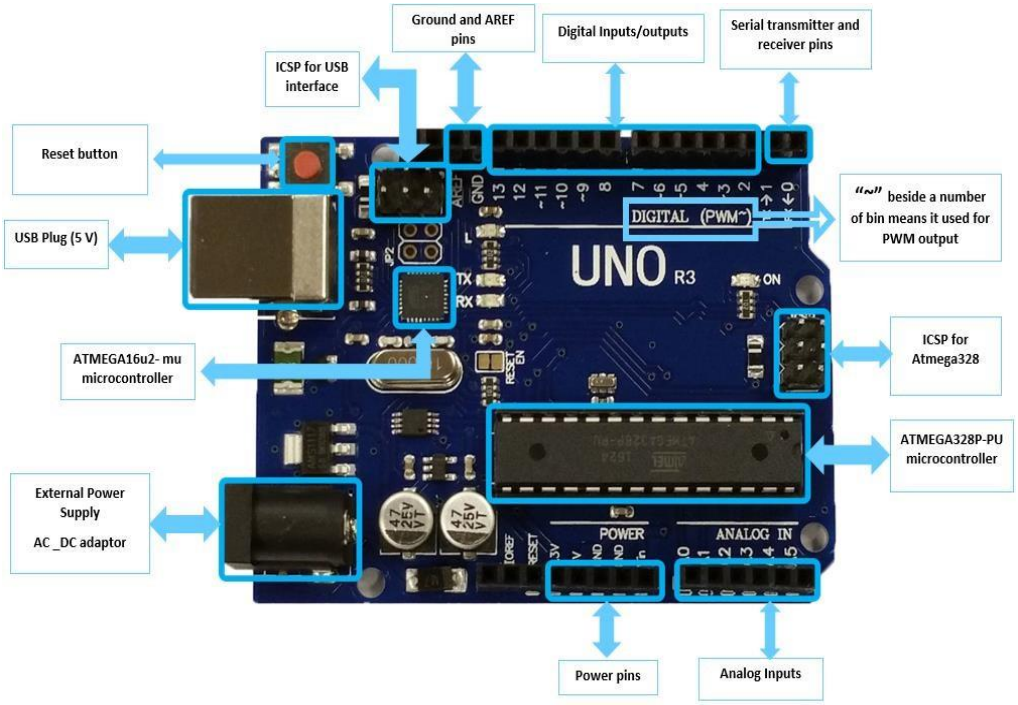
LAMPIRAN

Lampiran 1. *Datasheet* Arduino Uno

Arduino Uno R3



INTRODUCTION

Arduino is used for building different types of electronic circuits easily using of both a physical programmable circuit board usually microcontroller and piece of code running on computer with USB connection between the computer and Arduino.

Programming language used in Arduino is just a simplified version of C++ that can easily replace thousands of wires with words.

ARDUINO UNO-R3 PHYSICAL COMPONENTS

ATMEGA328P-PU microcontroller

The most important element in Arduino Uno R3 is ATMEGA328P-PU is an 8-bit Microcontroller with flash memory reach to 32k bytes. It's features as follow:

- High Performance, Low Power AVR
- Advanced RISC Architecture

- 131 Powerful Instructions – Most Single Clock Cycle Execution ○ 32 x 8 General Purpose Working Registers ○ Up to 20 MIPS Throughput at 20 MHz ○ On-chip 2-cycle Multiplier

• High Endurance Non-volatile Memory Segments

- 4/8/16/32K Bytes of In-System Self-Programmable Flash program memory ○ 256/512/512/1K Bytes EEPROM ○ 512/1K/1K/2K Bytes Internal SRAM
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM ○ Data retention: 20 years at 85°C/100 years at 25°C ○ Optional Boot Code Section with Independent Lock Bits ○ In-System Programming by On-chip Boot Program ○ True Read-While-Write Operation ○ Programming Lock for Software Security

• Peripheral Features

- Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode ○ One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode ○ Real Time Counter with Separate Oscillator
- Six PWM Channels
- 8-channel 10-bit ADC in TQFP and QFN/MLF package
- Temperature Measurement ○ 6-channel 10-bit ADC in PDIP Package ○ Temperature Measurement ○ Programmable Serial USART
- Master/Slave SPI Serial Interface
- Byte-oriented 2-wire Serial Interface (Philips I2 C compatible) ○ Programmable Watchdog Timer with Separate On-chip Oscillator ○ On-chip Analog Comparator ○ Interrupt and Wake-up on Pin Change

• Special Microcontroller Features

- Power-on Reset and Programmable Brown-out Detection
- Internal Calibrated Oscillator ○ External and Internal Interrupt Sources
- Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby

• I/O and Packages

- 23 Programmable I/O Lines
- 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF

• Operating Voltage:

- 1.8 - 5.5V

• Temperature Range:

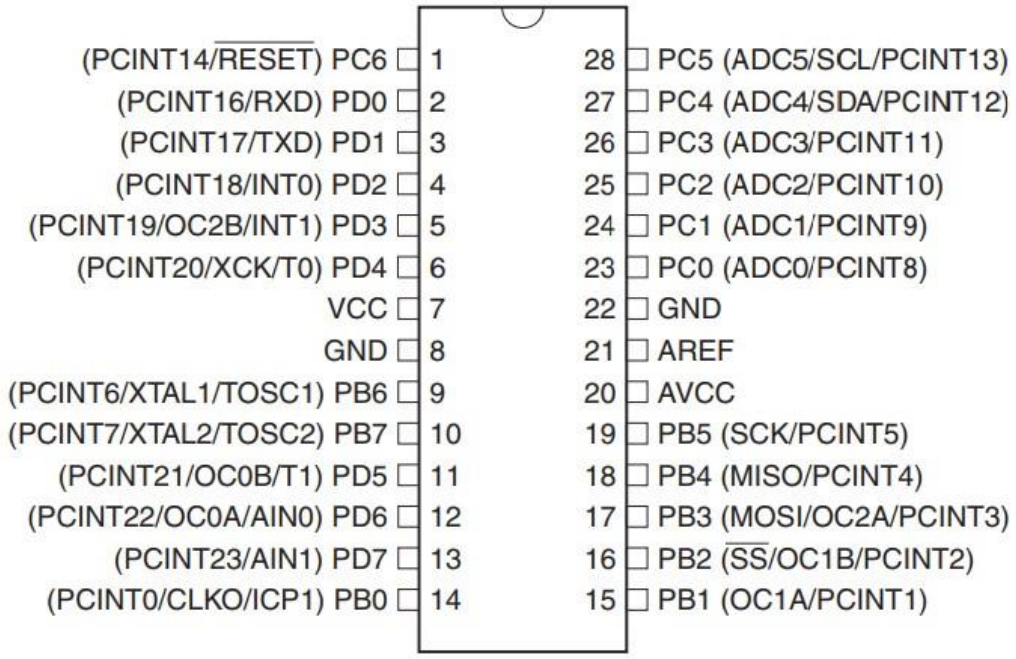
- -40°C to 85°C

• Speed Grade: ○ 0 - 4 MHz@1.8 - 5.5V, 0 - 10 MHz@2.7 - 5.5.V, 0 - 20 MHz @ 4.5 - 5.5V

• Power Consumption at 1 MHz, 1.8V, 25°C

- Active Mode: 0.2 mA ○ Power-down Mode: 0.1 µA
- Power-save Mode: 0.75 µA (Including 32 kHz RTC)

• Pin configuration



ATMEGA16u2- mu microcontroller

Is a 8-bit microcontroller used as USB driver in Arduino uno R3 it's features as follow:

- High Performance, Low Power AVR

• Advanced RISC Architecture

- 125 Powerful Instructions – Most Single Clock Cycle Execution ○ 32 x 8 General Purpose Working Registers ○ Fully Static Operation
- Up to 16 MIPS Throughput at 16 MHz

• Non-volatile Program and Data Memories

- 8K/16K/32K Bytes of In-System Self-Programmable Flash
- 512/512/1024 EEPROM ○ 512/512/1024 Internal SRAM

- Write/Erase Cycles: 10,000 Flash/ 100,000 EEPROM ○ Data retention: 20 years at 85˚C/ 100 years at 25˚C ○ Optional Boot Code Section with Independent Lock Bits
- In-System Programming by on-chip Boot Program hardware-activated after reset ○ Programming Lock for Software Security

• USB 2.0 Full-speed Device Module with Interrupt on Transfer Completion

- Complies fully with Universal Serial Bus Specification REV 2.0 ○ 48 MHz PLL for Full-speed Bus Operation: data transfer rates at 12 Mbit/s ○ Fully independent 176 bytes USB DPRAM for endpoint memory allocation
- Endpoint 0 for Control Transfers: from 8 up to 64-bytes ○ 4 Programmable Endpoints:
  - IN or Out Directions
  - Bulk, Interrupt and Isochronous Transfers
  - Programmable maximum packet size from 8 to 64 bytes
  - Programmable single or double buffer
- Suspend/Resume Interrupts
- Microcontroller reset on USB Bus Reset without detach ○ USB Bus Disconnection on Microcontroller Request

• Peripheral Features

- One 8-bit Timer/Counters with Separate Prescaler and Compare Mode (two 8-bit PWM channels)
- One 16-bit Timer/Counter with Separate Prescaler, Compare and Capture Mode(three 8bit PWM channels)
- USART with SPI master only mode and hardware flow control (RTS/CTS) ○ Master/Slave SPI Serial Interface
- Programmable Watchdog Timer with Separate On-chip Oscillator ○ On-chip Analog Comparator ○ Interrupt and Wake-up on Pin Change

• On Chip Debug Interface (debug WIRE)

• Special Microcontroller Features

- Power-On Reset and Programmable Brown-out Detection
- Internal Calibrated Oscillator ○ External and Internal Interrupt Sources
- Five Sleep Modes: Idle, Power-save, Power-down, Standby, and Extended Standby

• I/O and Packages

- 22 Programmable I/O Lines

- QFN32 (5x5mm) / TQFP32 packages

• Operating Voltages

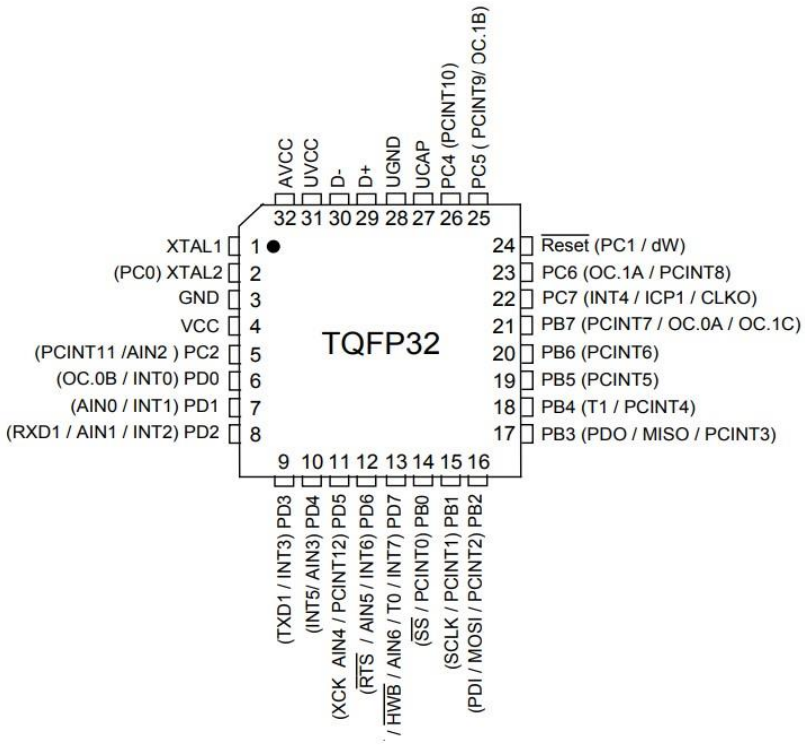
- 2.7 - 5.5V

• Operating temperature

- Industrial (-40°C to +85°C)

• Maximum Frequency

- 8 MHz at 2.7V - Industrial range
- 16 MHz at 4.5V - Industrial range
  - Pin configuration



OTHER ARDUINO UNO R3 PARTS

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 k Ohms. 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.
- 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 using the SPI library.
- 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.

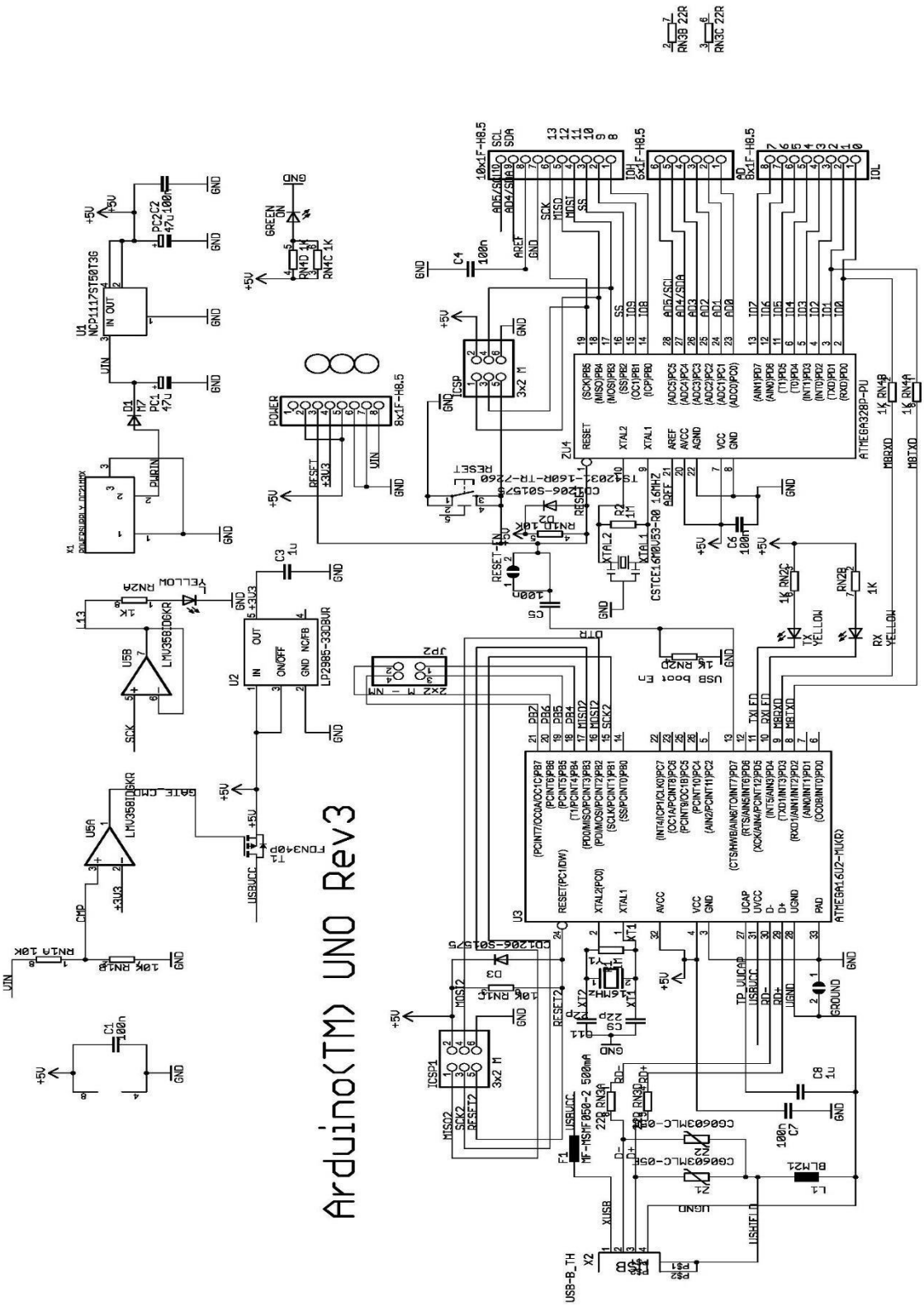
The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e.1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- TWI: A4 or SDA pin and A5 or SCL pin. Support 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 add a reset button to shields which block the one on the board.

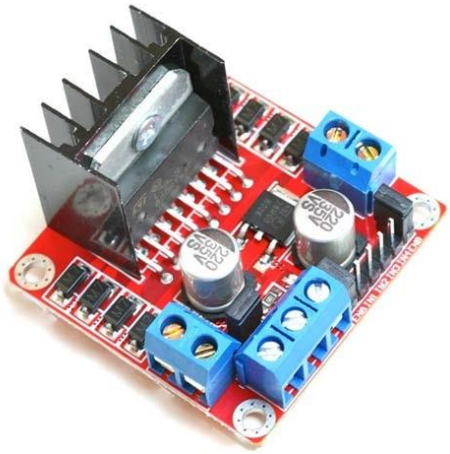
ARDUINO UNO R3 SCHEMATIC DIAGRAM



Lampiran 2. *Datasheet Driver* Motor L298N

L298N Dual H-Bridge Motor Driver

This dual bidirectional motor driver, is based on the very popular L298 Dual H-Bridge Motor Driver Integrated Circuit. The circuit will allow you to easily and independently control two motors of up to 2A each in both directions.It is ideal for robotic applications and well suited for connection to a microcontroller requiring just a couple of control lines per motor. It can also be interfaced with simple manual switches, TTL logic gates, relays, etc. This board equipped with power LED indicators, on-board +5V regulator and protection diodes.



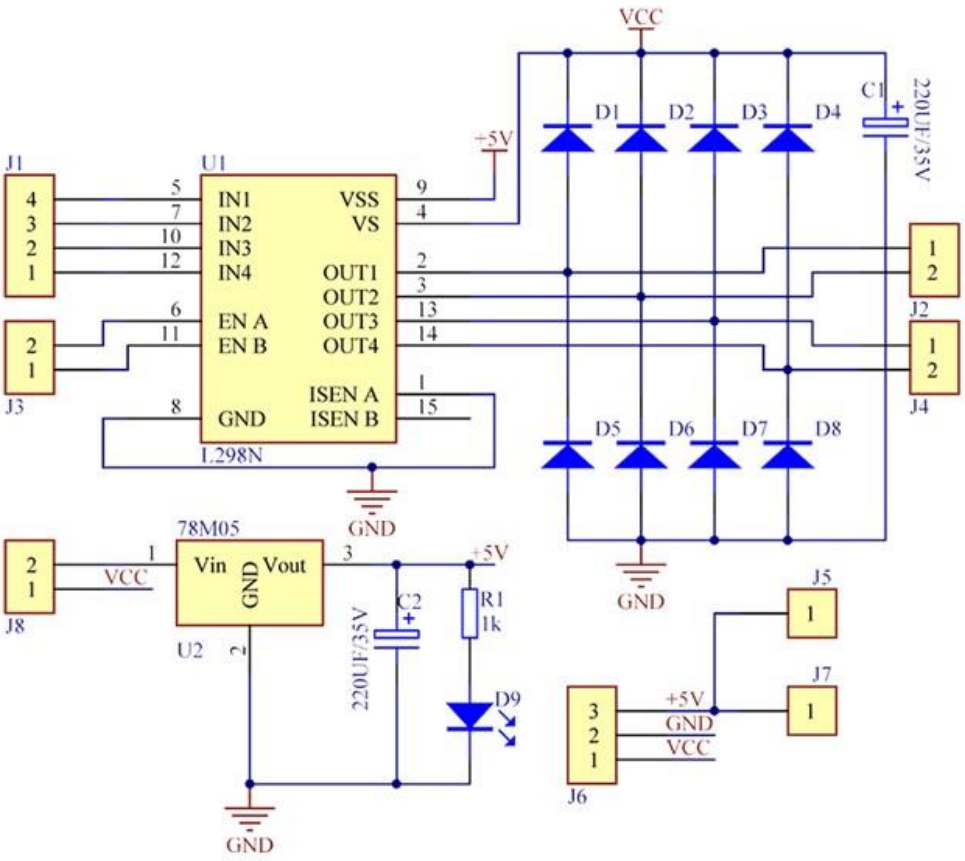
SKU: MDU-1049

Brief Data:

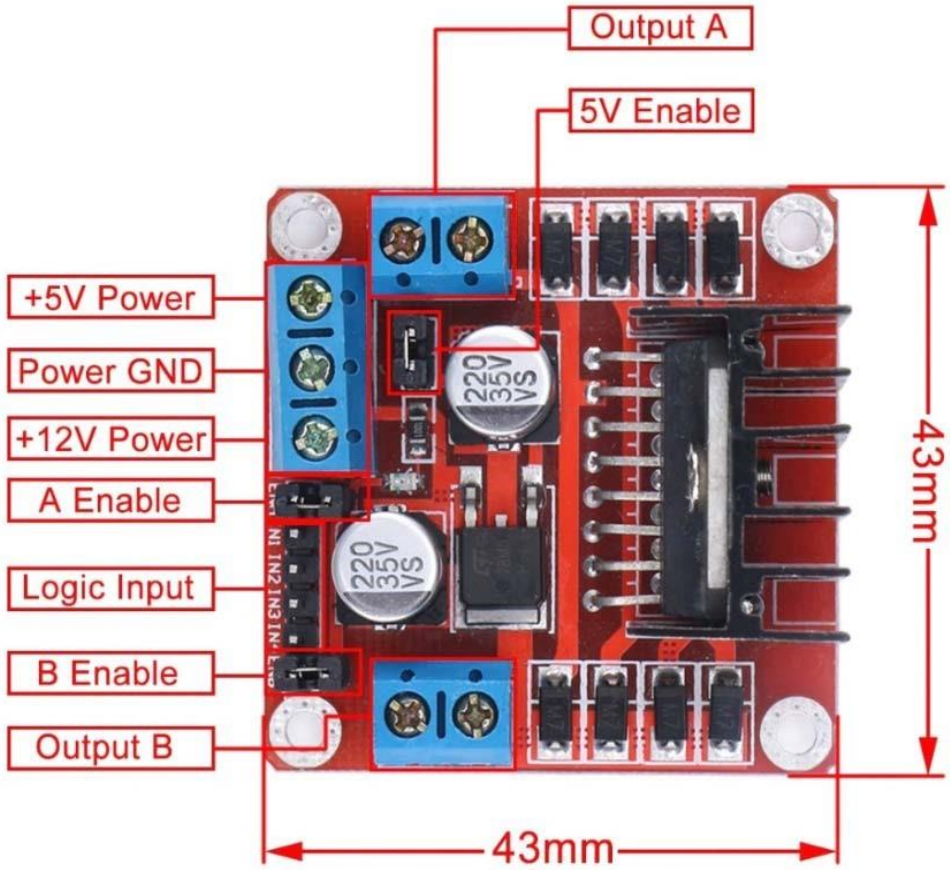
- Input Voltage: 3.2V~40Vdc.
- Driver: L298N Dual H Bridge DC Motor Driver
- Power Supply: DC 5 V - 35 V
- Peak current: 2 Amp
- Operating current range: 0 ~ 36mA • Control signal input voltage range :
- Low: -0.3V ⩽ Vin ⩽ 1.5V.
- High: 2.3V ⩽ Vin ⩽ Vss.
- Enable signal input voltage range : ○ Low: -0.3 ⩽ Vin ⩽ 1.5V (control signal is invalid). ○ High: 2.3V ⩽ Vin ⩽ Vss (control signal active).

- Maximum power consumption: 20W (when the temperature T = 75 ℃).
- Storage temperature: -25 ℃ ~ +130 ℃.
- On-board +5V regulated Output supply (supply to controller board i.e. Arduino).
- Size: 3.4cm x 4.3cm x 2.7cm

Schematic Diagram:



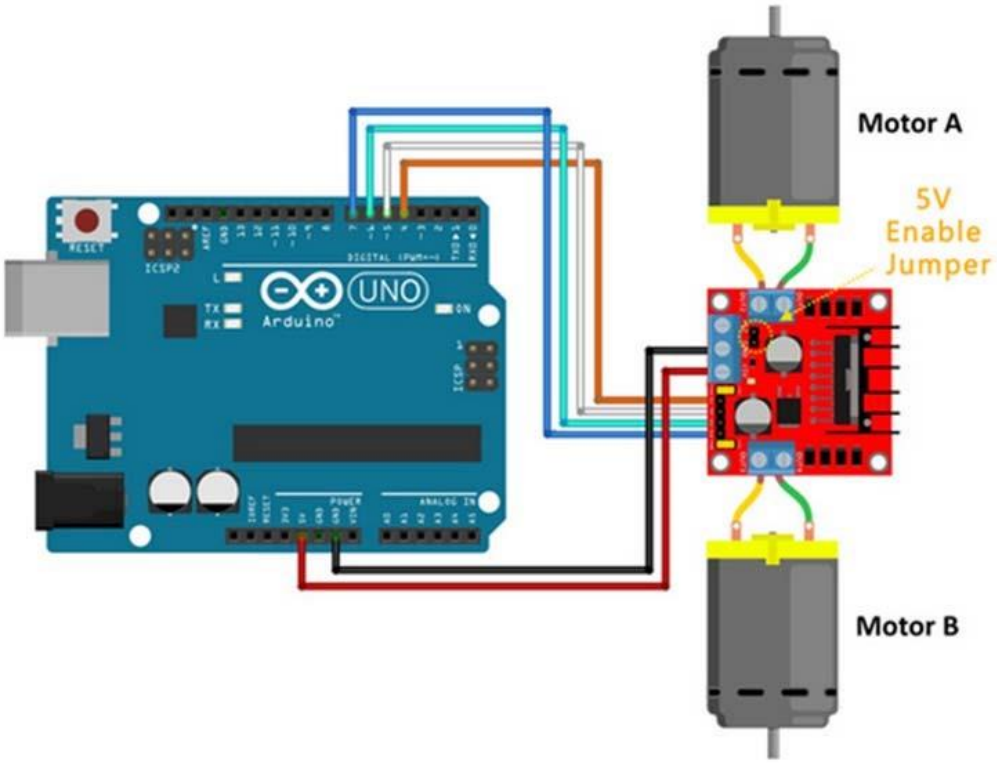
Board Dimension & Pins Function:



Connection Examples:

Controlling 2-DC Motor with +5V Arduino onboard Power Supply:

Below is the circuit connection use the on-board +5V power supply from Arduino board, and should be done without the 5V Enable Jumper on (Active 5V). This connection can drive two 5V DC motors simultaneously.



Sketch Listing:

Copy and paste the sketch below to Arduino IDE and upload to Arduino Uno/Mega board.

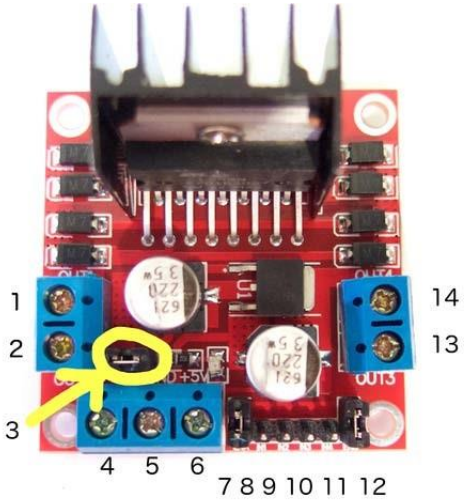
```
/*=============================================================
================

// Author      : Handson Technology

// Project     : Arduino Uno

// Description : L298N Motor Driver

// Source-Code : L298N_Motor.ino

// Program: Control 2 DC motors using L298N H Bridge Driver

//=============================================================
================

*/
```

```
// Definitions Arduino pins connected to input H Bridge int IN1 = 4; int IN2 = 5;
int IN3 = 6; int IN4 = 7;


void setup() {
 // Set the output pins
 pinMode(IN1, OUTPUT); pinMode(IN2, OUTPUT); pinMode(IN3,
OUTPUT); pinMode(IN4, OUTPUT);
}
  void loop() {
 // Rotate the Motor A clockwise digitalWrite(IN1, HIGH); digitalWrite(IN2,
LOW); delay(2000);
 // Motor A digitalWrite(IN1, HIGH); digitalWrite(IN2, HIGH); delay(500);


 // Rotate the Motor B clockwise digitalWrite(IN3, HIGH); digitalWrite(IN4,
LOW); delay(2000);
 // Motor B digitalWrite(IN3, HIGH); digitalWrite(IN4, HIGH); delay(500);


 // Rotates the Motor A counter-clockwise digitalWrite(IN1, LOW);
digitalWrite(IN2, HIGH); delay(2000);
 // Motor A digitalWrite(IN1, HIGH); digitalWrite(IN2, HIGH); delay(500);


 // Rotates the Motor B counter-clockwise digitalWrite(IN3, LOW);
digitalWrite(IN4, HIGH); delay(2000);
 // Motor B digitalWrite(IN3, HIGH); digitalWrite(IN4, HIGH); delay(500); }
```

Controlling Stepper Motor

In this example we have a typical NEMA-17 stepper motor with four wires:

The key to successful stepper motor control is identifying the wires - that is which one is which. You will need to determine the A+, A-, B+ and B- wires. With our example motor these are red, green, yellow and blue. Now let's get the wiring done.



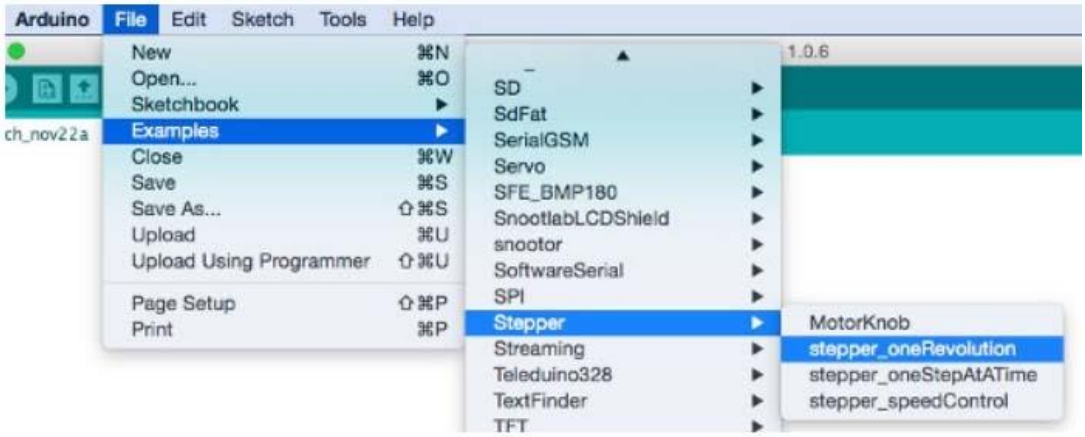
Connect the A+, A-, B+ and B- wires from the stepper motor to the module connections 1, 2, 13 and 14 respectively. Place the jumpers included with the L298N module over the pairs at module points 7 and 12. Then connect the power supply as required to points 4 (positive) and 5 (negative/GND).

Once again if your stepper motor's power supply is less than 12V, fit the jumper to the module at point 3 which gives you a neat 5V power supply for your Arduino.

Next, connect L298N module pins IN1, IN2, IN3 and IN4 to Arduino digital pins D8, D9, D10 and D11 respectively. Finally, connect Arduino GND to point 5 on the module, and Arduino 5V to point 6 if sourcing 5V from the module.

Controlling the stepper motor from your sketches is very simple, thanks to the *Stepper* Arduino library included with the Arduino IDE as standard.

To demonstrate your motor, simply load the "*stepper_oneRevolution"* sketch that is included with the *Stepper* library, for example:



Finally, check the value for

```
const int stepsPerRevolution = 200;
```

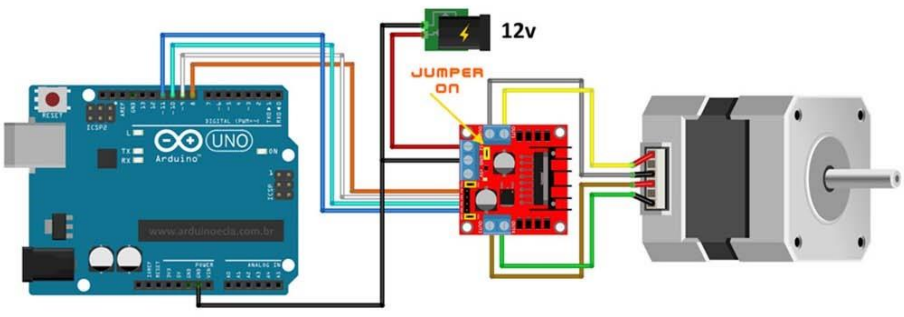
in the sketch and change the 200 to the number of steps per revolution for your stepper motor, and also the speed which is preset to 60 RPM in the following line:

```
myStepper.setSpeed(60);
```

Now you can save and upload the sketch, which will send your stepper motor around one revolution, then back again. This is achieved with the function

```
    myStepper.step(stepsPerRevolution); // for clockwise
myStepper.step(-stepsPerRevolution); // for anti-clockwise
```

Connection for the sketch "*stepper_oneRevolution":*



Lampiran 3. *Datasheet* Sensor Warna TCS3200

High-Resolution Conversion of Light Intensity to Frequency

Programmable Color and Full-Scale Output Frequency

Communicates Directly With a Microcontroller

Single-Supply Operation (2.7 V to 5.5 V)

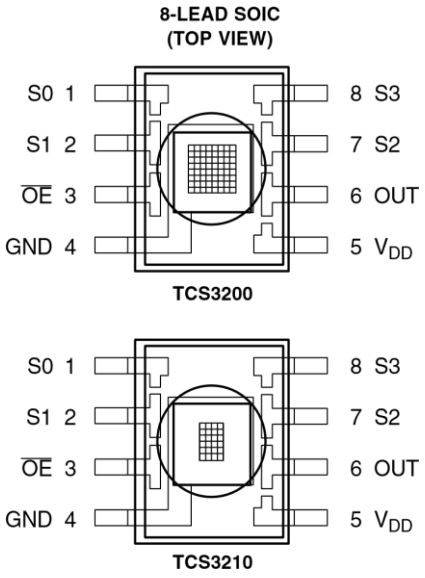
Power Down Feature

Nonlinearity Error Typically 0.2% at 50 kHz

Stable 200 ppm/°C Temperature Coefficient

Low-Profile Lead (Pb) Free and RoHS Compliant Surface-Mount Package

PACKAGE D



Description

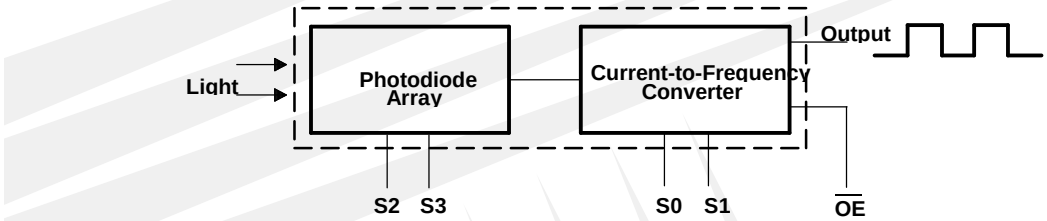
The TCS3200 and TCS3210 programmable color light-to-frequency converters that combine configurable silicon photodiodes and a current-to-frequency converter on a single monolithic CMOS integrated circuit. The output is a square wave (50% duty cycle) with frequency directly proportional to light intensity (irradiance).

The full-scale output frequency can be scaled by one of three preset values via two control input pins. Digital

inputs and digital output allow direct interface to a microcontroller or other logic circuitry. Output enable (OE) places the output in the high-impedance state for multiple-unit sharing of a microcontroller input line.

In the TCS3200, the light-to-frequency converter reads an 8 x 8 array of photodiodes. Sixteen photodiodes have blue filters, 16 photodiodes have green filters, 16 photodiodes have red filters, and 16 photodiodes are clear with no filters.

Functional Block Diagram



In the TCS3210, the light-to-frequency converter reads a 4 x 6 array of photodiodes. Six photodiodes have blue filters, 6 photodiodes have green filters, 6 photodiodes have red filters, and 6 photodiodes are clear with no filters.

The four types (colors) of photodiodes are interdigitated to minimize the effect of non-uniformity of incident irradiance. All photodiodes of the same color are connected in parallel. Pins S2 and S3 are used to select which group of photodiodes (red, green, blue, clear) are active. Photodiodes are 110 µm x 110 µm in size and are on 134-µm centers.

Terminal Functions

TERMINAL NAME	NO.	I/O	DESCRIPTION
GND	4		Power supply ground. All voltages are referenced to GND.
$\overline{OE}$	3	I	Enable for f_o (active low).
OUT	6	O	Output frequency (f_o).
S0, S1	1, 2	I	Output frequency scaling selection inputs.
S2, S3	7, 8	I	Photodiode type selection inputs.
V_{DD}	5		Supply voltage

Table 1. Selectable Options

S0	S1	OUTPUT FREQUENCY SCALING (f_o)
L	L	Power down
L	H	2%
H	L	20%
H	H	100%

S2	S3	PHOTODIODE TYPE
L	L	Red
L	H	Blue
H	L	Clear (no filter)
H	H	Green

Available Options

DEVICE	T_A	PACKAGE − LEADS	PACKAGE DESIGNATOR	ORDERING NUMBER
TCS3200	−40°C to 85°C	SOIC−8	D	TCS3200D
TCS3210	−40°C to 85°C	SOIC−8	D	TCS3210D

2

Absolute Maximum Ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{DD} (see Note 1) . . . . . 6 V

Input voltage range, all inputs, V_I . . . . . −0.3 V to V_{DD} + 0.3 V Operating free-air temperature range, T_A (see Note 2) . . . . . −40°C to 85°C Storage temperature range (see Note 2) . . . . . −40°C to 85°C Solder conditions in accordance with JEDEC J−STD−020A, maximum temperature (see Note 3) . . . 260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltage values are with respect to GND.

2. Long-term storage or operation above 70°C could cause package yellowing that will lower the sensitivity to wavelengths < 500nm.
3. The device may be hand soldered provided that heat is applied only to the solder pad and no contact is made between the tip ofthe solder iron and the device lead. The maximum time heat should be applied to the device is 5 seconds.

Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{DD}		2.7	5	5.5	V
High-level input voltage, V_{IH}	V_{DD} = 2.7 V to 5.5 V	2		V_{DD}	V
Low-level input voltage, V_{IL}	V_{DD} = 2.7 V to 5.5 V	0		0.8	V
Operating free-air temperature range, T_A		−40		70	°C

Electrical Characteristics at T_A = 25°C, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = −2 mA	4	4.5		V
V_{OL}	Low-level output voltage	I_{OL} = 2 mA		0.25	0.40	V

I_{IH}	High-level input current		5	µA
I_{IL}	Low-level input current		5	µA
I_{DD}	Supply current	Power-on mode	1.4 2	mA
		Power-down mode	0.1	µA
	Full scale- frequency (See Note 4)	S0 = H, S1 = H	500 600	kHz
		S0 = H, S1 = L	100 120	kHz
		S0 = L, S1 = H	10 12	kHz
	Temperature coefficient of responsivity	λ ≤ 700 nm, −25°C ≤ T_A ≤ 70°C	±200	ppm/°C
k_{SVS}	Supply voltage sensitivity	V_{DD} = 5 V ±10%	±0.5	%/V

NOTE 4: Full-scale frequency is the maximum operating frequency of the device without saturation.

Operating Characteristics at V_{DD} = 5 V, T_A = 25°C, S0 = H, S1 = H (unless otherwise noted) (See Notes 5, 6, 7, and 8). Values for TCS3200 (TCS3210) are below.

PARAMETER	TEST CONDITIONS	CLEAR PHOTODIODE S2 = H, S3 = L			BLUE PHOTODIODE S2 = L, S3 = H			GREEN PHOTODIODE S2 = H, S3 = H			RED PHOTODIODE S2 = L, S3 = L			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Output frequency (Note 9) f_O	E_e = 47.2 µW/cm², λ_p = 470 nm	12.5	15.6	18.7	61%		84%	22%		43%	0%		6%	kHz
		(4.7)	(5.85)	(7)										
	E_e = 40.4 µW/cm², λ_p = 524 nm	12.5	15.6	18.7	8%		28%	57%		80%	9%		27%	
		(4.7)	(5.85)	(7)										
	E_e = 34.6 µW/cm², λ_p = 640 nm	13.1	16.4	19.7	5%		21%	0%		12%	84%		105%	
		(4.9)	(6.15)	(7.4)										
Irradiance responsivity (Note 10) R_e	λ_p = 470 nm	331			61%		84%	22%		43%	0%		6%	Hz/ (µW/ cm²)
		(124)												
	λ_p = 524 nm	386			8%		28%	57%		80%	9%		27%	
		(145)												
	λ_p = 640 nm	474			5%		21%	0%		12%	84%		105%	
		(178)												
Saturation irradiance (Note 11)	λ_p = 470 nm	1813			--			--			--			µW/ cm²
		(4839)												
	λ_p = 524 nm	1554			--			--			--			
		(4138)												
	λ_p = 640 nm	1266			--			--			--			

			(3371)							
f_D	Dark frequency	E_e = 0	2	10	2	10	2	10	2	10	Hz
	Nonlinearity (Note 12)	f_O = 0 to 5 kHz	±0.1		±0.1		±0.1		±0.1		% F.S.
		f_O = 0 to 50 kHz	±0.2		±0.2		±0.2		±0.2		
		f_O = 0 to 500 kHz	±0.5		±0.5		±0.5		±0.5		
	Recovery from power down		100		100		100		100		µs
	Response time to output enable ($\overline{OE}$)		100		100		100		100		ns

NOTES: 5. Optical measurements are made using small-angle incident radiation from a light-emitting diode (LED) optical source.

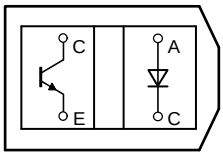
6. The 470 nm input irradiance is supplied by an InGaN light-emitting diode with the following characteristics: peak wavelength λ_p = 470 nm, spectral halfwidth $\Delta\lambda_{½}$ = 35 nm, and luminous efficacy = 75 lm/W.
7. The 524 nm input irradiance is supplied by an InGaN light-emitting diode with the following characteristics: peak wavelength λ_p = 524 nm, spectral halfwidth $\Delta\lambda_{½}$ = 47 nm, and luminous efficacy = 520 lm/W.
8. The 640 nm input irradiance is supplied by a AlInGaP light-emitting diode with the following characteristics:

   peak wavelength λ_p = 640 nm, spectral halfwidth $\Delta\lambda_{½}$ = 17 nm, and luminous efficacy = 155 lm/W.
9. Output frequency Blue, Green, Red percentage represents the ratio of the respective color to the Clear channel absolute value.
10. Irradiance responsivity R_e is characterized over the range from zero to 5 kHz.
11. Saturation irradiance = (full-scale frequency)/(irradiance responsivity) for the Clear reference channel.
12. Nonlinearity is defined as the deviation of f_O from a straight line between zero and full scale, expressed as a percent of full scale.

Lampiran 4. *Datasheet* Sensor *Infrared* TCRT5000

Reflective Optical Sensor with Transistor Output

19156_2



FEATURES

- Package type: leaded
- Detector type: phototransistor
- Dimensions (L x W x H in mm): 10.2 x 5.8 x 7
- Peak operating distance: 2.5 mm
- Operating range within > 20 % relative collectorcurrent: 0.2 mm to 15 mm
- Typical output current under test: I_C = 1 mA
- Daylight blocking filter
- Emitter wavelength: 950 nm
- Lead (Pb)-free soldering released
- Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC

Top view

19156_1

DESCRIPTION

The TCRT5000 and TCRT5000L are reflective sensors which include an infrared emitter and phototransistor in a leaded package which blocks visible light. The package includes two mounting clips. TCRT5000L is the long lead version.

APPLICATIONS

- Position sensor for shaft encoder
- Detection of reflective material such as paper, IBM cards,magnetic tapes etc.
- Limit switch for mechanical motions in VCR
- General purpose - wherever the space is limited

PRODUCT SUMMARY				
PART NUMBER	**DISTANCE FOR MAXIMUM CTR_{rel} (1) (mm)**	**DISTANCE RANGE FOR RELATIVE I_{out} > 20**	**TYPICAL OUTPUT CURRENT UNDER TEST (2)**	**DAYLIGHT BLOCKING FILTER**

		% (mm)	(mA)	INTEGRATED
TCRT5000	2.5	0.2 to 15	1	Yes
TCRT5000L	2.5	0.2 to 15	1	Yes

Notes

(1) CTR: current transfere ratio, I_{out}/I_{in}

(2) Conditions like in table basic charactristics/sensors

ORDERING INFORMATION			
ORDERING CODE	**PACKAGING**	**VOLUME (1)**	**REMARKS**
TCRT5000	Tube	MOQ: 4500 pcs, 50 pcs/tube	3.5 mm lead length
TCRT5000L	Tube	MOQ: 2400 pcs, 48 pcs/tube	15 mm lead length

Note

(1) MOQ: minimum order quantity

ABSOLUTE MAXIMUM RATINGS (1)						
PARAMETER	**TEST CONDITION**	**SYMBOL**			**VALUE**	**UNIT**
INPUT (EMITTER)						
		V_R	5	V		
		I_F	60	mA		
		I_{FSM}				
		P_V				
		T_j	100	°C	3	A
	≤				100	mW

ABSOLUTE MAXIMUM RATINGS (1)						
PARAMETER	**TEST CONDITION**	**SYMBOL**			**VALUE**	**UNIT**
OUTPUT (DETECTOR)						
		V_{CEO}	70	V		
		V_{ECO}	5	V		
		I_C	100	mA		
		P_V				
		T_j	100	°C		
	≤				100	mW
SENSOR						
Total power dissipation	T_{amb} ≤ 25 °C	P_{tot}			200	mW
Ambient temperature range		T_{amb}			- 25 to + 85	°C

Storage temperature range		T_{stg}	- 25 to + 100	°C
Soldering temperature	2 mm from case, t ≤ 10 s	T_{sd}	260	°C

Note

(1) T_{amb} = 25 °C, unless otherwise specified

ABSOLUTE MAXIMUM RATINGS

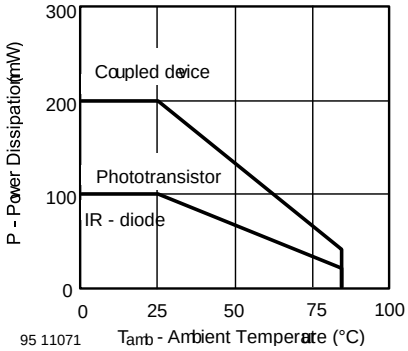


Fig. 1 - Power Dissipation Limit vs. Ambient Temperature

BASIC CHARACTERISTICS (1)						
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
INPUT (EMITTER)						
Forward voltage	I_F = 60 mA	V_F		1.25	1.5	V
Junction capacitance	V_R = 0 V, f = 1 MHz	C_j		17		pF
Radiant intensity	I_F = 60 mA, t_p = 20 ms	I_e			21	mW/sr
Peak wavelength	I_F = 100 mA	λ_P	940			nm
Virtual source diameter	Method: 63 % encircled energy	d		2.1		mm
OUTPUT (DETECTOR)						
Collector emitter voltage	I_C = 1 mA	V_{CEO}	70			V
Emitter collector voltage	I_e = 100 µA	V_{ECO}	7			V
Collector dark current	V_{CE} = 20 V, I_F = 0 A, E = 0 lx	I_{CEO}		10	200	nA
SENSOR						
Collector current	V_{CE} = 5 V, I_F = 10 mA, D = 12 mm	I_C (2) (3)	0.5	1	2.1	mA
Collector emitter saturation voltage	I_F = 10 mA, I_C = 0.1 mA, D = 12 mm	V_{CEsat} (2) (3)			0.4	V

Note

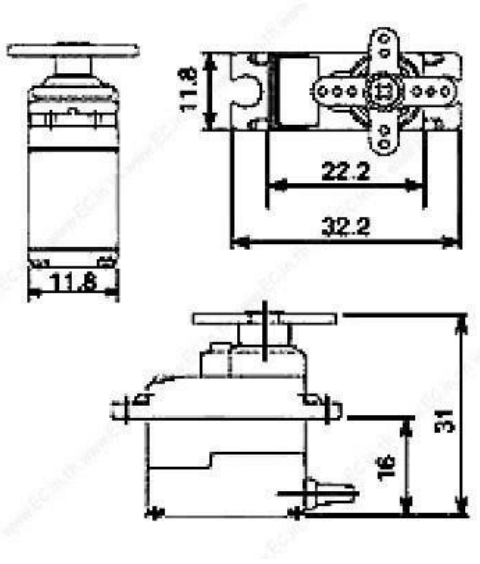
(1) T_{amb} = 25 °C, unless otherwise specified

(2) See figure 3

(3) Test surface: mirror (Mfr. Spindler a. Hoyer, Part No. 340005)

Lampiran 5. Motor Servo SG-90

SG90 9 g Micro Servo

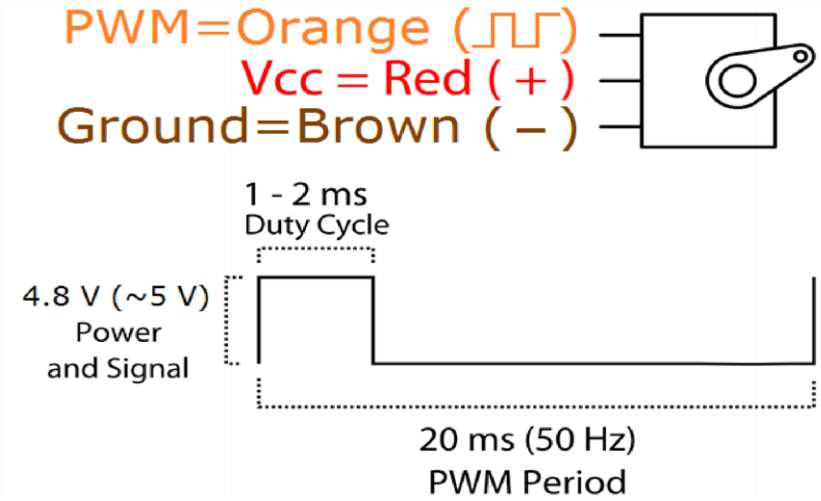


Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but *smaller*. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.

Specifications

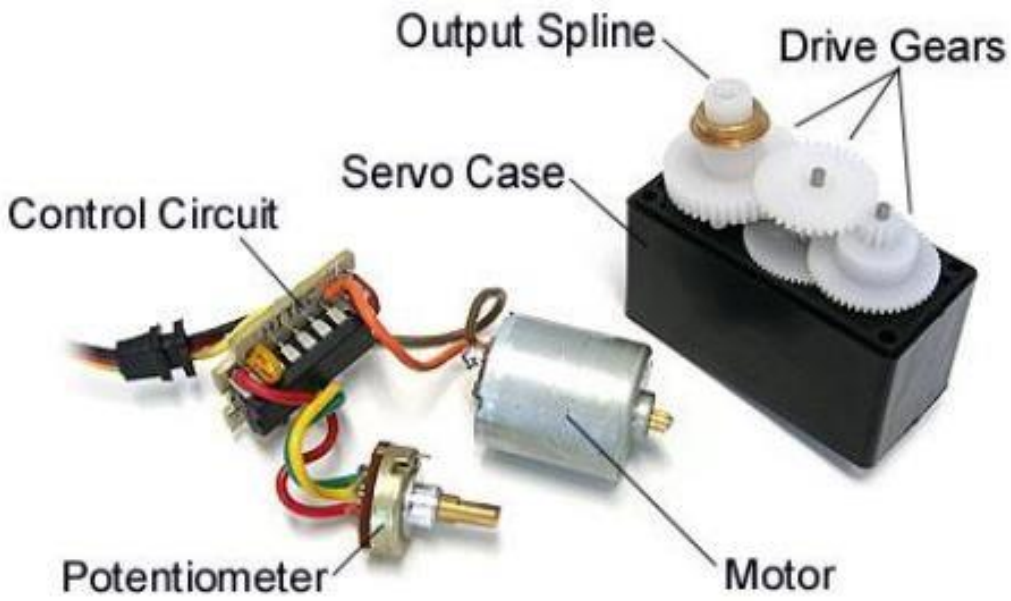
- Weight: 9 g
- Dimension: 22.2 x 11.8 x 31 mm approx.
- Stall torque: 1.8 kgf·cm
- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Dead band width: 10 µs

- Temperature range: 0 ºC – 55 ºC

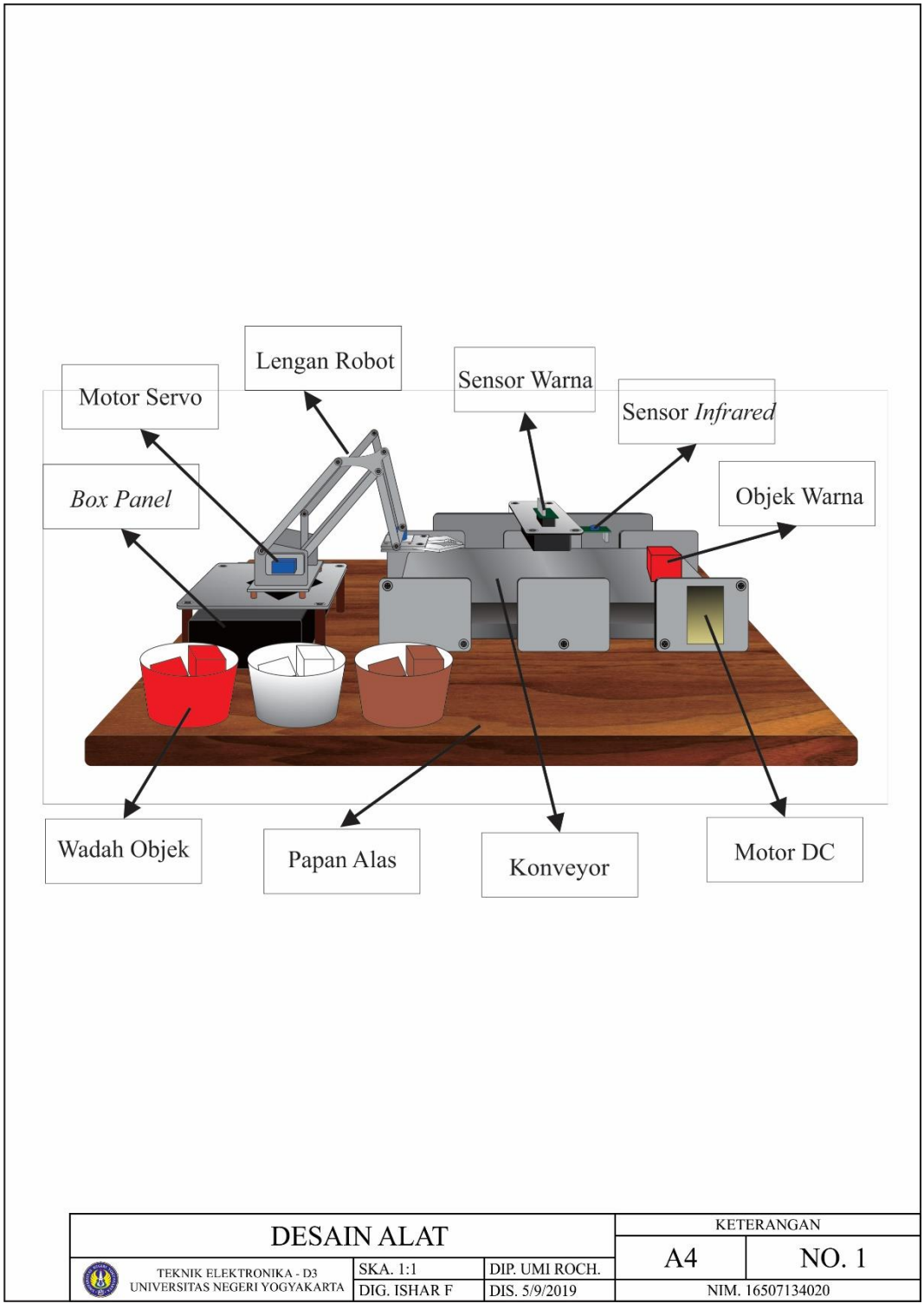


Position "0" (1.5 ms pulse) is middle, "90" (~2 ms pulse) is all the way to the right, "-90" (~1 ms pulse) is all the way to the left.

Structure



Lampiran 6. Desain Alat



Lampiran 7. Foto Alat

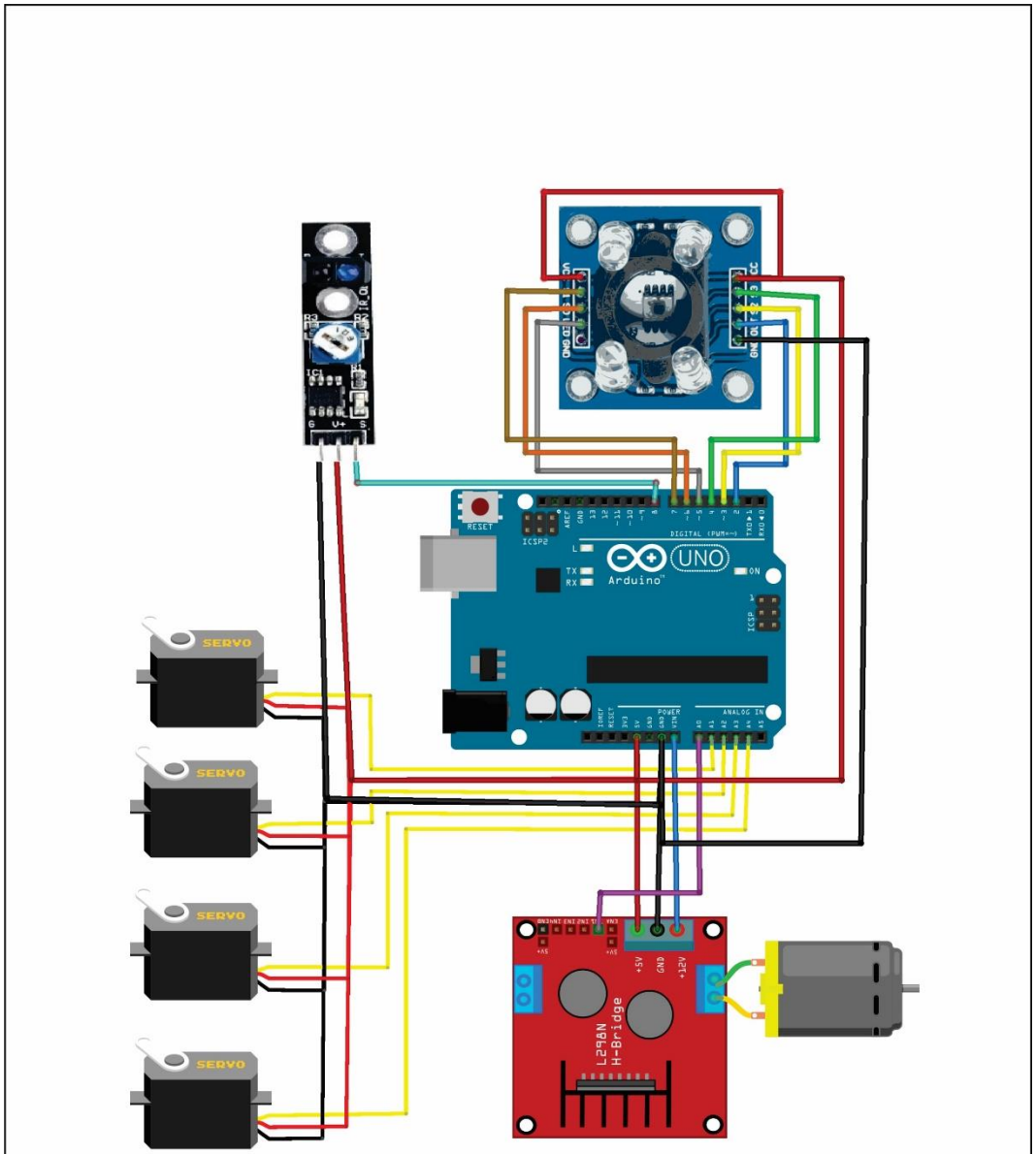
Tampak Samping

Tampak Samping

Tampak Atas

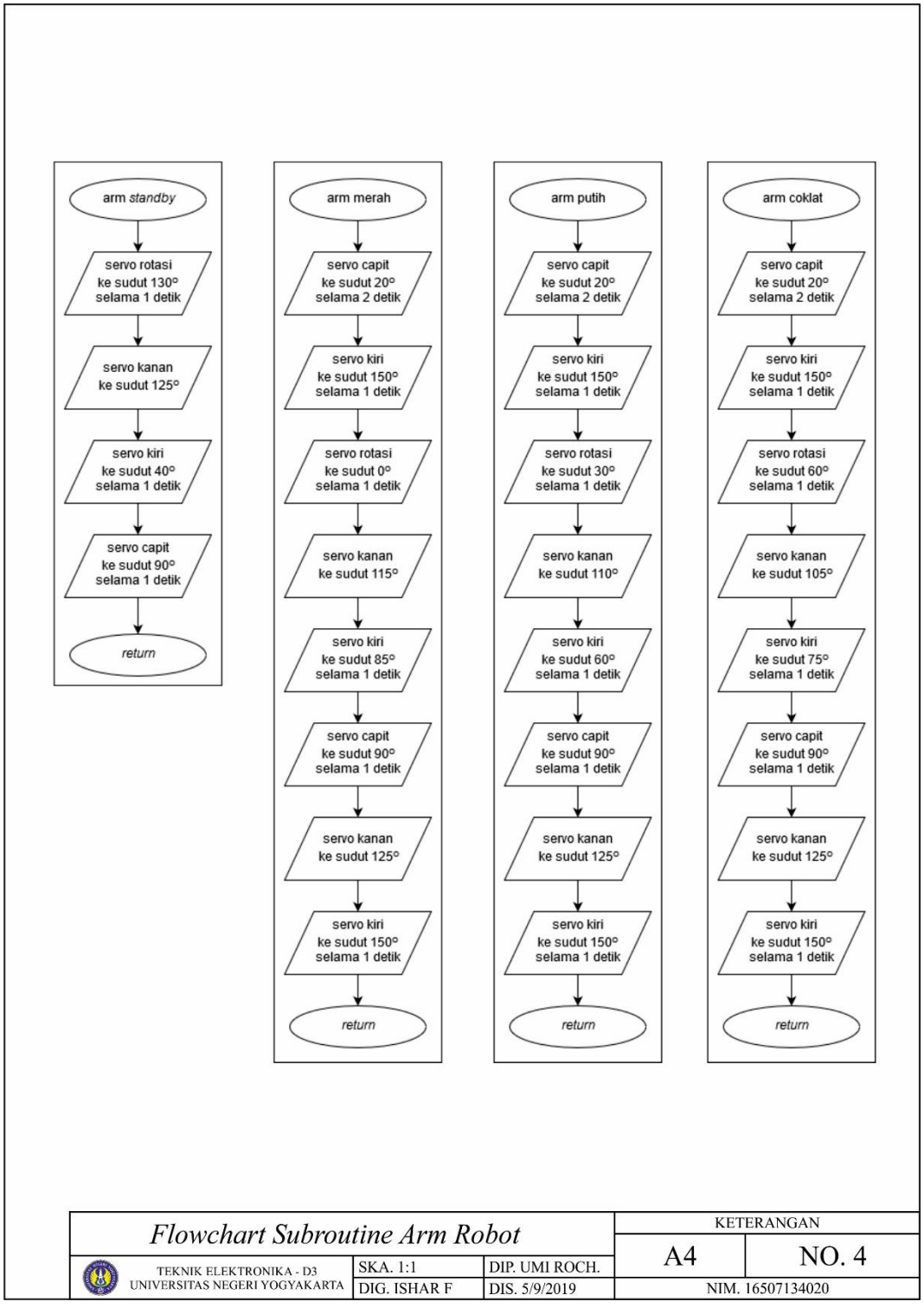
DESAIN ALAT			KETERANGAN	
TEKNIK ELEKTRONIKA - D3 UNIVERSITAS NEGERI YOGYAKARTA	SKA. 1:1	DIP. UMI ROCH.	A4	NO. 2
	DIG. ISHAR F	DIS. 5/9/2019	NIM. 16507134020	

Lampiran 8. Skematik Rangkaian

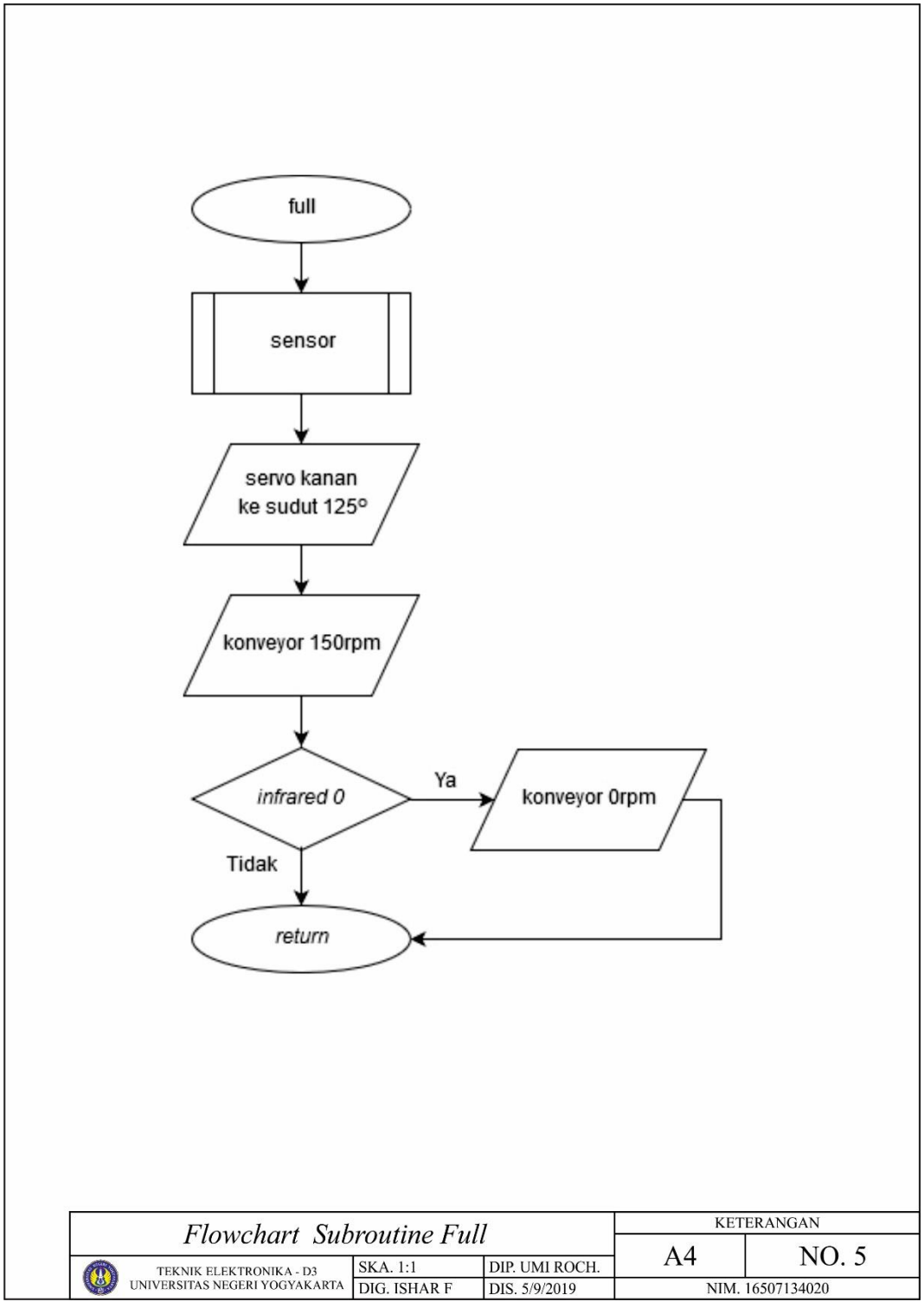


SKEMATIK RANGKAIAN			KETERANGAN	
TEKNIK ELEKTRONIKA - D3 UNIVERSITAS NEGERI YOGYAKARTA	SKA. 1:1	DIP. UMI ROCH.	A4	NO. 3
	DIG. ISHAR F	DIS. 5/9/2019	NIM. 16507134020	

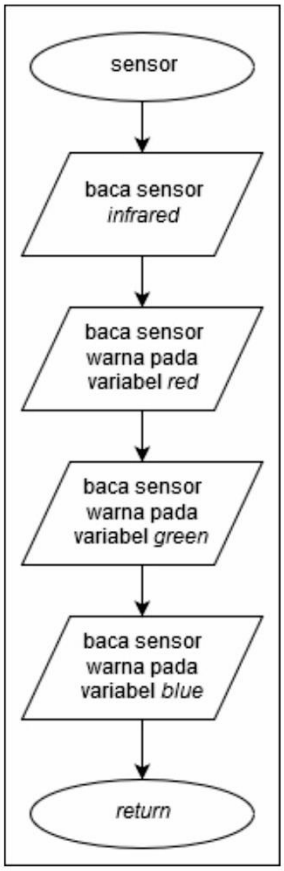
Lampiran 9. *Flowchart Subroution Arm Robot*



Lampiran 10. *Flowchart Subroution Full*

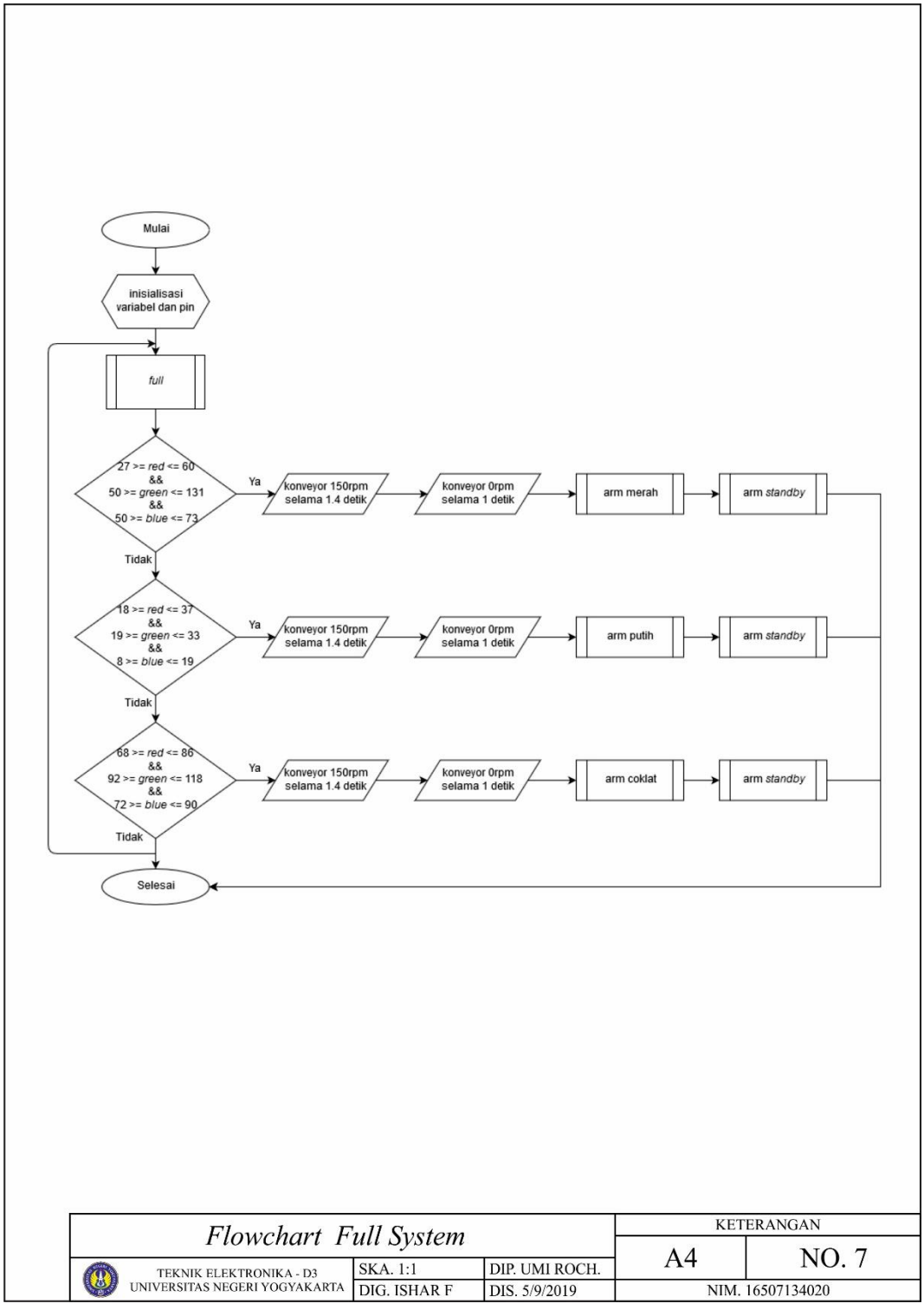


Lampiran 11. *Flowchart Subroution Sensor*



Flowchart Subroutine Sensor			KETERANGAN	
TEKNIK ELEKTRONIKA - D3 UNIVERSITAS NEGERI YOGYAKARTA	SKA. 1:1	DIP. UMI ROCH.	A4	NO. 6
	DIG. ISHAR F	DIS. 5/9/2019	NIM. 16507134020	

Lampiran 12. *Flowchart Full System*



Lampiran 13. *Listing* Program

```
#include <Servo.h>

#define konveyor  5
#define sensorIR  12
#define S0 3
#define S1 2
#define S2 8
#define S3 7
#define sensorOut 4

Servo rotasi;
Servo kiri;
Servo kanan;
Servo gripper;

int red = 0;
int green = 0;
int blue = 0;
int IR;

long periodSensor = 50;
long periodArm = 50;
long time_sensor = 0;
long time_arm = 0;

void sensor(){
  IR = digitalRead(sensorIR);
  digitalWrite(S2,LOW);
  digitalWrite(S3,LOW);
  red = pulseIn(sensorOut, LOW);
  digitalWrite(S2,HIGH);
  digitalWrite(S3,HIGH);
  green = pulseIn(sensorOut, LOW);
  digitalWrite(S2,LOW);
  digitalWrite(S3,HIGH);
  blue = pulseIn(sensorOut, LOW);

  Serial.print("IR Detect: ");
  Serial.print(IR);
  Serial.print(" R Intensity: ");
  Serial.print(red);
  Serial.print(" G Intensity: ");
  Serial.print(green);
  Serial.print(" B Intensity : ");
  Serial.print(blue);
  Serial.println();
 }
void armStandby(){
  rotasi.write(130);
  delay(1000);
  kanan.write(125);
  kiri.write(40);
```

```
  delay(1000);
  gripper.write(90);
  delay(1000);
}
void armSatu(){
  gripper.write(20);
  delay(2000);
  kiri.write(150);
  delay(1000);
  rotasi.write(0);
  delay(1000);
  kanan.write(115);
  kiri.write(85);
  delay(1000);
  gripper.write(90);
  delay(1000);
  kanan.write(125);
  kiri.write(150);
  delay(1000);
}
void armDua(){
  gripper.write(20);
  delay(2000);
  kiri.write(150);
  delay(1000);
  rotasi.write(30);
  delay(1000);
  kanan.write(110);
  kiri.write(60);
  delay(1000);
  gripper.write(90);
  delay(1000);
  kanan.write(125);
  kiri.write(150);
  delay(1000);
}
void armTiga(){
  gripper.write(20);
  delay(2000);
  kiri.write(150);
  delay(1000);
  rotasi.write(60);
  delay(1000);
  kanan.write(105);
  kiri.write(75);
  delay(1000);
  gripper.write(90);
  delay(1000);
  kanan.write(125);
  kiri.write(150);
  delay(1000);
}
void full(){
  if(millis() - time_sensor >
periodSensor){
    sensor();
```

```
    time_sensor = millis();
  }

  analogWrite(konveyor, 150);
  if(IR == 0){
    delay(600);
    analogWrite(konveyor, 0);
    delay(1000);
  }
}

void setup() {
  Serial.begin(9600);
  pinMode(S0, OUTPUT);
  pinMode(S1, OUTPUT);
  pinMode(S2, OUTPUT);
  pinMode(S3, OUTPUT);
  pinMode(sensorOut, INPUT);

  digitalWrite(S0,HIGH);
  digitalWrite(S1,LOW);

  rotasi.attach(11);
  kiri.attach(10);
  kanan.attach(9);
  gripper.attach(6);
  delay(3000);
  rotasi.write(130);
  kanan.write(125);
  kiri.write(40);
  gripper.write(90);
}
void loop() {
  if(millis() - time_arm > periodArm){
    full();
    time_arm = millis();
  }
  if(red >= 27 && red <= 60 && green >= 50 && green <= 131 && blue >= 50 && blue <= 73){
      Serial.println(" - Merah");
      analogWrite(konveyor, 150);
      delay(1400);
      analogWrite(konveyor, 0);
      delay(1000);
      armSatu();
      armStandby();
    }

    if(red >= 18 && red <= 37 && green >= 19 && green <= 33 && blue >= 8 && blue <= 19){
      Serial.println(" - Putih");
      analogWrite(konveyor, 150);
      delay(1400);
      analogWrite(konveyor, 0);
```

```
    delay(1000);
    armDua();
    armStandby();
   }

   if(red >= 68 && red <= 86 &&
green >= 92 && green <= 118 &&
blue >= 72 && blue <= 90){
    Serial.println(" - Coklat");
    analogWrite(konveyor, 150);
    delay(1400);
    analogWrite(konveyor, 0);
    delay(1000);
    armTiga();
    armStandby();
   }
}
```

Lampiran 14. Daftar Komponen

1. Adaptor 12V
2. Sensor Warna TCS3200
3. Sensor *Infrared* TCRT500
4. Motor DC
5. Motor Servo SG-90
6. Arduino Uno
7. *Driver* Motor L298N
8. *Box Panel*

Lampiran 15. Spesifikasi Alat

No.	Indikator	Spesifikasi
1	CPU	Atmega 328p
2	Power Supply	Adaptor 12V
3	Sensor	Sensor Warna TCS 3200 dan Sensor *Infrared* TCRT500
4	Motor DC	6V, 300rpm
5	Motor Servo	SG-90
6	Bahan	Besi, Kayu, dan Akrilik
7	Dimensi	60 cm x 28 cm x 18 cm
8	Berat	2,5 Kg
9	Jarak Sensor – Objek	Sensor Warna : 0,5 cm dan Sensor *Infrared* : 0,5 cm
10	Dimensi Objek	2,5 cm x 2,5 cm x 2,5 cm
11	Warna Objek	Merah, Putih, dan Coklat
12	Lengan Robot	4 DOF