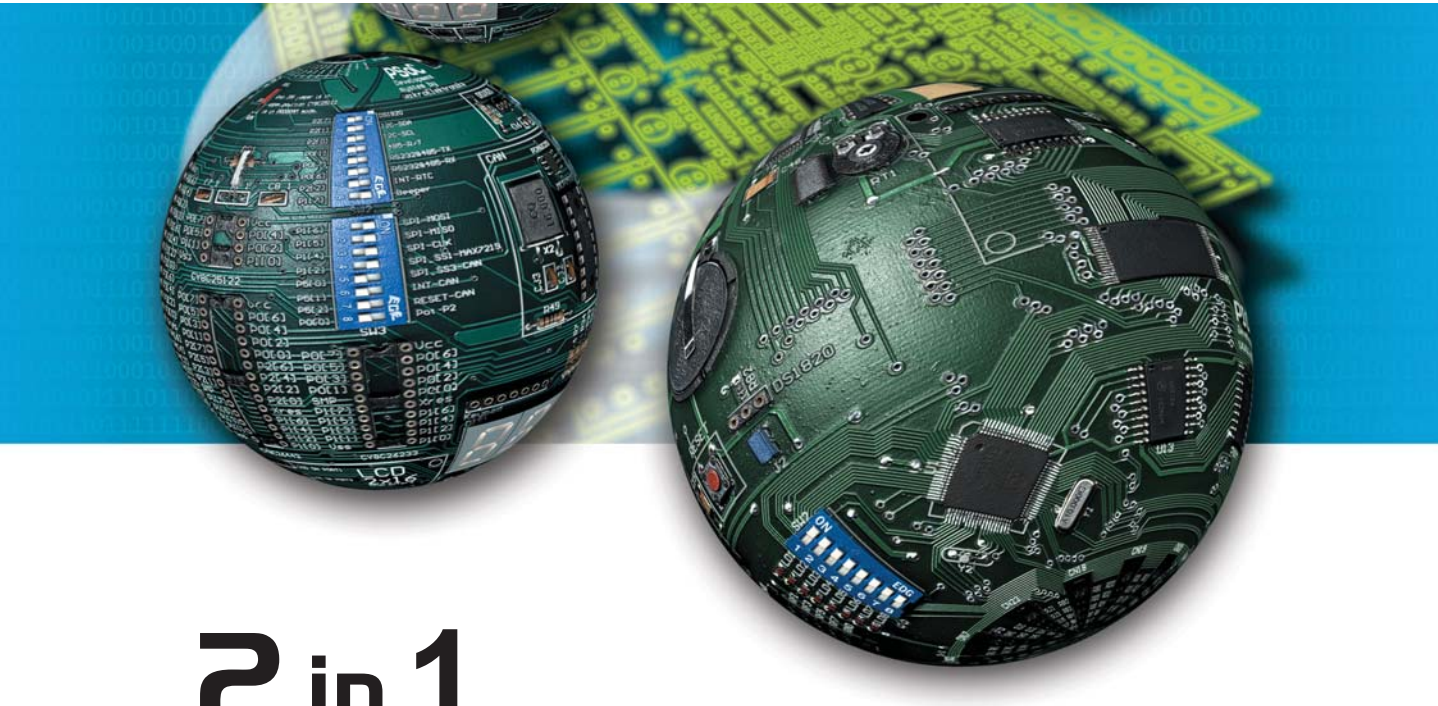
SOFTWARE AND HARDWARE SOLUTIONS FOR THE EMBEDDED WORLD

MikroElektronika
Development tools - Books - Compilers

BigAVR User's Manual



2 in 1

USB 2.0 IN-CIRCUIT PROGRAMMER

ATMEL AVR DEVELOPMENT BOARD

With useful implemented peripherals, plentiful practical code examples and a broad set of additional add-on boards (Serial Ethernet, Compact Flash, MMC/SD, ADC, DAC, CAN, RTC, RS-485, etc.), MikroElektronika development boards make fast and reliable tools that can satisfy the needs of experienced engineers and beginners alike.

Software and Hardware solutions for Embedded World

First edition
December 2006

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CONNECTING THE SYSTEM

The development system box contains the development system, product CD, USB cable, RS232 cable and this manual.

Step no.1 The first thing to do is to take the system out of the box. Unpack the USB cable and connect it to the PC. Please use USB ports on the back of the PC with direct connection to the motherboard.

Step no.2 Install the AVRFlash programmer and drivers. Start the installation from the product CD: CD_Drive:/product/zip/AVRFlash_setup.exe.

Step no.3 After the installation connect the USB cable to the BigAVR board. You will be asked for the AVRFlash drivers. Point to them in order to finish the driver installation. They are placed in folder:
System_Drive:\Program Files\Mikroelektronika\AVRFLASH\Driver.NT

Step no.4 Run and use AVRFlash as it is explained in the PDF document '*AVRFlash programmer*':
CD_Drive:/product/pdf/avrprog_manual.pdf

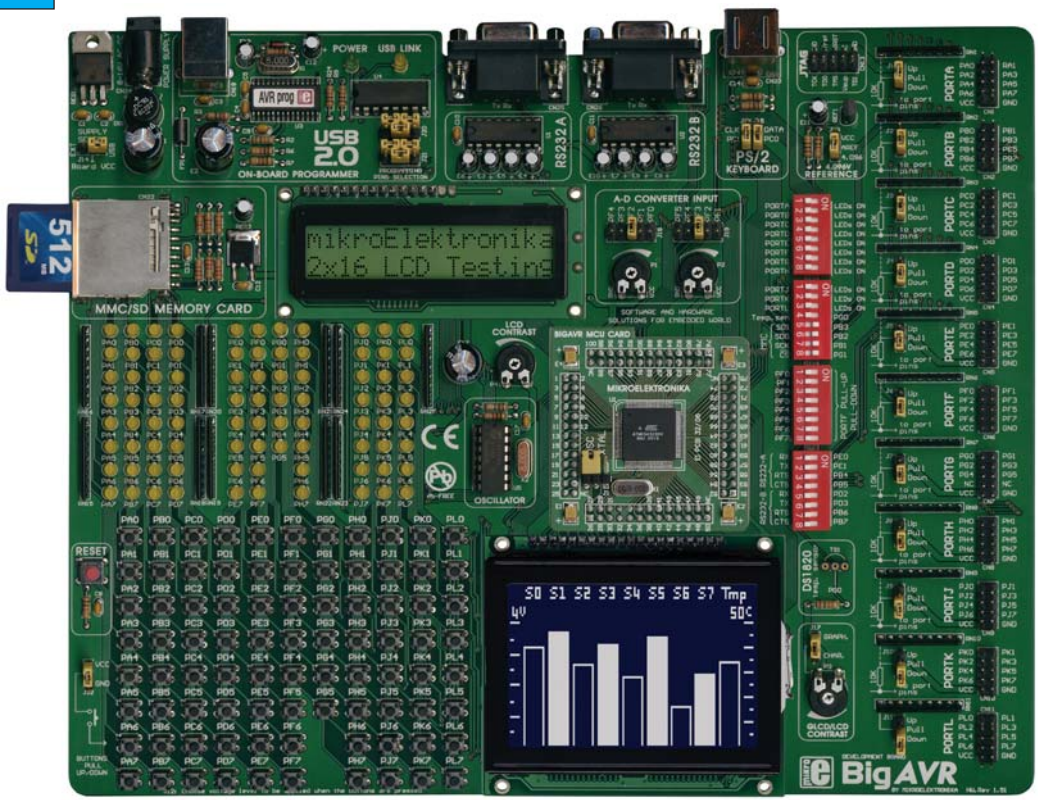
After these 4 steps, your BigAVR is installed and ready for use. You can try to read a program from the chip or to load an example from the examples folder of mikroElektronika's compilers for AVR or from the product CD:
CD_Drive:/product/zip/bigavr_examples.zip.

INTRODUCTION

The BigAVR development system is a full-featured development board for Atmel AVR microcontrollers. It has been designed to allow students and engineers to easily exercise and explore the capabilities of AVR microcontrollers. It allows AVR microcontrollers to be interfaced with external circuits and a broad range of peripheral devices, allowing a user to concentrate on software development.

Figure 1 illustrates the development board. Each component is marked on a silkscreen, both top and bottom. These marks describe connections to the microcontroller, operation modes, and provide some useful notes. The need for additional schematics is minimized since all relevant information is printed on the board.

Figure 1. BigAVR development board



SWITCHES

The BigAVR development board features a number of peripherial devices. In order to enable these devices before programming, you need to check if appropriate jumpers or switches have been properly set. Switches are devices that have two positions - ON and OFF, which have a role to establish or break a connection between two contacts. The BigAVR development board has four groups of switches.

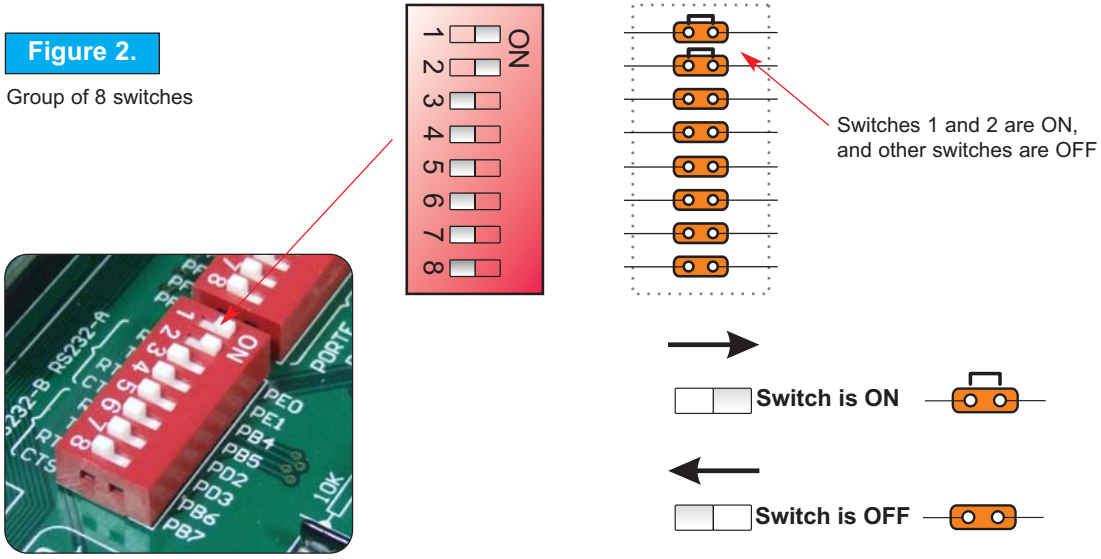
The first two groups, **SW1** and **SW2**, are used to enable LEDs connected to PORTA, PORTB, PORTC, PORTD, PORTE, PORTF, PORTG, PORTH, PORTJ, PORTK and PORTL. Switch **SW2** is also used to enable connection between DS1820 temperature sensor and microcontroller PG0 pin and also to enable SPI communication and CS pin for MMC/SD Card.

The switches of **SW4** are used to enable a connection between the microcontroller PORTF with external pull-up/down resistors. When PORTF pins are used as digital inputs/outputs, the appropriate pull-up/down resistors should be enabled.

The switches of **SW3** are used to enable connection between the microcontroller pins and both RS232 communication devices. The first four switches are used for RS232-A communication lines, while the second four are used for RS232-B communication lines.

Figure 2.

Group of 8 switches



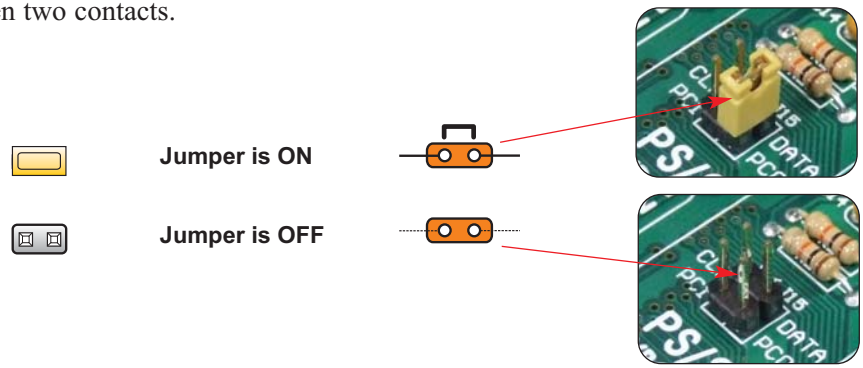
JUMPERS

Jumpers, like switches, can break or establish a connection between two points. Beneath the plastic cover of the jumper is a metal contact, which makes a connection when the jumper is placed between two disconnected pins.

For example, the jumpers J15 and J16 are used to connect or disconnect PS/2 Data and Clk lines to the PC0 and PC1 pins, respectively. A connection is made when the jumper is placed between two contacts.

Figure 3.

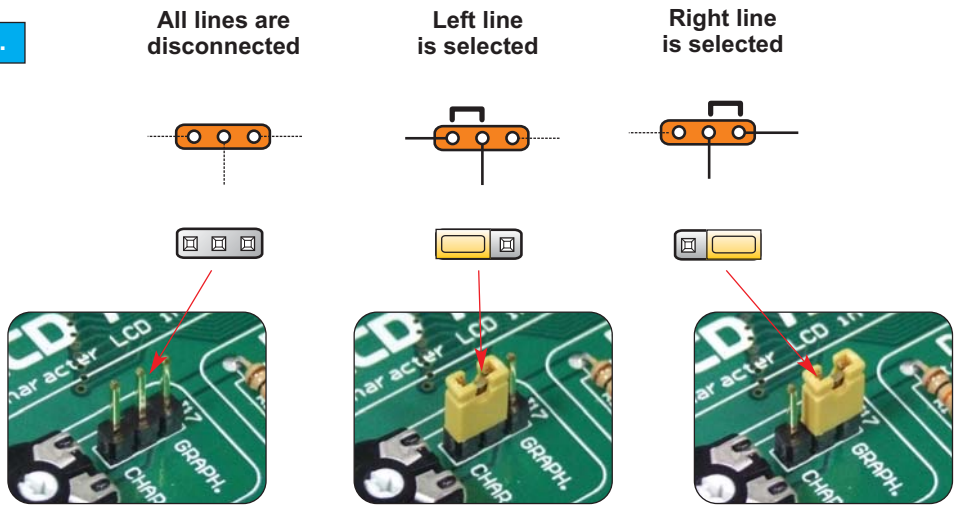
Jumper as a switch



More often, jumpers are used as a selector between two possible connections using a three pin connector. As illustrated in Fig. 4, the middle connector can be connected to the left or right pin, depending on the jumper's position.

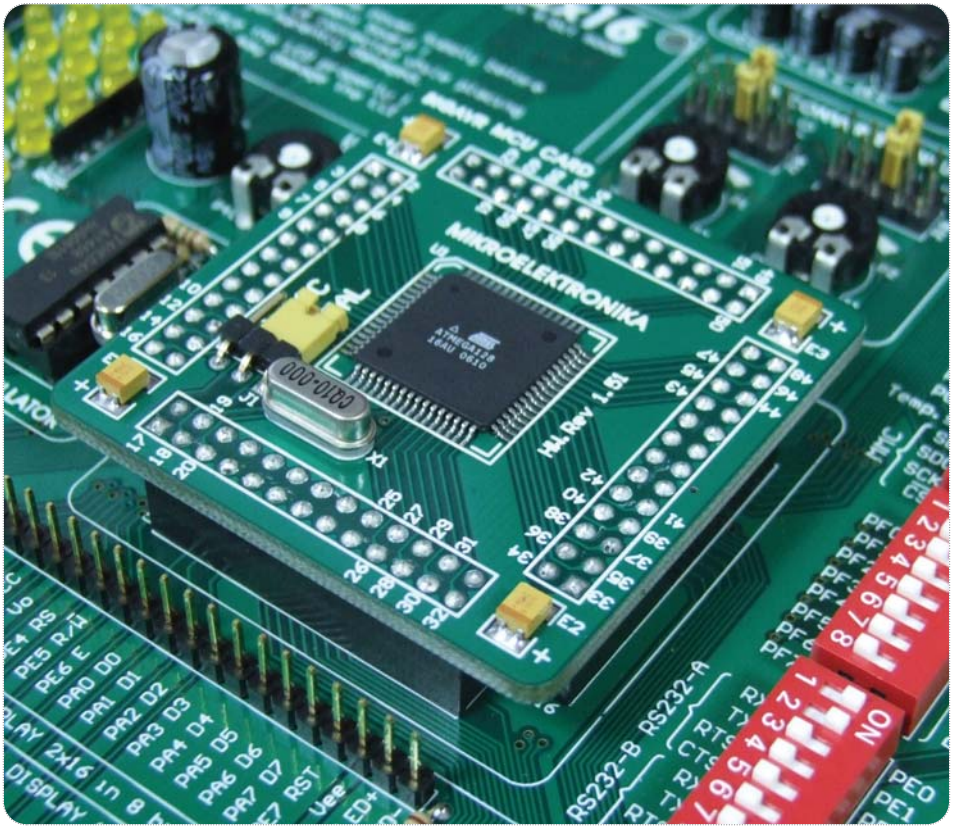
Figure 4.

Jumper as a multiplexer



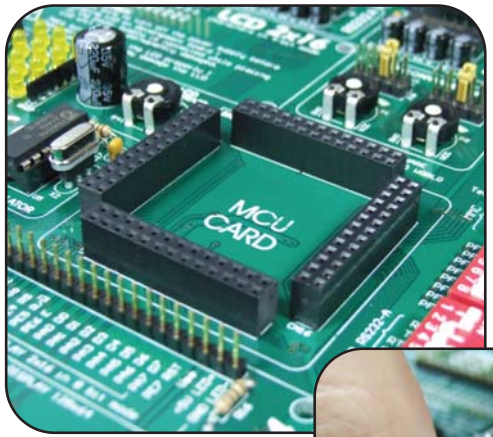
MCU CARD

The BigAVR development board has a 104-pin MCU Card. If you want to use some other microcontroller, all you have to do is to change MCU Cards. You can use 64-pin MCUs (ATmega128 for example) or 100-pin MCUs (ATmega1280 for example). BigAVR MCU Card is shown on the following picture:



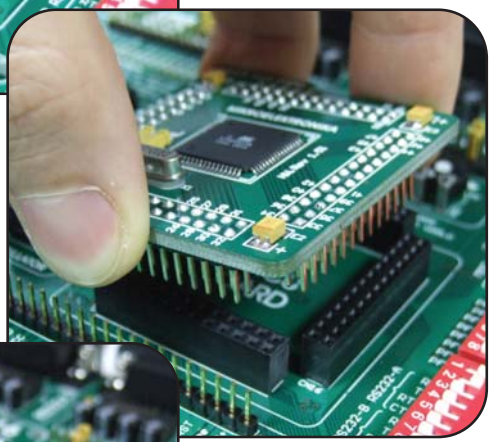
MCU Card **Figure 5.**

When you are placing MCU Card on the BigAVR MCU socket, you must follow these steps:



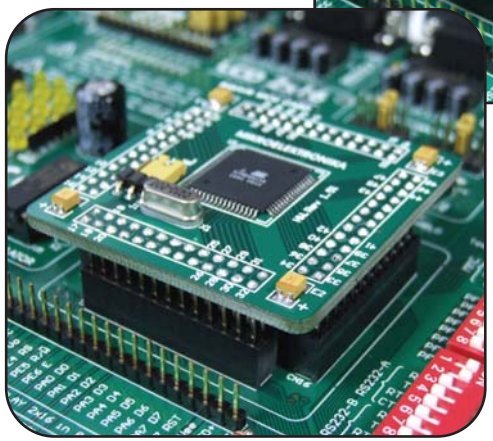
Step no.1

If there is already MCU Card placed on BigAVR, you must remove it by slowly pulling it up.



Step no.2

Place MCU Card on the board. Note that label on the MCU Card must be at the upper-left corner as it is drawn on the BigAVR board.



Step no.3

When MCU Card is on the place, push it down by applying the pressure on all edges at the same time.

Microcontroller's pins are routed to various peripherals as illustrated in Fig. 6. All ports have direct connections to Direct Port Access connectors. Such connectors are typically used for connecting external peripherals to the board or for providing useful points for connecting digital logic probe.

All ports are connected to LEDs, push-button switches and pull-up/down resistors, which allow easy monitoring and testing of digital pin state .

Some pins are connected to other peripherials such as the DS1820 temperature sensor, RS-232 communication, LCD, etc.

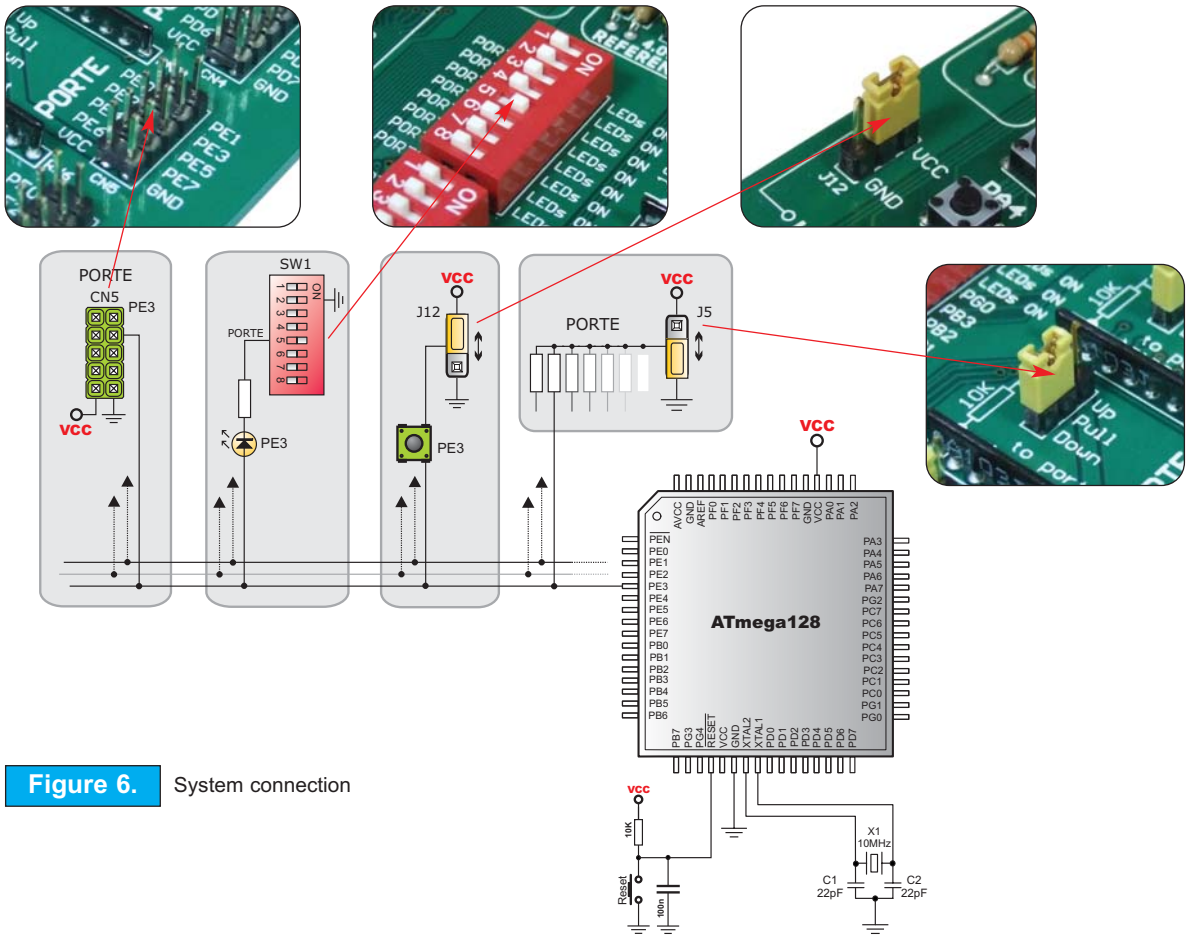


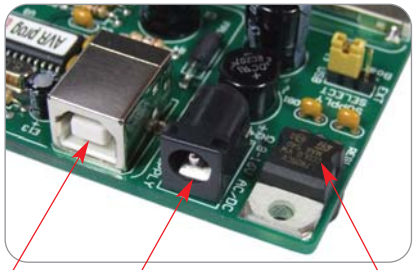
Figure 6. System connection

POWER SUPPLY

As a power supply source, users can select either a regulated supply from the USB cable (default) or an external power supply. In case of the USB power supply, the system should be connected to a PC using the USB programming cable, while the jumper J14 should be set in the right-hand position.

In the case of an external power supply, the BigAVR board produces +5V using an LM7805 voltage regulator. The external power supply can be AC or DC, with a voltage between 8V and 16V and the jumper J14 should be set in the left-hand position. In Fig. 7 you can see USB and external power supply connectors.

Figure 7. USB and power supply connectors



USB connector

External power supply connector

J14 in the left-hand position: system will take power from the external AC/DC power adapter.

J14 in the right-hand position: system will take power from the USB cable.

Figure 8. Power supply select jumper

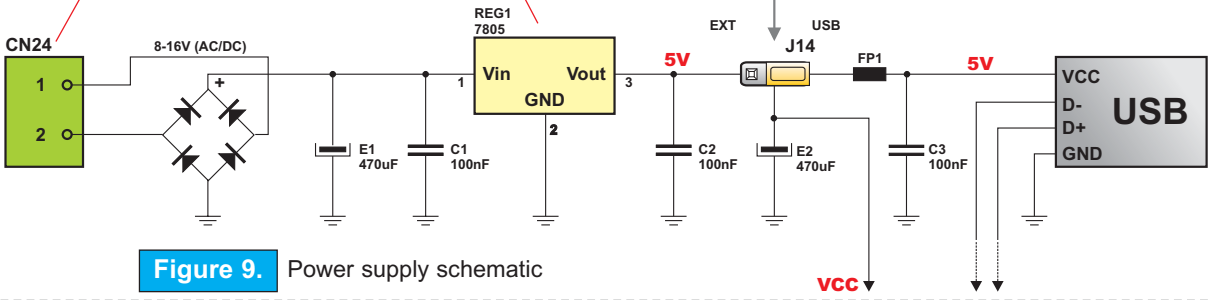


Figure 9. Power supply schematic

ON-BOARD USB 2.0 PROGRAMMER

There is no need for the use of external equipment during programming, as the BigAVR development system has its own on-board USB 2.0 programmer.

All you need to do is connect the system to a PC using the USB cable. Then, load your program into the microcontroller via the *AVRFlash* programming software, which is supplied with the board.

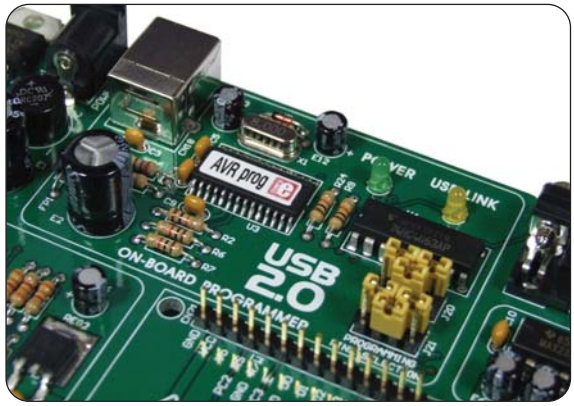


Figure 10. On-Board USB programmer

Note: There is no need for manually reseting MCU after programming. The programmer will reset the MCU automatically.

Figure 11.

PE0, PE1 and PB1 used as programming lines (Default)

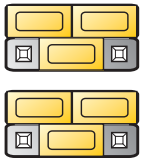
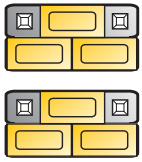
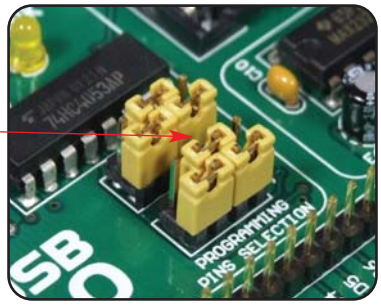


Figure 12.

PB2, PB3 and PB1 used as programming lines





There are two different AVR MCU groups. The first one (Default) uses special pins for programming: PDI (PE0 pin), PDO (PE1 pin) and SCK (PB1 pin). The second one uses SPI communication lines for programming: MOSI (PB2 pin), MISO (PB3 pin) and SCK (PB1 pin).

With jumpers J20 and J21 you can select which pins will be used for programming (acording to the MCU type).

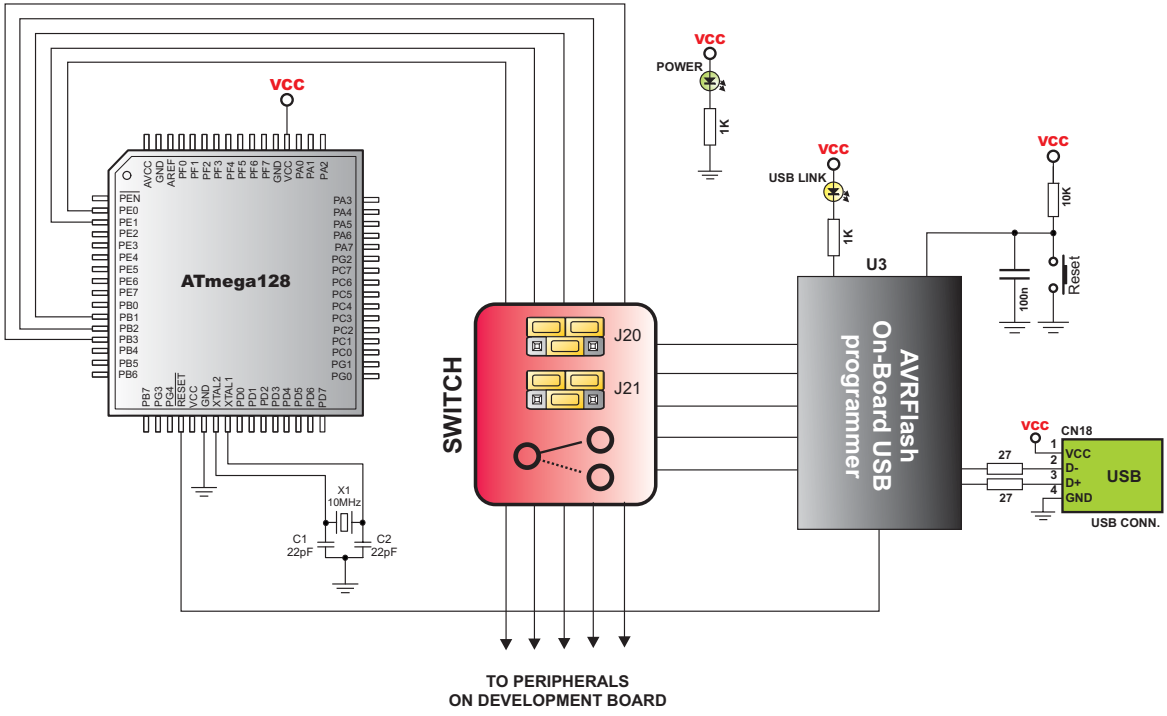
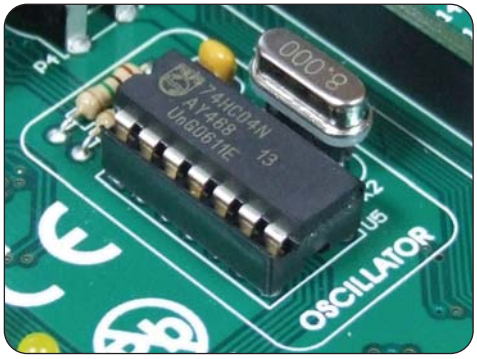


Figure 13. Programmer schematic

OSCILLATOR

BigAVR development board has on-board oscillator circuit for generating microcontroller's clock input and also crystal oscillator placed on MCU Card. Within the *AVRFlash* programmer you can either choose internal RC oscillator, external clock or external crystal. With jumper J1 (placed on MCU Card) you can choose which clock will be used to drive MCU: external oscillator or crystal.



Oscillator **Figure 14.**

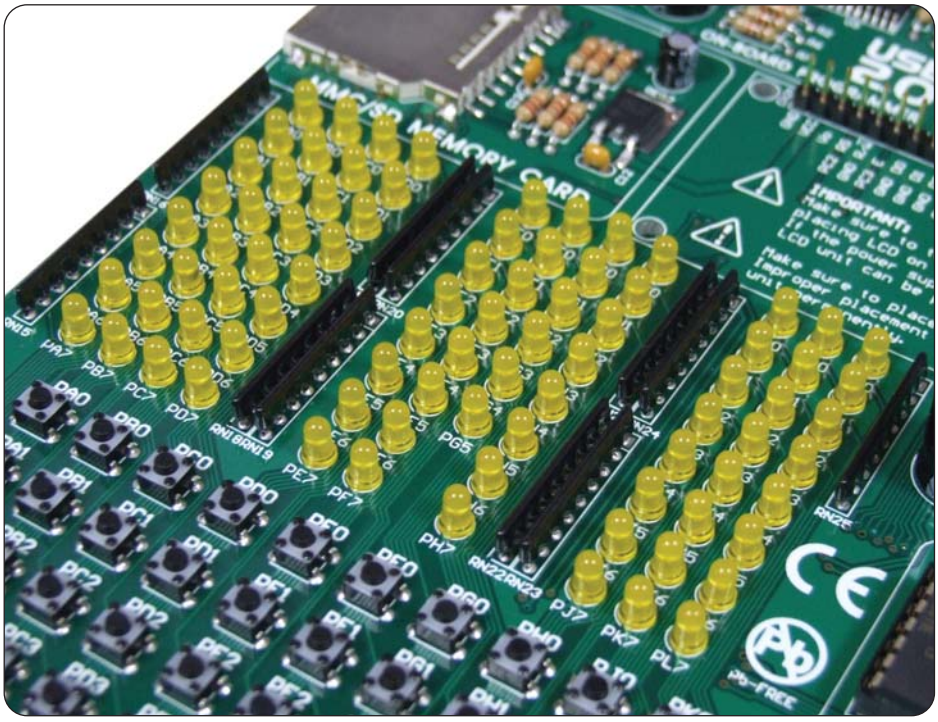
Figure 15.

Oscillator schematic

LEDs

Light Emitting Diodes (LEDs) are the most commonly used components, usually for displaying pin's digital state. BigAVR has 86 LEDs that are connected to the microcontroller's PORTA, PORTB, PORTC, PORTD, PORTE, PORTF, PORTG, PORTH, PORTJ, PORTK and PORTL.

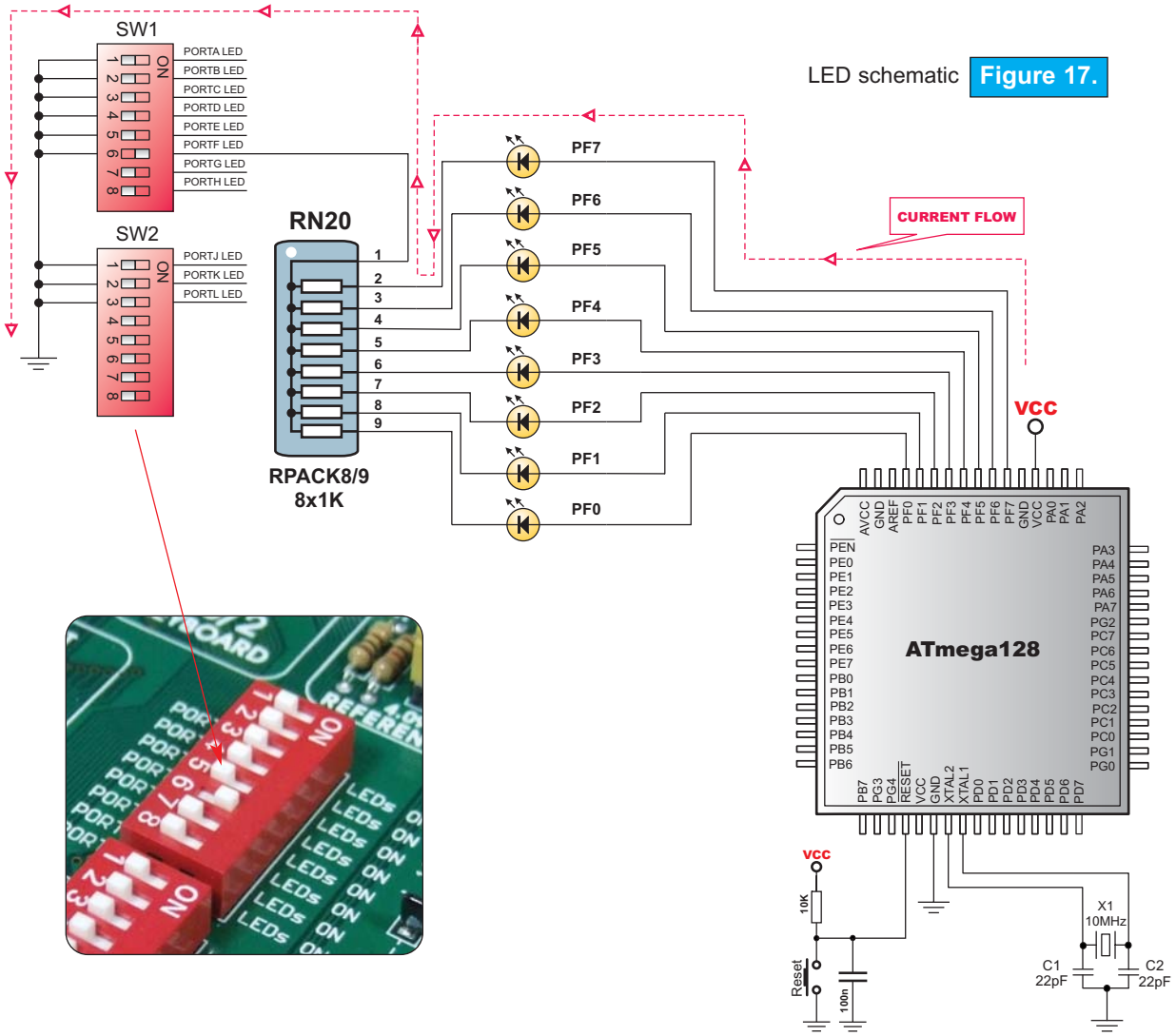
Figure 16. Light Emitting Diodes



Each group of LEDs can be enabled or disabled using the switches SW1 and SW2. Fig. 17. illustrates the connection of a LEDs to PORTF of the microcontroller. A resistor is used in series with the LED to limit the LED's current. In this case the resistor's value is 1K.

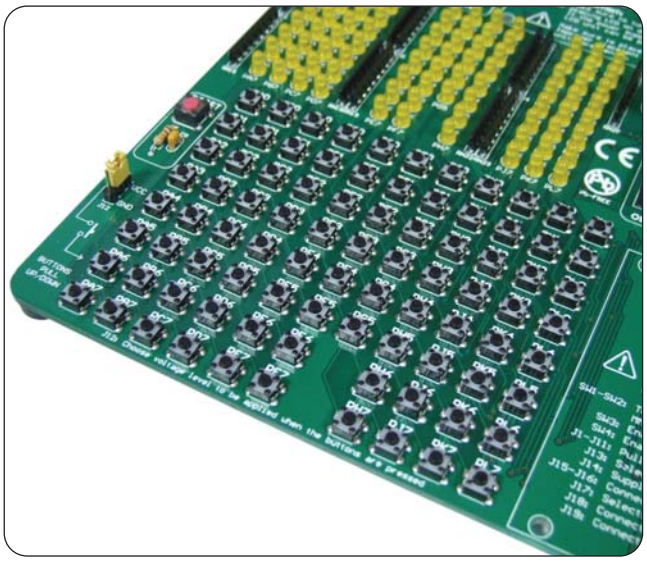
The LEDs are enabled when the corresponding switch on SW1 and SW2 is on. When enabled, LEDs will display the state of the corresponding microcontroller pin; otherwise the LEDs will always be off, no matter what the port state is, as no current can flow through LED.

LED schematic **Figure 17.**



PUSHBUTTON SWITCHES

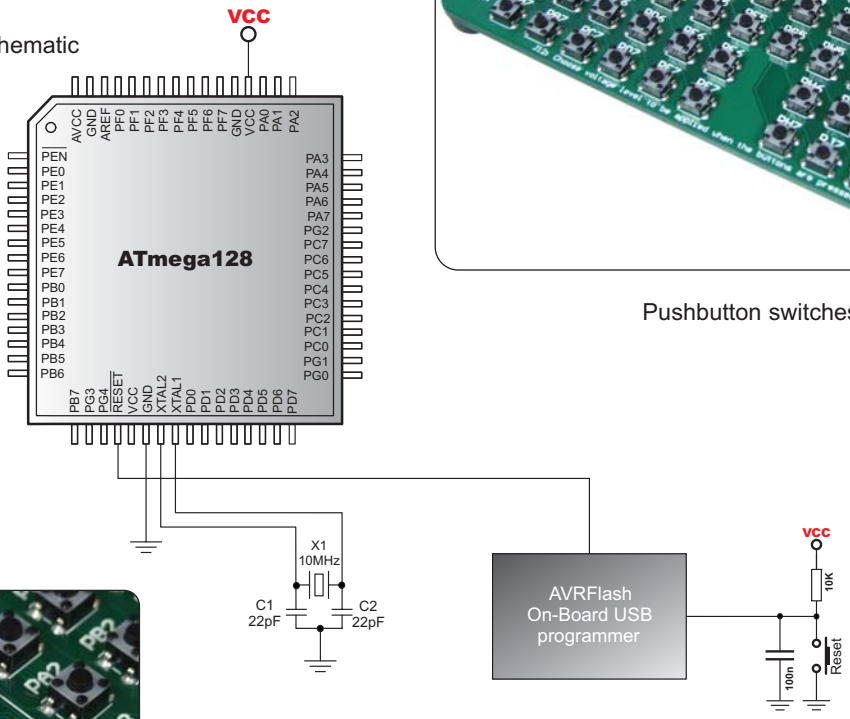
BigAVR has 86 push buttons, which can be used to change states of digital inputs to microcontroller's ports. There is also one switch that acts as a RESET. Reset switch schematic is shown in Figure 18.



Pushbutton switches **Figure 20.**

Figure 18.

Reset switch schematic



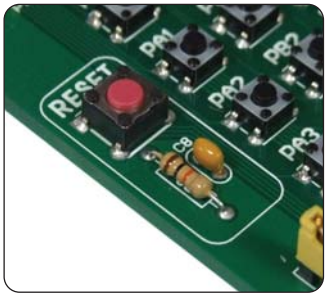


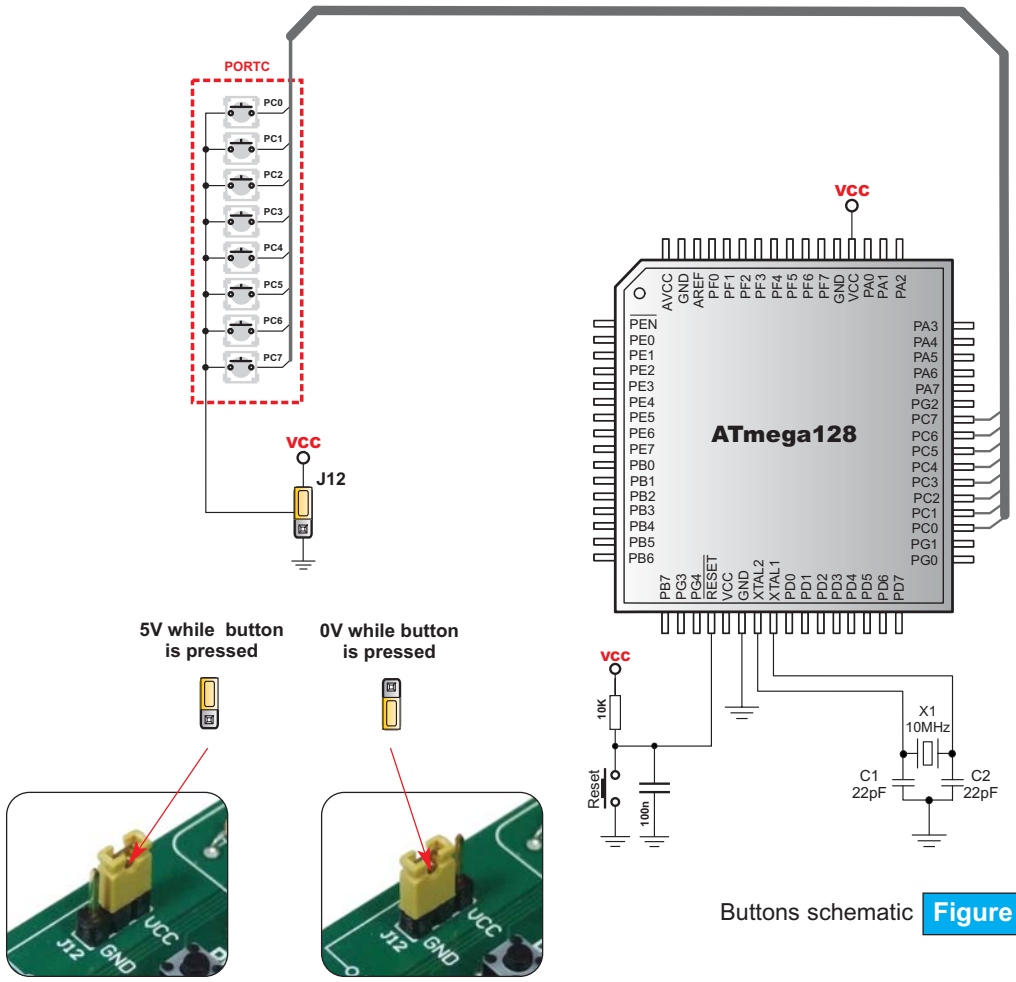
Figure 19.

Reset switch

Buttons connections to PORTC is shown in Fig. 21. Jumper J12 determines whether a button press will bring logical zero or logical one to the appropriate pin.

When button is not pressed, pin state is determined by the pull-up or pull-down port jumpers.

In the example shown in Fig. 21, J12 is connected to +5V, therefore pressing the buttons will bring logical one to the appropriate pins.



Buttons schematic **Figure 21.**

On Fig. 22 the J3 jumper is set to pull-up, therefore when the button is not pressed, pull-up resistor pulls the microcontroller's PC2 pin to +5V.

A button press causes the port pin to be connected to ground (J12 is in the lower position).

Thus, only when the button is pressed the microcontroller will sense a logical zero; otherwise the pin state will always be logical one.

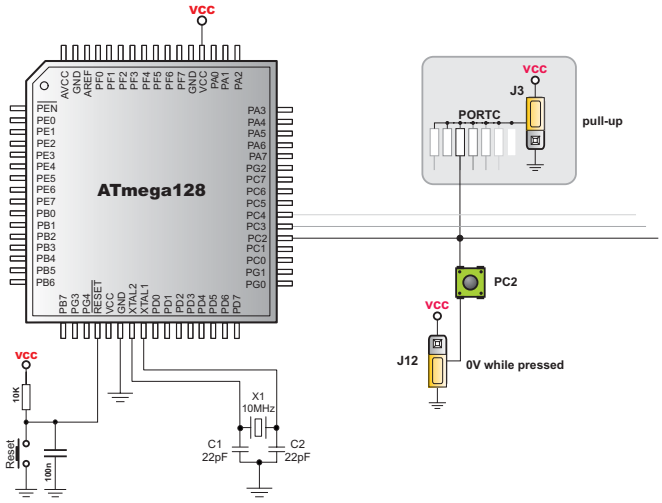


Figure 22. Button with pull-up resistor

On Fig. 23 the J3 jumper is set to pull-down, therefore when the button is not pressed, pull-down resistor pulls the microcontroller's PC2 pin to 0V.

A button press causes the port pin to be connected to +5V (J12 is in the higher position).

Thus, only when the button is pressed the microcontroller will sense a logical one; otherwise the pin state will always be logical zero.

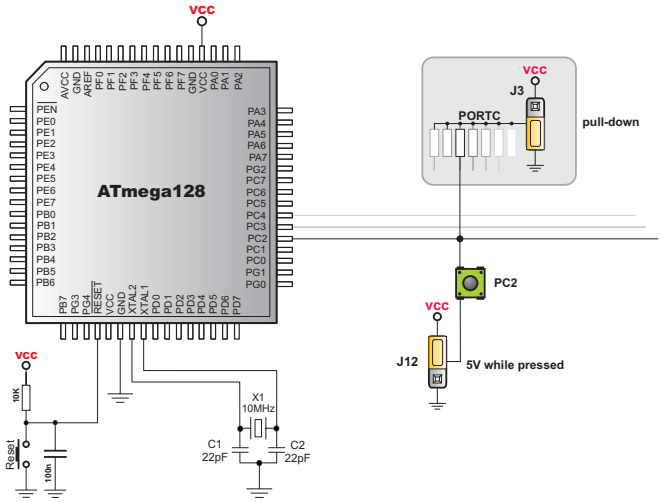


Figure 23. Button with pull-down resistor

GRAPHIC LCD CONNECTOR ON-BOARD

GRAPHIC LCD

A graphic LCD (GLCD) allows advanced visual messages to be displayed. While a character LCD can display only alphanumeric characters, a GLCD can be used to display messages in the form of drawings and bitmaps.

The most commonly used graphic LCD has the screen resolution of 128x64 pixels. Before a GLCD is connected, the user needs to set the jumper J17 (Fig. 25) to the upper position. The GLCD's contrast can be adjusted using the potentiometer P3, which is placed to the right of the GLCD.

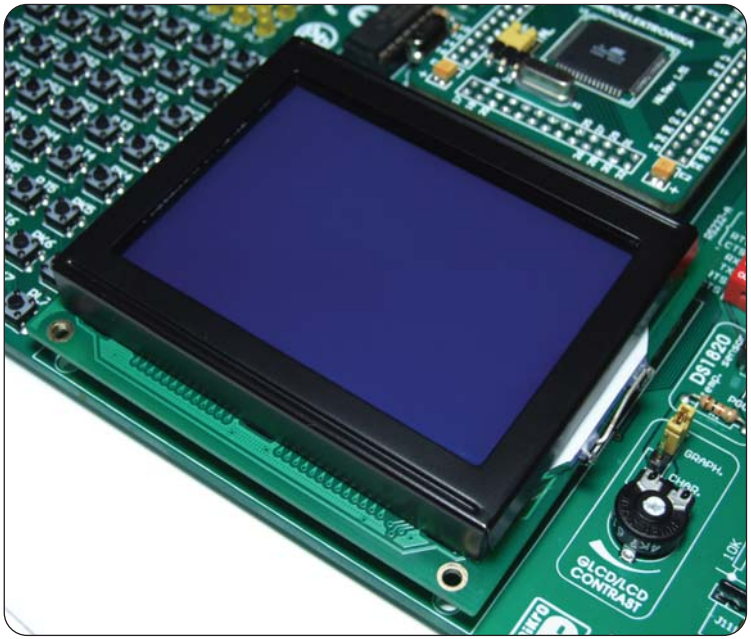


Figure 24. GLCD

NOTE: Make sure to turn off the power supply before placing GLCD on development board! If the power supply is connected while placing, GLCD unit can be permanently damaged!

In order to enable GLCD, jumper J17 should be set to the upper position, labeled as GRAPH.

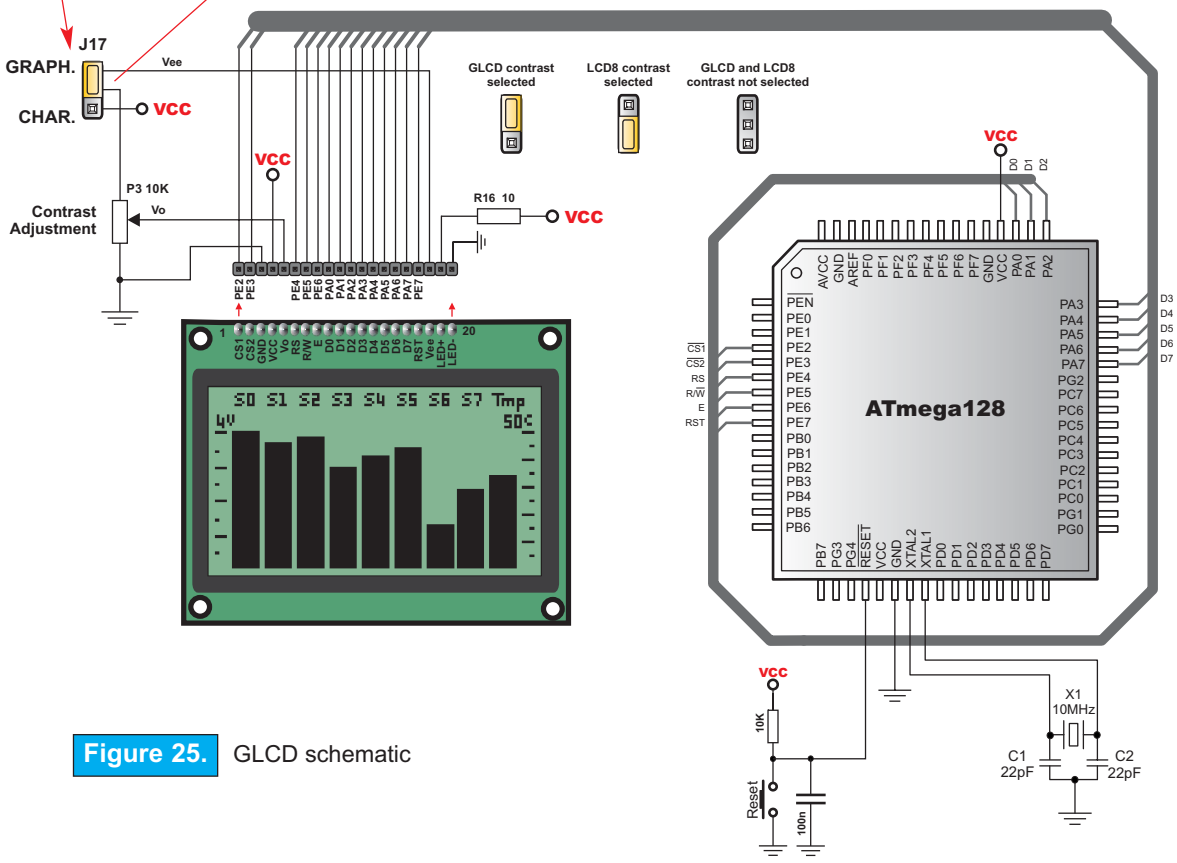


Figure 25. GLCD schematic

2x16 LCD CONNECTOR
2x16 LCD
ON-BOARD

LCD 2X16 IN 4-BIT MODE

A standard character LCD is probably the most widely used data visualization component. Usually, it can display two lines of 16 alphanumeric characters, each made up of 5x8 pixels. The character LCD communicates with the microcontroller via a 4-bit or 8-bit data bus, each requiring the use of a different connector on BigAVR development board.

For 4-bit data bus use, the LCD should be placed in the upper left of the board, above the LEDs. The connection to the microcontroller is shown in Fig. 27 where there are only four data lines.

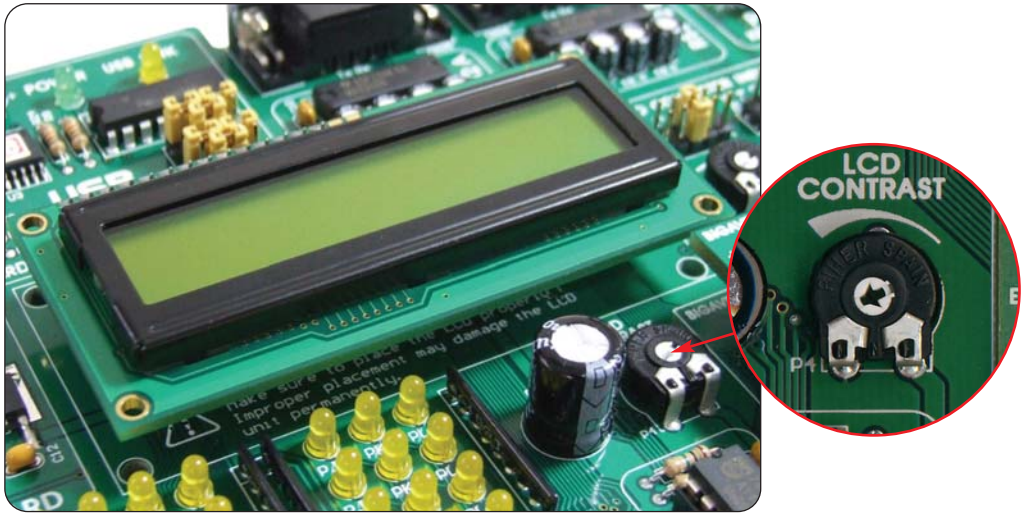
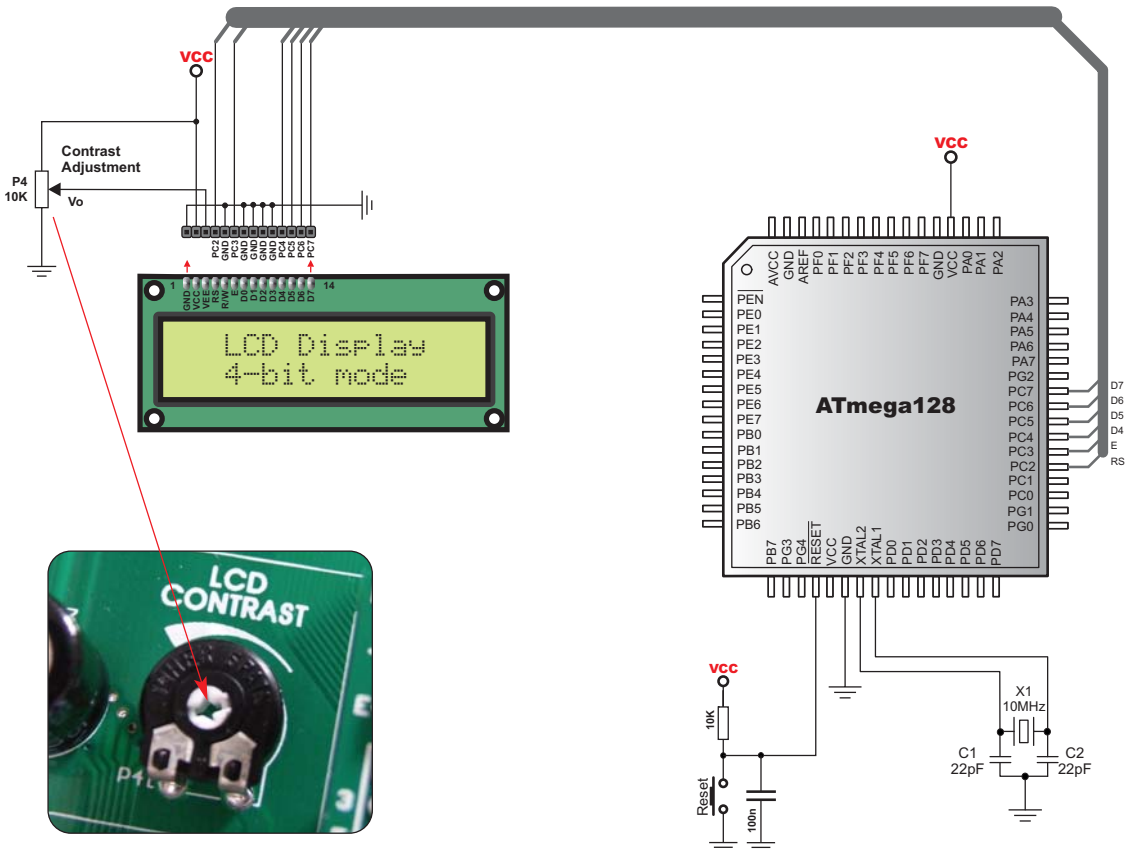


Figure 26. LCD 2x16 in 4-bit mode

NOTE: Make sure to turn off the power supply before placing GLCD on development board! If the power supply is connected while placing, GLCD unit can be permanently damaged!

Figure 27.

LCD 2x16 in 4-bit mode schematic



2x16 LCD CONNECTOR
2x16 LCD
ON-BOARD

LCD 2X16 IN 8-BIT MODE

When using a character LCD in 8-bit mode, the connector that is shared with the GLCD should be used. Since this connector has 20 pins and the character LCD has only 14 pins, special attention is required when placing the LCD. Otherwise the LCD can be permanently damaged.

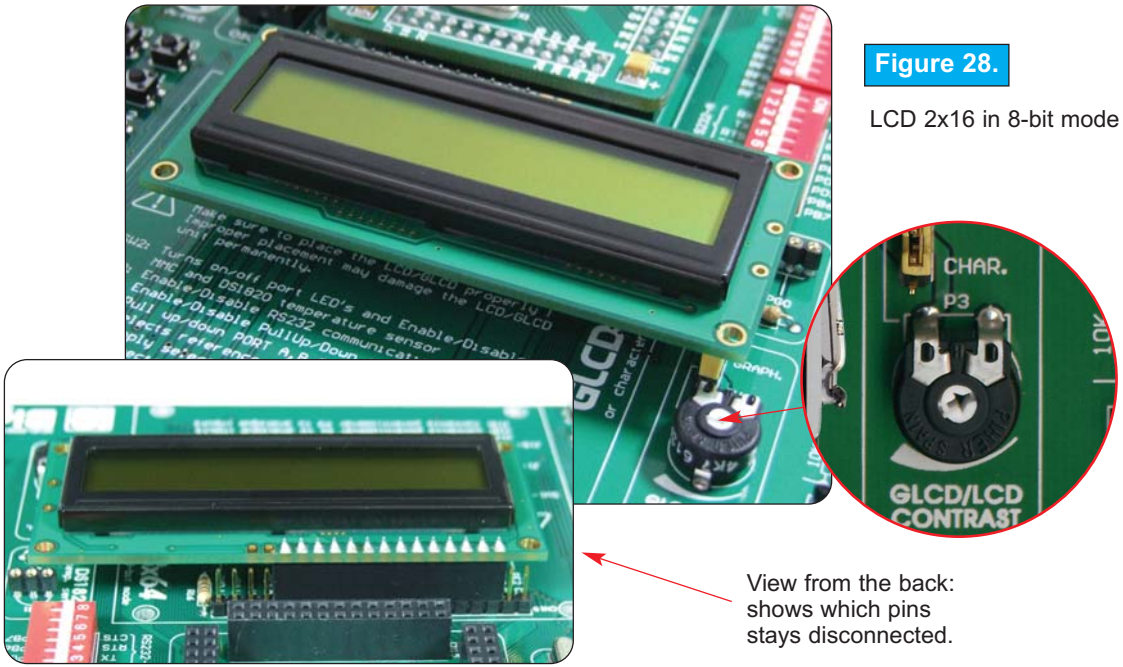


Figure 28.

LCD 2x16 in 8-bit mode

NOTE: Make sure to turn off the power supply before placing GLCD on development board! If the power supply is connected while placing, GLCD unit can be permanently damaged!

NOTE: Make sure to place the LCD properly! Improper placement may damage the LCD unit permanently!

The LCD must be placed in the marked position with two free pins to the left and four free pins to the right. It is important to note that the LCD should be placed or removed from BigAVR only when the power is off. Before attaching the LCD, set jumper J17 to the lower position. The LCD's contrast can be adjusted using potentiometer P3 which is located to the right of the GLCD/LCD connector.

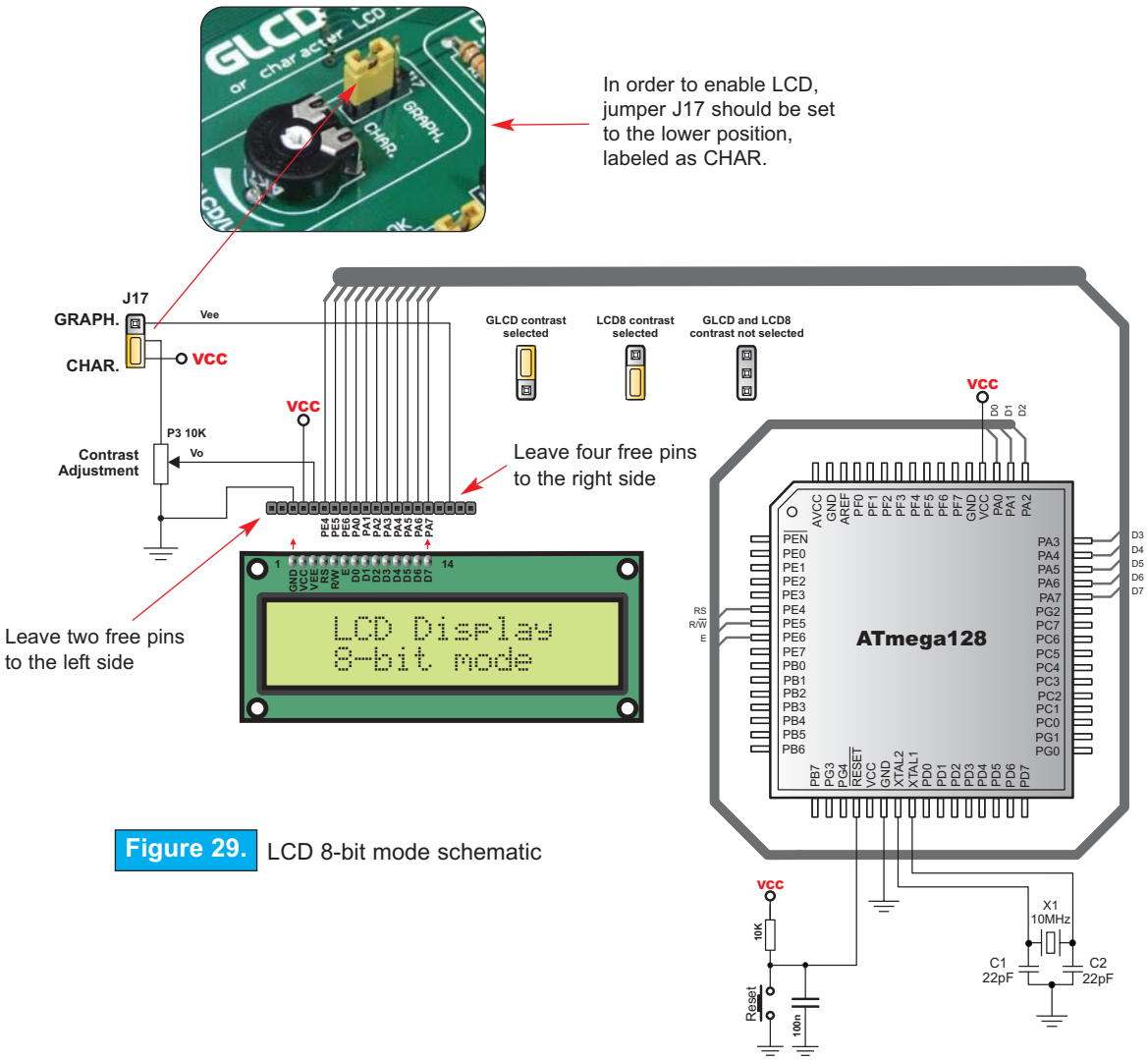


Figure 29. LCD 8-bit mode schematic

RS-232 COMMUNICATION

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

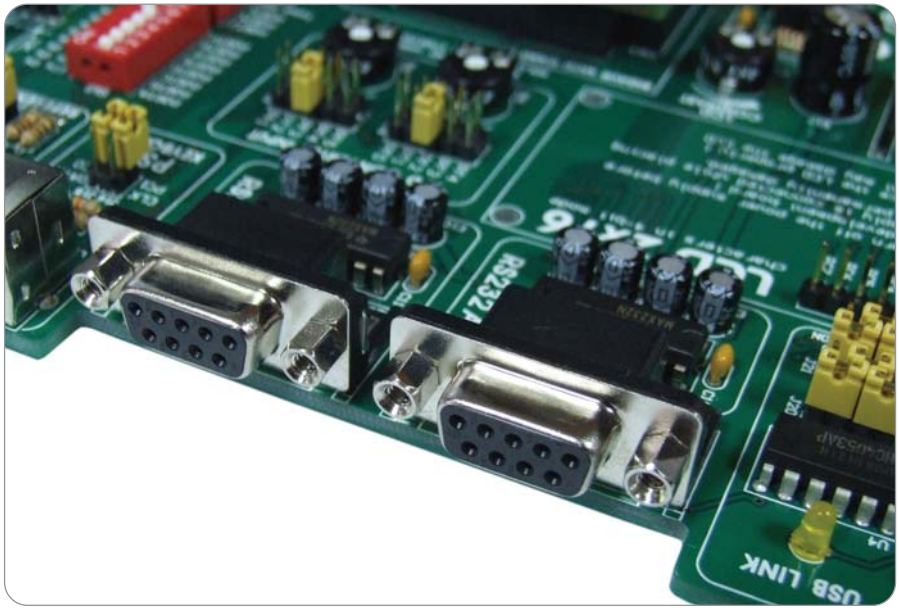


Figure 30. RS232 connectors

In order to provide a more flexible system, the microcontroller is connected to the MAX232 through the switches 1, 2, 3, and 4 on SW3 for the RS232-A port and the switches 5,6,7 and 8 on SW3 for the RS232-B port. Rx and Tx lines for the RS232-A port are connected to PE0 and PE1 pins, respectively. Rx and Tx lines for the RS232-B port are connected to PD2 and PD3 pins, respectively. Both RS232 ports have RTS and CTS lines for implementing hardware handshaking.

Figure 31.

Connection between microcontroller and a PC: RS232-A

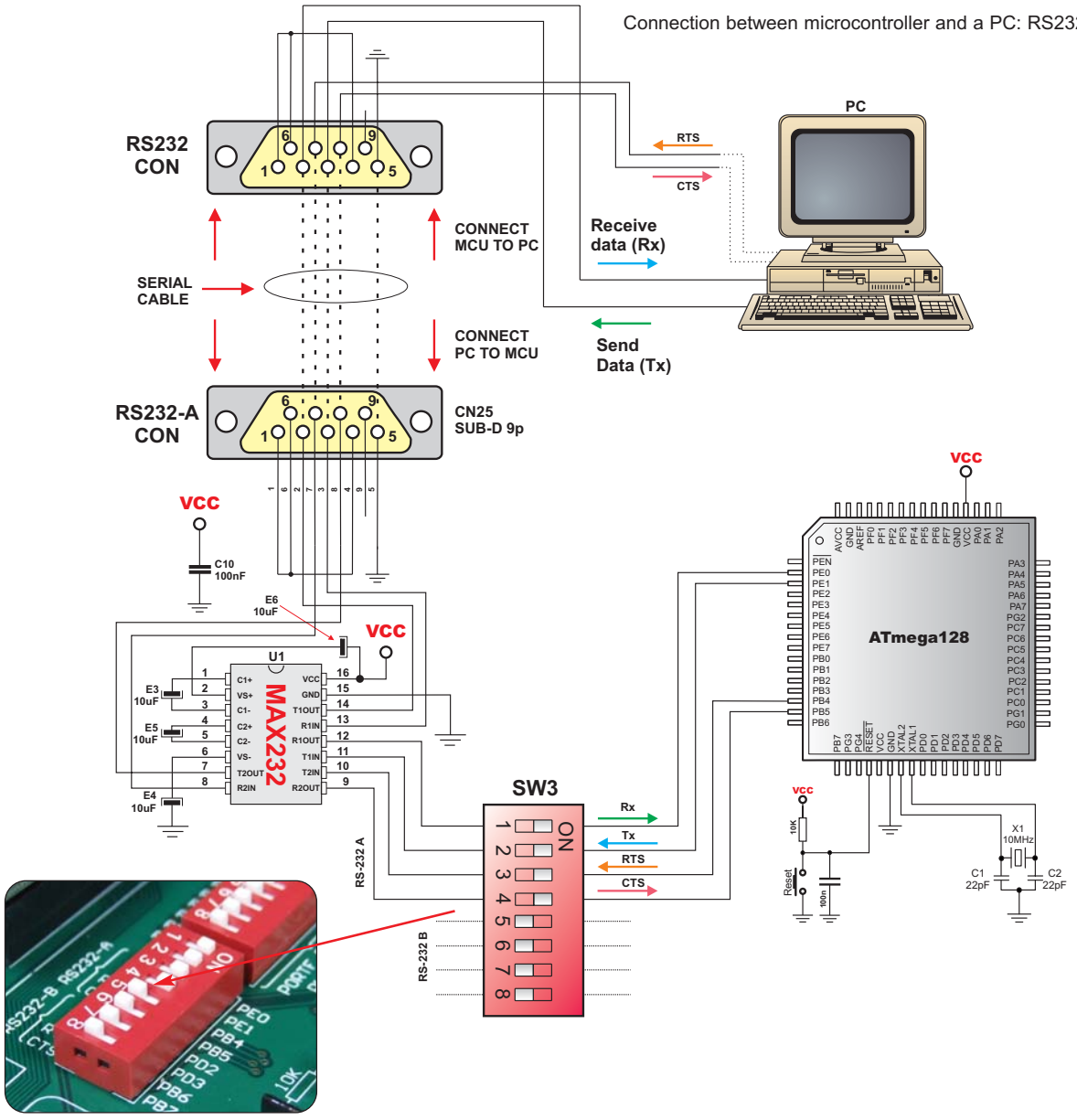
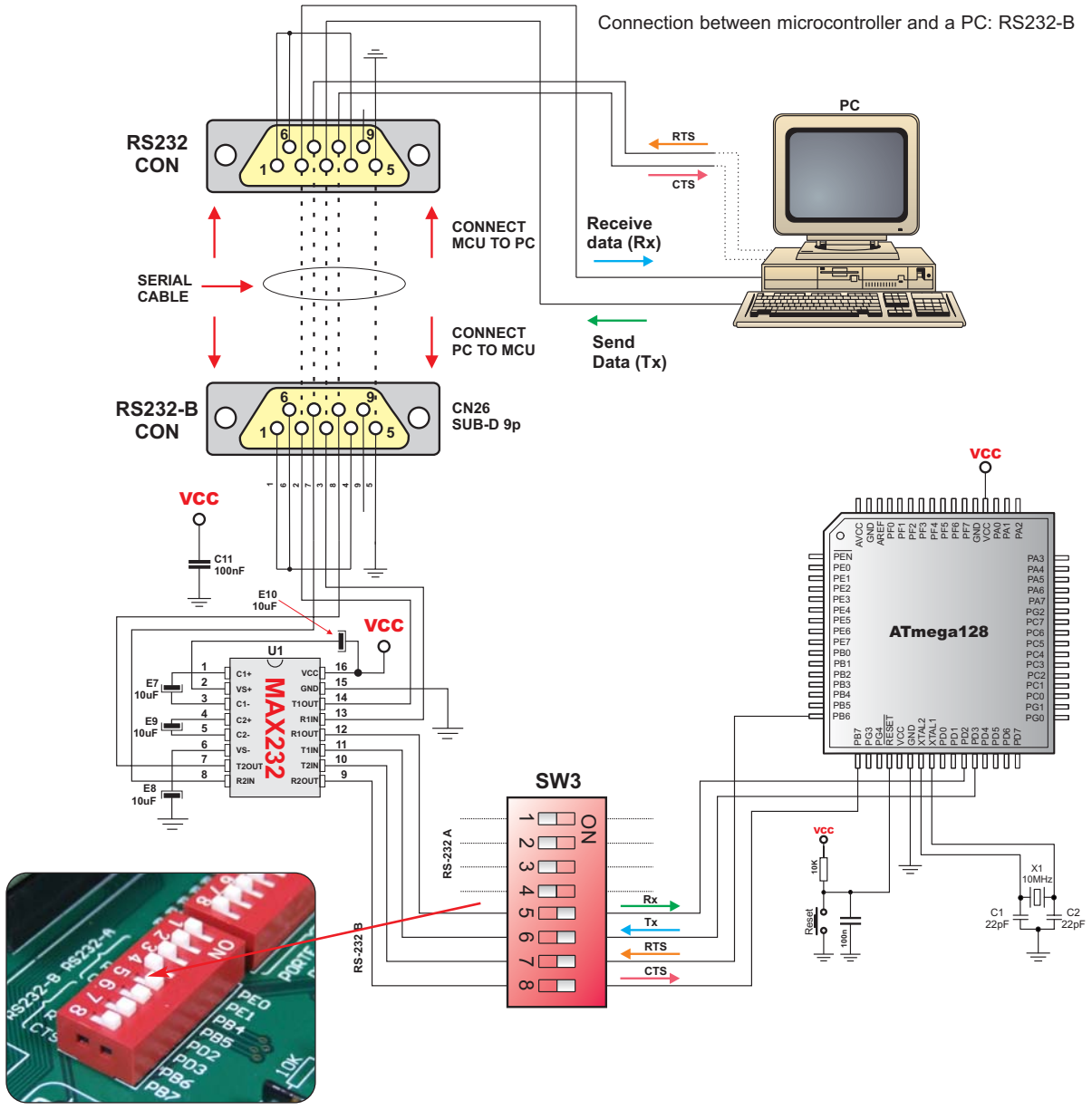


Figure 32.

Connection between microcontroller and a PC: RS232-B



DS1820 DIGITAL THERMOMETER

DS1820 digital thermometer is well suited to environmental temperature measurement, having the temperature range of -55°C to 125°C and the accuracy of +/- 0.5°C. It must be placed correctly in the 3-pin socket provided on BigAVR, with its rounded side to the upper edge of the board (see Fig. 33) otherwise the DS1820 could be permanently damaged. DS1820's data pin can be connected to PG0 pin by enabling switch 4 on SW2.

DS1820 **Figure 33.**

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

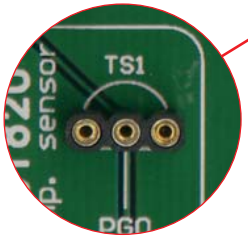


Figure 34.

DS1820 schematic

ADC INPUT ENABLED

VREF 4.096V ON-BOARD

A/D CONVERTER INPUT

BigAVR development board has two potentiometers for working with A/D Converter (Analog-to-Digital Converter). Both potentiometers outputs are in the range of 0V to 5V. Two analog signals can be connected on two different analog input pins at the same time. The jumpers group J18 enables connection between potentiometer P1 and one of the following pins: PF0, PF1, PF2, PF3 or PF4. The jumpers group J19 enables connection between potentiometer P2 and one of the following pins: PF1, PF2, PF3, PF4 or PF5.

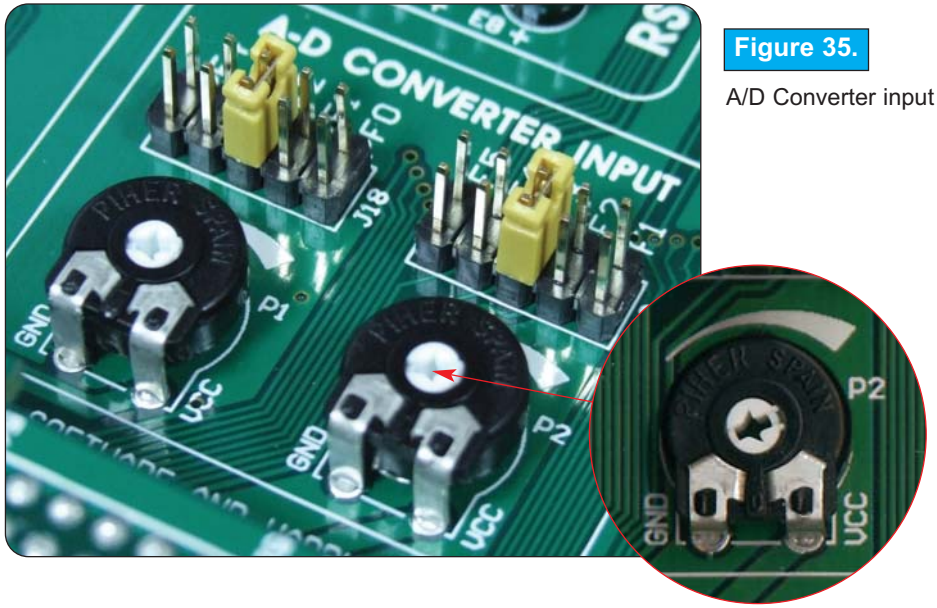


Figure 35.
A/D Converter input

In order to measure analog signal without interference, turn the coresponding switch on SW4 to OFF position. This will disable connection of the used PORTF pin to the pull-up/down resistors.

Applications of A/D Conversion are various. Microcontroller takes analog signal from its input pin and translates it into a digital value. Basically, you can measure any analog signal that fits in range acceptable by AVR. That range is 0V to 5V.

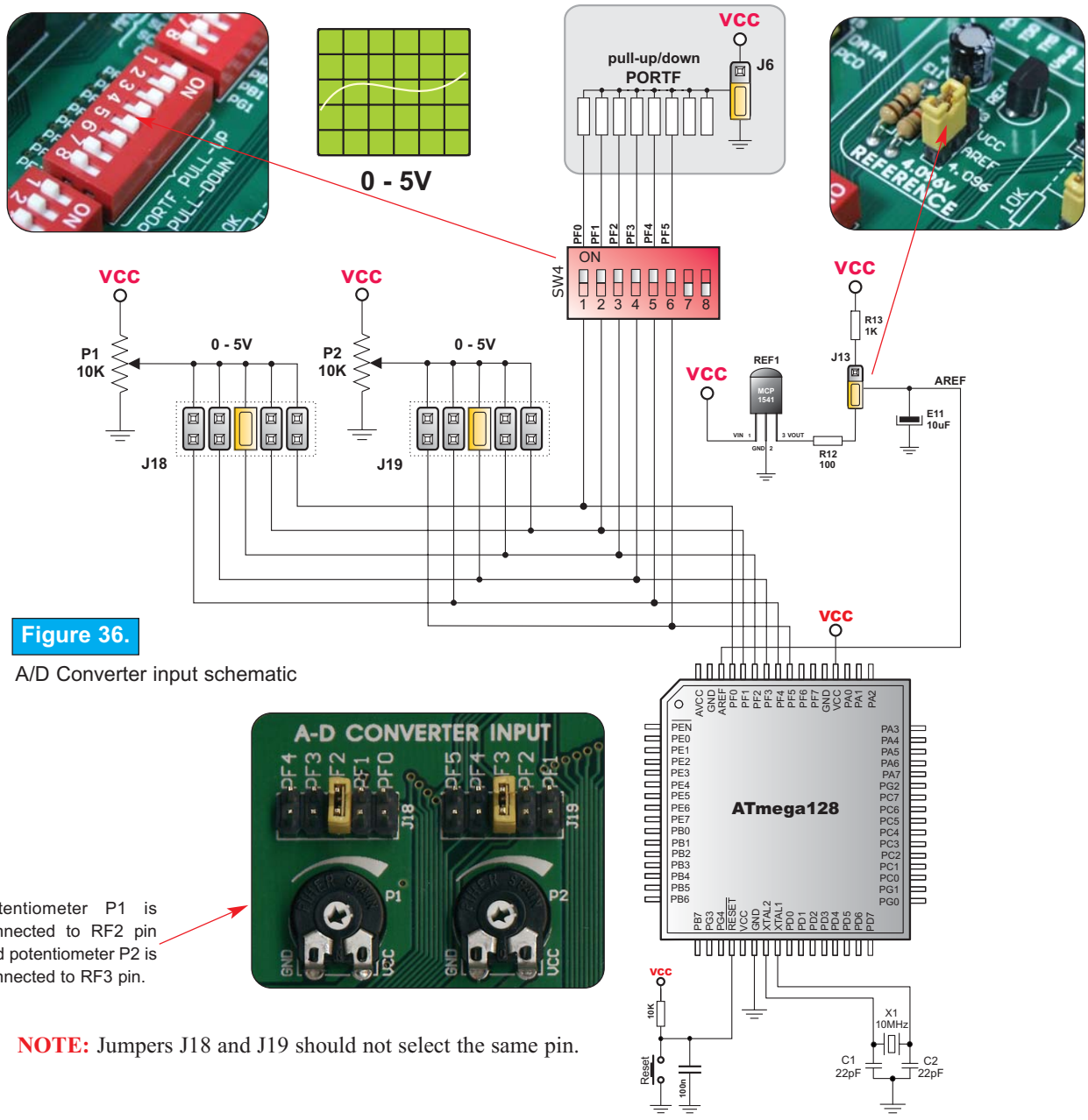


Figure 36.

A/D Converter input schematic

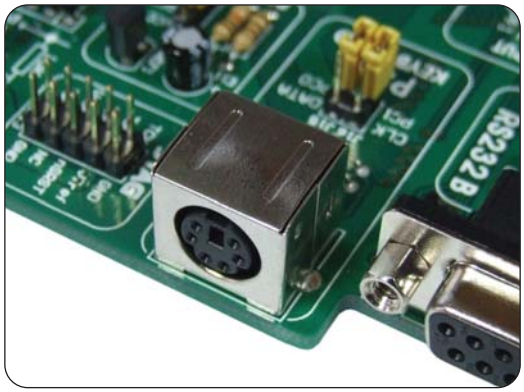
Potentiometer P1 is connected to RF2 pin and potentiometer P2 is connected to RF3 pin.

NOTE: Jumpers J18 and J19 should not select the same pin.

PS/2 READY
DEVELOPMENT

PS/2 (KEYBOARD) CONNECTOR

The PS/2 connector allows direct connection between BigAVR and devices that use PS/2 communication, such as PC, keyboard or mouse. For example, the microcontroller can be connected to a keyboard to capture pressed keys or it can be connected to a PC to act as a keyboard. CLK and DATA lines are used for data tansfer. In this case, they are connected to pins PC1 and PC0 respectively.



PS/2 connector **Figure 37.**

Figure 38.
Keyboard connected to development board

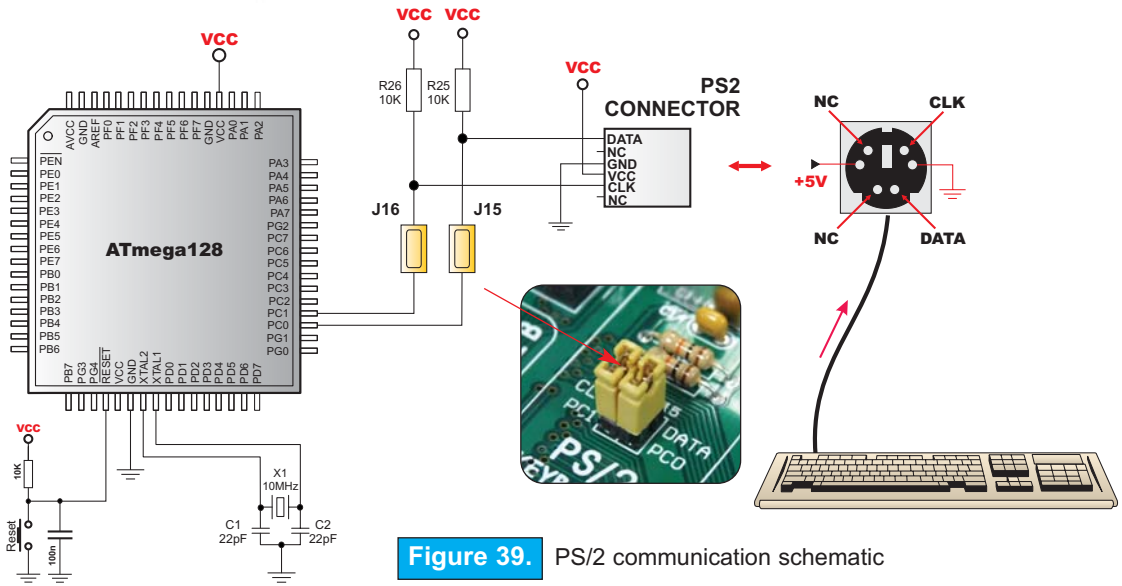
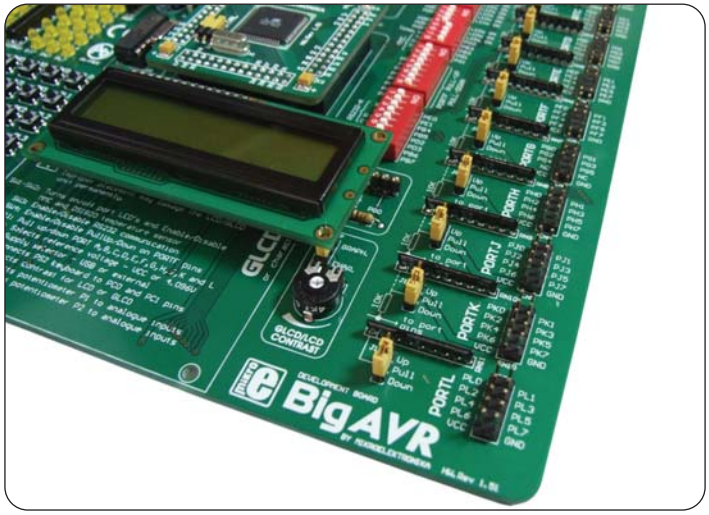


Figure 39. PS/2 communication schematic

DIRECT PORT ACCESS

All microcontroller input/output pins can be accessed via connectors placed along the right side of the board. For each of PORTA, PORTB, PORTC, PORTD, PORTE, PORTF, PORTG, PORTH, PORTJ, PORTK and PORTL there is one 10-pin connector providing VCC, GND and up to eight port pins.

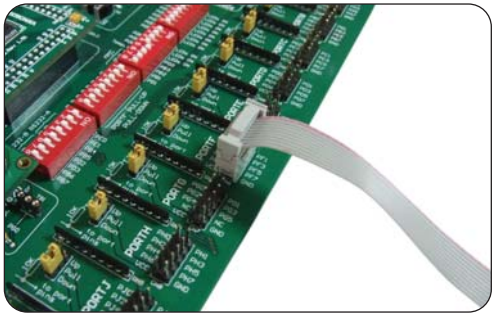


Direct port access connectors **Figure 40.**

These connectors can be used for system expansion with external boards such as Serial Ethernet, Compact Flash, MMC/SD, ADC, DAC, CAN, RTC, RS-485, etc. Ensure that the on-board peripherals are disconnected from microcontroller by setting the appropriate jumpers and switches, while external peripherals are using the same pins. The connectors can also be used for attaching logic probes or other test equipment.

Figure 41.

Example of how to connect external peripheral with flat cable



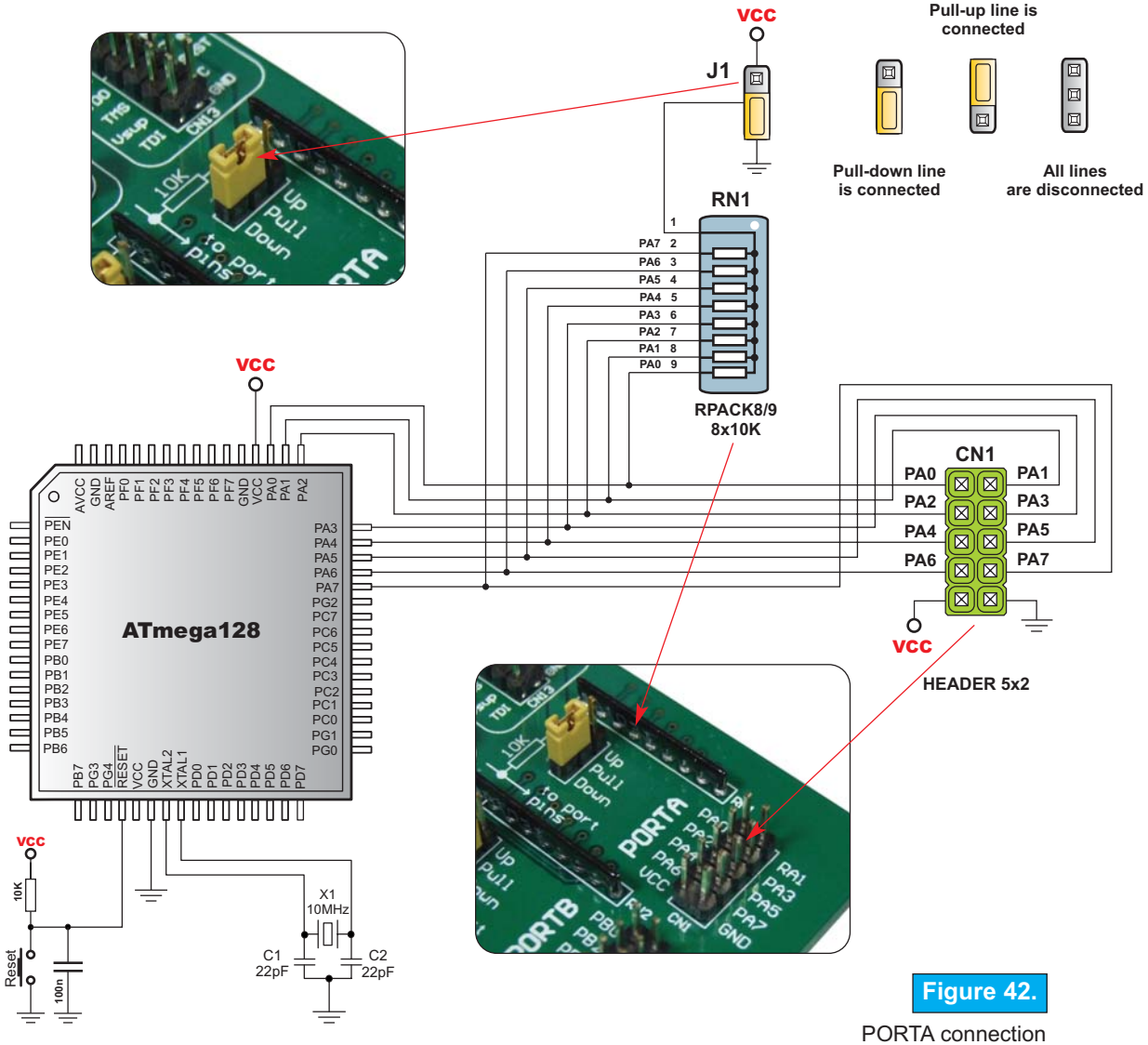


Figure 42.
PORTA connection

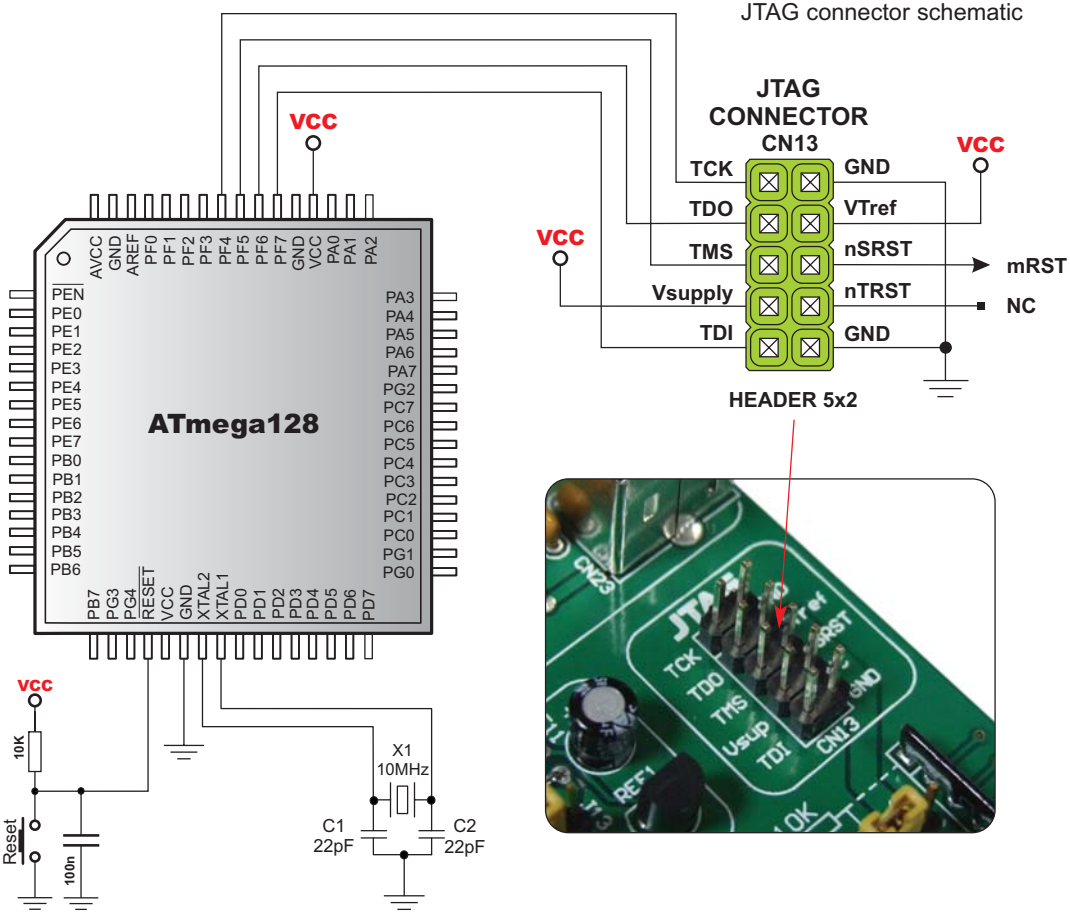
JTAG CONNECTOR

JTAG connector can be used as serial programming interface or On-Chip debug system. For the On-chip Debug system, in addition to the JTAG interface pins, the RESET pin is monitored by the debugger to be able to detect external reset sources. The debugger can also pull the RESET pin low to reset the whole system. The JTAG interface is accessed through four of the microcontroller's pins:

- TMS: Test Mode Select,
- TCK: Test Clock,
- TDI: Test Data In,
- TDO: Test Data Out.

Figure 43.

JTAG connector schematic



MMC/SD (MULTIMEDIA CARD)

MMC card is used as storage media for a portable devices, in a form that can easily be removed for access by a PC. For example, a digital camera would use an MMC card for storing image files. With an MMC reader (typically small box that connects via USB or some other serial connection) you can easily transfer data from MMC card to your computer. Microcontroller on BigAVR communicates with Multi Media Card via SPI communication.

Modern computers, both laptops and desktops, often have SD slots, which can read MMC cards.

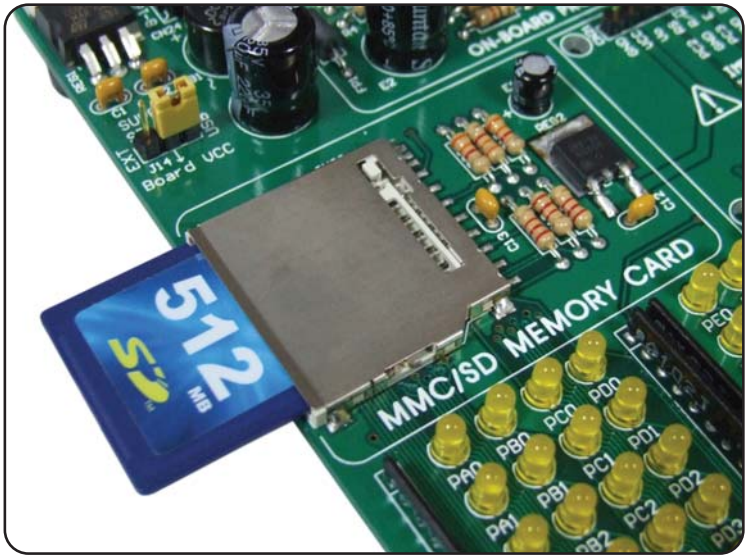
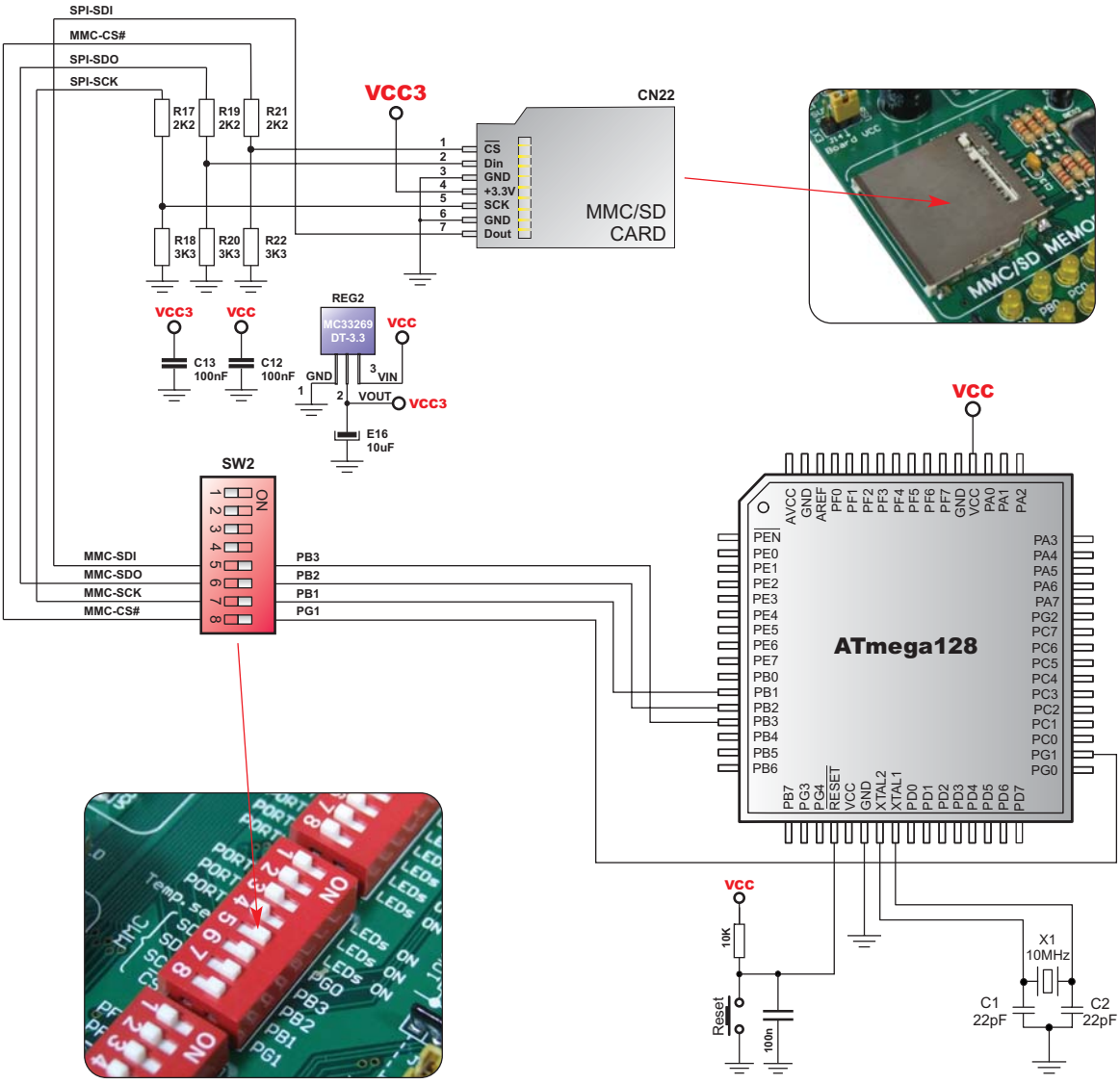


Figure 44.
MMC slot on-board

To enable MMC card you must turn on switches 5, 6, 7 and 8 on SW2. By doing that, microcontroller's SPI comunnication lines (SDI, SDO and SCK) and Chip Select are connected to MMC. Working voltage of BigAVR is 5V DC, while working voltage of MMC card is 3.3V DC. Because of that, there is a voltage regulator on-board with MMC card (MC33269DT-3.3). Data lines from microcontroller to MMC card must be also adjusted to 3.3V. It is done with resister voltage dividers as shown on Figure 45.



MMC schematic **Figure 45.**

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