Digital electronics essentials

Здесь когда-нибудь будет дизайн

Занятие 8. Микроконтроллеры

Recap?

Recap?

- Цифровые схемы
- Логические уровни
- Базовые блоки
  - AND
  - OR
  - NOT
  - NAND и NOR
  - XOR
- Сложные схемы
  - Полусумматор
  - Сумматор

Контроллер

- Законченное устройство, включающее в себя
  - АЛУ (вычислительное ядро ЦПУ)
  - Память
    - Оперативную
    - (не всегда) постоянную
  - Устройства ввода-вывода

Читаем даташит

- http://www.atmel.com/images/Atmel-8271-8-bit-AVR-Microcontroller-ATmega48A-48PA-88A-88PA-168A-168PA-328-328P_datasheet_Complete.pdf

Структура МК

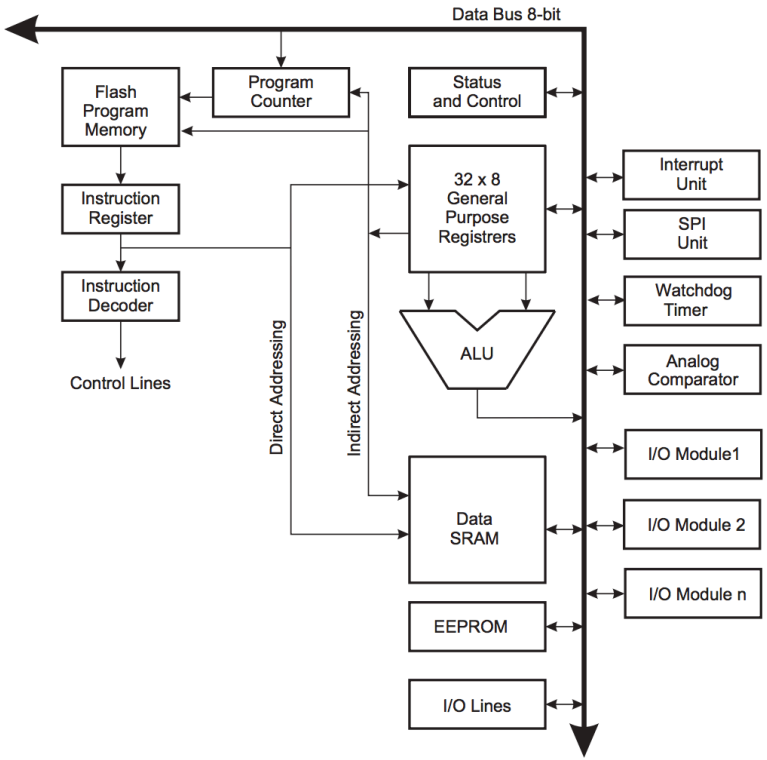
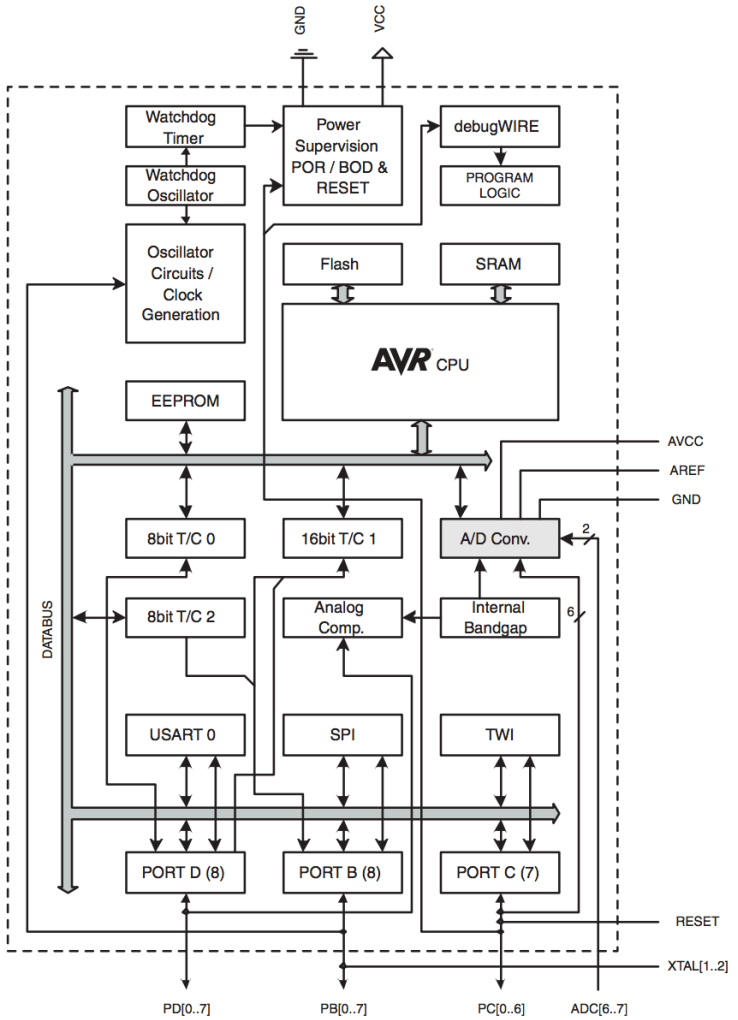


Figure 2-1. Block Diagram



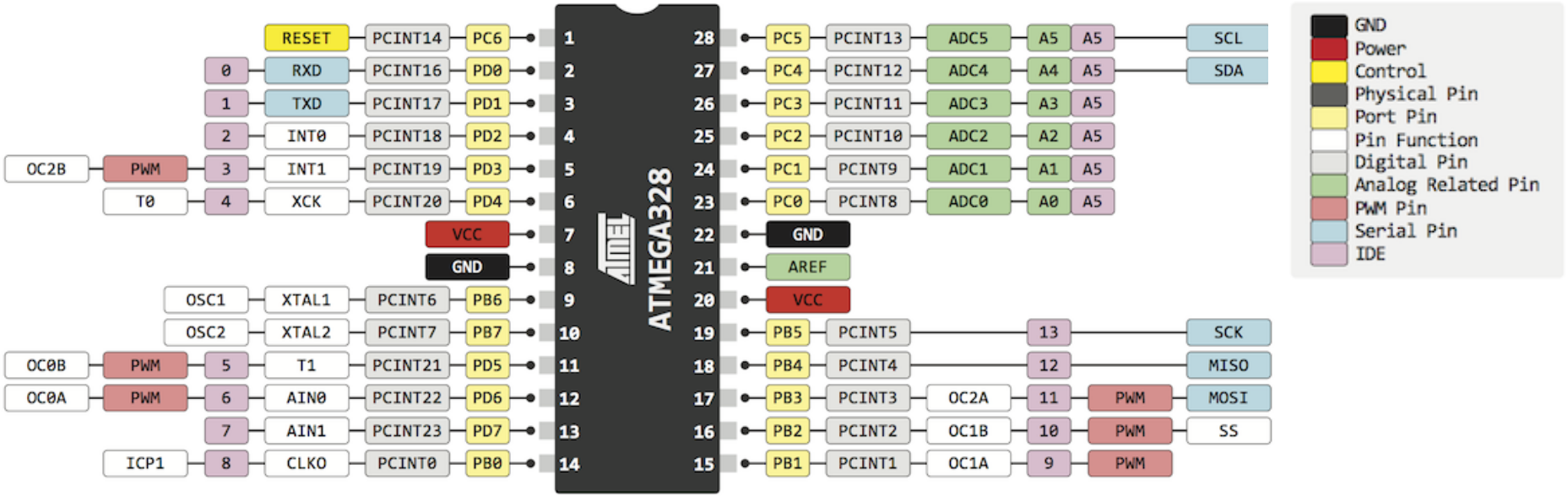
SREG – AVR Status Register

The AVR Status Register – SREG – is defined as:

Bit	7	6	5	4	3	2	1	0	
0x3F (0x5F)	I	T	H	S	V	N	Z	C	SREG
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- • Bit 7 – I: Global Interrupt Enable The Global Interrupt Enable bit must be set for the interrupts to be enabled. The individual interrupt enable control is then performed in separate control registers. If the Global Interrupt Enable Register is cleared, none of the interrupts are enabled independent of the individual interrupt enable settings. The I-bit is cleared by hardware after an interrupt has occurred, and is set by the RETI instruction to enable subsequent interrupts. The I-bit can also be set and cleared by the application with the SEI and CLI instructions, as described in the instruction set reference.
- • Bit 6 – T: Bit Copy: BLD (Bit LoaD) and BST (Bit STore) instructions use the T-bit as source or destination for the operated bit. A bit from a register in the Register File can be copied into T by the BST instruction, and a bit in T can be copied into a bit in a register in the Register File by the BLD instruction.
- • Bit 5 – H: Half Carry Flag The Half Carry Flag H indicates a Half Carry in some arithmetic operations. Half Carry Is useful in BCD arithmetic.
- • Bit 4 – S: Sign Bit, S = N□□ V The S-bit is always an exclusive or between the Negative Flag N and the Two’s Complement Overflow Flag V.
- • Bit 3 – V: Two’s Complement Overflow Flag The Two’s Complement Overflow Flag V supports two’s complement arithmetic.
- • Bit 2 – N: Negative Flag The Negative Flag N indicates a negative result in an arithmetic or logic operation• Bit 1 – Z: Zero Flag The Zero Flag Z indicates a zero result in an arithmetic or logic operation.
- • Bit 0 – C: Carry Flag The Carry Flag C indicates a carry in an arithmetic or logic operation.

Распиновка ATMega328



Сравнение систем

	Архитектура	Примеры	Примечания
	AVR	**Arduino** (AtMega 328, 2560, 32U4)	8 бит, разработана в 1996.
	PIC	EasyPIC	
	PIC32	EasyPIC Fusion, Mini-32	
	ARM Cortex M0	mBed LPC11U24	
	ARM Cortex M3	mBed LPC1768	
	ARM Cortex M4	STM32Discovery	
		Espruino	Используется в модулях IskraJS (конструктор Йодо)
	ARM Cortex A*	Raspberry Pi BeagleBone * ODroid	Микрокомпьютеры широкого назначения
	SuperH (SH)		Используется в автомобильной электронике
	x86	~~Intel Galileo, Intel Edison~~ Intel NUC AMD Geode	Высокое энергопотребление, производительность, совместимость
	Xtensa	**ESP8266**, ESP32	Удобен в качестве SoM

Выбор

- Платформы, созданные для быстрого прототипирования
- => подходят нам:
  - Arduino (AVR)
  - Espruino
  - ESP8266

Устройство Arduino

- Основана на микроконтроллере
- Управляется написанной программой
- Содержит необходимые средства программирования и отладки
    - Подключается к компьютеру без дополнительных средств

Системы лучше и больше

Как писать хороший код и не лажать

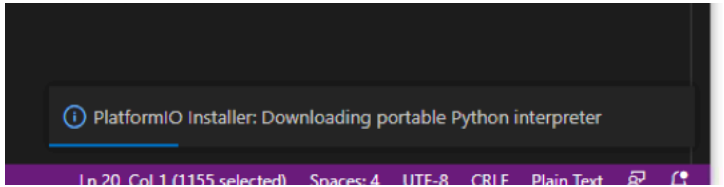
Простейший код: Blink

- На плате Arduino Uno и клонах на выводе 13 присутствует индикаторный светодиод

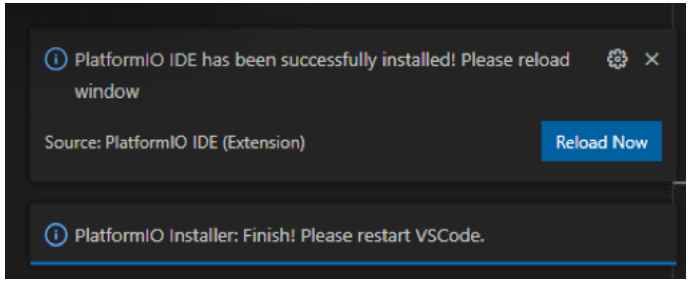
```
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);                       // wait for a second
}
```

Установка систем

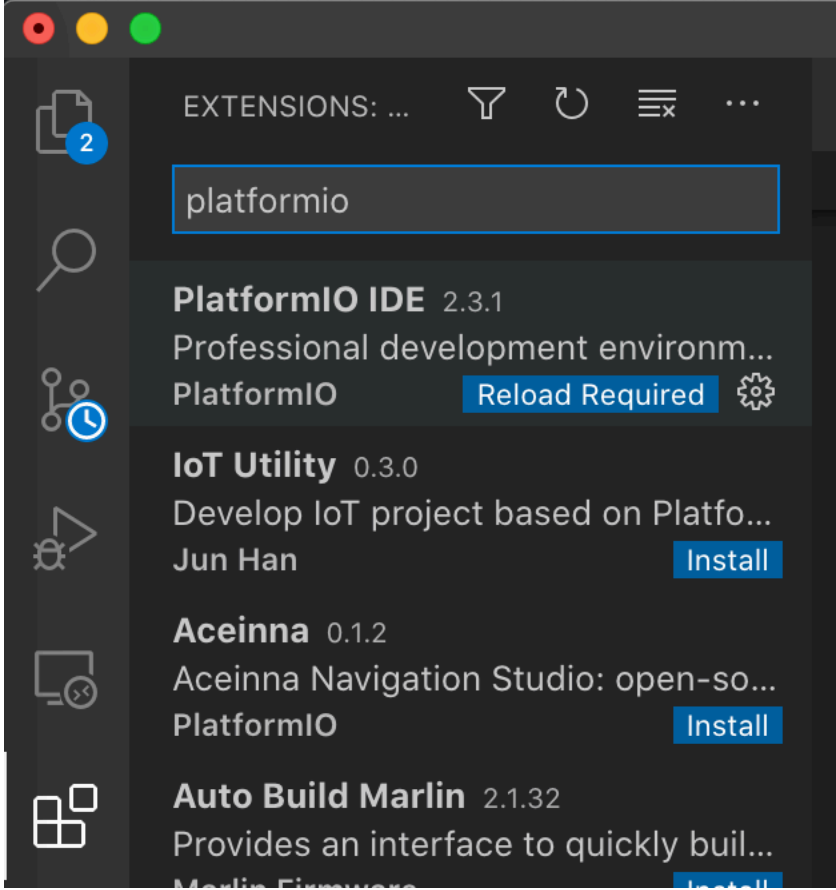
- https://code.visualstudio.com/Download
- Extensions -> “PlatformIO”
- …

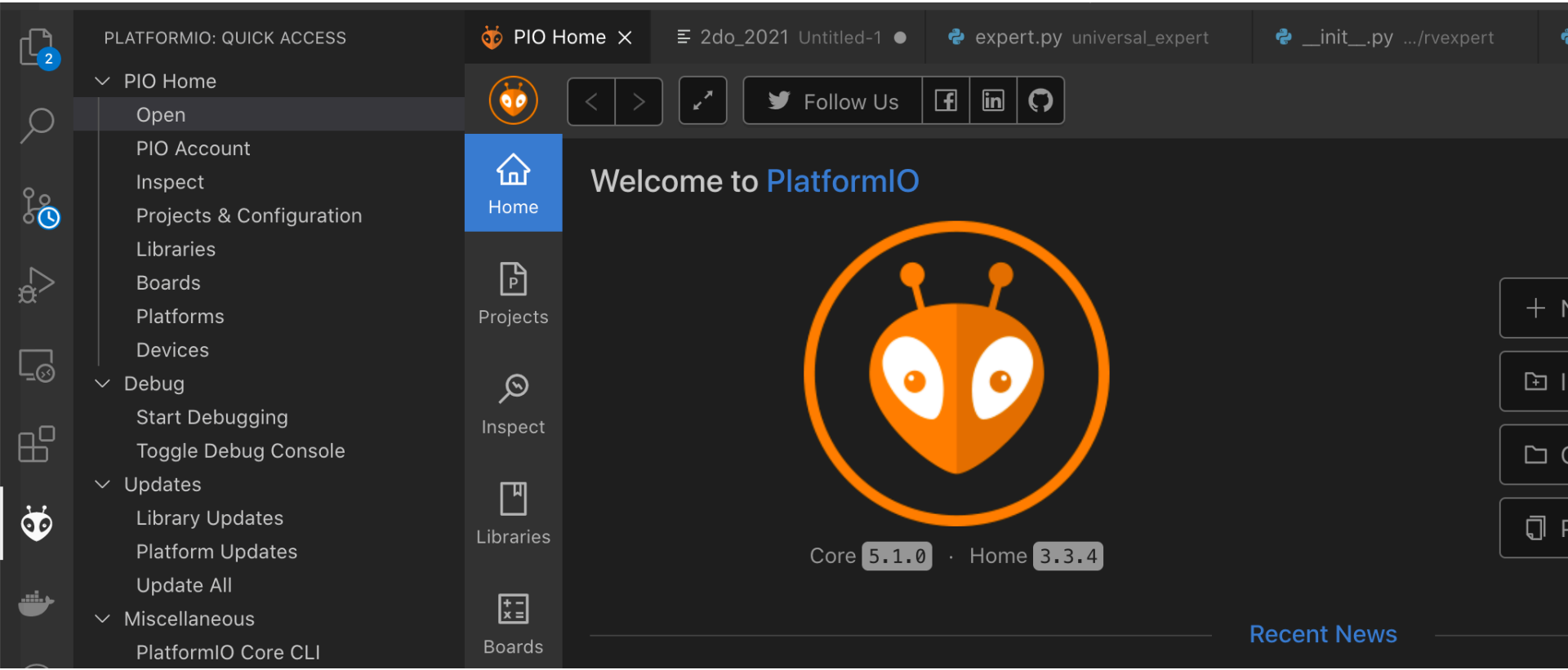


- …

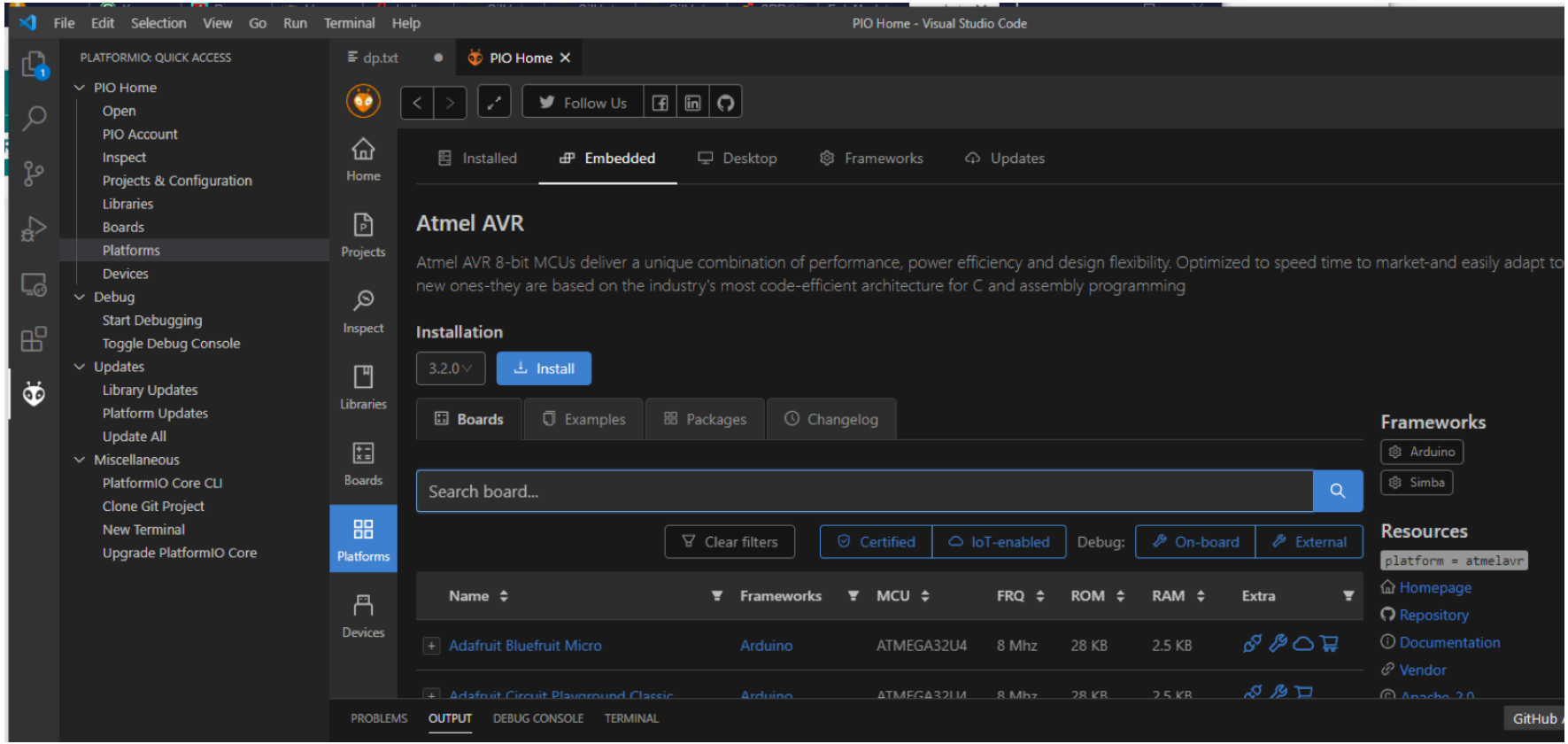


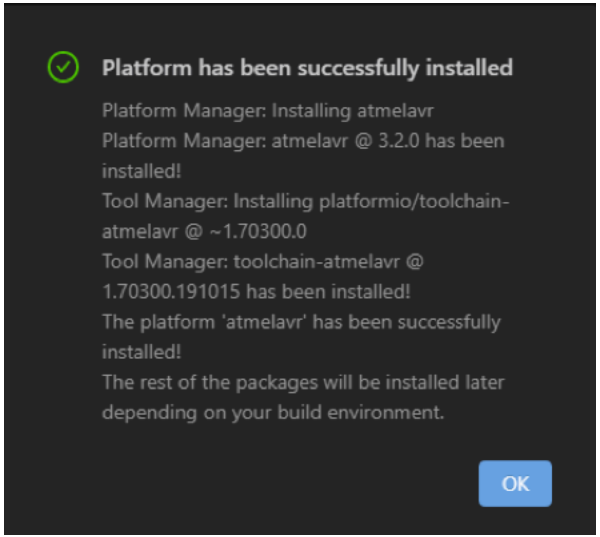
- Открыть PIO Home



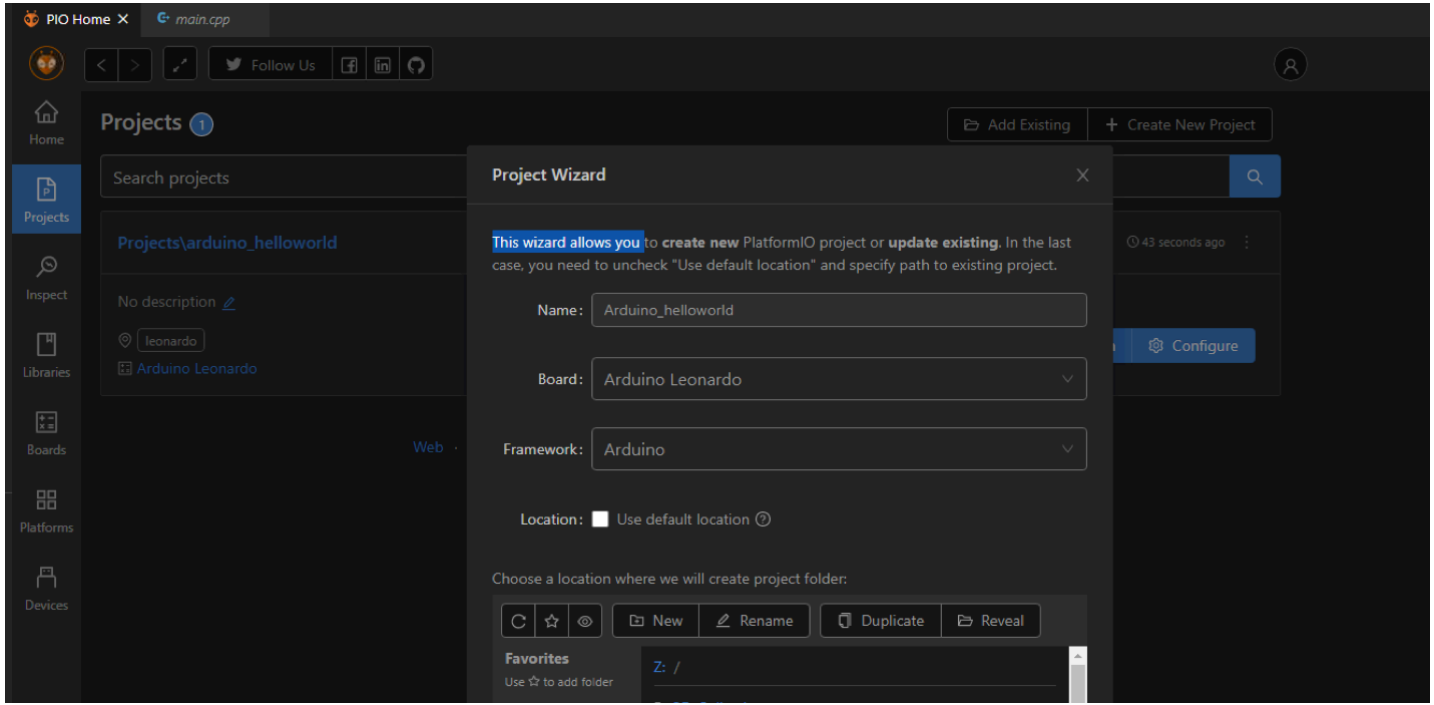

PLATFORMIO: QUICK ACCESS
PIO Home
Open
PIO Account
Inspect
Projects & Configuration
Libraries
Boards
Platforms
Devices
Debug
Start Debugging
Toggle Debug Console
Updates
Library Updates
Platform Updates
Update All
Miscellaneous
PlatformIO Core CLI
PIO Home
2do_2021 Untitled-1
expert.py universal_expert
__init__.py .../rvexpert
Follow Us
Home
Projects
Inspect
Libraries
Boards
Welcome to PlatformIO
Core 5.1.0 · Home 3.3.4
Recent News

Platforms -> Atmel AVR -> Install




Platform has been successfully installed
Platform Manager: Installing atmelavr
Platform Manager: atmelavr @ 3.2.0 has been installed!
Tool Manager: Installing platformio/toolchain-atmelavr @ ~1.70300.0
Tool Manager: toolchain-atmelavr @ 1.70300.191015 has been installed!
The platform 'atmelavr' has been successfully installed!
The rest of the packages will be installed later depending on your build environment.
OK

Projects -> Create new project

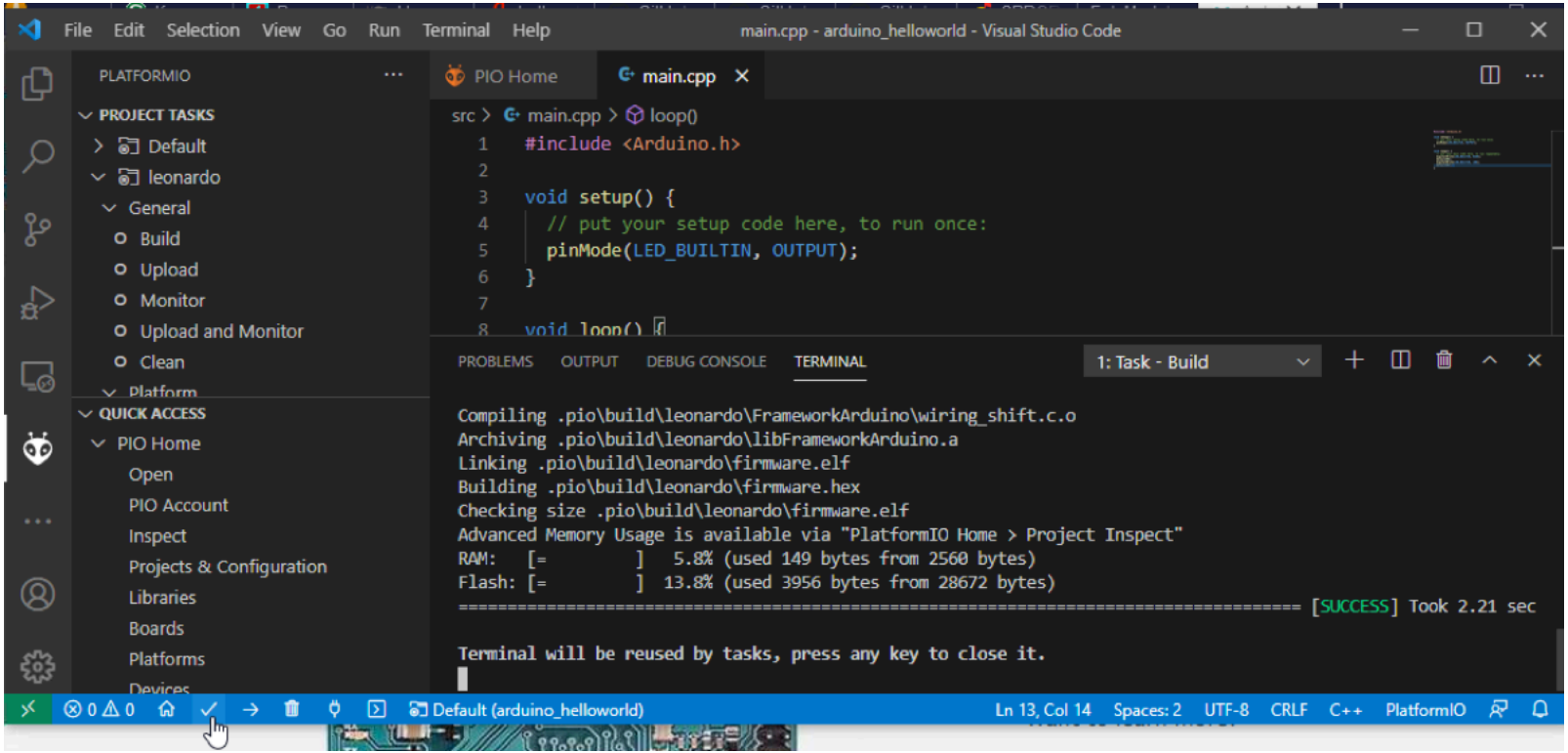


Простейший код: Blink (src/main.cpp)

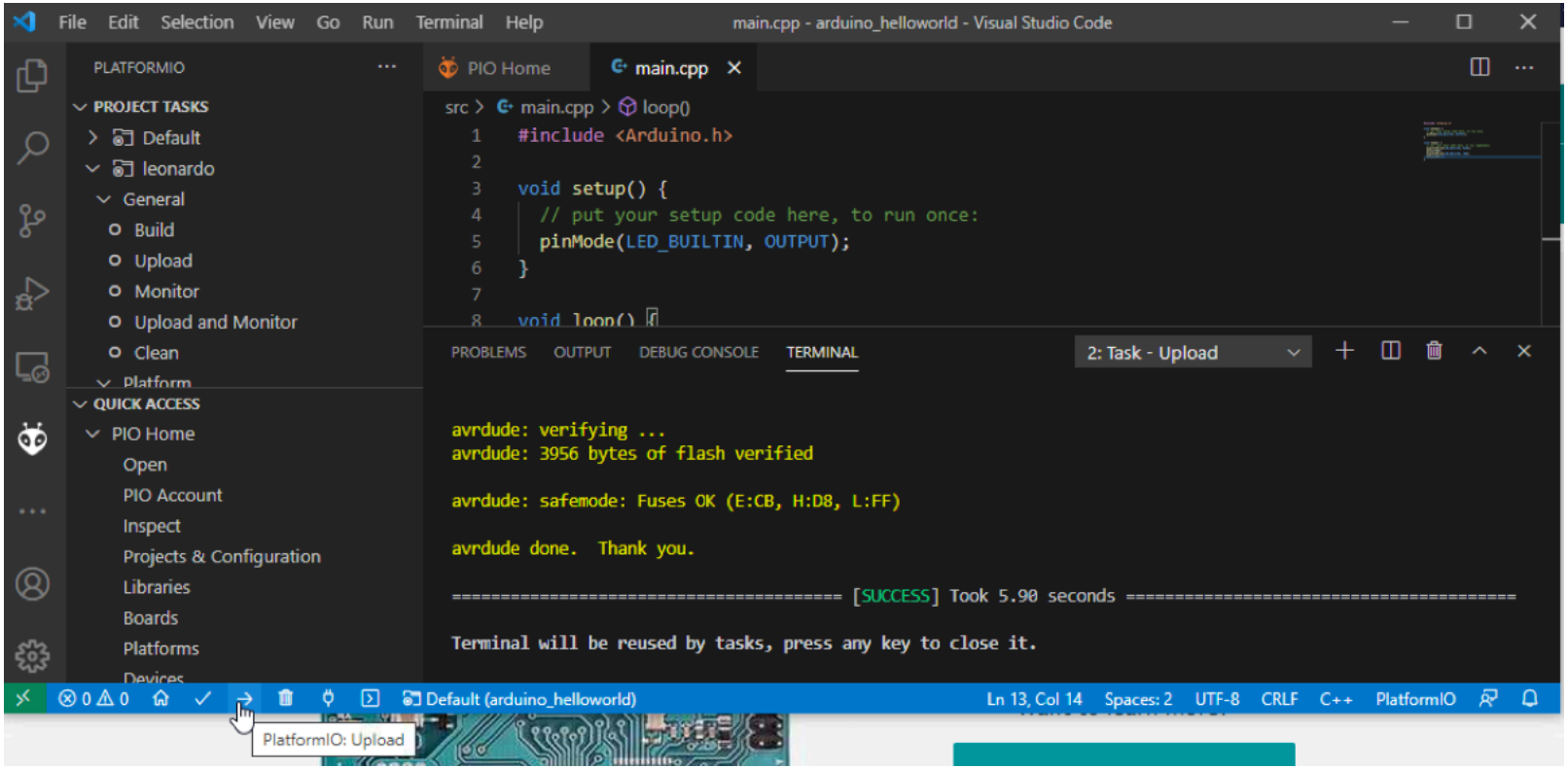
- На плате Arduino Uno и клонах на выводе 13 присутствует индикаторный светодиод

```
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);                       // wait for a second
}
```

Build: сборка и проверка валидности кода



Upload: загрузка в целевую плату



Вынос параметра в переменную

```
      /*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

  This example code is in the public domain.
 */

// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  digitalWrite(led, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);               // wait for a second
  digitalWrite(led, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);               // wait for a second
}
```

Вынос параметра в переменную

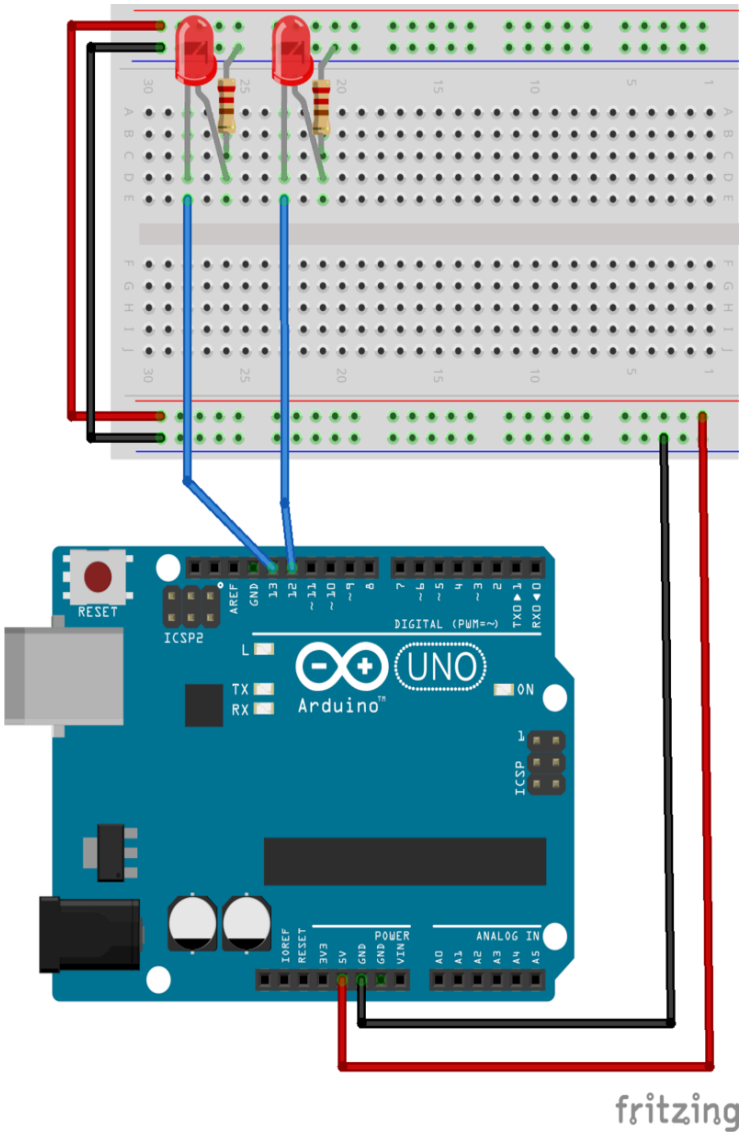
- Но лучше либо так

```
const int ledPin = 13
```

- Либо

```
#define PIN_LED 13
```

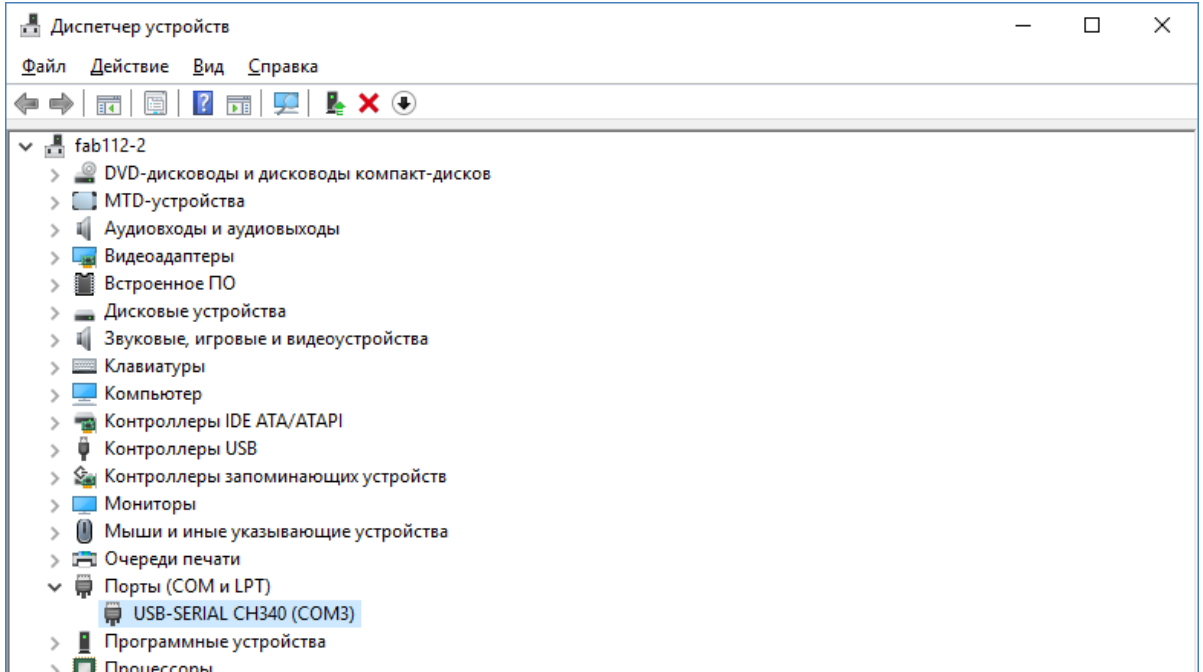
```
 http://www.arduino.cc/en/Tutorial/BlinkWithoutDelay
 */

// constants won't change. Used here to
// set pin numbers:
const int ledPin =  13;      // the number of the LED pin

// Variables will change:
int ledState = LOW;             // ledState used to set the LED
long previousMillis = 0;        // will store last time LED was updated

// the follow variables is a long because the time, measured in miliseconds,
// will quickly become a bigger number than can be stored in an int.
long interval = 1000;           // interval at which to blink (milliseconds)

void setup() {
  // set the digital pin as output:
  pinMode(ledPin, OUTPUT);
}

void loop()
{
  // here is where you'd put code that needs to be running all the time.

  // check to see if it's time to blink the LED; that is, if the
  // difference between the current time and last time you blinked
  // the LED is bigger than the interval at which you want to
  // blink the LED.
  unsigned long currentMillis = millis();

  if(currentMillis - previousMillis > interval) {
    // save the last time you blinked the LED
    previousMillis = currentMillis;

    // if the LED is off turn it on and vice-versa:
    if (ledState == LOW)
      ledState = HIGH;
    else
      ledState = LOW;

    // set the LED with the ledState of the variable:
    digitalWrite(ledPin, ledState);
  }
}
```


RESET
ICSP2
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX→1
RX←0
DIGITAL (PWM=~)
L
TX
RX
Arduino
UNO
ON
ICSP
POWER
ANALOG IN
IOREF
RESET
3V3
5V
GND
GND
VIN
A0
A1
A2
A3
A4
A5
fritzing

```
class Flasher
{
        // Class Member Variables
        // These are initialized at startup
        int ledPin;      // the number of the LED pin
        long OnTime;     // milliseconds of on-time
        long OffTime;    // milliseconds of off-time

        // These maintain the current state
        int ledState;                             // ledState used to set the LED
        unsigned long previousMillis;   // will store last time LED was updated

  // Constructor - creates a Flasher
  // and initializes the member variables and state
  public:
  Flasher(int pin, long on, long off)
  {
        ledPin = pin;
        pinMode(ledPin, OUTPUT);

        OnTime = on;
        OffTime = off;

        ledState = LOW;
        previousMillis = 0;
  }
};
```

Отладка: Serial

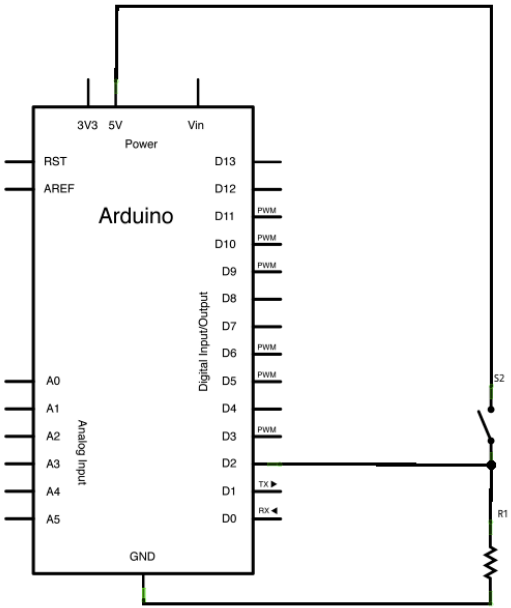
- При подключении к компьютеру Arduino выглядит как последовательный порт (Serial port)

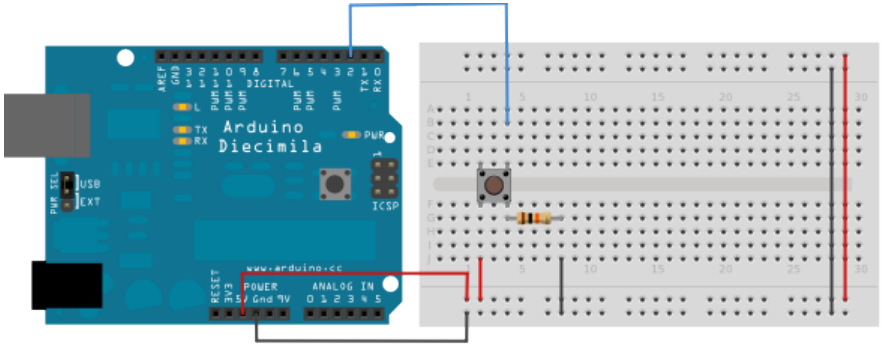


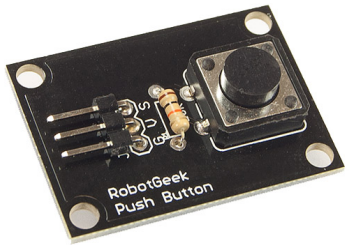
Отладка: Serial

```
// digital pin 2 has a pushbutton attached to it. Give it a name:
int pushButton = 2;

// the setup routine runs once when you press reset:
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
  // make the pushbutton's pin an input:
  pinMode(pushButton, INPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  // read the input pin:
  int buttonState = digitalRead(pushButton);
  // print out the state of the button:
  Serial.println(buttonState);
  delay(1);        // delay in between reads for stability
}
```

Схема с внешним событием



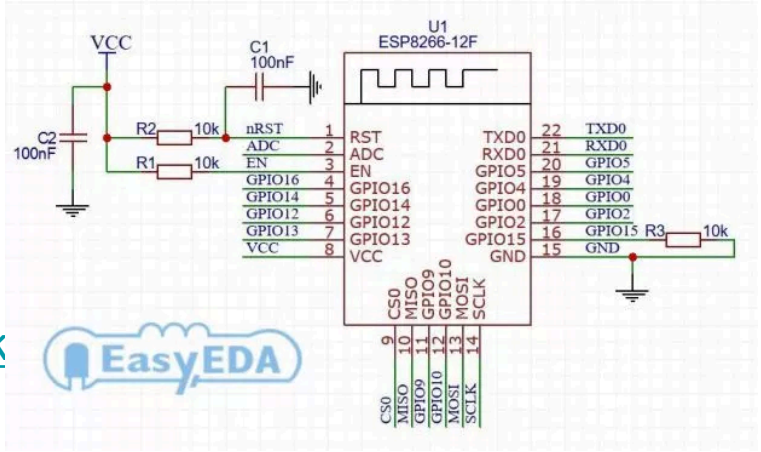




ССЫЛКИ

- http://easyelectronics.ru/osnovy-na-palcax-chast-1.html
- http://www.atmel.com/images/Atmel-8271-8-bit-AVR-Microcontroller-ATmega48A-48PA-88A-88PA-168A-168PA-328-328P_datasheet_Complete.pdf
- https://www.circuitar.com/nanoshields/modules/triac/

ESP8266



- https://esp8266.ru/
- http://www.instructables.com/id/Quick
  Arduino-IDE/
- https://esp8266.ru/esp8266-nodemcu/
- https://esp8266.ru/category/esp8266/esp8266-for-beginners/

Полезные ссылки

- http://www.chipnews.ru/html.cgi/arhiv/99_09/stat_2.htm - обзор Microchip, Atmel, Scenix от 2001 года
- http://www.chipnews.ru/html.cgi/arhiv/00_01/stat-3.htm - старые ST, NS, TI, Zilog
- http://housea.ru/index.php/micro/14906 - старые 16-битные Hitachi, Mitsubishi, Motorola
- http://playground.arduino.cc