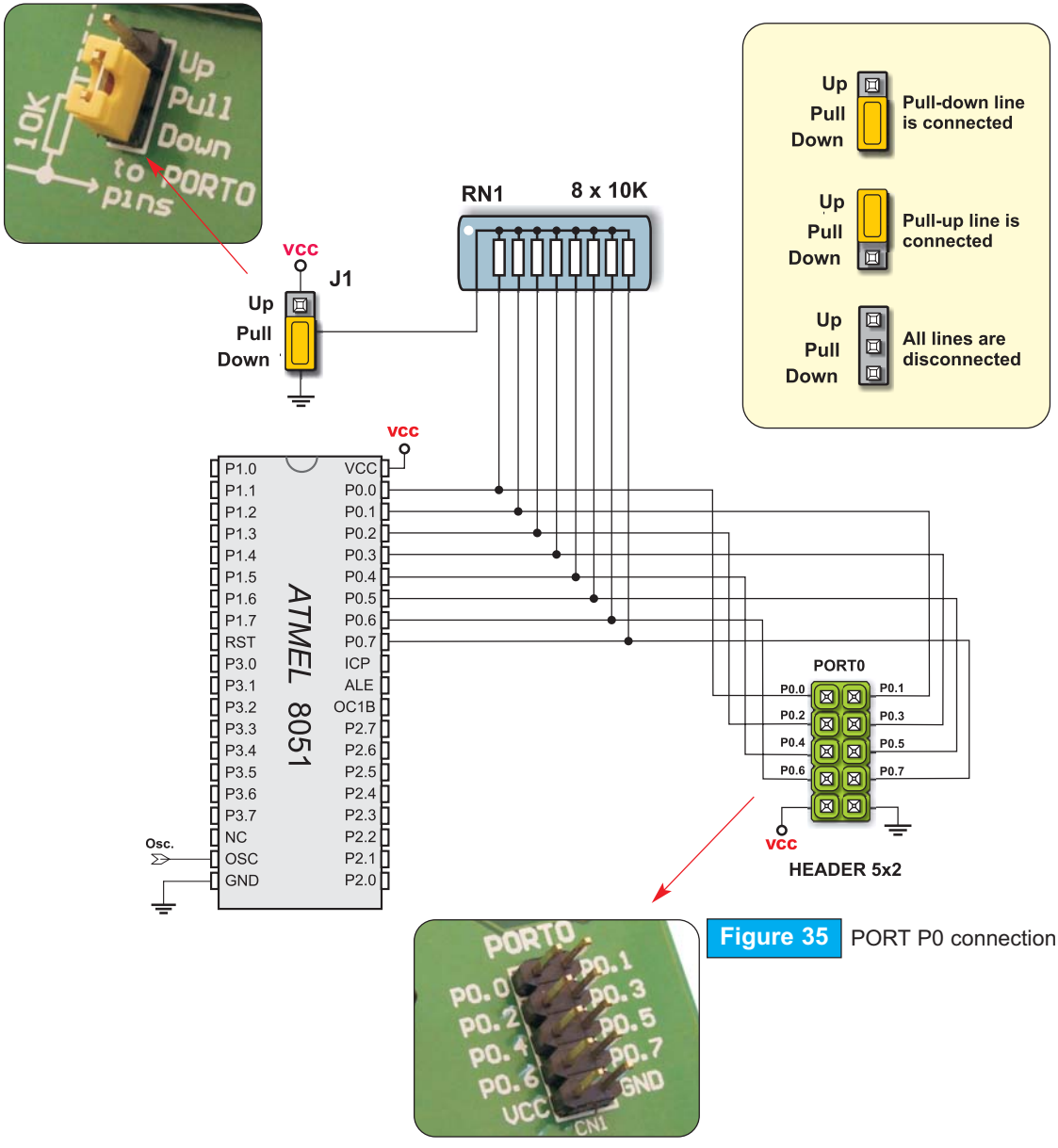
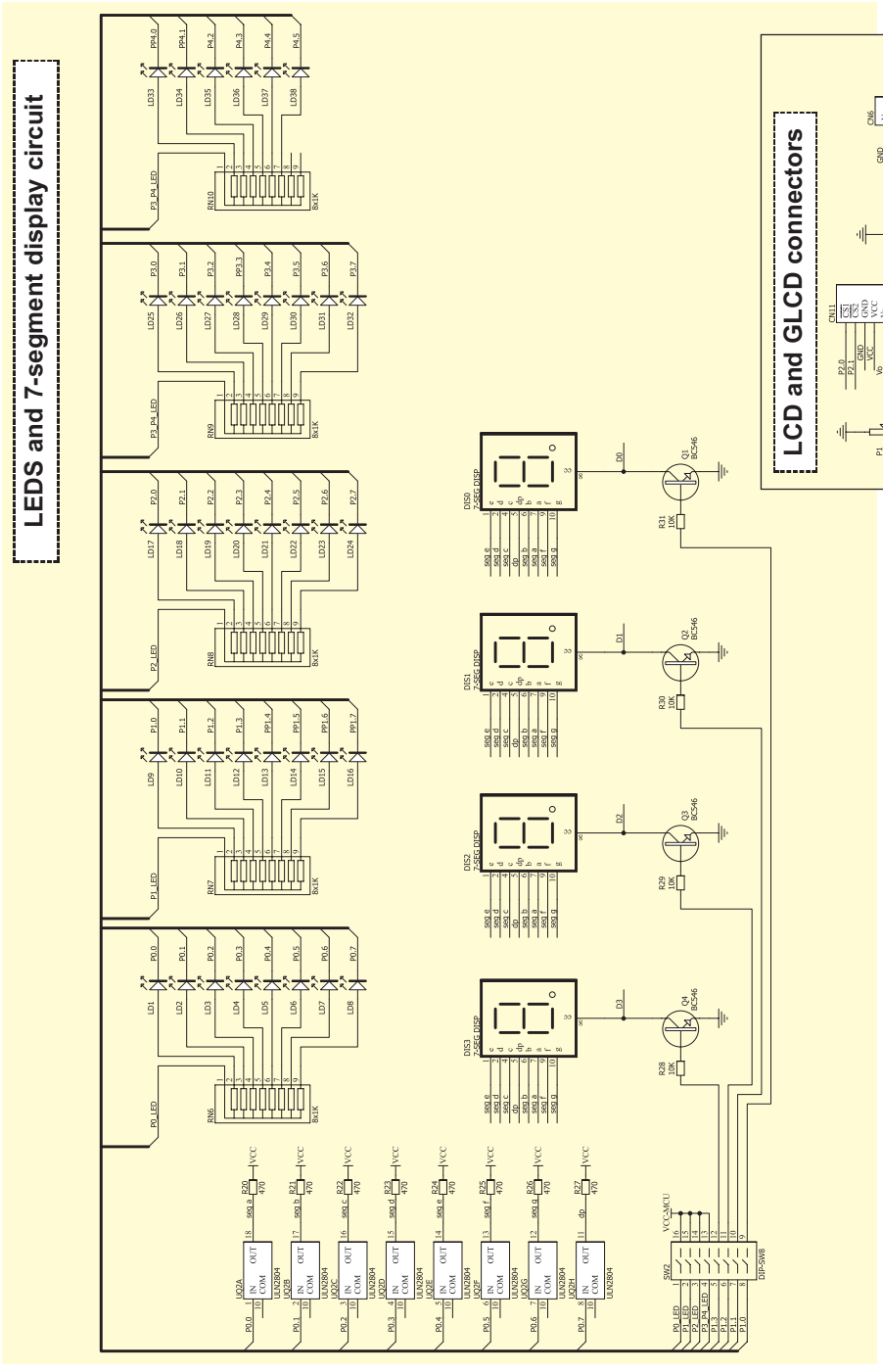
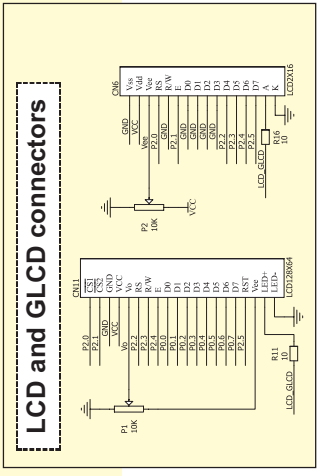


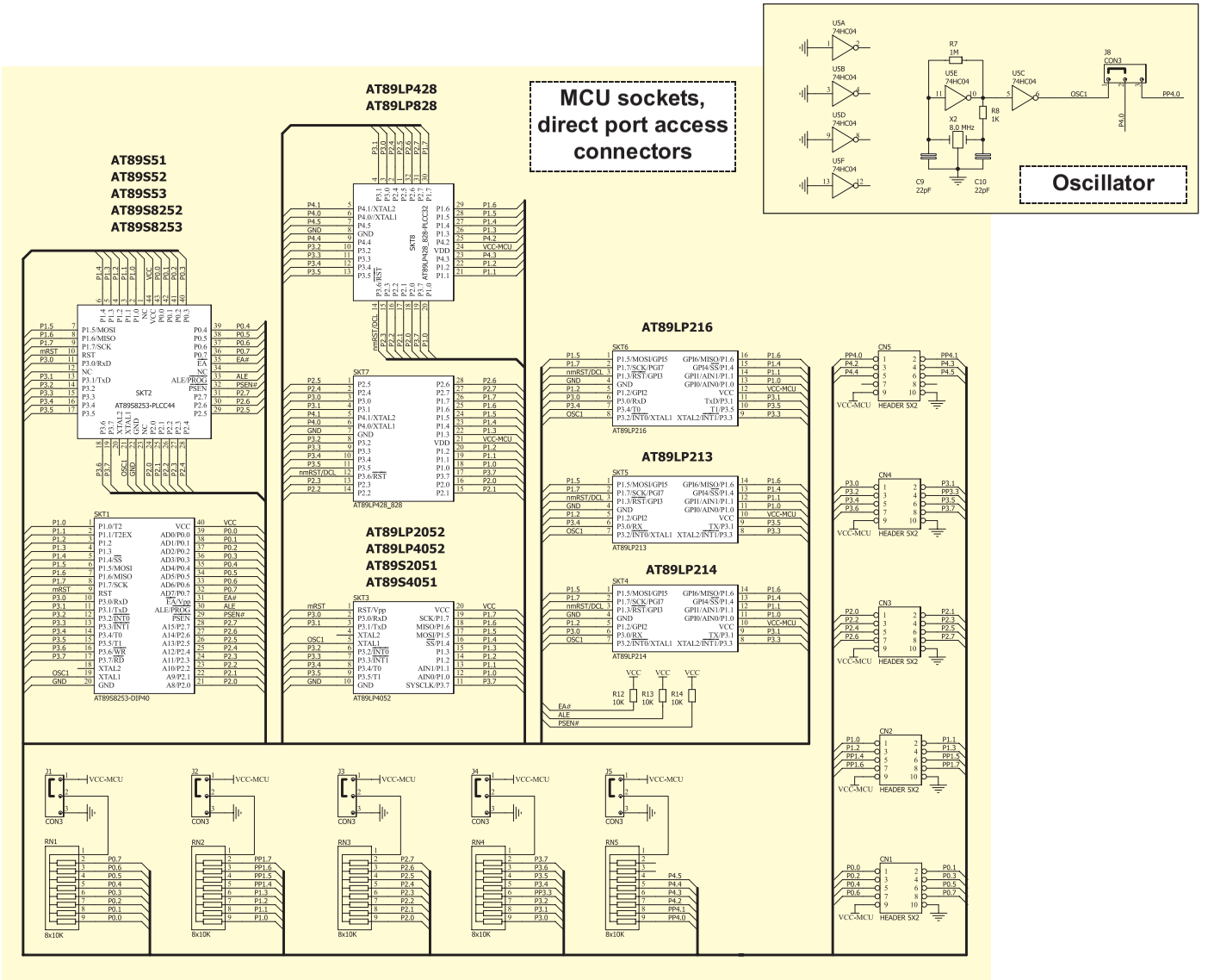
Figure 35 PORT P0 connection

LEDS and 7-segment display circuit

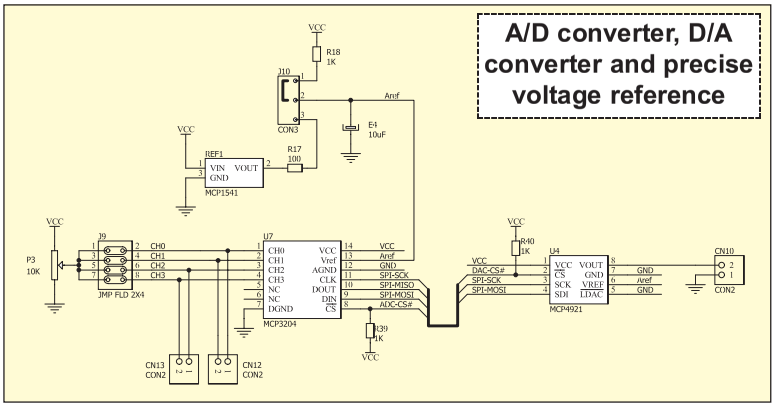


LCD and GLCD connectors

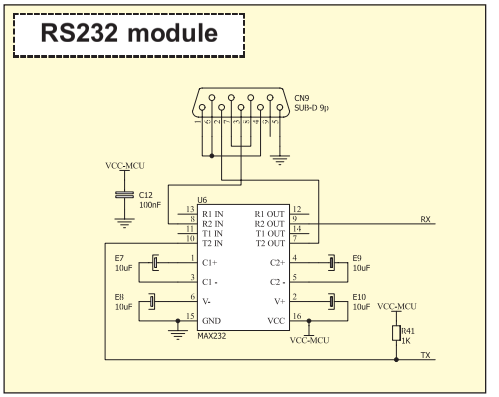



AT89S51
AT89S52
AT89S53
AT89S8252
AT89S8253
AT89LP428
AT89LP828
MCU sockets, direct port access connectors
AT89LP216
AT89LP213
AT89LP214
AT89LP2052
AT89LP4052
AT89S2051
AT89S4051
Oscillator
U5A 74HC04
U5B 74HC04
U5D 74HC04
U5F 74HC04
U5E 74HC04
U5C 74HC04
R7 1M
R8 1K
X2 8.0 MHz
C9 22pF
C10 22pF
J8 CON3
OSC1
PP4.0
P4.0
VCC-MCU
HEADER 5X2
CON3
8x10K

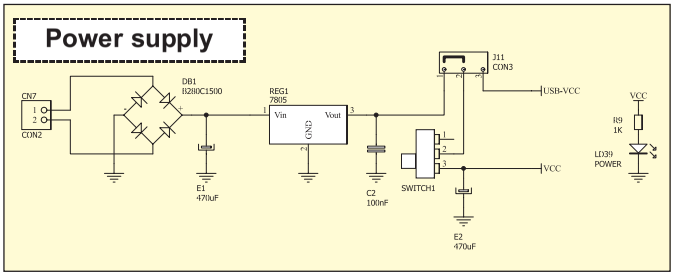
A/D converter, D/A converter and precise voltage reference



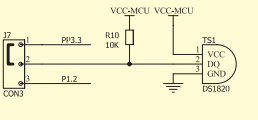
RS232 module



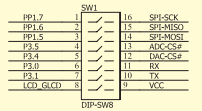
Power supply



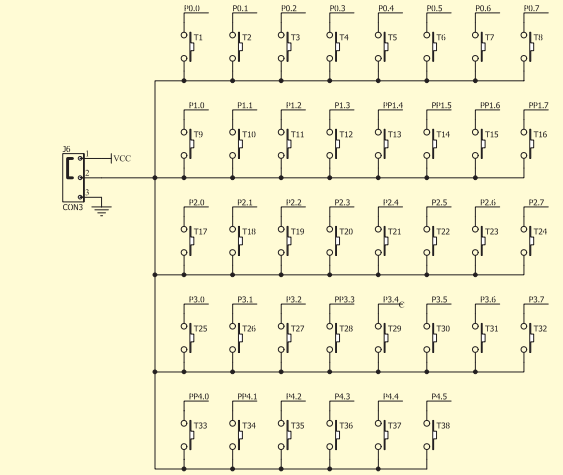
Temperature sensor



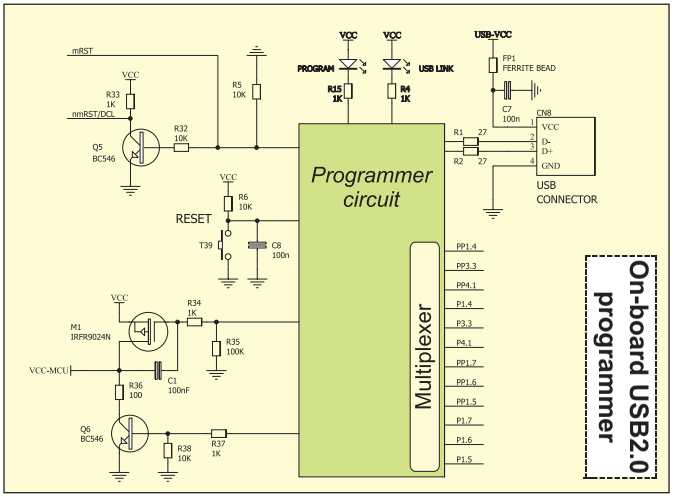
Switch group SW1



Push-buttons



On-board USB2.0 programmer



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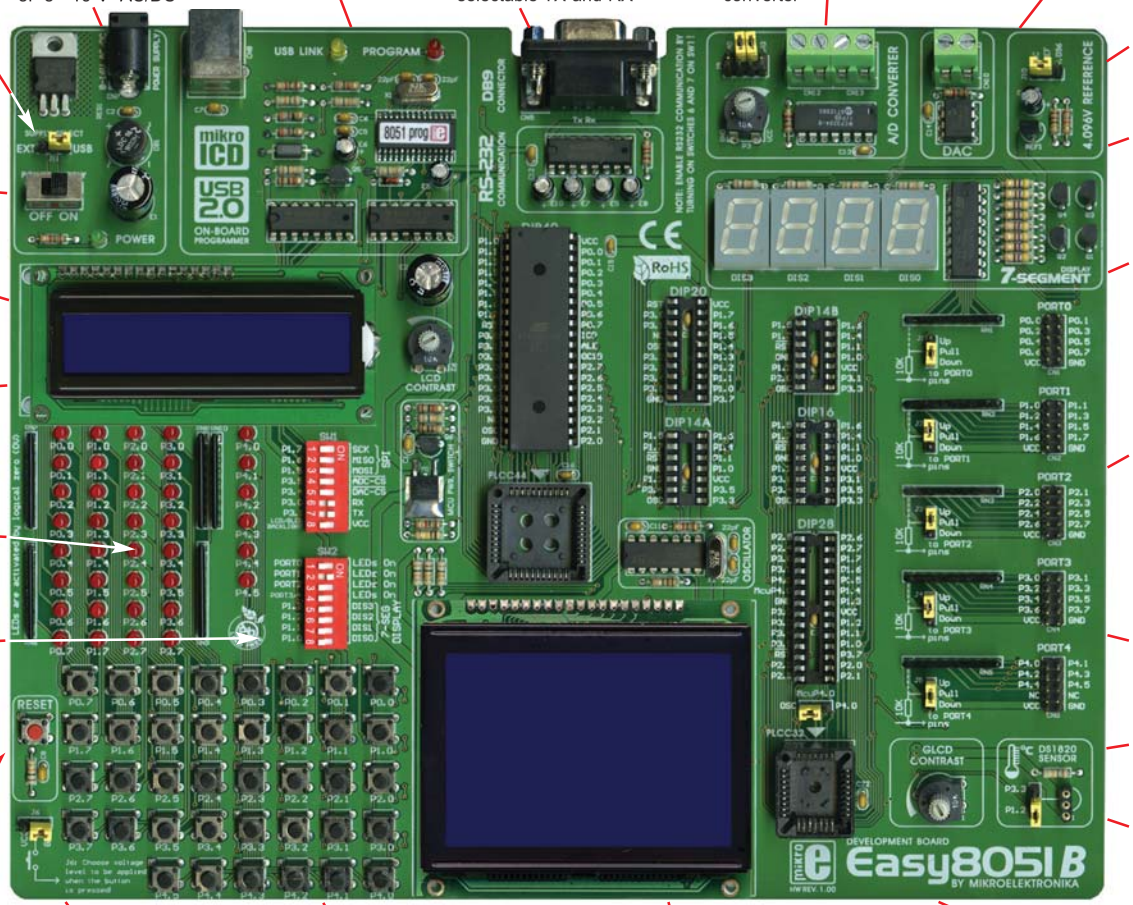
Easy8051B



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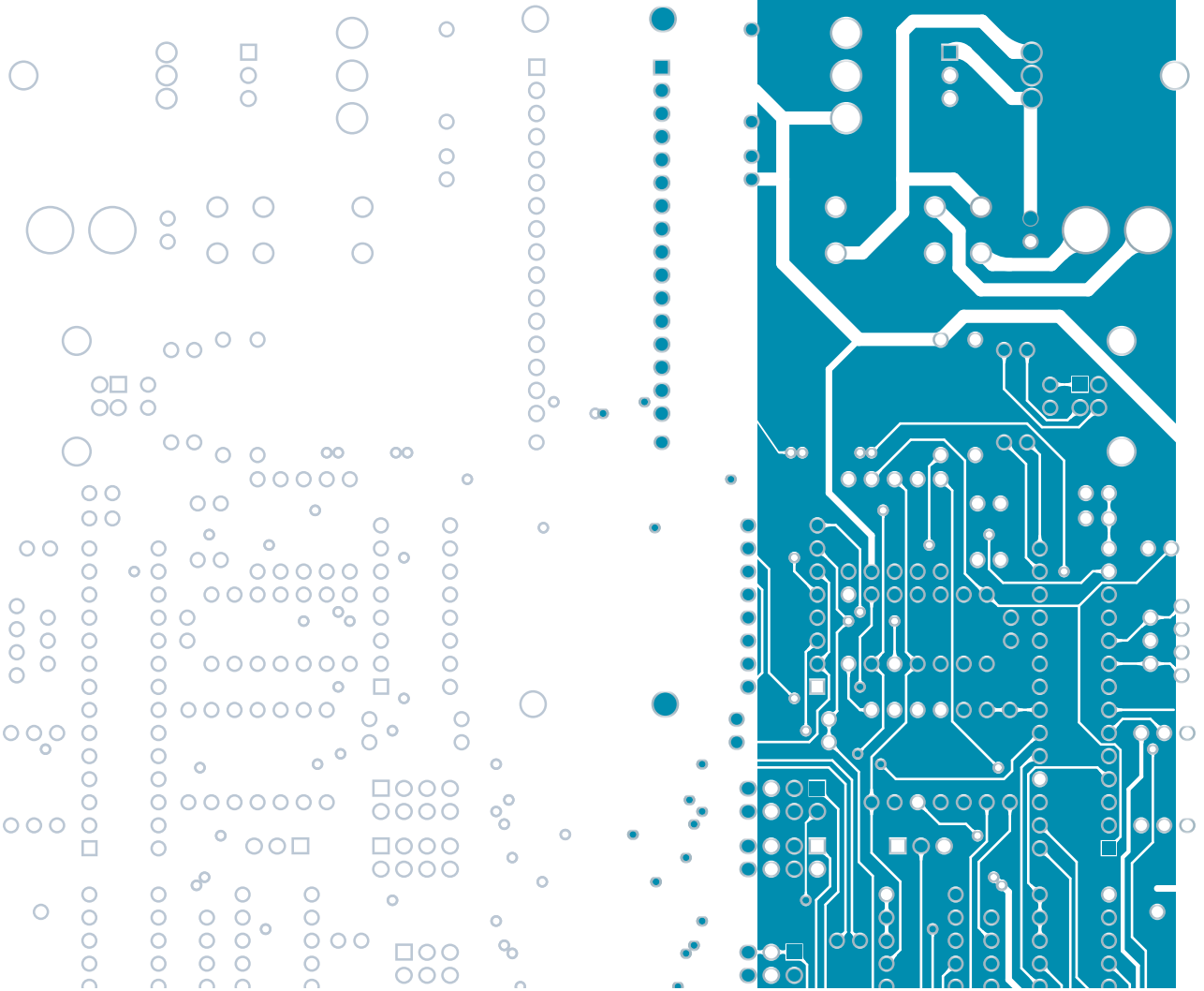
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