

Android, Bluetooth e Arduino: Controle de motor via Fast PWM

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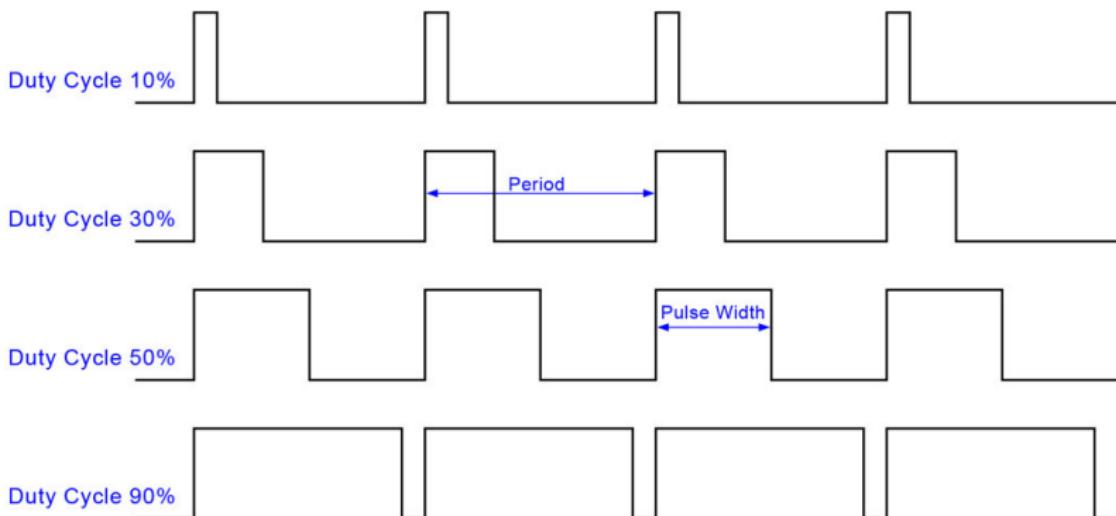
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O que é PWM?

Pulse Width Modulation é uma técnica de modulação de pulso quadrado que permite controlar a voltagem média na saída pela largura dos pulsos.



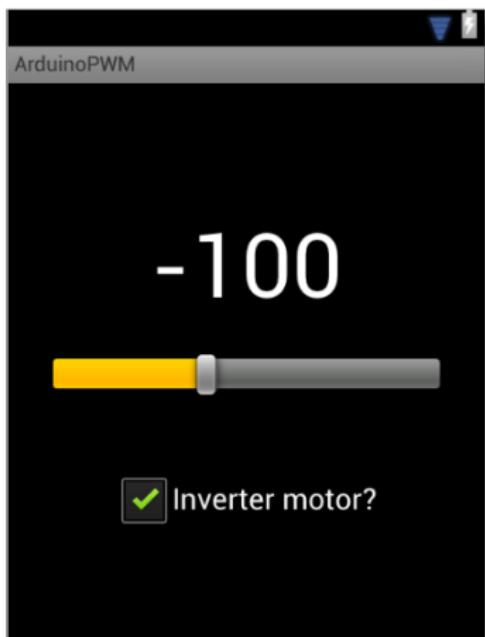
$$\text{Duty Cycle} = \text{Pulse Width} \times 100 / \text{Period}$$

Arduino: Um Simples Exemplo

Um PWM feito “manualmente” é mostrado abaixo:

```
1 void setup() {
2     pinMode(13, OUTPUT);
3 }
4
5 /* Period: 1000 microseconds */
6 void loop() {
7     digitalWrite (13, HIGH);
8     delayMicroseconds(100); //Duty Cycle: 10% @1kHz
9     digitalWrite (13, LOW);
10    delayMicroseconds(1000 - 100);
11 }
```

Android: Layout



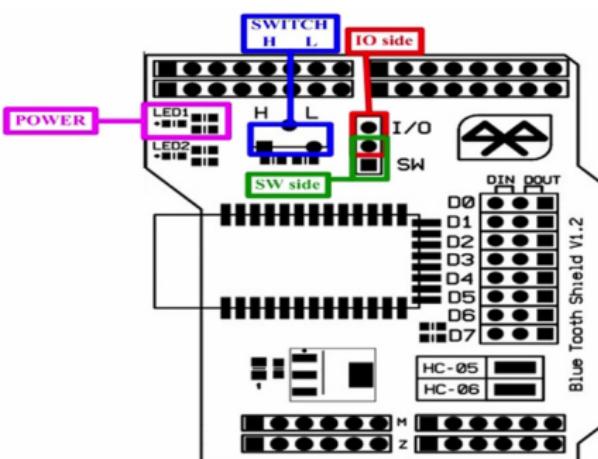
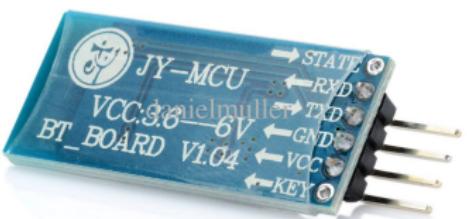
O aplicativo contém uma **SeekBar**, cujos valores (mostrados na **TextView**) variam entre -255 e 0 ou entre 0 e 255, dependendo do estado da **CheckBox**. Esse valor inteiro (9 bits) representa a mensagem que é transmitida para o *shield* Bluetooth do arduino.

Código: AndroidBluetooth.java



Shield Bluetooth

- Possui 34 pinos ligados diretamente aos pinos do arduino
 - Os pinos digitais 2 e 3 (Tx e Rx) são ligados, respectivamente, nos pinos Rx e Tx do *shield* através de um *jumper*
 - Biblioteca auxiliar: *SoftwareSerial*



O Comando AT

O BTM-5 utiliza um conjunto de comandos AT para configurar seus parâmetros. Todos começam com **AT+**. Os mais importantes são:

Command	Default value	Short Description
NAME	HC-05	Nome do dispositivo
ROLE	0 (Slave)	Modo (Master/Slave)
PSWD	1234	Senha de Pairing
BIND	00:00:00:00:00:00	Solicita conexão

Dispositivos Bluetooth

HC-05

Pareado



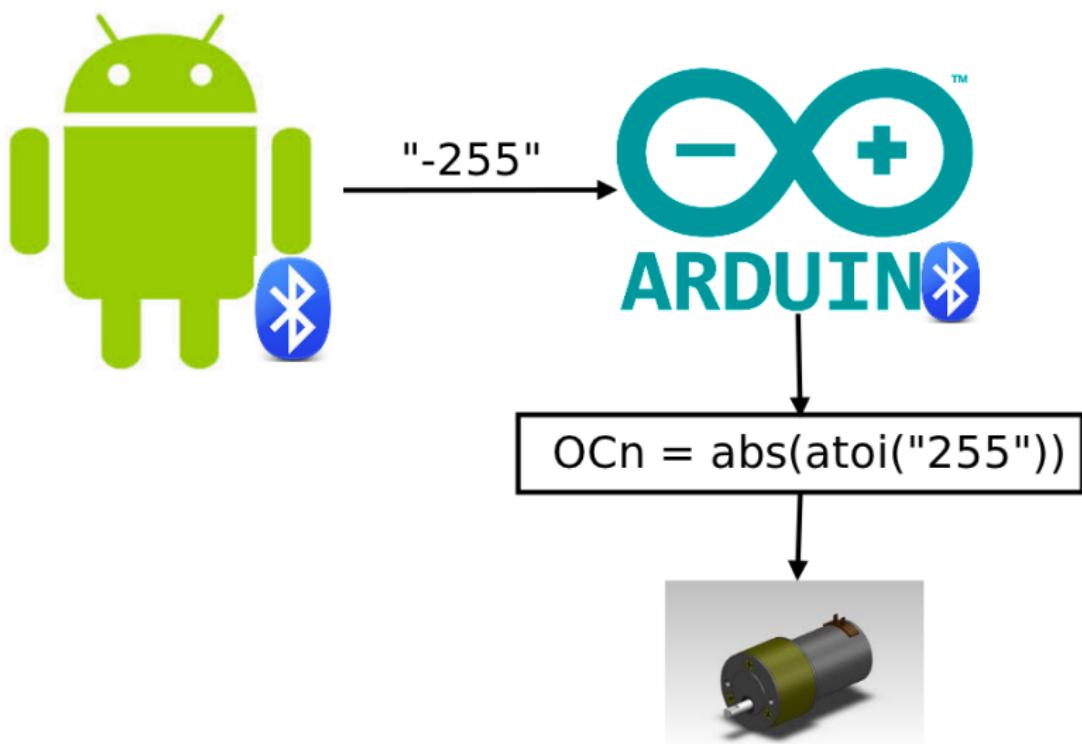
Dispositivos Bluetooth

Bussangra

Pairar com este dispositivo

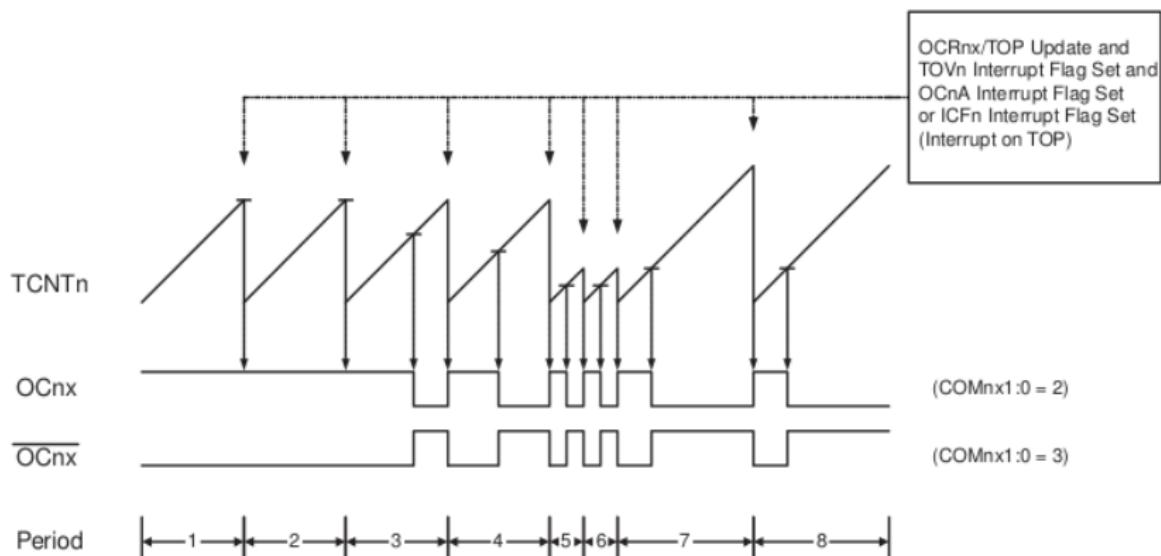


Diagrama: Comunicação Android-Arduino



Pulse Width Modulation

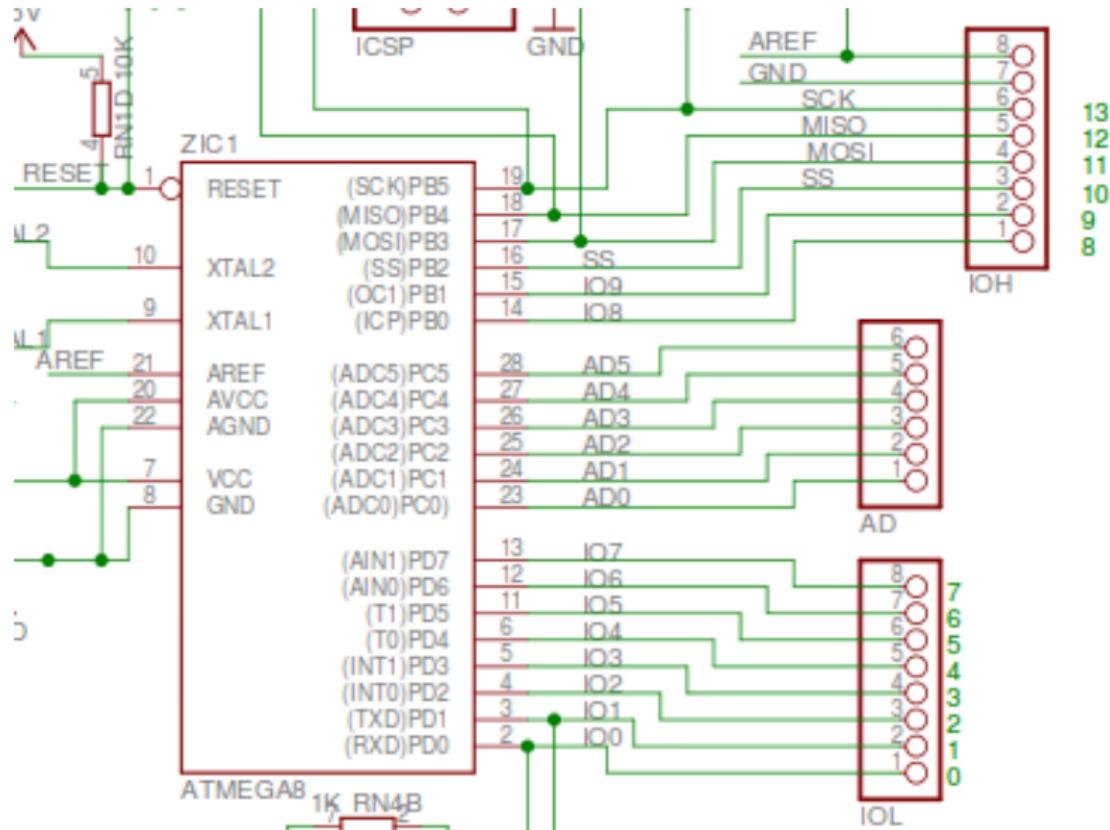
Compare Match: Tensão média



PWM: Registradores

No arduino, certos registradores são utilizados para controlar a PWM. Os pinos do ATMega utilizados como saída para a PWM são **OC1A** e **OC1B** (PB1 e PB2) que são mapeados para os pinos 9 e 10 do arduino.

ATMega 328p: Mapa de Pinos



Os Registradores TCCRn

TCCR1A e **TCCR1B** são registradores que dão características ao PWM. A disposição dos 8 bits de cada registrador se dá a seguir:

Bit (0x80)	7	6	5	4	3	2	1	0	
Read/Write	COM1A1	COM1A0	COM1B1	COM1B0	-	-	WGM11	WGM10	TCCR1A
Initial Value	0	0	0	0	0	0	0	0	

Bit (0x81)	7	6	5	4	3	2	1	0	
Read/Write	ICNC1	ICES1	-	WGM13	WGM12	CS12	CS11	CS10	TCCR1B
Initial Value	0	0	0	0	0	0	0	0	

TCCR1A = 0b10100001

Value	Bits	Descrição
1010	7:4	Invert Mode
00	3:2	Default
01	1:0	WGM(11/10)

Bit	7	6	5	4	3	2	1	0	
(0x80)	COM1A1	COM1A0	COM1B1	COM1B0	-	-	WGM11	WGM10	TCCR1A
ReadWrite	R/W	R/W	R/W	R/W	R	R	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

COM1A1/COM1B1	COM1A0/COM1B0	Description
0	0	Normal port operation, OC1A/OC1B disconnected.
0	1	WGM13:0 = 14 or 15: Toggle OC1A on Compare Match, OC1B disconnected (normal port operation). For all other WGM1 settings, normal port operation, OC1A/OC1B disconnected.
1	0	Clear OC1A/OC1B on Compare Match, set OC1A/OC1B at BOTTOM (non-inverting mode)
1	1	Set OC1A/OC1B on Compare Match, clear OC1A/OC1B at BOTTOM (inverting mode)

Mode	WGM13	WGM12 (CTC1)	WGM11 (PWM11)	WGM10 (PWM10)	Timer/Counter Mode of Operation	TOP	Update of OCR1x at	TOV1 Flag Set on
0	0	0	0	0	Normal	0xFFFF	Immediate	MAX
1	0	0	0	1	PWM, Phase Correct, 8-bit	0x00FF	TOP	BOTTOM
2	0	0	1	0	PWM, Phase Correct, 9-bit	0x01FF	TOP	BOTTOM
3	0	0	1	1	PWM, Phase Correct, 10-bit	0x03FF	TOP	BOTTOM
4	0	1	0	0	CTC	OCR1A	Immediate	MAX
5	0	1	0	1	Fast PWM, 8-bit	0x00FF	BOTTOM	TOP
6	0	1	1	0	Fast PWM, 9-bit	0x01FF	BOTTOM	TOP
7	0	1	1	1	Fast PWM, 10-bit	0x03FF	BOTTOM	TOP
8	1	0	0	0	PWM, Phase and Frequency Correct	ICR1	BOTTOM	BOTTOM
9	1	0	0	1	PWM, Phase and Frequency Correct	OCR1A	BOTTOM	BOTTOM
10	1	0	1	0	PWM, Phase Correct	ICR1	TOP	BOTTOM
11	1	0	1	1	PWM, Phase Correct	OCR1A	TOP	BOTTOM
12	1	1	0	0	CTC	ICR1	Immediate	MAX
13	1	1	0	1	(Reserved)	-	-	-
14	1	1	1	0	Fast PWM	ICR1	BOTTOM	TOP
15	1	1	1	1	Fast PWM	OCR1A	BOTTOM	TOP

TCCR1B = 0b00001011

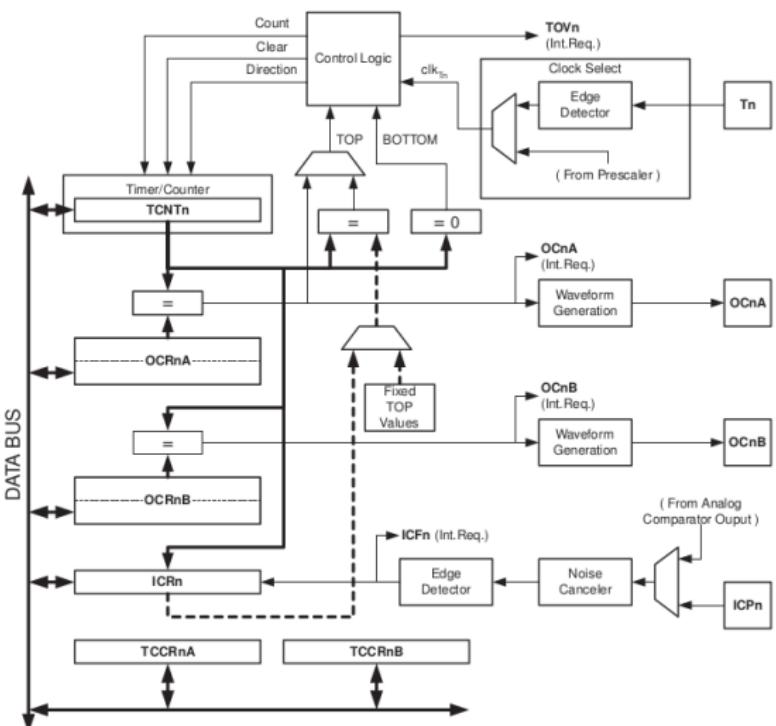
Value	Bits	Descrição
0	7	Noise Canceler
0	6	Edge Select
0	5	Reserved Bit

Value	Bits	Descrição
01	4:3	WGM(13/12)
011	2:0	CS(12/11/10)

Bit	7	6	5	4	3	2	1	0	
(0x81)	ICNC1	ICES1	-	WGM13	WGM12	CS12	CS11	CS10	TCCR1B
Read/Write	R/W	R/W	R	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

CS12	CS11	CS10	Description
0	0	0	No clock source (Timer/Counter stopped).
0	0	1	$\text{clk}_{\text{IO}}/1$ (No prescaling)
0	1	0	$\text{clk}_{\text{IO}}/8$ (From prescaler)
0	1	1	$\text{clk}_{\text{IO}}/64$ (From prescaler)
1	0	0	$\text{clk}_{\text{IO}}/256$ (From prescaler)
1	0	1	$\text{clk}_{\text{IO}}/1024$ (From prescaler)
1	1	0	External clock source on T1 pin. Clock on falling edge.
1	1	1	External clock source on T1 pin. Clock on rising edge.

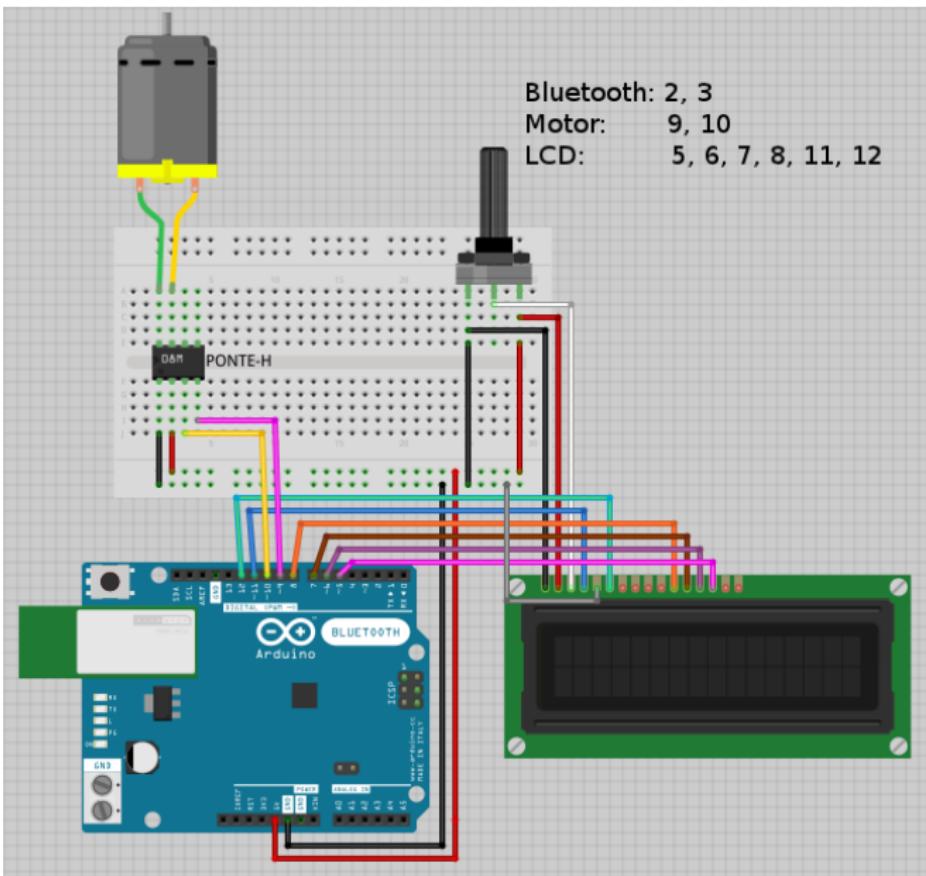
Diagrama: Dos Registradores aos Pinos OCn



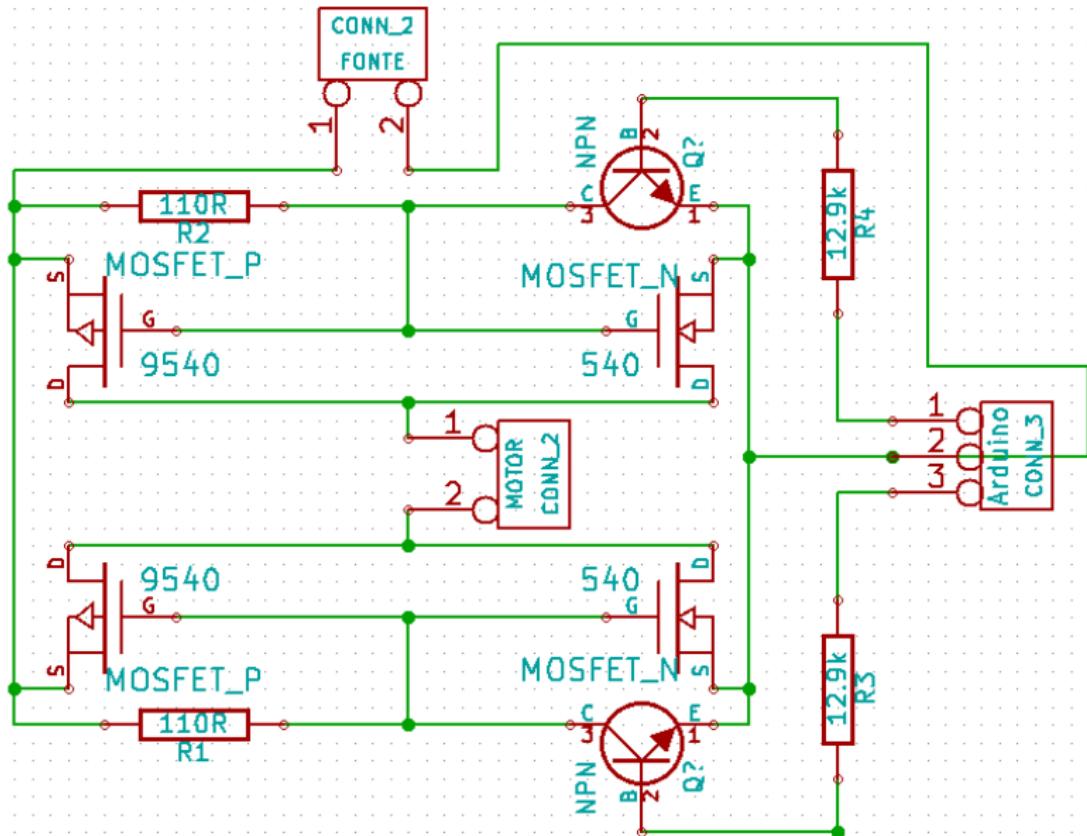
Componentes



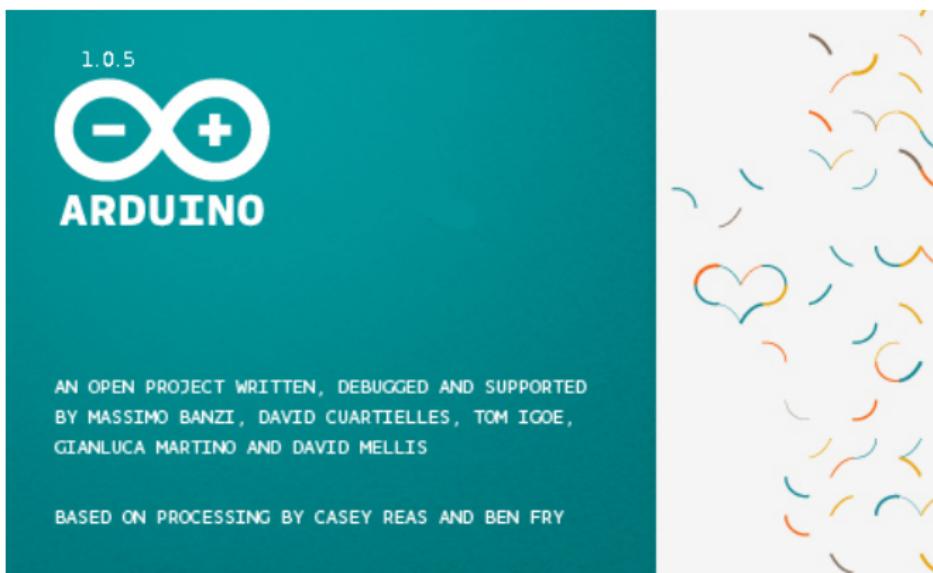
Fritzing: Circuito



Ponte H



Código: pwm_bluetooth.ino



Referências

1. 2009 Atmel Corporation *Arduino Uno ATmega48PA/88PA/168PA/328P datasheet*
2. *Arduino Uno Schematic*
http://arduino.cc/en/uploads/Main/Arduino_Unc_Rev3-schematic.pdf
3. *ATmega168/328 pin mapping*
<http://arduino.cc/en/Hacking/PinMapping168>
4. Developer Android: Bluetooth
<http://developer.android.com/>
5. 2010 BTM-5 Bluetooth: AT Command User Guide
6. Wikipédia: Bluetooth Protocols
7. Secrets of Arduino PWM
<http://arduino.cc/en/Tutorial/SecretsOfArduinoPWM>