

LAMPIRAN



LAMPIRAN 1 GAMBAR ALAT DAN DOKUMENTASI





LAMPIRAN 2 *LISTING PROGRAM*



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/*****/

```

```

// NAMA      :Muchammad Najiulloh Alamuddin Romdhoni

```

```

// NIM       :115060307111016

```

```

// JUDUL     :Pengendalian Kecepatan Propeller pada Keseimbangan Bicopter
menggunakan Kontroler Logika Fuzzy

```

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/*****/

```

```

#include <FuzzyRule.h>

```

```

#include <FuzzyComposition.h>

```

```

#include <Fuzzy.h>

```

```

#include <FuzzyRuleConsequent.h>

```

```

#include <FuzzyOutput.h>

```

```

#include <FuzzyInput.h>

```

```

#include <FuzzyIO.h>

```

```

#include <FuzzySet.h>

```

```

#include <FuzzyRuleAntecedent.h>

```

```

int AnFback = A0;

```

```

int outPWM = 13;

```

```

int d, spoint, sudut, e, e_old, ce;

```

```

// class fuzzy

```

```

Fuzzy* fuzzy = new Fuzzy();

```

```

// fuzzyset error

```

```

FuzzySet* e_mn = new FuzzySet(-45, -45, -30, -15);

```

```

FuzzySet* e_n = new FuzzySet(-30, -15, -15, 0);

```

```

FuzzySet* e_z = new FuzzySet(-15, 0, 0, 15);

```

```

FuzzySet* e_p = new FuzzySet(0, 15, 15, 30);

```

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FuzzySet* e_mp = new FuzzySet(15, 30, 45, 45);

```

```

// fuzzyset change error

```

```

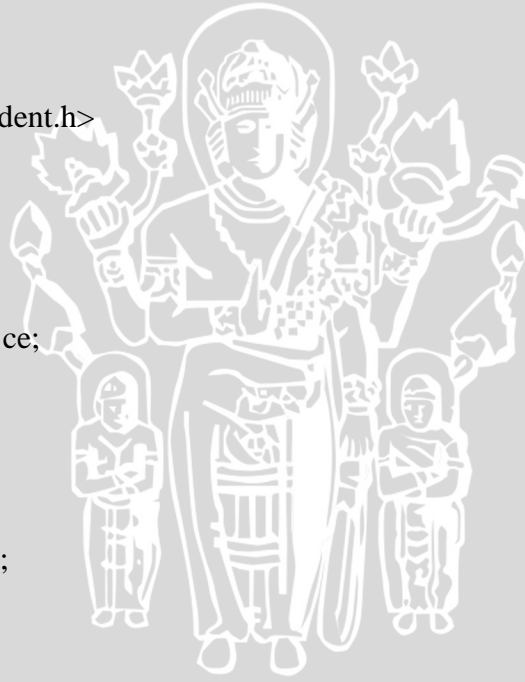
FuzzySet* ce_mn = new FuzzySet(-45, -45, -30, -15);

```

```

FuzzySet* ce_n = new FuzzySet(-30, -15, -15, 0);

```



```

FuzzySet* ce_z = new FuzzySet(-15, 0, 0, 15);
FuzzySet* ce_p = new FuzzySet(0, 15, 15, 30);
FuzzySet* ce_mp = new FuzzySet(15, 30, 45, 45);

// fuzzysset singleton output
FuzzySet* o_vlp = new FuzzySet(0, 0, 0, 0);
FuzzySet* o_lp = new FuzzySet(64, 64, 64, 64);
FuzzySet* o_mp = new FuzzySet(128, 128, 128, 128);
FuzzySet* o_hp = new FuzzySet(192, 192, 192, 192);
FuzzySet* o_fp = new FuzzySet(255, 255, 255, 255);

int ReadSudut()
{
    d = analogRead(AnFback);
    if (d == 512) { sudut = 0; }
    if (sudut < 512) { sudut = -(d/512)*30; }
    if (sudut > 512) { sudut = (d/512)*30; }
    return(sudut);
}

void setup(){
    Serial.begin(9600);

    e =0; ce = 0;
    // fuzzy input error
    FuzzyInput* error = new FuzzyInput(1);
    error->addFuzzySet(e_mn);
    error->addFuzzySet(e_n);
    error->addFuzzySet(e_z);
    error->addFuzzySet(e_p);
    error->addFuzzySet(e_mp);
    fuzzy->addFuzzyInput(error);

```

```
// fuzzy input change error
FuzzyInput* cerror = new FuzzyInput(2);
ceerror->addFuzzySet(ce_mn);
ceerror->addFuzzySet(ce_n);
ceerror->addFuzzySet(ce_z);
ceerror->addFuzzySet(ce_p);
ceerror->addFuzzySet(ce_mp);
fuzzy->addFuzzyInput(ceerror);

// fuzzy output
FuzzyOutput* output = new FuzzyOutput(1);
output->addFuzzySet(o_vlp);
output->addFuzzySet(o_lp);
output->addFuzzySet(o_mp);
output->addFuzzySet(o_hp);
output->addFuzzySet(o_fp);
fuzzy->addFuzzyOutput(output);

// consequent
FuzzyRuleConsequent* thenVLP = new FuzzyRuleConsequent();
thenVLP->addOutput(o_vlp);
FuzzyRuleConsequent* thenLP = new FuzzyRuleConsequent();
thenLP->addOutput(o_lp);
FuzzyRuleConsequent* thenMP = new FuzzyRuleConsequent();
thenMP->addOutput(o_mp);
FuzzyRuleConsequent* thenHP = new FuzzyRuleConsequent();
thenHP->addOutput(o_hp);
FuzzyRuleConsequent* thenFP = new FuzzyRuleConsequent();
thenFP->addOutput(o_fp);

// antecedent baris 1
FuzzyRuleAntecedent* antecedent1_1 = new FuzzyRuleAntecedent();
antecedent1_1->joinWithAND(e_mn, ce_mn);
```

```

FuzzyRuleAntecedent* antecedent1_2 = new FuzzyRuleAntecedent();
antecedent1_2->joinWithAND(e_n, ce_mn);
FuzzyRuleAntecedent* antecedent1_3 = new FuzzyRuleAntecedent();
antecedent1_3->joinWithAND(e_z, ce_mn);
FuzzyRuleAntecedent* antecedent1_4 = new FuzzyRuleAntecedent();
antecedent1_4->joinWithAND(e_p, ce_mn);
FuzzyRuleAntecedent* antecedent1_5 = new FuzzyRuleAntecedent();
antecedent1_5->joinWithAND(e_mp, ce_mn);
// antecedent baris 2
FuzzyRuleAntecedent* antecedent2_1 = new FuzzyRuleAntecedent();
antecedent2_1->joinWithAND(e_mn, ce_n);
FuzzyRuleAntecedent* antecedent2_2 = new FuzzyRuleAntecedent();
antecedent2_2->joinWithAND(e_n, ce_n);
FuzzyRuleAntecedent* antecedent2_3 = new FuzzyRuleAntecedent();
antecedent2_3->joinWithAND(e_z, ce_n);
FuzzyRuleAntecedent* antecedent2_4 = new FuzzyRuleAntecedent();
antecedent2_4->joinWithAND(e_p, ce_n);
FuzzyRuleAntecedent* antecedent2_5 = new FuzzyRuleAntecedent();
antecedent2_5->joinWithAND(e_mp, ce_n);
// antecedent baris 3
FuzzyRuleAntecedent* antecedent3_1 = new FuzzyRuleAntecedent();
antecedent3_1->joinWithAND(e_mn, ce_z);
FuzzyRuleAntecedent* antecedent3_2 = new FuzzyRuleAntecedent();
antecedent3_2->joinWithAND(e_n, ce_z);
FuzzyRuleAntecedent* antecedent3_3 = new FuzzyRuleAntecedent();
antecedent3_3->joinWithAND(e_z, ce_z);
FuzzyRuleAntecedent* antecedent3_4 = new FuzzyRuleAntecedent();
antecedent3_4->joinWithAND(e_p, ce_z);
FuzzyRuleAntecedent* antecedent3_5 = new FuzzyRuleAntecedent();
antecedent3_5->joinWithAND(e_mp, ce_z);
// antecedent baris 4
FuzzyRuleAntecedent* antecedent4_1 = new FuzzyRuleAntecedent();
antecedent4_1->joinWithAND(e_mn, ce_p);
FuzzyRuleAntecedent* antecedent4_2 = new FuzzyRuleAntecedent();

```



```

antecedent4_2->joinWithAND(e_n, ce_p);
FuzzyRuleAntecedent* antecedent4_3 = new FuzzyRuleAntecedent();
antecedent4_3->joinWithAND(e_z, ce_p);
FuzzyRuleAntecedent* antecedent4_4 = new FuzzyRuleAntecedent();
antecedent4_4->joinWithAND(e_p, ce_p);
FuzzyRuleAntecedent* antecedent4_5 = new FuzzyRuleAntecedent();
antecedent4_5->joinWithAND(e_mp, ce_p);
// antecedent baris 5
FuzzyRuleAntecedent* antecedent5_1 = new FuzzyRuleAntecedent();
antecedent5_1->joinWithAND(e_mn, ce_mp);
FuzzyRuleAntecedent* antecedent5_2 = new FuzzyRuleAntecedent();
antecedent5_2->joinWithAND(e_n, ce_mp);
FuzzyRuleAntecedent* antecedent5_3 = new FuzzyRuleAntecedent();
antecedent5_3->joinWithAND(e_z, ce_mp);
FuzzyRuleAntecedent* antecedent5_4 = new FuzzyRuleAntecedent();
antecedent5_4->joinWithAND(e_p, ce_mp);
FuzzyRuleAntecedent* antecedent5_5 = new FuzzyRuleAntecedent();
antecedent5_5->joinWithAND(e_mp, ce_mp);

// rule
FuzzyRule* rule1_1 = new FuzzyRule(1, antecedent1_1, thenMP);
fuzzy->addFuzzyRule(rule1_1);
FuzzyRule* rule1_2 = new FuzzyRule(2, antecedent1_2, thenLP);
fuzzy->addFuzzyRule(rule1_2);
FuzzyRule* rule1_3 = new FuzzyRule(3, antecedent1_3, thenHP);
fuzzy->addFuzzyRule(rule1_3);
FuzzyRule* rule1_4 = new FuzzyRule(4, antecedent1_4, thenHP);
fuzzy->addFuzzyRule(rule1_4);
FuzzyRule* rule1_5 = new FuzzyRule(5, antecedent1_5, thenHP);
fuzzy->addFuzzyRule(rule1_5);

FuzzyRule* rule2_1 = new FuzzyRule(6, antecedent2_1, thenLP);
fuzzy->addFuzzyRule(rule2_1);

```

```
FuzzyRule* rule2_2 = new FuzzyRule(7, antecedent2_2, thenMP);
fuzzy->addFuzzyRule(rule2_2);
FuzzyRule* rule2_3 = new FuzzyRule(8, antecedent2_3, thenMP);
fuzzy->addFuzzyRule(rule2_3);
FuzzyRule* rule2_4 = new FuzzyRule(9, antecedent2_4, thenHP);
fuzzy->addFuzzyRule(rule2_4);
FuzzyRule* rule2_5 = new FuzzyRule(10, antecedent2_5, thenFP);
fuzzy->addFuzzyRule(rule2_5);

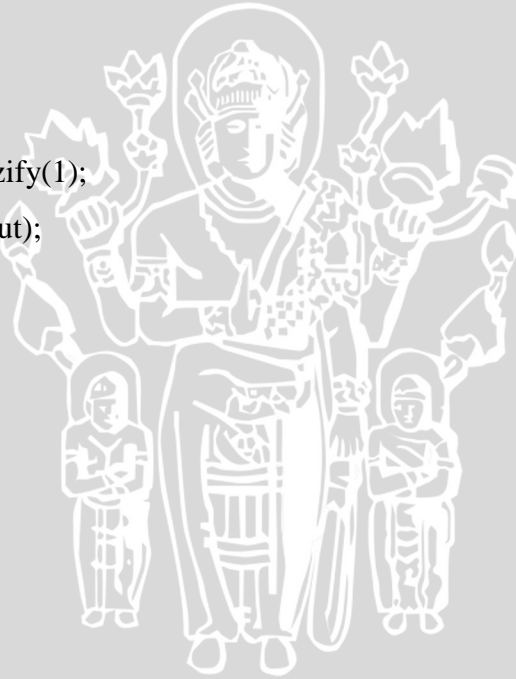
FuzzyRule* rule3_1 = new FuzzyRule(11, antecedent3_1, thenLP);
fuzzy->addFuzzyRule(rule3_1);
FuzzyRule* rule3_2 = new FuzzyRule(12, antecedent3_2, thenMP);
fuzzy->addFuzzyRule(rule3_2);
FuzzyRule* rule3_3 = new FuzzyRule(13, antecedent3_3, thenMP);
fuzzy->addFuzzyRule(rule3_3);
FuzzyRule* rule3_4 = new FuzzyRule(14, antecedent3_4, thenMP);
fuzzy->addFuzzyRule(rule3_4);
FuzzyRule* rule3_5 = new FuzzyRule(15, antecedent3_5, thenFP);
fuzzy->addFuzzyRule(rule3_5);

FuzzyRule* rule4_1 = new FuzzyRule(16, antecedent4_1, thenVLP);
fuzzy->addFuzzyRule(rule4_1);
FuzzyRule* rule4_2 = new FuzzyRule(17, antecedent4_2, thenLP);
fuzzy->addFuzzyRule(rule4_2);
FuzzyRule* rule4_3 = new FuzzyRule(18, antecedent4_3, thenMP);
fuzzy->addFuzzyRule(rule4_3);
FuzzyRule* rule4_4 = new FuzzyRule(19, antecedent4_4, thenMP);
fuzzy->addFuzzyRule(rule4_4);
FuzzyRule* rule4_5 = new FuzzyRule(20, antecedent4_5, thenLP);
fuzzy->addFuzzyRule(rule4_5);

FuzzyRule* rule5_1 = new FuzzyRule(21, antecedent5_1, thenVLP);
fuzzy->addFuzzyRule(rule5_1);
FuzzyRule* rule5_2 = new FuzzyRule(22, antecedent5_2, thenVLP);
```

```
fuzzy->addFuzzyRule(rule5_2);  
FuzzyRule* rule5_3 = new FuzzyRule(23, antecedent5_3, thenLP);  
fuzzy->addFuzzyRule(rule5_3);  
FuzzyRule* rule5_4 = new FuzzyRule(24, antecedent5_4, thenLP);  
fuzzy->addFuzzyRule(rule5_4);  
FuzzyRule* rule5_5 = new FuzzyRule(25, antecedent5_5, thenMP);  
fuzzy->addFuzzyRule(rule5_5);  
}
```

```
void loop(){  
    e = -ReadSudut();  
    ce = e - e_old;  
    fuzzy->setInput(1, e);  
    fuzzy->setInput(2, ce);  
    fuzzy->fuzzify();  
    float output = fuzzy->defuzzify(1);  
    analogWrite(outPWM, output);  
    e_old = e;  
    delay(100);  
}
```



LAMPIRAN 3 *DATA SHEET*



EMAX Brushless Motors

See – www.emax.modeldiy.com

Product Range and Specifications-



EMAX BL1812 / BL1806

Very Lightweight - Ideal for Indoor Foams :-

BL1812 – Weight: 28g (including the firewall), KV=1800				
Battery (LiPo)	Current	Prop	Thrust	rpm
7.4V	10A	9X4.5	220 g	
11.1V	13A	10X4.7	380 g	

BL1806 – Weight: 18g (including the firewall), KV=1650				
Battery (LiPo)	Current	Prop		
Thrust	rpm	7.4V	6.0 A	
7X5	180 g	6750	11.1V	
10 A	7X5	240 g		
7550				



EMAX BL2215

Light weight (60g) brushless motors with rotating case suitable for all models of 300-400 size As a result of using the latest ferromagnetic materials the EMAX 2215/xx motors offer extremely high efficiency and high load capability for their weight. Includes all mounting hardware, 3 gold connectors and Prop adapter.


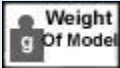





BL221/25 KV= 950 Performance Chart

Model	Voltage	Propeller	RPM	Max Current	Max Thrust
BL2215/25	12.0V	10X5(Thin)	8180	14A	850g
BL2215/25	12.0V	11X7(Thin)	6280	18A	905g
BL2215/25	12.0V	1047GWS	7200	16.5A	930g
BL2215/25	12.0V	10X4.7(Slow)	7250	16.5A	950g
BL2215/25	12.0V	1060GWS	7800	15A	850g
BL2215/25	12.0V	9X4(Slow)	8750	12A	810g

	Weight Of Model	Weight Of Model	EMAX ESC	Propeller
TRAINER	800g./28oz.	3S 1800mAH	EMAX 18A	9X4.7(SLOW)
3D	500g./18oz.	3S 1800mAH	EMAX 18A	10X4.7(Slow)
AEROBATIC	600g./14oz.	3S 1800mAH	EMAX 18A	10X5(Thin)

BL221/25 KV= 950 Performance Chart

Model	Voltage	Propeller	RPM	Max Current	Max Thrust
BL2215/20	12.0V	10X4(Slow)	7250	19A	1040g
BL2215/20	12.0V	9X4(Slow)	9900	17.5A	1020g
BL2215/20	10.9V	10X5(Thin)	9350	24.5A	1200g
BL2215/20	10.9V	8X3(Slow)	11050	16.5A	960g

	 Weight Of Model	 Weight Of Model	 EMAX ESC	 Propeller
	1000g./35.2oz.	3S 1800mAH	EMAX 25A	10X5(Thin)
	600g./21oz.	3S 1800mAH	EMAX 25A	10X4.7(Slow)
	800g./28oz.	3S 1800mAH	EMAX 25A	10X5(Thin)

Specifications	
No. Of cells	2-3x Li-Poly
Max. efficiency	82%
Max. efficiency current	8 - 13 A (>75%)
No load current / 10 V	0,5 A
Current capacity	2215/25 15 A/60s 2215/20 20 A/60s
Internal Resistance	275 mohm
Dimensions	28x32 mm
Shaft diameter	3 mm
Weight	59 g/2.08oz.
Recommended model weight	300-800 g
Recommended prop without gearbox	8"-10"



Lipo Batteries – High Quality – Economical Power Source

Type Model	Specifications for 20C	Dimensions (L x W x D)	Weight
LP20-800-2	20C, 800 mAh - 2s1p - 2 cell - 7.4V	62X35X11mm (2.44X1.37X0.4in)	1.24oz (35g)
LP20-800-3	20C, 800 mAh - 3s1p - 3 cell - 11.1V	62X35X14mm (2.44X1.37X0.5in)	1.76oz (50g)
LP20-1000-2	20C, 1000 mAh - 2s1p - 2 cell - 7.4V	62X35X11mm (2.44X1.37X0.4in)	1.87oz (53g)
LP20-1000-3	20C, 1000 mAh - 3s1p - 3 cell - 11.1V	62X35X11mm (2.44X1.37X0.4in)	2.75oz (78g)
LP20-1300-2	20C, 1300 mAh - 2s1p - 2 cell - 7.4V	80X32X11mm (3.15X1.26X0.4in)	2.33oz (66g)
LP20-1300-3	20C, 1300 mAh - 3s1p - 3 cell - 11.1V	80X32X15mm (3.15X1.26X0.5in)	3.42oz (97g)
LP20-1600-2	20C, 1600 mAh - 2s1p - 2 cell - 7.4V	96X34X11mm (3.77X1.33X0.4in)	3.14oz (89g)
LP20-1600-3	20C, 1600 mAh - 3s1p - 3 cell - 11.1V	96X34X16mm (3.77X1.33X0.6in)	4.62oz (131g)
LP20-1800-3	20C, 1800 mAh - 3s1p - 3 cell - 11.1V	96X34X17mm (3.77X1.33X0.6in)	5.86oz (166g)
LP15-2250-3	15C, 2250 mAh - 3s1p - 3 cell - 11.1V	96X34X18mm (3.77X1.33X0.7in)	5.86oz (166g)

All EMAX ESC's have the following Features and Programming Functions-

Safety Arming Feature: Regardless the Throttle Stick position, the motor will not run after the battery is connected. This will avoid any injuries.

Throttle Calibration: Throttle range can be configured to provide best throttling linearity, fully compatible with all available transmitters.

Programmable Features (Program card Available) -

Brake Settings : brake enabled / brake disabled, default is brake disabled

Battery Type : Li-xx(Li-ion or Li-poly) / Ni-xx(NiMh or Nicd), default is Li-xx.



Low Voltage Protection Mode (Cutoff Mode) : power reducing / power cutoff, default is power reducing.

Low Voltage Protection Threshold (Cutoff Threshold) : low / medium / high, default is medium cutoff voltage. For Li-xx battery, number of battery cells are judged automatically, low / medium / high cutoff voltage for each cell are: 2.6V/2.85V/3.1V. For example: 3 Cells Li-Poly, when medium cutoff voltage is set, the cutoff voltage is: 2.85*3=8.55V. For Ni-xx

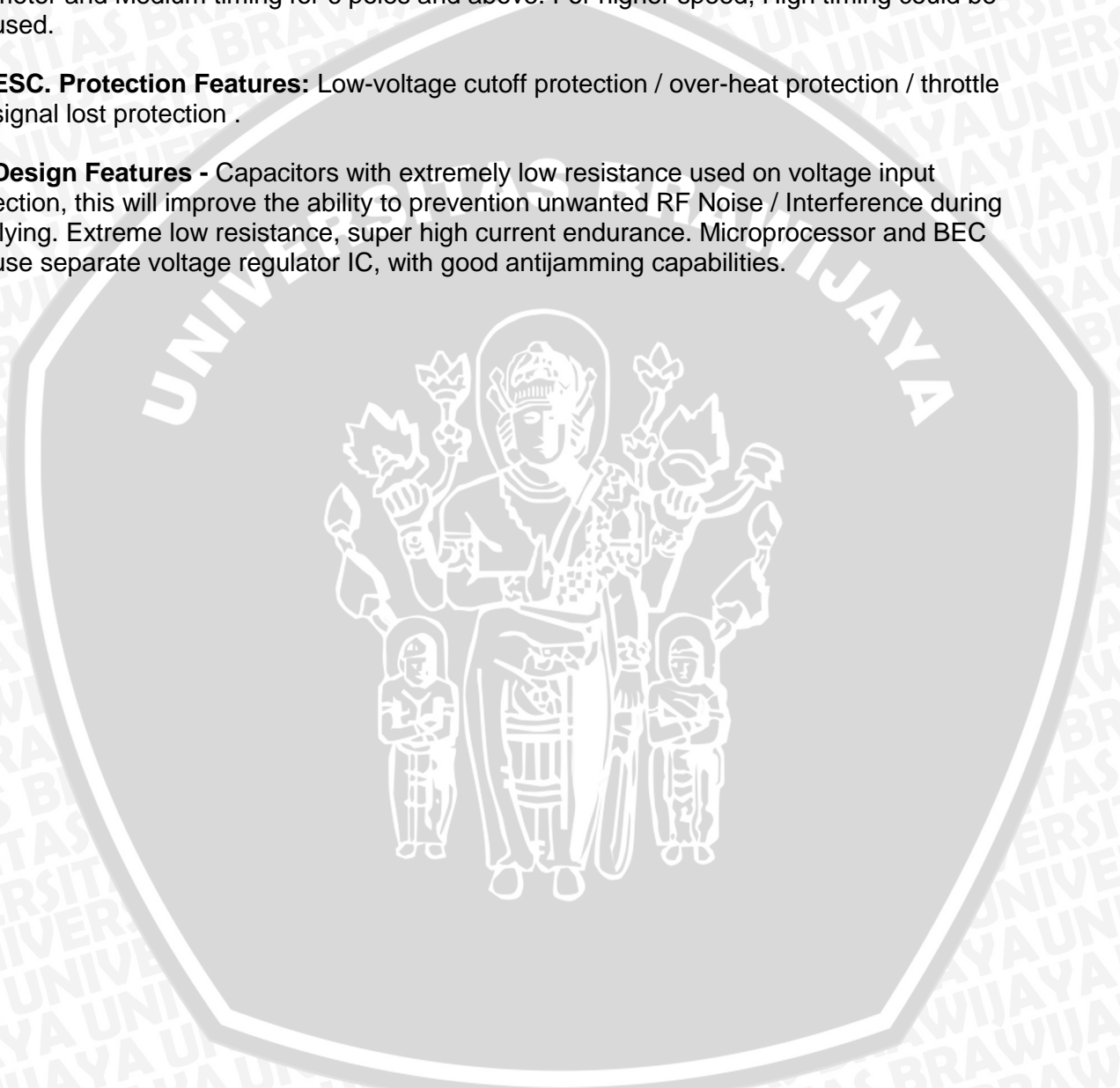
battery, low / medium / high cutoff voltages are 0/45%/60% of the startup voltage. (0% means the low voltage cutoff function is disabled). For example: 10 cells NiMH battery, fully charged voltage is $1.44 \times 10 = 14.4V$, when medium cutoff voltage is set, the cutoff voltage is : $14.4 \times 45\% = 6.5V$

Startup mode: normal / soft / super-soft, default is normal startup.

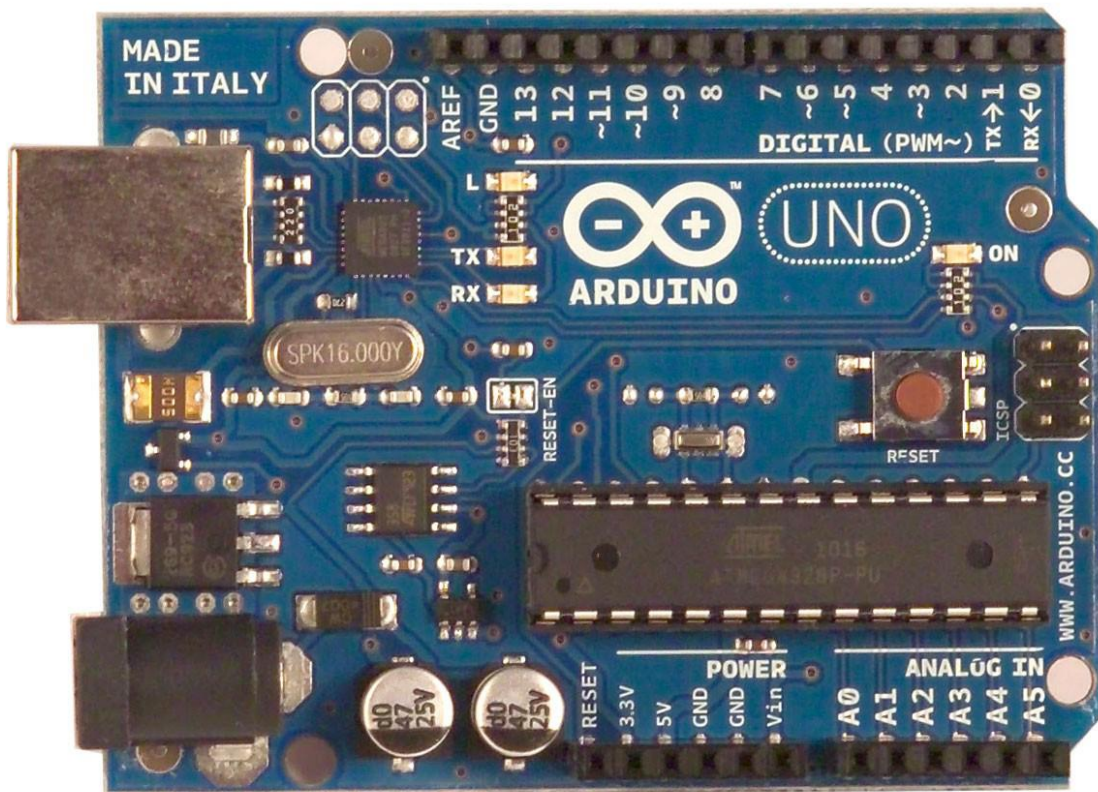
Timing: low / medium / high, default is medium timing. In normal cases, low timing can be used for most motors. But for high efficiency, we recommend the Low timing for 2 poles motor and Medium timing for 6 poles and above. For higher speed, High timing could be used.

ESC. Protection Features: Low-voltage cutoff protection / over-heat protection / throttle signal lost protection .

Design Features - Capacitors with extremely low resistance used on voltage input section, this will improve the ability to prevention unwanted RF Noise / Interference during flying. Extreme low resistance, super high current endurance. Microprocessor and BEC use separate voltage regulator IC, with good antijamming capabilities.



Arduino UNO



Product Overview

The Arduino Uno is a microcontroller board based on the ATmega328 ([datasheet](#)). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the [index of Arduino boards](#)



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RADIONICS



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Technical Specification



EAGLE files: [arduino-duemilanove-uno-design.zip](#) Schematic: [arduino-uno-schematic.pdf](#)

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins output)	14 (of which 6 provide PWM)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

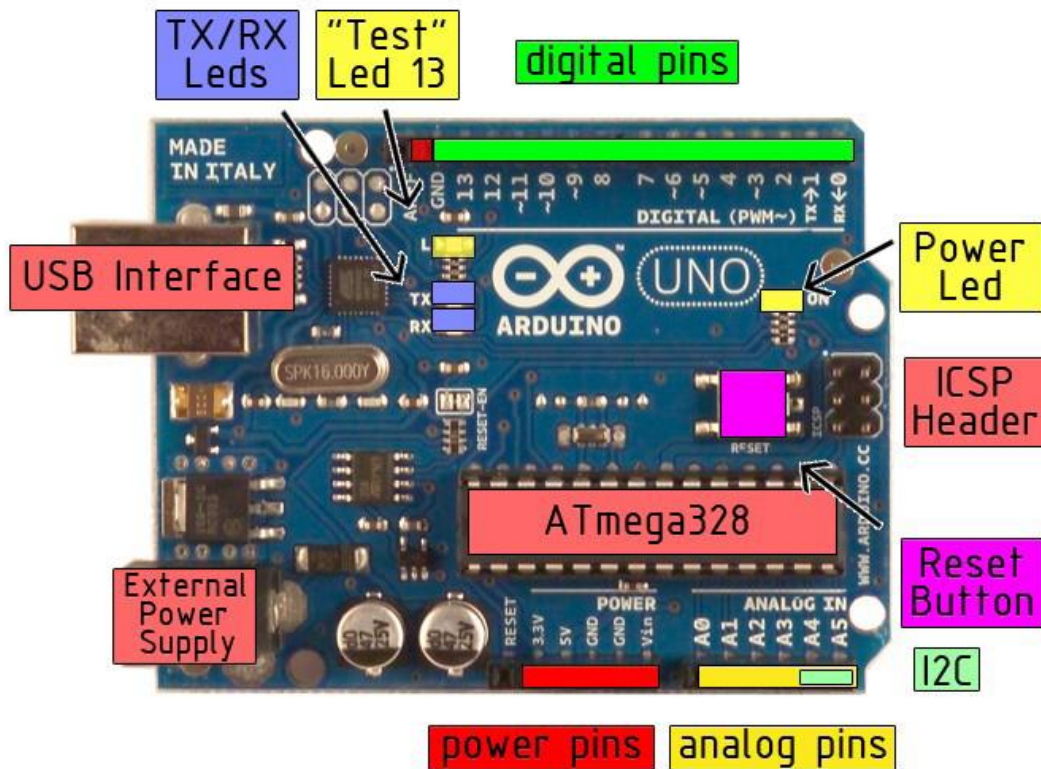


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the board



Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.



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- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the bootloader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the [EEPROM library](#)).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using [pinMode\(\)](#), [digitalWrite\(\)](#), and [digitalRead\(\)](#) functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip .
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the [attachInterrupt\(\)](#) function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the [analogWrite\(\)](#) function.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.
- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the [analogReference\(\)](#) function. Additionally, some pins have specialized functionality:

- **I2C: 4 (SDA) and 5 (SCL).** Support I2C (TWI) communication using the [Wire library](#).

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with [analogReference\(\)](#).
 - **Reset.** Bring this line LOW to reset the microcontroller. Typically used to
- See also the [mapping between Arduino pins and Atmega328 ports](#).



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Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an *.inf file is required..

The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A [SoftwareSerial library](#) allows for serial communication on any of the Uno's digital pins.

The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the [documentation](#) for details. To use the SPI communication, please see the ATmega328 datasheet.

Programming

The Arduino Uno can be programmed with the Arduino software ([download](#)). Select "Arduino Uno w/ ATmega328" from the **Tools > Board** menu (according to the microcontroller on your board). For details, see the [reference](#) and [tutorials](#).

The ATmega328 on the Arduino Uno comes preburned with a [bootloader](#) that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol ([reference](#), [C header files](#)).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see [these instructions](#) for details.

The ATmega8U2 firmware source code is available . The ATmega8U2 is loaded with a DFU bootloader, which can be activated by connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. You can then use [Atmel's FLIP software](#) (Windows) or the [DFU programmer](#) (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader).



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Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see [this forum thread](#) for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

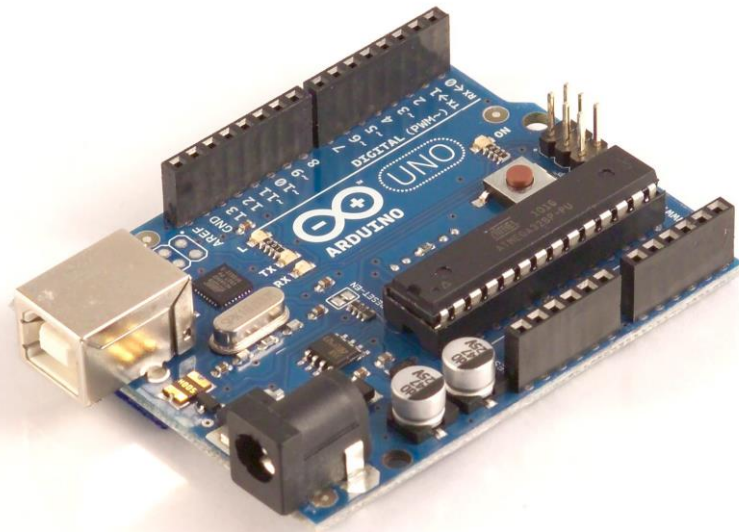
The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.



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How to use Arduino



Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the [Arduino programming language](#) (based on [Wiring](#)) and the Arduino development environment (based on [Processing](#)). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).

Arduino is a cross-platform program. You'll have to follow different instructions for your personal OS. Check on the [Arduino site](#) for the latest instructions.

<http://arduino.cc/en/Guide/HomePage>

Linux Install **Windows Install**
Mac Install

Once you have downloaded/unzipped the arduino IDE, you can Plug the Arduino to your PC via USB cable.

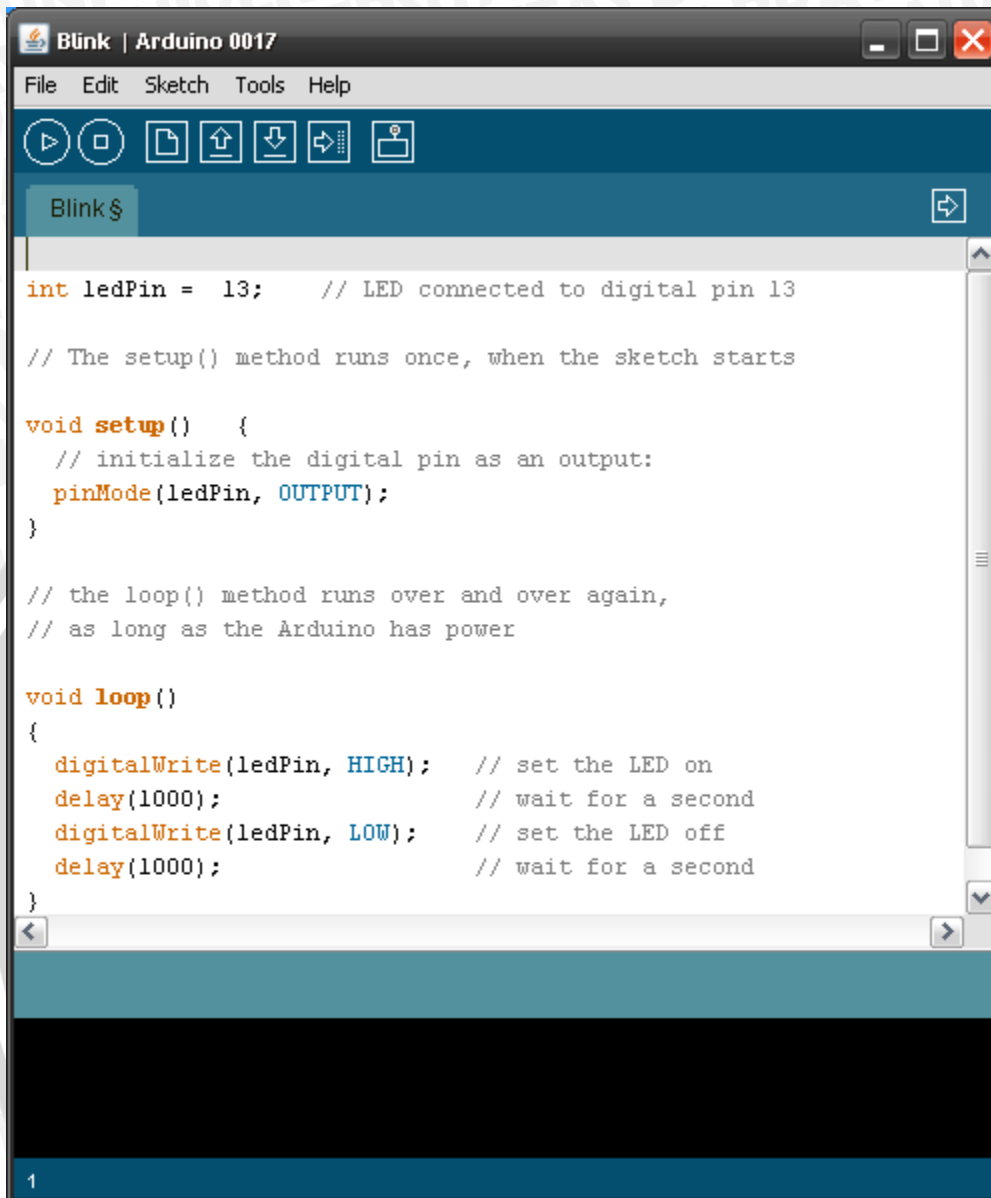


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Blink led



```

Blink | Arduino 0017
File Edit Sketch Tools Help
Blink$
int ledPin = 13;    // LED connected to digital pin 13

// The setup() method runs once, when the sketch starts

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

// the loop() method runs over and over again,
// as long as the Arduino has power

void loop()
{
  digitalWrite(ledPin, HIGH);  // set the LED on
  delay(1000);                // wait for a second
  digitalWrite(ledPin, LOW);  // set the LED off
  delay(1000);                // wait for a second
}

```

Now you're actually ready to "burn" your first program on the arduino board. To select "blink led", the physical translation of the well known programming "hello world", select

File>Sketchbook>Arduino-0017>Examples>Digital>Blink

Once you have your sketch you'll see something very close to the screenshot on the right.

In **Tools>Board** select

Now you have to go to **Tools>SerialPort** and select the right serial port, the one arduino is attached to.



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Done compiling.



Upload

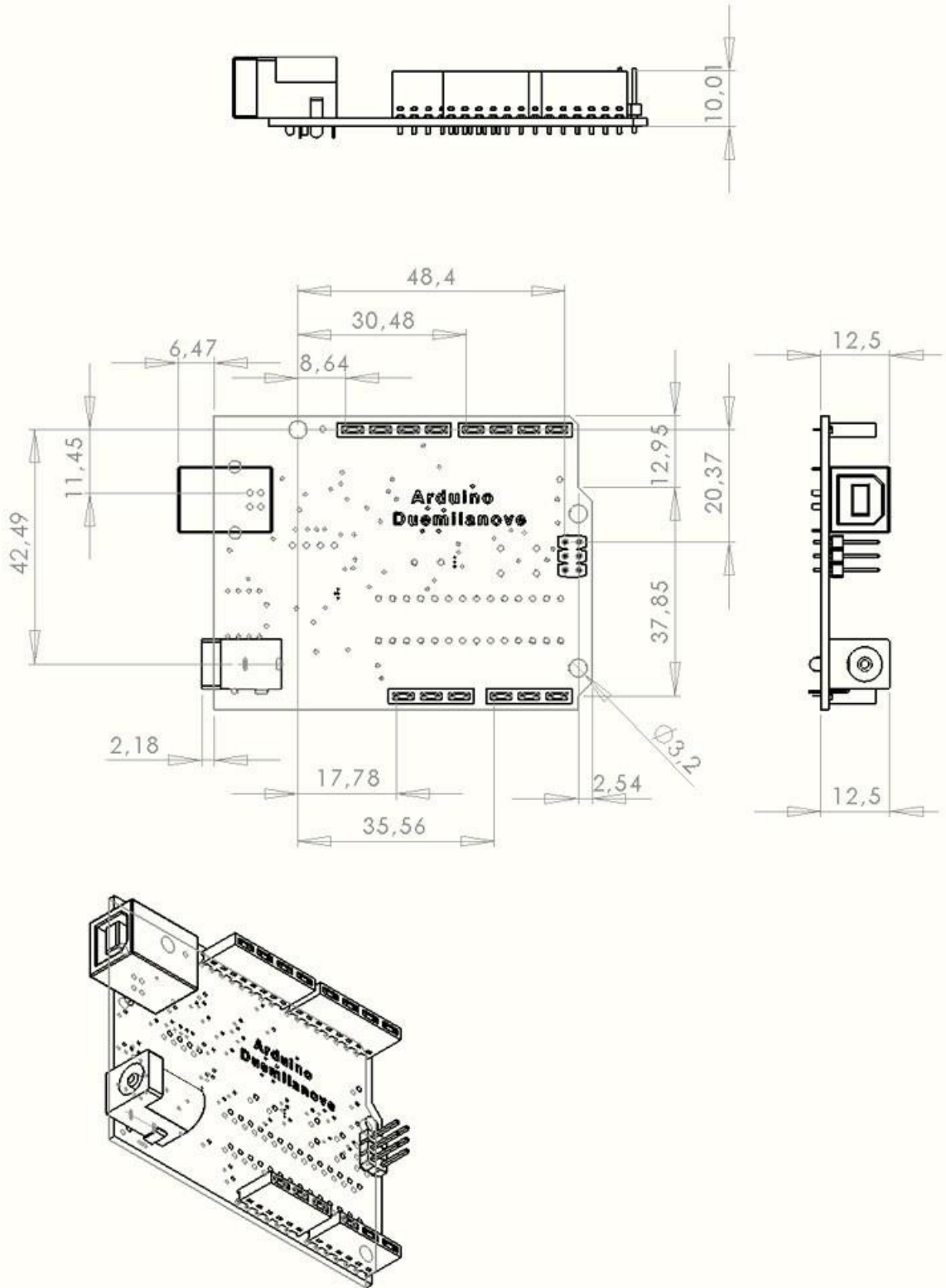


TX RX Flashing



Blinking Led!

Dimensioned Drawing



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Terms & Conditions



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1.1 The producer warrants that its products will conform to the Specifications. This warranty lasts for one (1) years from the date of the sale. The producer shall not be liable for any defects that are caused by neglect, misuse or mistreatment by the Customer, including improper installation or testing, or for any products that have been altered or modified in any way by a Customer. Moreover, The producer shall not be liable for any defects that result from Customer's design, specifications or instructions for such products. Testing and other quality control techniques are used to the extent the producer deems necessary.

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1.5 The Arduino™ products are not authorized for use in safety-critical applications where a failure of the product would reasonably be expected to cause severe personal injury or death. Safety-Critical Applications include, without limitation, life support devices and systems, equipment or systems for the operation of nuclear facilities and weapons systems. Arduino™ products are neither designed nor intended for use in military or aerospace applications or environments and for automotive applications or environment. Customer acknowledges and agrees that any such use of Arduino™ products which is solely at the Customer's risk, and that Customer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

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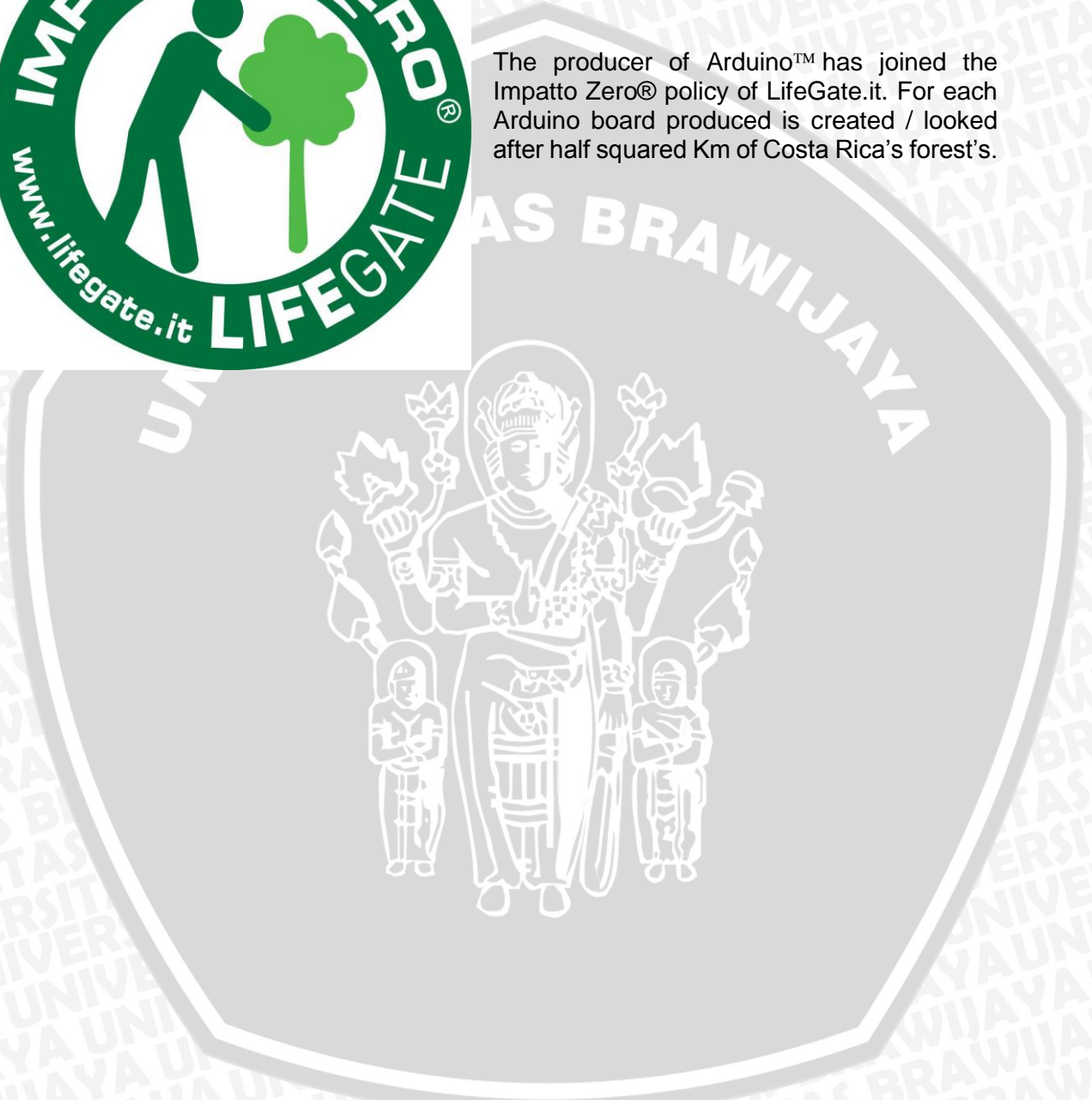




Environmental Policies



The producer of Arduino™ has joined the Impatto Zero® policy of LifeGate.it. For each Arduino board produced is created / looked after half squared Km of Costa Rica's forest's.



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