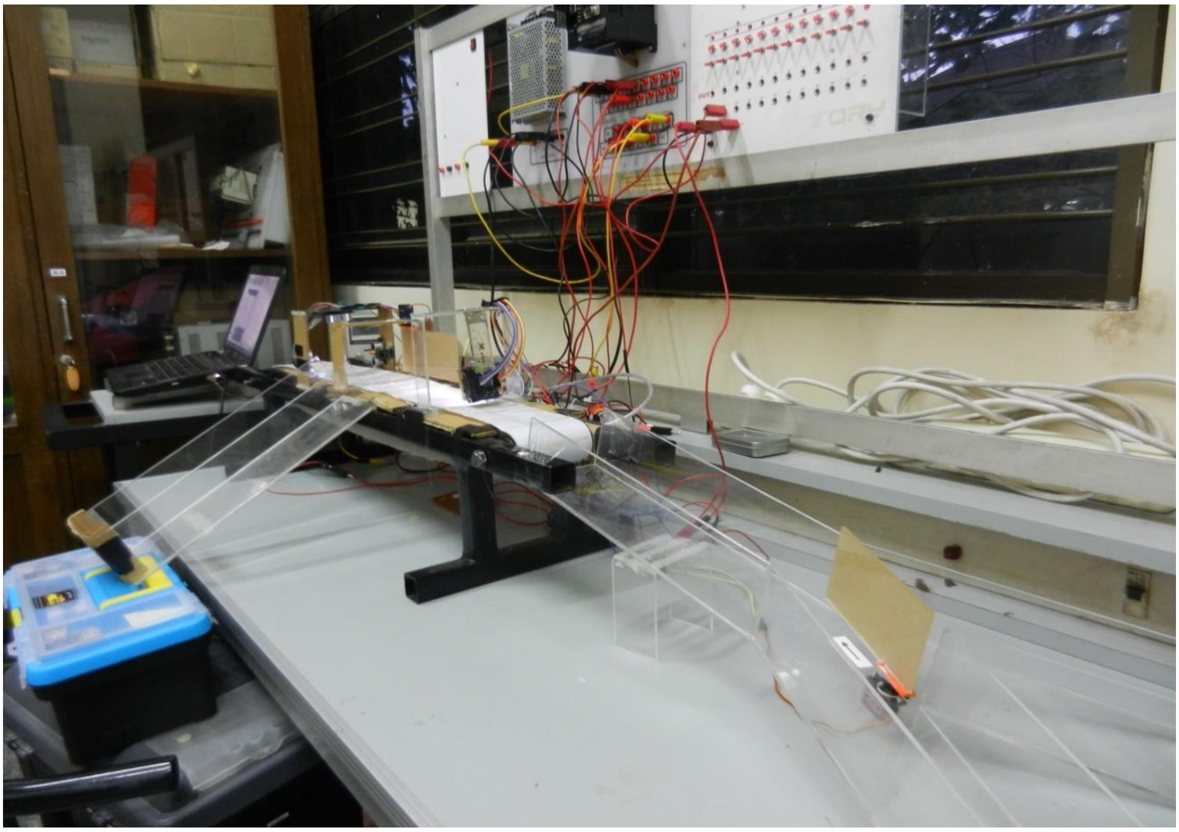
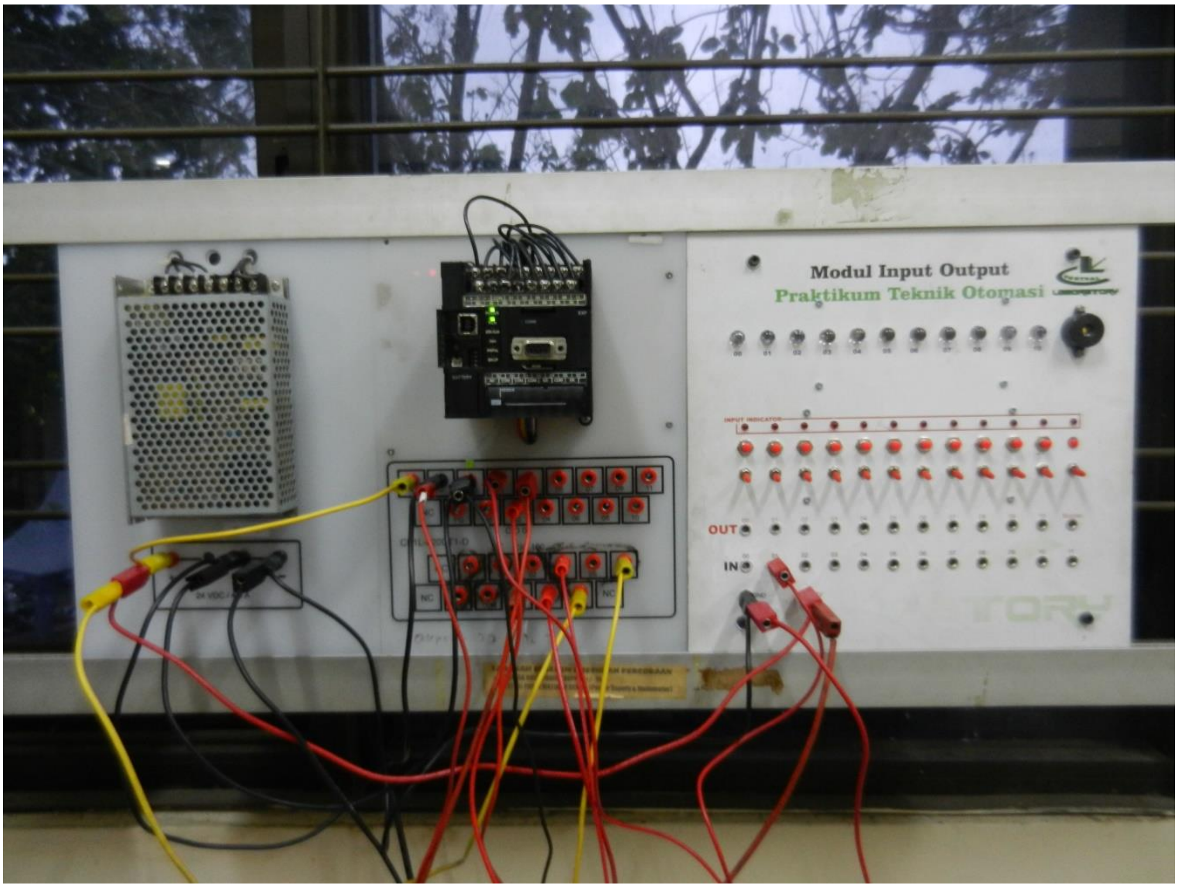
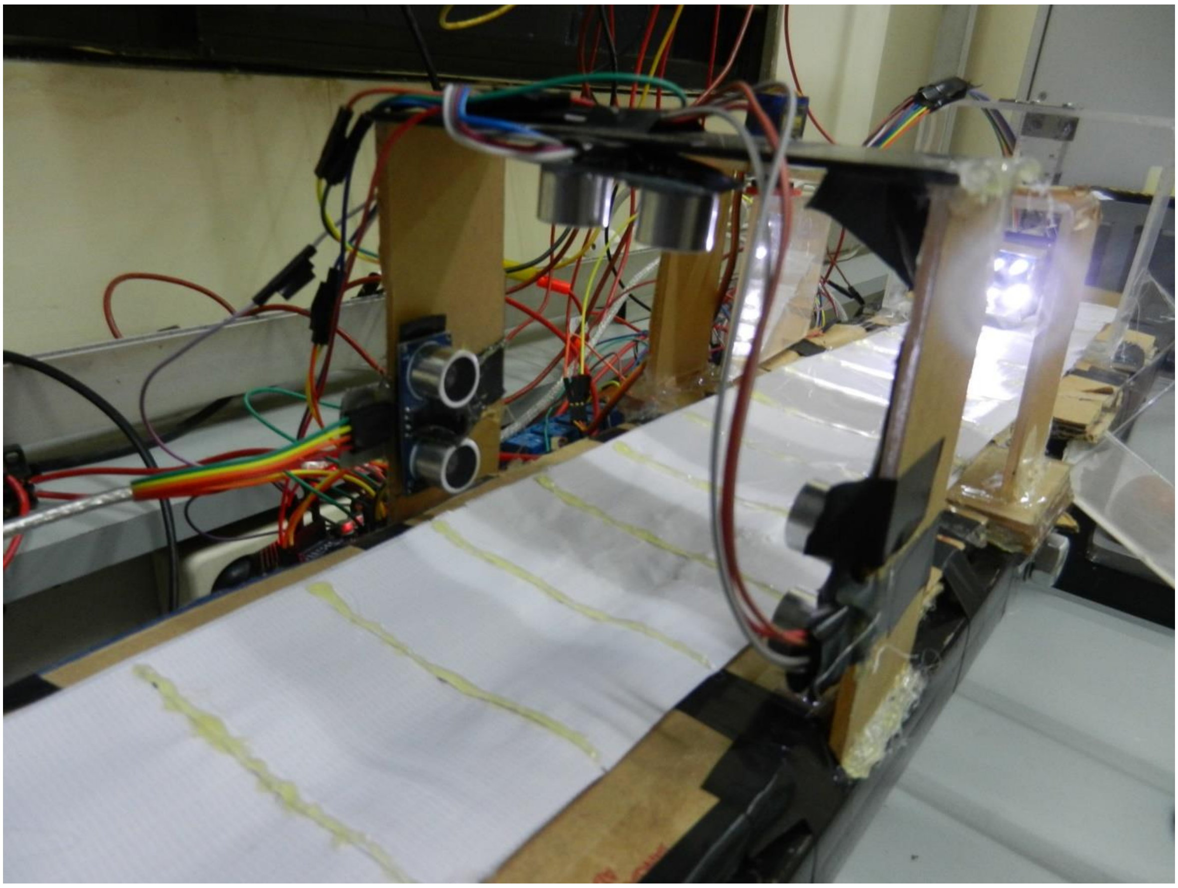
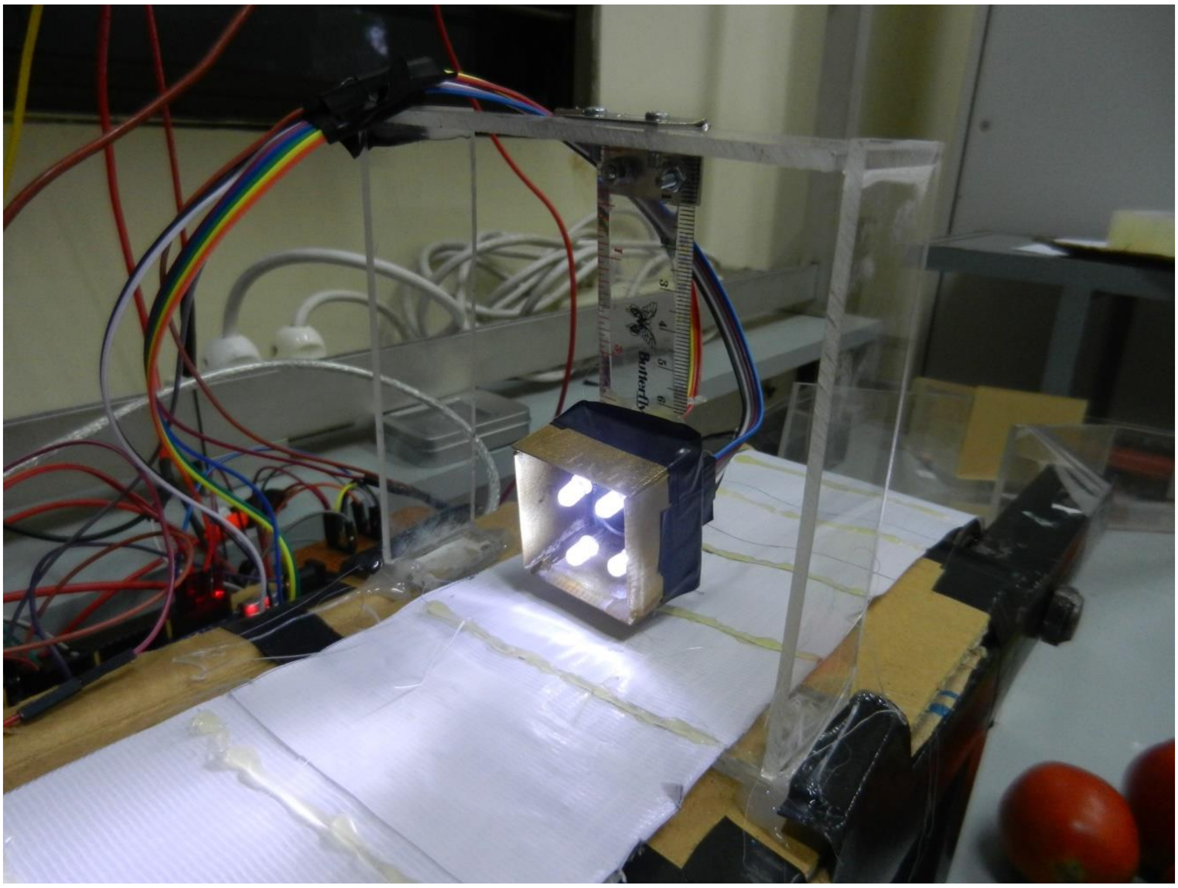
<u>Lampiran 1</u>

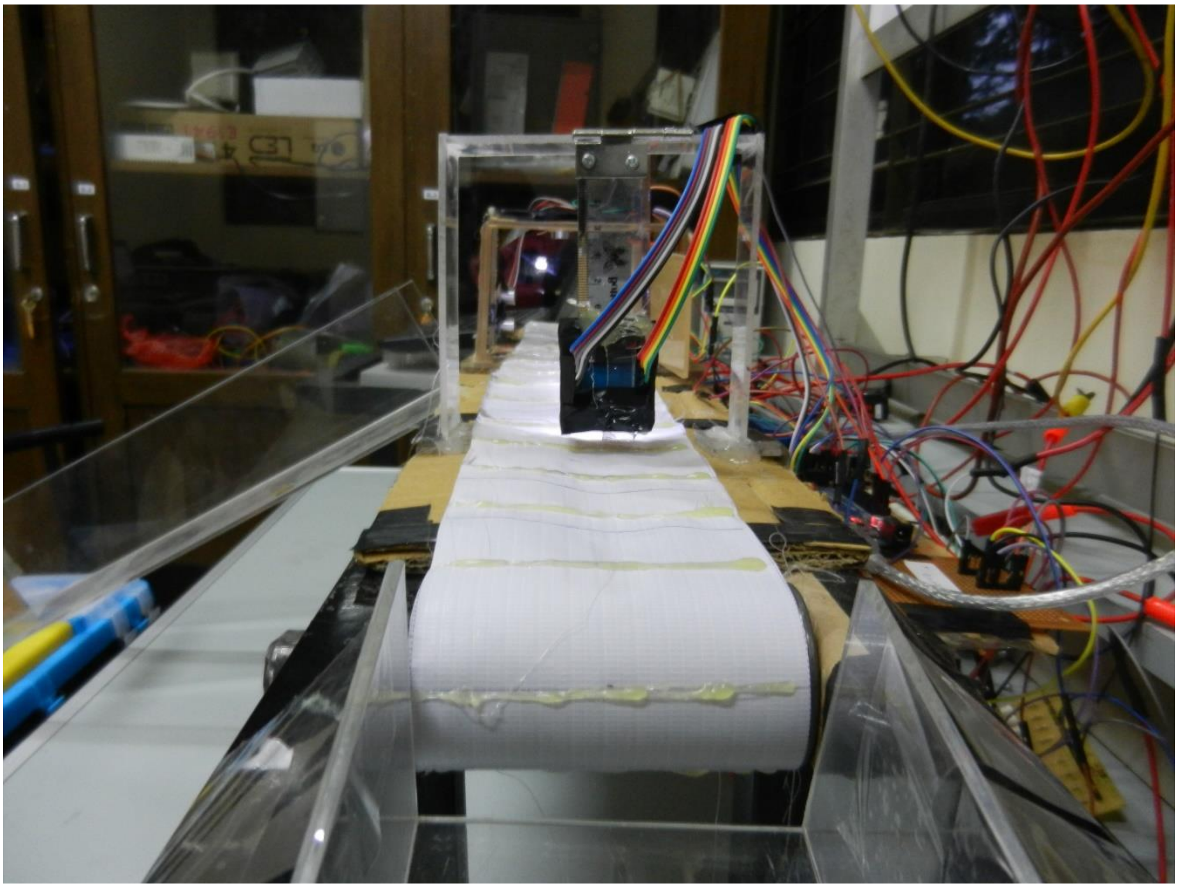
Foto Alat

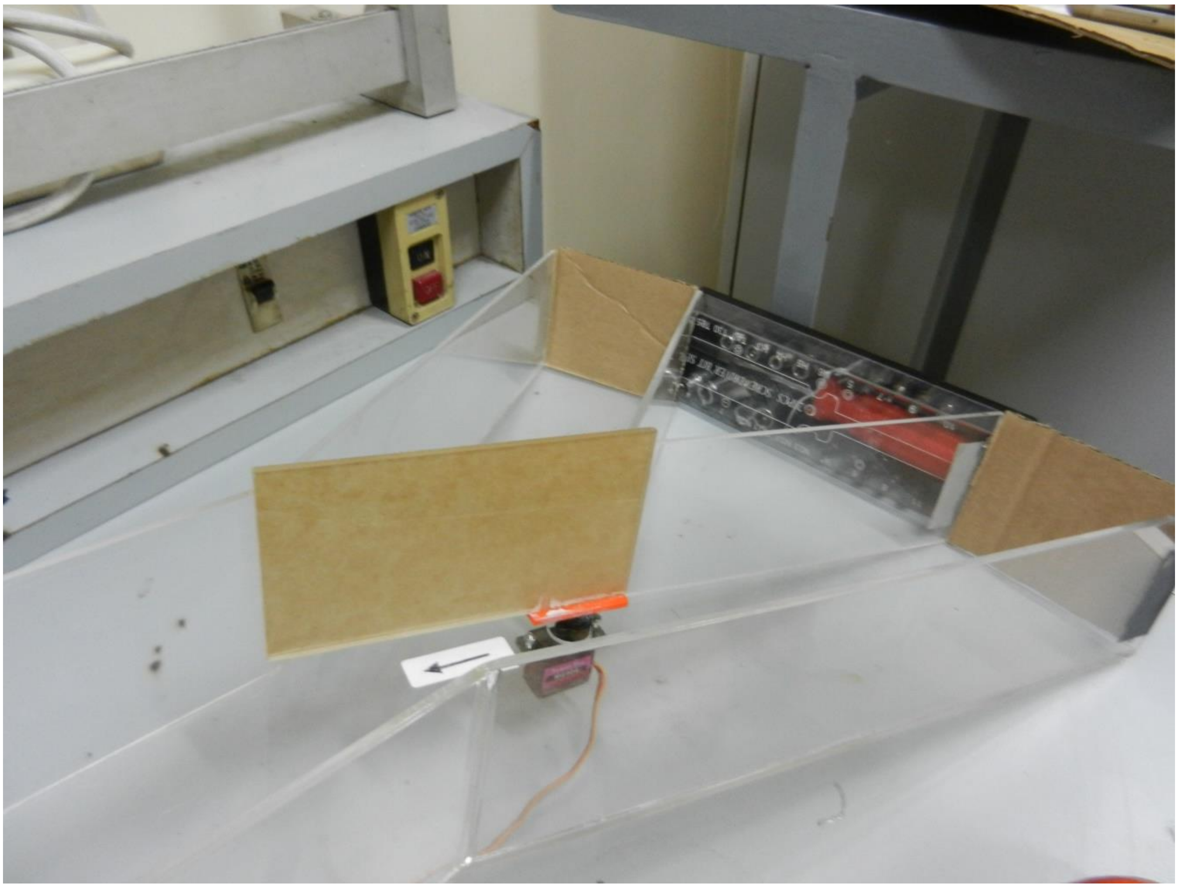


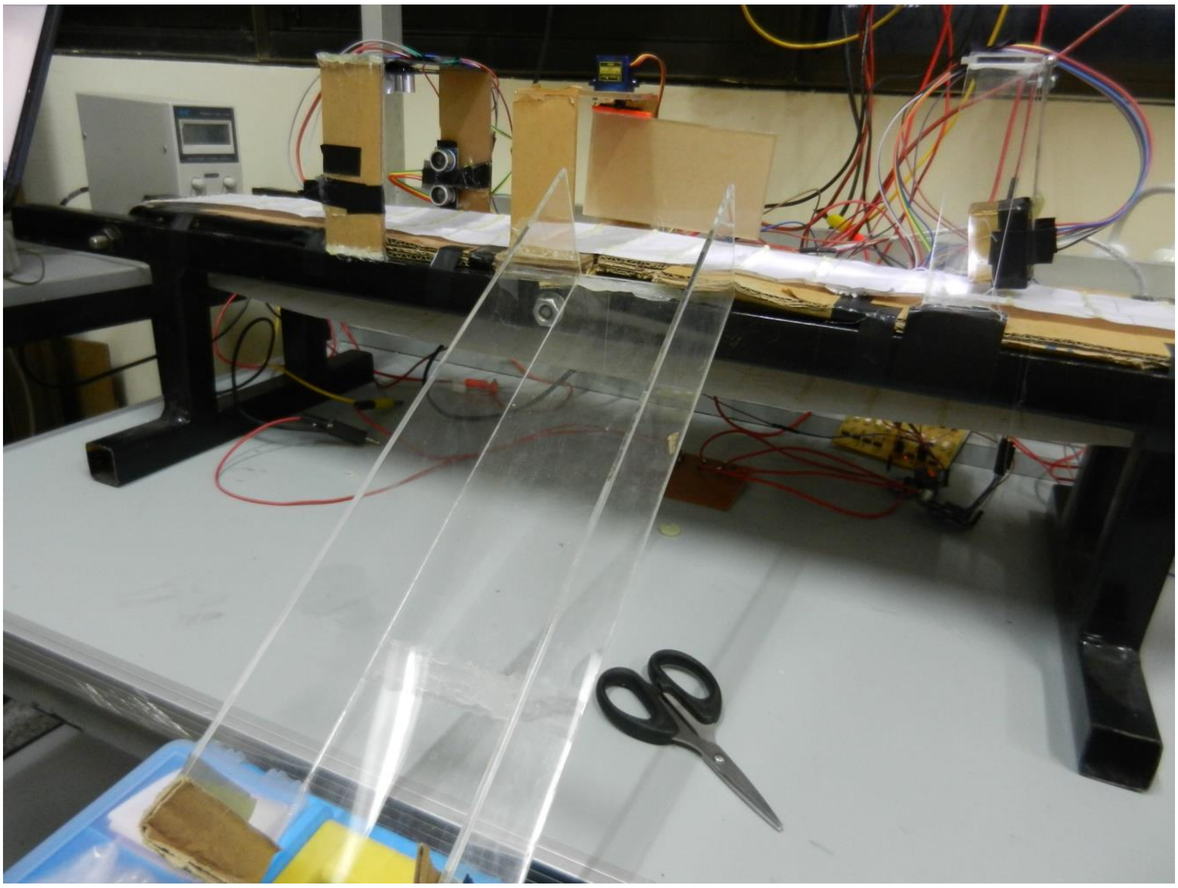

Modul Input Output
Praktikum Teknik Otomasi
OUT
IN



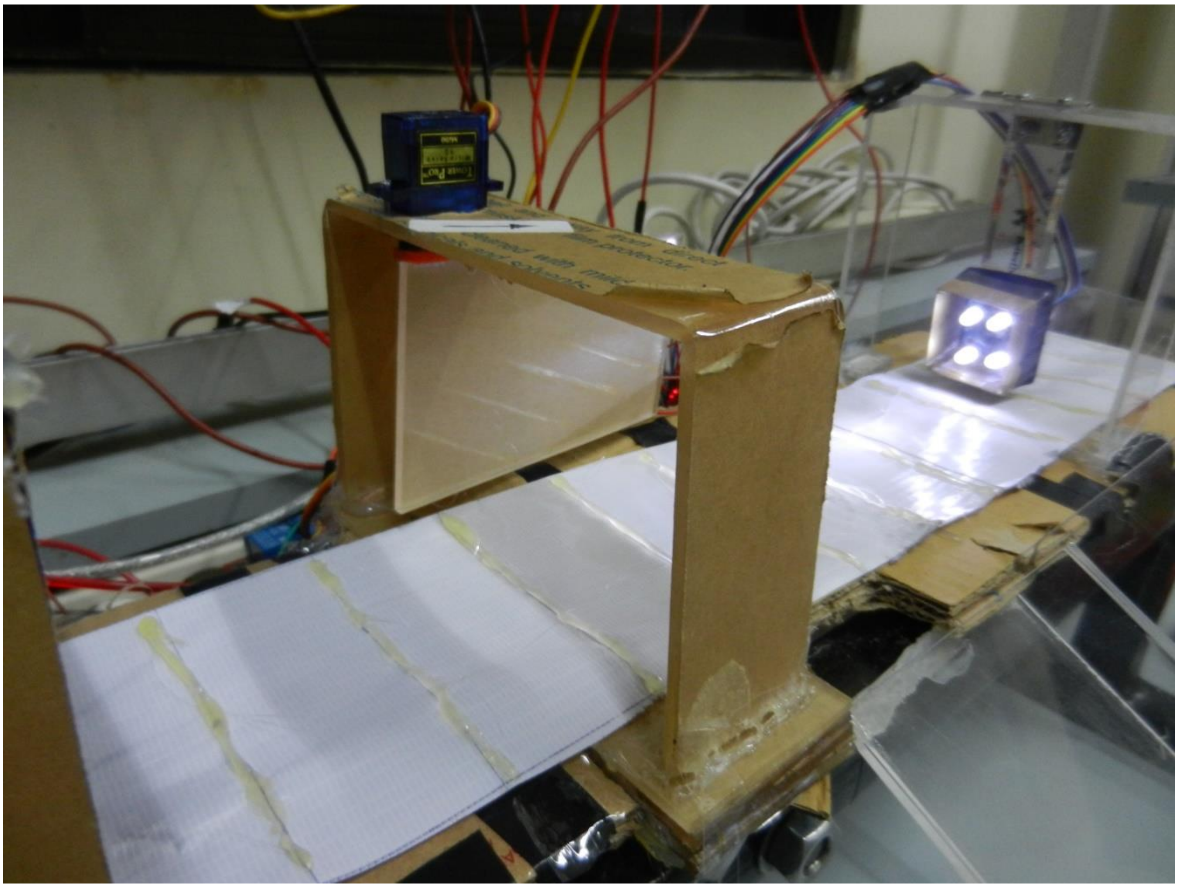









PS3005 0-30V 0-5A
SWITCHING POWER SUPPLY
VOLTAGE
FINE
COARSE
ON
OFF



Lampiran 2

***Listing* Program PLC dan Arduino**

***Listing Program* CX=*Programmer* pada Alat Penyortir Tomat menggunakan PLC Omron tipe CP1L-L20DTI-D**

```
LD 0.01
OUT 200.00

LD 200.00
OUT 100.06

LD 0.02
OR 200.01
ANDNOT T0001
OUT 200.01

LD 200.00
AND 200.01
ANDNOT T0001
OUT 100.03

LD 200.00
AND 200.01
TIM 0001 #20

LD 0.03
OR 200.02
ANDNOT T0002
```

OUT 200.02

LD 200.00

AND 200.02

TIM 0002 #20

LD 200.00

AND 200.02

ANDNOT T0002

OUT 100.04

***Listing Program* Sensor Ultrasonik beserta Penyortir Ukuran Tomat menggunakan Arduino Mega 2560**

```
#include <Servo.h>
const unsigned int PING_TRIGGER1 = 4;
const unsigned int ECHO_PIN1 = 5;
const unsigned int PING_TRIGGER = 6;
const unsigned int ECHO_PIN = 7;
const unsigned int PING_TRIGGER2 = 8;
const unsigned int ECHO_PIN2 = 9;

const unsigned int BAUD_RATE = 9600;

float duration, inches, cm;
float duration1, inches1, cm1;
float duration2, inches2, cm2;
float calculation = 0;

Servo servo;

int bacainputPUT, inputPUT = 2;

void setup()
{
  Serial.begin(BAUD_RATE);
  pinMode (12, OUTPUT);
```

```
  pinMode(inputPUT, INPUT); //input PUT dari PLC
  servo.attach(13);
  servo.write(0);
}

void loop() {
  pinMode (PING_TRIGGER2, OUTPUT);
  digitalWrite (PING_TRIGGER2, LOW);
  delayMicroseconds(5);
  digitalWrite(PING_TRIGGER2, HIGH);
  delayMicroseconds(10);
  digitalWrite(PING_TRIGGER2, LOW);
  pinMode (ECHO_PIN2, INPUT);
  duration2 = pulseIn (ECHO_PIN2, HIGH);
  ////////////////////////////////////////////////////
  pinMode (PING_TRIGGER1, OUTPUT);
  digitalWrite (PING_TRIGGER1, LOW);
  delayMicroseconds(5);
  digitalWrite(PING_TRIGGER1, HIGH);
  delayMicroseconds(10);
  digitalWrite(PING_TRIGGER1, LOW);
  pinMode (ECHO_PIN1, INPUT);
  duration1 = pulseIn (ECHO_PIN1, HIGH);
  ////////////////////////////////////////////////////
```

```
pinMode (PING_TRIGGER, OUTPUT);
digitalWrite (PING_TRIGGER, LOW);
delayMicroseconds(5);

digitalWrite(PING_TRIGGER, HIGH);
delayMicroseconds(10);
digitalWrite(PING_TRIGGER, LOW);

//  delayMicroseconds(750);

pinMode (ECHO_PIN, INPUT);
duration = pulseIn (ECHO_PIN, HIGH);
//////////////////////////////////////////////////////



inches = microsecondsToInches (duration);
cm = microsecondsToCentimeters (duration);

inches1 = microsecondsToInches (duration1);
cm1 = microsecondsToCentimeters (duration1);

inches2 = microsecondsToInches (duration2);
cm2 = microsecondsToCentimeters (duration2);
```

```
if (duration == 0 && duration1 == 0 && duration2 == 0)
{
 Serial.println ("pulsa echo tidak diterima ");
}
else
{



 calculation = 15 - cm1 - cm;
  Serial.print ("Sensor : ");
  Serial.print (cm2);
  Serial.print ("cm || ");
  Serial.print (calculation);
  Serial.print ("cm");
  Serial.println();

 //        TINGGI        LEBAR
 if ((calculation >= 0 && calculation <= 7) && cm2 <= 7) {
  digitalWrite(12, HIGH);
  Serial.print ("\t\t HIGH ");
  //delay(1500);



 }
```

```
    else {
      digitalWrite(12, LOW);
            Serial.print ("\t\t LOW ");
    }
  }



  bacainputPUT = digitalRead(inputPUT);
  Serial.println();
  Serial.print ("logika:");
  Serial.print (bacainputPUT);
  Serial.println();
  ///////// PUT //////////
   if (bacainputPUT == LOW) //Tomat dideteksi besar, PUT ON
    {
      servo.write(0);
    }
    else
    {
      servo.write(45);
    }

  //delay(1);
}
```

```
float microsecondsToInches(float microseconds)

{

  return microseconds / 74 / 2;

}


float microsecondsToCentimeters(float microseconds)

{

  return microseconds / 29 / 2;

}
```

***Listing Program* Sensor Warna beserta Penyortir Warna Tomat menggunakan Arduino Uno**

```
#include <Servo.h>


#define inputPWT 45 // PWT dari PLC

#define outputSW 42 //output sensorwarna ke PLC



//ping servo

Servo servo;

Servo servo2;

int servoPin = 26;

int servo2Pin = 28; //output ke motor

int servoAngle = 0;

int servo2Angle = 0;

//pin sensor warna

const int s0 = 8;

const int s1 = 9;

const int s2 = 12;

const int s3 = 11;

const int out = 10;

int redLed = 2;

int greenLed = 3;

int blueLed = 4;

// Variables
```

```
int red = 0;
int green = 0;
int blue = 0;
//pin lain-lain

int bacainputPWT;
static int datair1 = 0;
static int datair2 = 0;

void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);
  pinMode(inputPWT, INPUT); //input PWT dari PLC
  pinMode(outputSW, OUTPUT); //output Sensor Warna
  servo.attach(servoPin);
  servo2.attach(servo2Pin);
  servo.write(90);
  servo2.write(90);
  pinMode(s0, OUTPUT);
  pinMode(s1, OUTPUT);
  pinMode(s2, OUTPUT);
  pinMode(s3, OUTPUT);
  pinMode(out, INPUT);
  pinMode(redLed, OUTPUT);
```

```
  pinMode(greenLed, OUTPUT);
  pinMode(blueLed, OUTPUT);
  digitalWrite(s0, HIGH);
  digitalWrite(s1, HIGH);
}


void loop() {
  color();
  Serial.print("R:");
  Serial.print(red, DEC);
  Serial.print(" G:");
  Serial.print(green, DEC);
  Serial.print(" B:");
  Serial.print(blue, DEC);
  Serial.println();

  float gray = (float)(0.2989 * red) + (float)(0.587 * green) + (float)(0.114 * blue);
  float mean = (red+green)/2;
  Serial.println(gray);
  Serial.println(mean);
  int selisih = green - red;
  Serial.println(selisih);
  if (gray > 65 && gray < 70 && selisih > 30)
```

```
{

  Serial.println(" - (Merah)");
  digitalWrite(outputSW, LOW); // Turn RED LED ON
  digitalWrite(greenLed, LOW);
  digitalWrite(blueLed, LOW);
}

else if (gray > 38 && gray < 45 && selisih < 5)
{
  Serial.println(" - (Hijau)");
  digitalWrite(outputSW, HIGH);
  digitalWrite(greenLed, HIGH);
  digitalWrite(blueLed, HIGH); // Turn BLUE LED ON
  servo2.write(60);
  servo.write(60);

}

else if (gray > 60 && gray < 65 && selisih > 32 && selisih < 38)
{
  Serial.println(" - (Oranye)");
  digitalWrite(outputSW, HIGH);
  digitalWrite(greenLed, HIGH); // Turn GREEN LED ON
```

```
    digitalWrite(blueLed, HIGH);
    servo2.write(60);
    servo.write(60);


  }
  else {
    servo2.write(0);
    servo.write(0);
    Serial.println();
  }
  delay(100);
//  digitalWrite(redLed, LOW);
//  digitalWrite(greenLed, LOW);
//  digitalWrite(blueLed, LOW);




  bacainputPWT = digitalRead(inputPWT);
  Serial.println();
  Serial.print ("logika:");
  Serial.print (bacainputPWT);
  Serial.println();
  ///////// PWT //////////
  { if (bacainputPWT == LOW) //Telur dideteksi coklat, PWT ON
```

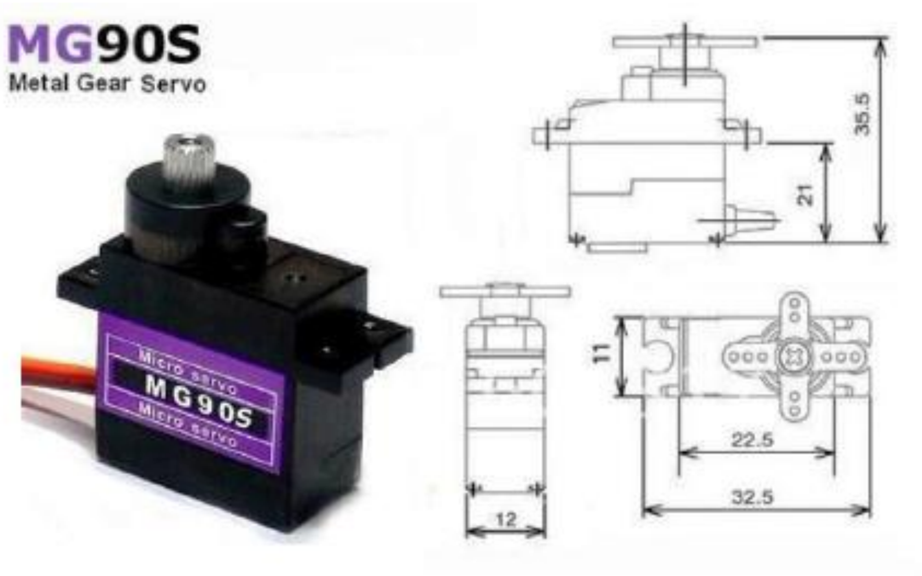
```
    {
    servo2.write(60);
    }
    else
    {
      servo2.write(0);
    }
  }
}

void color()
{
  digitalWrite(s2, LOW);
  digitalWrite(s3, LOW);
  //count OUT, pRed, RED
  red = pulseIn(out, digitalRead(out) == HIGH ? LOW : HIGH);
  digitalWrite(s3, HIGH);
  //count OUT, pBLUE, BLUE
  blue = pulseIn(out, digitalRead(out) == HIGH ? LOW : HIGH);
  digitalWrite(s2, HIGH);
  //count OUT, pGreen, GREEN
  green = pulseIn(out, digitalRead(out) == HIGH ? LOW : HIGH);
}
```

Lampiran 3

Datasheet

Motor Servo



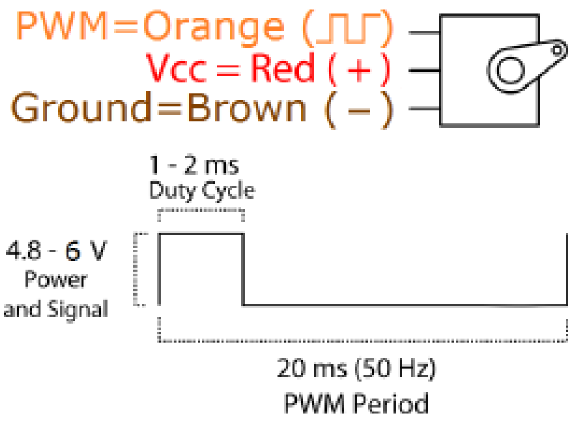
MG90S servo, Metal gear with one bearing

Tiny and lightweight with high output power, this tiny servo is perfect for RC Airplane, Helicopter, Quadcopter or Robot. This servo has *metal gears* for added strength and durability.

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: 13.4 g
- Dimension: 22.5 x 12 x 35.5 mm approx.
- Stall torque: 1.8 kgf·cm (4.8V), 2.2 kgf·cm (6 V)
- Operating speed: 0.1 s/60 degree (4.8 V), 0.08 s/60 degree (6 V)
- Operating voltage: 4.8 V - 6.0 V
- Dead band width: 5 µs



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.

Sensor Ultrasonik HC-SR04

HC-SR04 User Guide

1. Ultrasonic Distance Measurement Principles

The transmitter emits a 8 bursts of an directional 40KHz ultrasonic wave when triggered and starts a timer. Ultrasonic pulses travel outward until they encounter an object, The object causes the the wave to be reflected back towards the unit. The ultrasonic receiver would detect the reflected wave and stop the stop timer. The velocity of the ultrasonic burst is 340m/sec. in air. Based on the number of counts by the timer, the distance can be calculated between the object and transmitter The TRD Measurement formula is expressed as: D = C X T which is know as the time/rate/distance measurement formula where D is the measured distance, and R is the propagation velocity (Rate) in air (speed of sound) and T represents time. In this application T is devided by 2 as T is double the time value from transmitter to object back to receiver.

2. Product Features

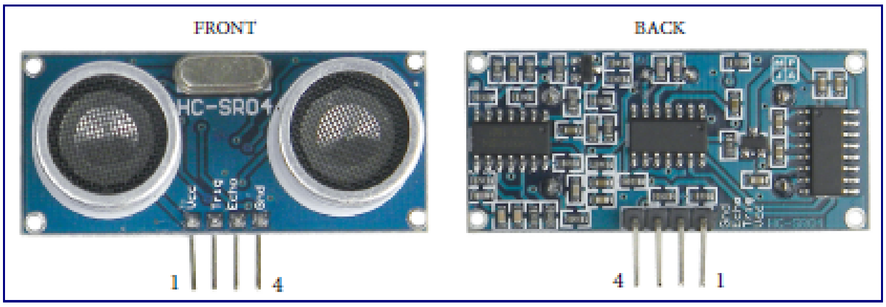
Features

- Stable performance (Xtal.)
- Accurate distance measurement
- High-density SMD Board
- Close Range (2cm)

Uses

- Robotics barrier
- Object distance measurement
- Level detection
- Security systems
- Vehicle detection/avoidance

3. Product Views



4. Module Pin Asignments

	Pin Symbol	Pin Function Description
1	VCC	5V power supply
2	Trig	Trigger Input pin
3	Echo	Receiver Output pin
4	GND	Power ground

5. Electrical Specifications

WARARNING
Do Not connect Module with Power Applied! Always apply power after connecting
Connect "GND" Terminal first

Electrical Parameters	HC-SR04 Ultrasonic Module
Operating Voltage	5VDC
Operating Current	15mA
Operating Frequency	40KHz
Max. Range	4m
Nearest Range	2cm
Measuring Angle	15 Degrees
Input Trigger Signal	10us min. TTL pulse
Output Echo Signal	TTL level signal, proportional to distance
Board Dimensions	1-13/16" X 13/16" X 5/8"
Board Connections	4 X 0.1" Pitch Right Angle Header Pins

6. Module Operation

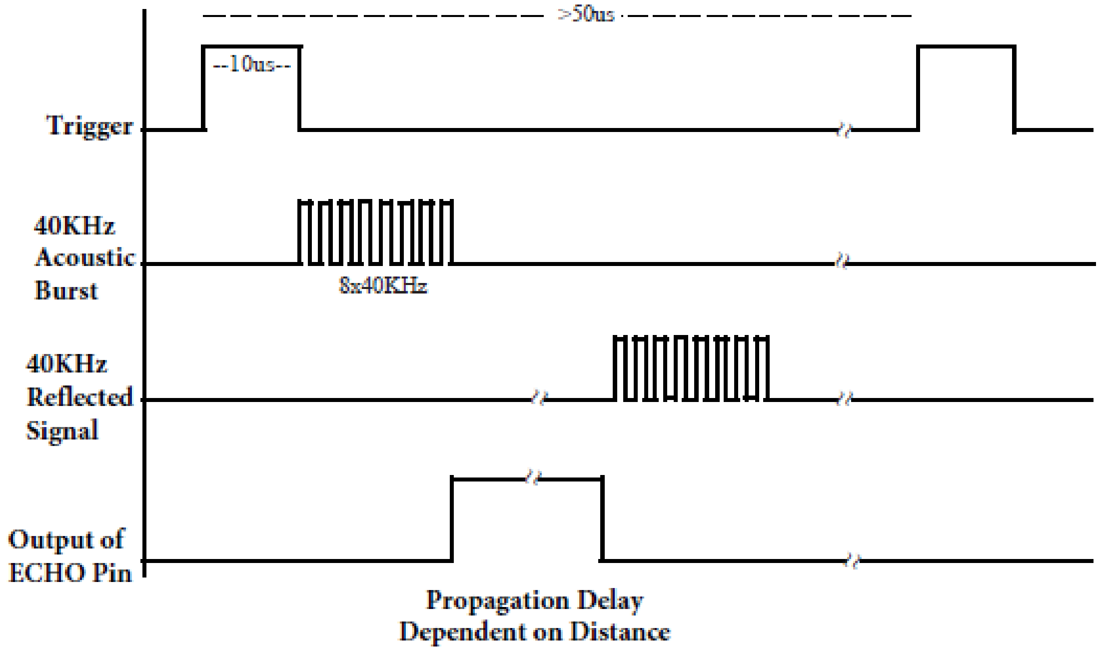
Set Trig and Echo Low to initalize module. Place a minimum 10us High level pulse to "Trigger" (module will automatically send eight 40KHz acoustic bursts). At the same time, Gate the microcontroller timer to start timing.

Wait to capture the rising edge output of ECHO port to stop the timer. Now read the time of the counter, which is the ultrasonic propagation time in the air. According to the formula: Distance = (ECHO high level time X ultrasonic velocity (Speed of Sound in air 340m/sec) / 2, you can calculate the distance to the obstacle.

For best results and maximum range, the Object should be larger than $0.5M^2$ the nearer the target object, the smaller it may be

7. ModuleTiming

HC-SR04 ULTRASONIC MODULE



Trigger 10us min. start measurement from microcontroller.
Max Rep. Rate: 50us
ECHO Output pulse to microcontroller, width is the time from last of 8 40KHz bursts to detected reflected signal (microcontroller Timer gate signal)
Distance in cm = echo pulse width in uS/58
Distance in inch = echo pulse width in uS/148

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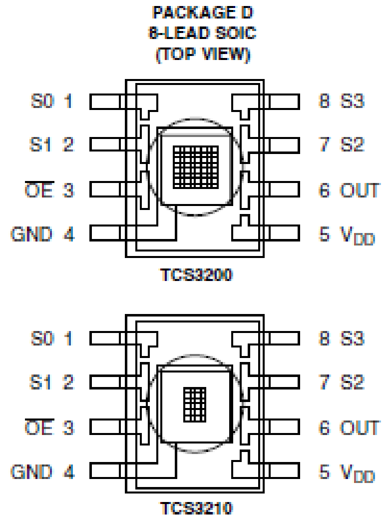
Sensor Warna TCS3200

- **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**



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).

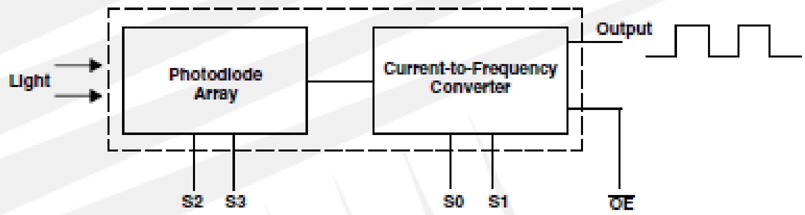
The full-scale output frequency can be scaled by one of three preset values via two control input pins. Digital inputs and digital output allow direct interface to a microcontroller or other logic circuitry. Output enable ($\overline{OE}$) places the output in the high-impedance state for multiple-unit 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.

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.

Functional Block Diagram



Terminal Functions

TERMINAL NAME	TERMINAL 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

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 of the 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	
f_O	Output frequency (Note 9)	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)										
R_e	Irradiance responsivity (Note 10)	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 $\Delta\lambda½$ = 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 $\Delta\lambda½$ = 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 $\Delta\lambda½$ = 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.

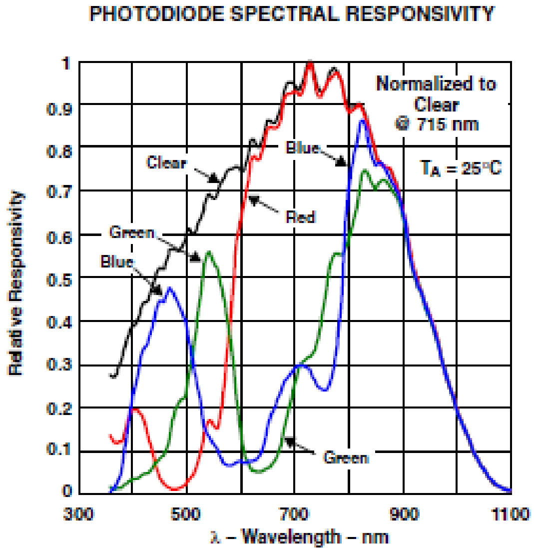


Figure 1

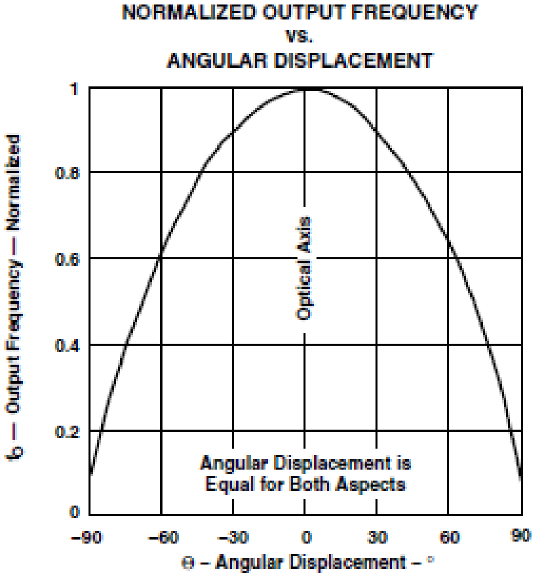


Figure 2

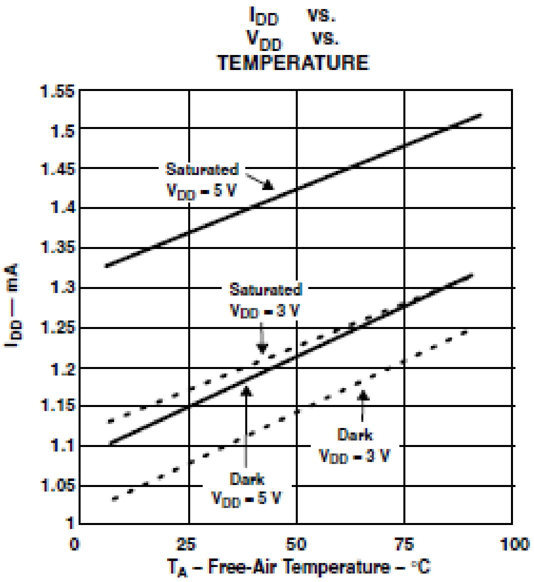


Figure 3

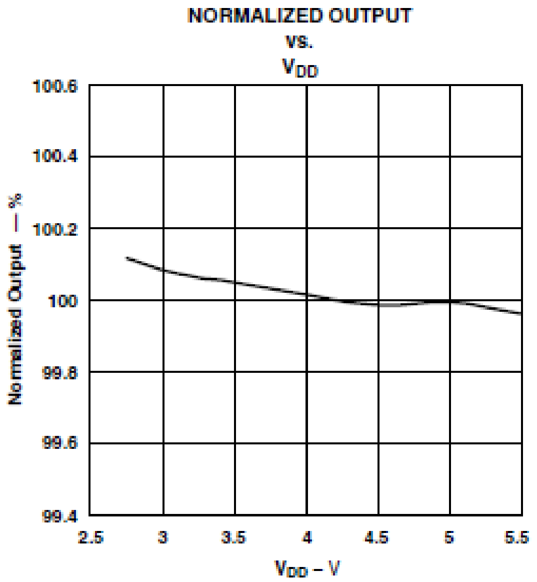


Figure 4

TYPICAL CHARACTERISTICS

PHOTODIODE RESPONSIVITY TEMPERATURE COEFFICIENT vs. WAVELENGTH OF INCIDENT LIGHT

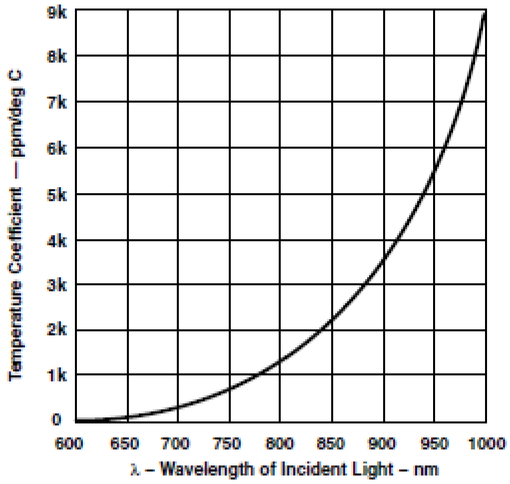


Figure 5

APPLICATION INFORMATION

Power supply considerations

Power-supply lines must be decoupled by a 0.01-µF to 0.1-µF capacitor with short leads mounted close to the device package.

Input interface

A low-impedance electrical connection between the device $\overline{OE}$ pin and the device GND pin is required for improved noise immunity. All input pins must be either driven by a logic signal or connected to VDD or GND — they should not be left unconnected (floating).

Output interface

The output of the device is designed to drive a standard TTL or CMOS logic input over short distances. If lines greater than 12 inches are used on the output, a buffer or line driver is recommended.

A high state on Output Enable (OE) places the output in a high-impedance state for multiple-unit sharing of a microcontroller input line.

Power down

Powering down the sensor using S0/S1 (L/L) will cause the output to be held in a high-impedance state. This is similar to the behavior of the output enable pin, however powering down the sensor saves significantly more power than disabling the sensor with the output enable pin.

Photodiode type (color) selection

The type of photodiode (blue, green, red, or clear) used by the device is controlled by two logic inputs, S2 and S3 (see Table 1).

Output frequency scaling

Output-frequency scaling is controlled by two logic inputs, S0 and S1. The internal light-to-frequency converter generates a fixed-pulsewidth pulse train. Scaling is accomplished by internally connecting the pulse-train output of the converter to a series of frequency dividers. Divided outputs are 50%-duty cycle square waves with relative frequency values of 100%, 20%, and 2%. Because division of the output frequency is accomplished by counting pulses of the principal internal frequency, the final-output period represents an average of the multiple periods of the principle frequency.

The output-scaling counter registers are cleared upon the next pulse of the principal frequency after any transition of the S0, S1, S2, S3, and $\overline{OE}$ lines. The output goes high upon the next subsequent pulse of the principal frequency, beginning a new valid period. This minimizes the time delay between a change on the input lines and the resulting new output period. The response time to an input programming change or to an irradiance step change is one period of new frequency plus 1 µs. The scaled output changes both the full-scale frequency and the dark frequency by the selected scale factor.

The frequency-scaling function allows the output range to be optimized for a variety of measurement techniques. The scaled-down outputs may be used where only a slower frequency counter is available, such as low-cost microcontroller, or where period measurement techniques are used.

APPLICATION INFORMATION

Measuring the frequency

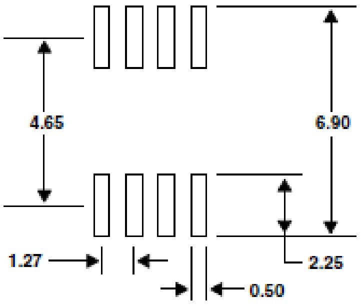
The choice of interface and measurement technique depends on the desired resolution and data acquisition rate. For maximum data-acquisition rate, period-measurement techniques are used.

Output data can be collected at a rate of twice the output frequency or one data point every microsecond for full-scale output. Period measurement requires the use of a fast reference clock with available resolution directly related to reference clock rate. Output scaling can be used to increase the resolution for a given clock rate or to maximize resolution as the light input changes. Period measurement is used to measure rapidly varying light levels or to make a very fast measurement of a constant light source.

Maximum resolution and accuracy may be obtained using frequency-measurement, pulse-accumulation, or integration techniques. Frequency measurements provide the added benefit of averaging out random- or high-frequency variations (jitter) resulting from noise in the light signal. Resolution is limited mainly by available counter registers and allowable measurement time. Frequency measurement is well suited for slowly varying or constant light levels and for reading average light levels over short periods of time. Integration (the accumulation of pulses over a very long period of time) can be used to measure exposure, the amount of light present in an area over a given time period.

PCB Pad Layout

Suggested PCB pad layout guidelines for the D package are shown in Figure 6.

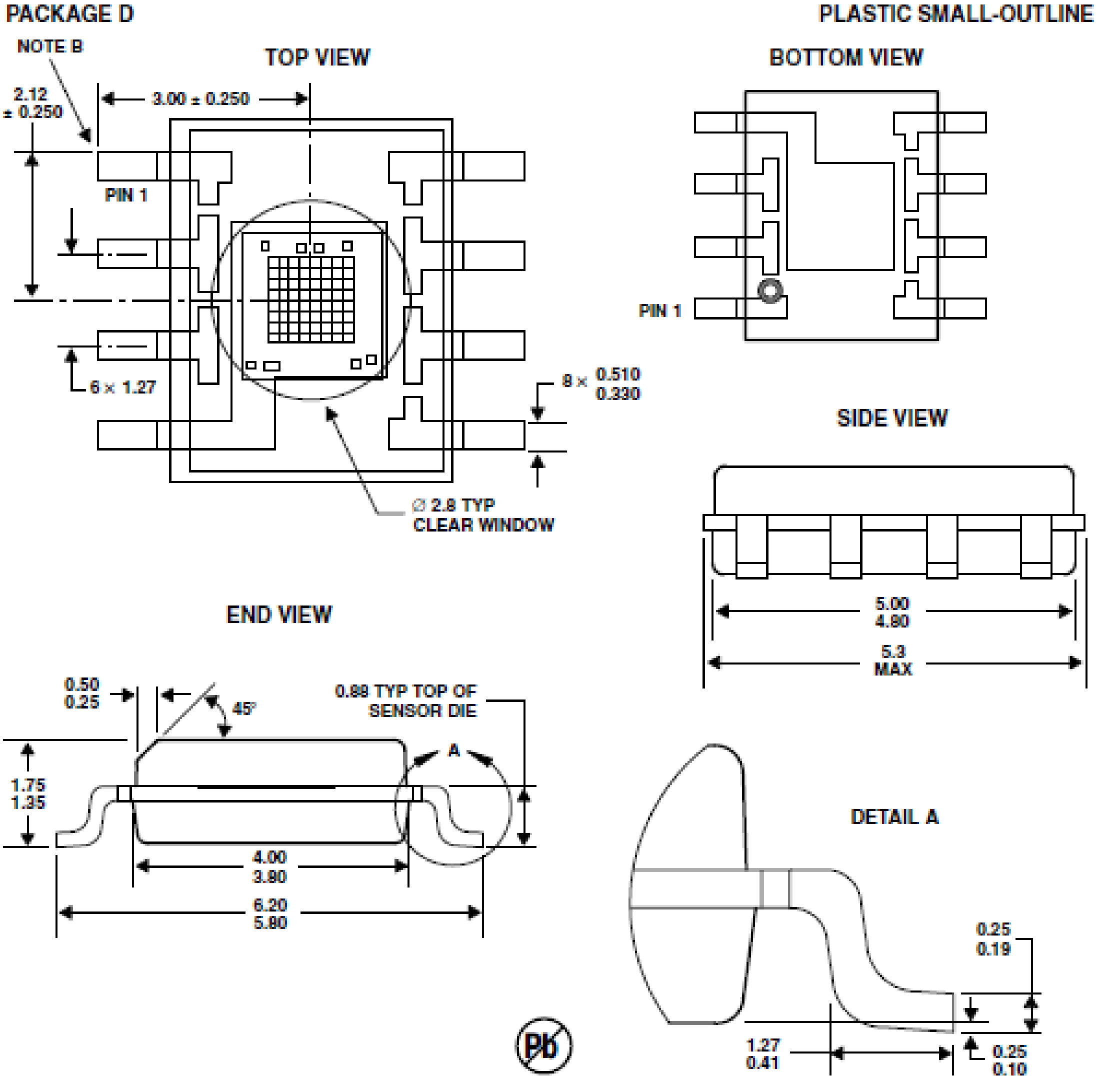


NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.

Figure 6. Suggested D Package PCB Layout

MECHANICAL INFORMATION

This SOIC package consists of an integrated circuit mounted on a lead frame and encapsulated with an electrically nonconductive clear plastic compound. The TCS3200 has an 8 × 8 array of photodiodes with a total size of 1 mm by 1 mm. The photodiodes are 110 μm × 110 μm in size and are positioned on 134 μm centers.

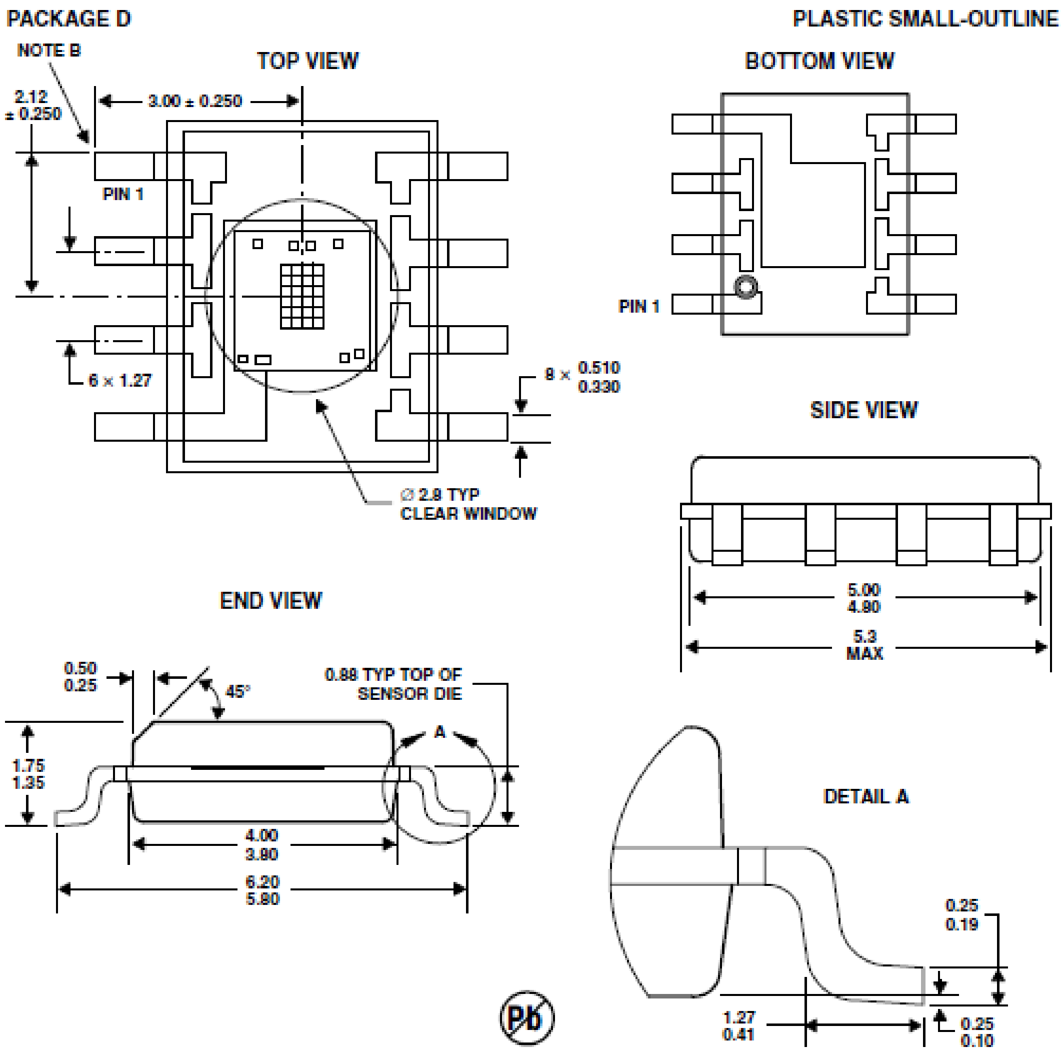


NOTES: A. All linear dimensions are in millimeters.
B. The center of the 1-mm by 1-mm photo-active area is referenced to the upper left corner tip of the lead frame (Pin 1).
C. Package is molded with an electrically nonconductive clear plastic compound having an index of refraction of 1.55.
D. This drawing is subject to change without notice.

Figure 7. Package D — TCS3200 Plastic Small Outline IC Packaging Configuration

MECHANICAL INFORMATION

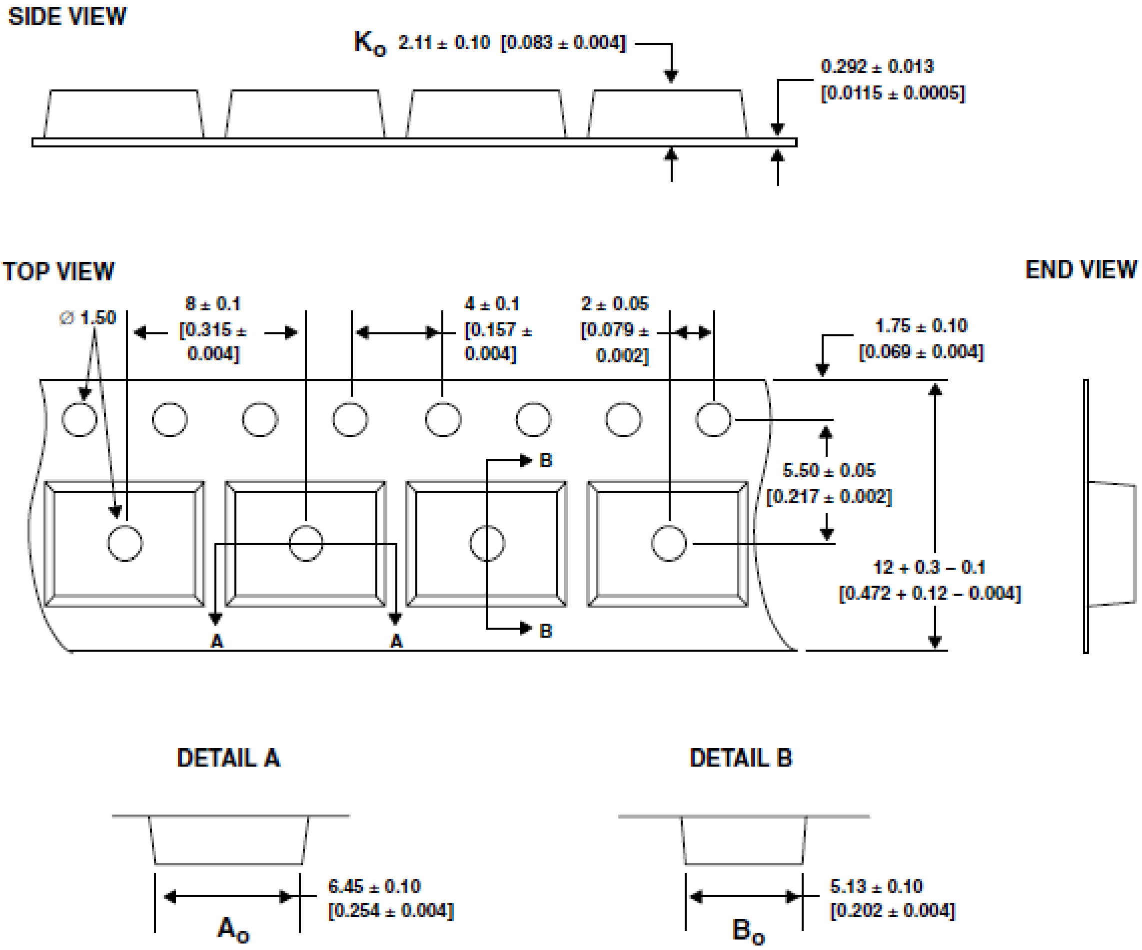
This SOIC package consists of an integrated circuit mounted on a lead frame and encapsulated with an electrically nonconductive clear plastic compound. The TCS3210 has a 4 × 6 array of photodiodes with a total size of 0.54 mm by 0.8 mm. The photodiodes are 110 µm × 110 µm in size and are positioned on 134 µm centers.



NOTES: A. All linear dimensions are in millimeters.
B. The center of the 0.54-mm by 0.8-mm photo-active area is referenced to the upper left corner tip of the lead frame (Pin 1).
C. Package is molded with an electrically nonconductive clear plastic compound having an index of refraction of 1.55.
D. This drawing is subject to change without notice.

Figure 8. Package D — TCS3210 Plastic Small Outline IC Packaging Configuration

MECHANICAL INFORMATION



NOTES:
- A. All linear dimensions are in millimeters [inches].
- B. The dimensions on this drawing are for illustrative purposes only. Dimensions of an actual carrier may vary slightly.
- C. Symbols on drawing A_o, B_o, and K_o are defined in ANSI EIA Standard 481–B 2001.
- D. Each reel is 178 millimeters in diameter and contains 1000 parts.
- E. TAOS packaging tape and reel conform to the requirements of EIA Standard 481–B.
- F. This drawing is subject to change without notice.

Figure 9. Package D Carrier Tape

MANUFACTURING INFORMATION

The Plastic Small Outline IC package (D) has been tested and has demonstrated an ability to be reflow soldered to a PCB substrate.

The solder reflow profile describes the expected maximum heat exposure of components during the solder reflow process of product on a PCB. Temperature is measured on top of component. The component should be limited to a maximum of three passes through this solder reflow profile.

Table 2. TCS3200, TCS3210 Solder Reflow Profile

PARAMETER	REFERENCE	TCS32x0
Average temperature gradient in preheating		2.5°C/sec
Soak time	t_{soak}	2 to 3 minutes
Time above 217°C	t_1	Max 60 sec
Time above 230°C	t_2	Max 50 sec
Time above T_{peak} −10°C	t_3	Max 10 sec
Peak temperature in reflow	T_{peak}	260° C (−0°C/+5°C)
Temperature gradient in cooling		Max −5°C/sec

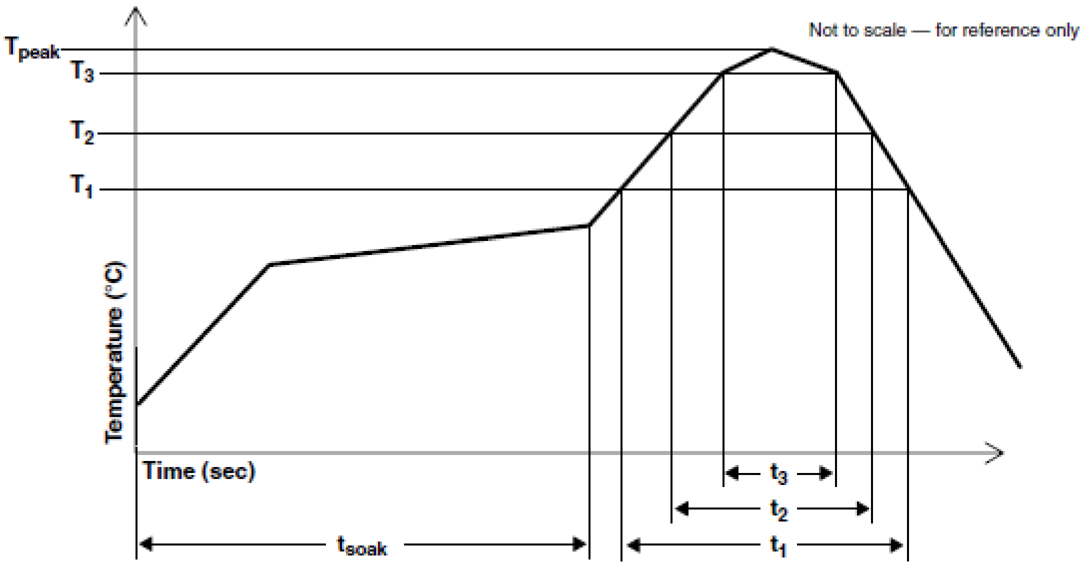


Figure 10. TCS3200, TCS3210 Solder Reflow Profile Graph

Moisture Sensitivity

Optical characteristics of the device can be adversely affected during the soldering process by the release and vaporization of moisture that has been previously absorbed into the package molding compound. To prevent these adverse conditions, all devices shipped in carrier tape have been pre-baked and shipped in a sealed moisture-barrier bag. No further action is necessary if these devices are processed through solder reflow within 24 hours of the seal being broken on the moisture-barrier bag.

However, for all devices shipped in tubes or if the seal on the moisture barrier bag has been broken for 24 hours or longer, it is recommended that the following procedures be used to ensure the package molding compound contains the smallest amount of absorbed moisture possible.

For devices shipped in tubes:

1. Remove devices from tubes
2. Bake devices for 4 hours, at 90°C
3. After cooling, load devices back into tubes
4. Perform solder reflow within 24 hours after bake

Bake only a quantity of devices that can be processed through solder reflow in 24 hours. Devices can be re-baked for 4 hours, at 90°C for a cumulative total of 12 hours (3 bakes for 4 hours at 90°C).

For devices shipped in carrier tape:

1. Bake devices for 4 hours, at 90°C in the tape
2. Perform solder reflow within 24 hours after bake

Bake only a quantity of devices that can be processed through solder reflow in 24 hours. Devices can be re–baked for 4 hours in tape, at 90°C for a cumulative total of 12 hours (3 bakes for 4 hours at 90°C).

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Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), 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 Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

Schematic & Reference Design

EAGLE files: arduino-mega2560-reference-design.zip

Schematic: arduino-mega2560-schematic.pdf

Summary

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	54 (of which 14 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

Power

The Arduino Mega 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 Mega2560 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.

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.

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

- **GND.** Ground pins.

Memory

The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 54 digital pins on the Mega 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); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

- **External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2).** 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: 0 to 13.** Provide 8-bit PWM output with the analogWrite() function.

- **SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS).** These pins support SPI communication using the SPI library. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Uno, Duemilanove and Diecimila.

- **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.

- **I^2C: 20 (SDA) and 21 (SCL).** Support I^2C (TWI) communication using the Wire library (documentation on the Wiring website). Note that these pins are not in the same location as the I^2C pins on the Duemilanove or Diecimila.

The Mega2560 has 16 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 analogReference() function.

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.

Communication

The Arduino Mega2560 has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega8U2 on the board channels one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2 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 Mega2560's digital pins.

The ATmega2560 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation on the Wiring website for details. For SPI communication, use the SPI library.

Programming

The Arduino Mega can be programmed with the Arduino software (download). For details, see the reference and tutorials.

The ATmega2560 on the Arduino Mega 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 in the Arduino repository. 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). See this user-contributed tutorial for more information.

Automatic (Software) Reset

Rather then requiring a physical press of the reset button before an upload, the Arduino Mega2560 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 ATmega2560 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 Mega2560 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 Mega2560. 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 Mega2560 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 Mega2560 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.

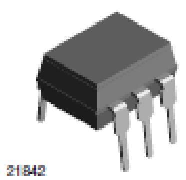
Physical Characteristics and Shield Compatibility

The maximum length and width of the Mega2560 PCB are 4 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.

The Mega2560 is designed to be compatible with most shields designed for the Uno, Diecimila or Duemilanove. Digital pins 0 to 13 (and the adjacent AREF and GND pins), analog inputs 0 to 5, the power header, and ICSP header are all in equivalent locations. Further the main UART (serial port) is located on the same pins (0 and 1), as are external interrupts 0 and 1 (pins 2 and 3 respectively). SPI is available through the ICSP header on both the Mega2560 and Duemilanove / Diecimila. *Please note that I²C is not located on the same pins on the Mega (20 and 21) as the Duemilanove / Diecimila (analog inputs 4 and 5).*

Optocoupler

Optocoupler, Phototransistor Output, with Base Connection



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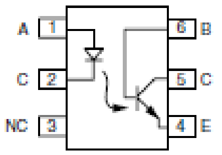


FEATURES

- Isolation test voltage 5000 V_{RMS}
- Interfaces with common logic families
- Input-output coupling capacitance < 0.5 pF
- Industry standard dual-in-line 6 pin package
- Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC

APPLICATIONS

- AC mains detection
- Reed relay driving
- Switch mode power supply feedback
- Telephone ring detection
- Logic ground isolation
- Logic coupling with high frequency noise rejection

DESCRIPTION

Each optocoupler consists of gallium arsenide infrared LED and a silicon NPN phototransistor.

AGENCY APPROVALS

- Underwriters laboratory file no. E52744
- BSI: EN 60065:2002, EN 60950:2000
- FIMKO; EN 60065, EN 60335, EN 60950 certificate no. 25156

ORDER INFORMATION	
PART	REMARKS
4N35	CTR > 100 %, DIP-6
4N36	CTR > 100 %, DIP-6
4N37	CTR > 100 %, DIP-6

ABSOLUTE MAXIMUM RATINGS (1)				
PARAMETER	TEST CONDITION	SYMBOL	VALUE	UNIT
INPUT				
Reverse voltage		V_R	6	V
Forward current		I_F	50	mA
Surge current	$t \le 10$ µs	I_{FSM}	1	A
Power dissipation		P_{diss}	70	mW
OUTPUT				
Collector emitter breakdown voltage		V_{CEO}	70	V
Emitter base breakdown voltage		V_{EBO}	7	V
Collector current		I_C	50	mA
	$t \le 1$ ms	I_C	100	mA
Power dissipation		P_{diss}	70	mW
COUPLER				
Isolation test voltage		V_{ISO}	5000	V_{RMS}
Creepage			≥ 7	mm
Clearance			≥ 7	mm
Isolation thickness between emitter and detector			≥ 0.4	mm

ABSOLUTE MAXIMUM RATINGS (1)				
PARAMETER	TEST CONDITION	SYMBOL	VALUE	UNIT
COUPLER				
Comparative tracking index	DIN IEC 112/VDE 0303, part 1		175	
Isolation resistance	V_{IO} = 500 V, T_{amb} = 25 °C	R_{IO}	10^{12}	Ω
	V_{IO} = 500 V, T_{amb} = 100 °C	R_{IO}	10^{11}	Ω
Storage temperature		T_{stg}	- 55 to + 150	°C
Operating temperature		T_{amb}	- 55 to + 100	°C
Junction temperature		T_j	100	°C
Soldering temperature (2)	max.10 s dip soldering: distance to seating plane ≥ 1.5 mm	T_{sld}	260	°C

Notes

(1) T_{amb} = 25 °C, unless otherwise specified.
Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of this document. Exposure to absolute maximum ratings for extended periods of the time can adversely affect reliability.

(2) Refer to wave profile for soldering condditions for through hole devices (DIP).

ELECTRICAL CHARACTERISTICS (1)							
PARAMETER	TEST CONDITION	PART	SYMBOL	MIN.	TYP.	MAX.	UNIT
INPUT							
Junction capacitance	V_R = 0 V, f = 1 MHz		C_j		50		pF
Forward voltage (2)	I_F = 10 mA		V_F		1.3	1.5	V
	I_F = 10 mA, T_{amb} = - 55 °C		V_F	0.9	1.3	1.7	V
Reverse current (2)	V_R = 6 V		I_R		0.1	10	µA
Capacitance	V_R = 0 V, f = 1 MHz		C_O		25		pF
OUTPUT							
Collector emitter breakdown voltage(2)	I_C = 1 mA	4N35	BV_{CEO}	30			V
		4N36	BV_{CEO}	30			V
		4N37	BV_{CEO}	30			V
Emitter collector breakdown voltage(2)	I_E = 100 µA		BV_{ECO}	7			V
OUTPUT							
Collector base breakdown voltage (2)	I_C = 100 µA, I_B = 1 µA	4N35	BV_{CBO}	70			V
		4N36	BV_{CBO}	70			V
		4N37	BV_{CBO}	70			V
Collector emitter leakage current (2)	V_{CE} = 10 V, I_F = 0	4N35	I_{CEO}		5	50	nA
		4N36	I_{CEO}		5	50	nA
	V_{CE} = 10 V, I_F = 0	4N37	I_{CEO}		5	50	nA
	V_{CE} = 30 V, I_F = 0, T_{amb} = 100 °C	4N35	I_{CEO}			500	µA
		4N36	I_{CEO}			500	µA
		4N37	I_{CEO}			500	µA
Collector emitter capacitance	V_{CE} = 0		C_{CE}		6		pF
COUPLER							
Resistance, input output (2)	V_{IO} = 500 V		R_{IO}	10^{11}			Ω
Capacitance, input output	f = 1 MHz		C_{IO}		0.6		pF

Notes

(1) T_{amb} = 25 °C, unless otherwise specified.
Minimum and maximum values are testing requirements. Typical values are characteristics of the device and are the result of engineering evaluation. Typical values are for information only and are not part of the testing requirements.

(2) Indicates JEDEC registered value.

CURRENT TRANSFER RATIO

PARAMETER	TEST CONDITION	PART	SYMBOL	MIN	TYP.	MAX	UNIT
DC current transfer ratio [1]	V_{CE} = 10 V, I_F = 10 mA	4N35	CTR_{DC}	100			%
		4N36	CTR_{DC}	100			%
		4N37	CTR_{DC}	100			%
	V_{CE} = 10 V, I_F = 10 mA, T_A = - 55 °C to + 100 °C	4N35	CTR_{DC}	40	50		%
		4N36	CTR_{DC}	40	50		%
		4N37	CTR_{DC}	40	50		%

Note
(1) Indicates JEDEC registered values.

SWITCHING CHARACTERISTICS

PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Switching time [1]	V_{CC} = 10 V, I_C = 2 mA, R_L = 100 Ω	t_{on}, t_{off}		10		μs

Note
(1) Indicates JEDEC registered values.

TYPICAL CHARACTERISTICS

T_{amb} = 25 °C, unless otherwise specied

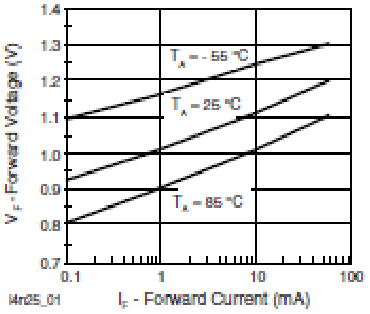


Fig. 1 - Forward Voltage vs. Forward Current

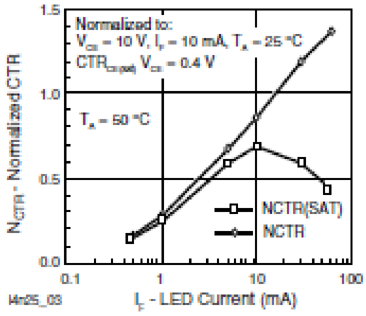


Fig. 3 - Normalized Non-Saturated and Saturated CTR vs. LED Current

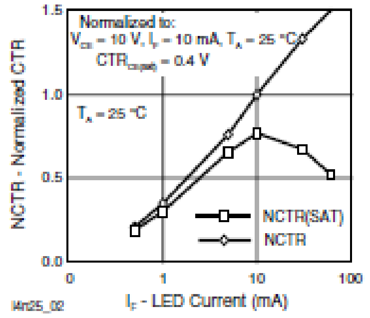


Fig. 2 - Normalized Non-Saturated and Saturated CTR vs. LED Current

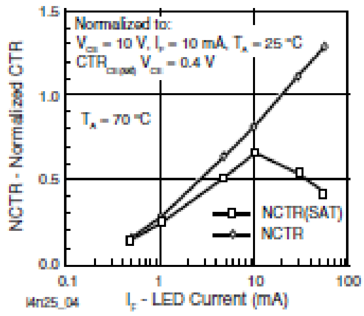


Fig. 4 - Normalized Non-Saturated and Saturated CTR vs. LED Current

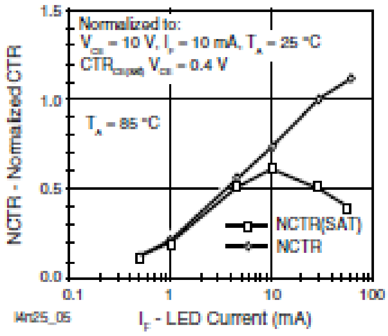


Fig. 5 - Normalized Non-Saturated and Saturated CTR vs. LED Current

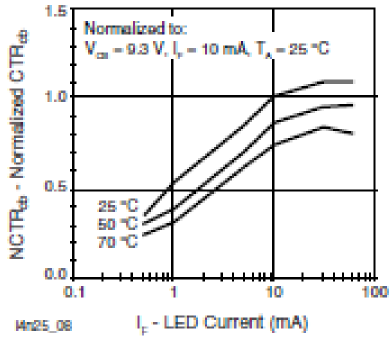


Fig. 8 - Normalized CTR_{cb} vs. LED Current and Temperature

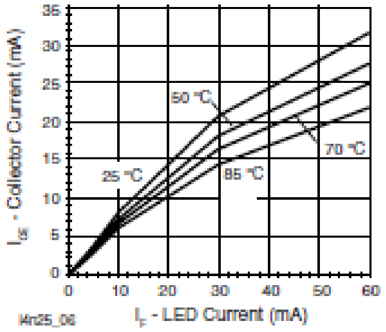


Fig. 6 - Collector Emitter Current vs. Temperature and LED Current

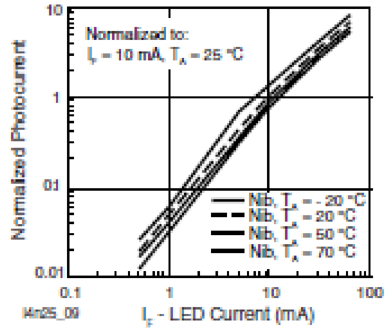


Fig. 9 - Normalized Photocurrent vs. I_F and Temperature

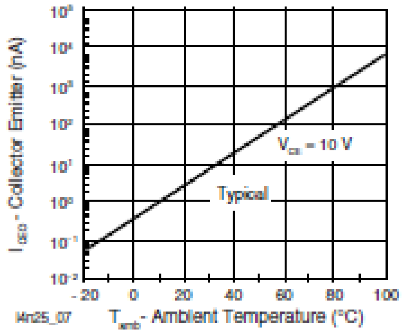


Fig. 7 - Collector Emitter Leakage Current vs. Temperature

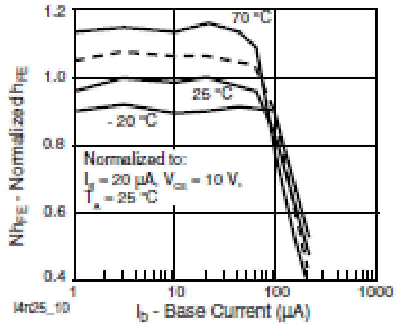


Fig. 10 - Normalized Non-Saturated h_{FE} vs. Base Current and Temperature

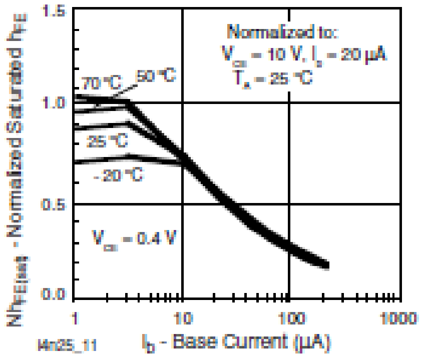


Fig. 11 - Normalized h_{FE} vs. Base Current and Temperature

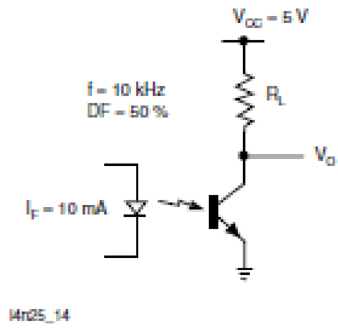


Fig. 14 - Switching Schematic

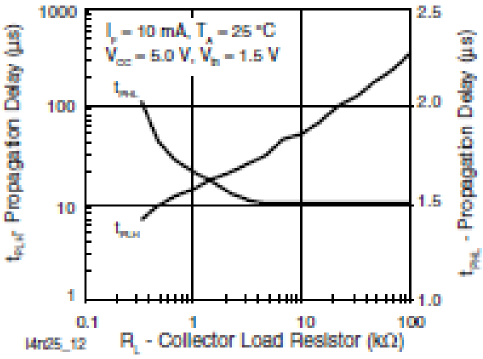


Fig. 12 - Propagation Delay vs. Collector Load Resistor

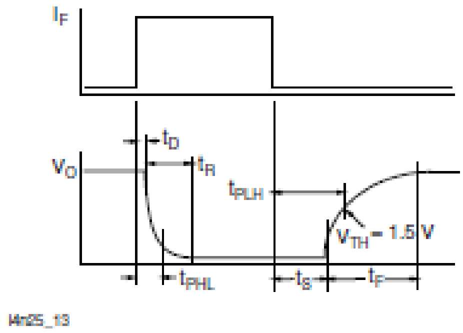
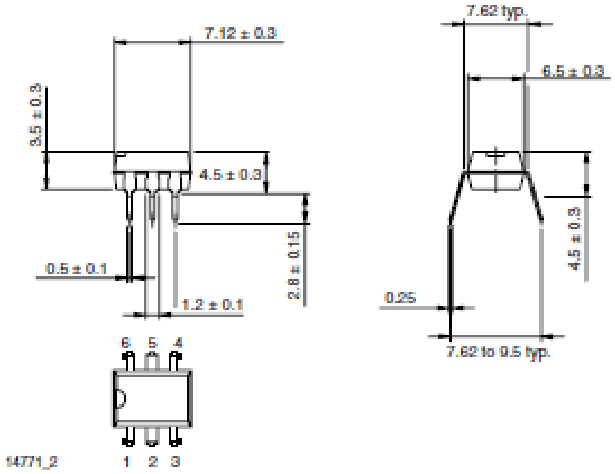


Fig. 13 - Switching Timing

PACKAGE DIMENSIONS in millimeters



PACKAGE MARKING

Relay

4-Channel 5V Relay Module

Description

Overview

This is a 5V 4-Channels Relay module, It can be controlled directly by a wide range of microcontrollers such as Arduino, AVR, PIC, ARM and MSP430.

4 relays are included in this module, with "NC" ports means "Normally connected to COM" and "NO" ports means "Normally open to COM". This module also equipped with 4 LEDS to show the status of relays.

Features

- 4 mechanical relays with status indicator LED
- Both "NC" and "NO" ports for each relay

Specification

- Module Type: Control
- Weight: 70.00g
- Board Size: 8 x 4.8 x 2cm
- Version: 1
- Operation Level: Digital 5V
- Power Supply: External 5V

PLC Omron tipe CP1L

OMRON

CP1L

CPU Units and Expansion Units

When it comes to controllers for compact machines, Omron's new CP1L series offers the compactness of a micro-PLC with the capability of a modular PLC.

But this new and exciting range is not only compact, it is scaleable, has a faster processing speed than other controllers and is in a class of its own when it comes to price/performance. Naturally, it is compatible with all other devices in the Omron PLC line up.

- 4 high-speed encoder inputs and 2 high-speed pulse outputs
- CPUs with AC or DC supply and 14, 20, 30 or 40 I/O built-in
- Instruction set compatible with CP1H-, CJ1-, and CS1 series PLC
- Optional RS232C and RS-422A/485 serial ports
- USB programming port
- Scaleable with a wide range of I/O units (maximum up to 160 I/O points)
- Motion functionality
- One and the same software as other Omron controllers

CPU Unit Specification

Item / Type / Model	AC power supply models	DC power supply models
	CP1L-□□□-A	CP1L-□□□-D
Power supply	100 to 240 VAC 50/60 Hz	24 VDC
Operating voltage range	85 to 264 VAC	20.4 to 26.4 VDC
Power consumption	50 VA max. (CP1L-M40/M30DR-A) (See next page.) 30 VA max. (CP1L-L20/L14DR-A)	20 W max. (CP1L-M40/M30□□-D) (See next page.) 13 W max. (CP1L-L20/L14□□-D)
Inrush current (See note.)	100 to 120 VAC inputs: 20 A max. (for cold start at room temperature) 8 ms max. 200 to 240 VAC inputs: 40 A max. (for cold start at room temperature), 8 ms max.	30 A max. (for cold start at room temperature) 20 ms max.
External power supply	300 mA at 24 VDC (CP1L-M30/M40) 200 mA at 24 VDC (CP1L-L14/L20)	None
Insulation resistance	20 MΩ min. (at 500 VDC) between the external AC terminals and GR terminals	No insulation between primary and secondary for DC power supply
Dielectric strength	2,300 VAC at 50/60 Hz for 1 min between the external AC and GR terminals, leakage current: 5 mA max.	No insulation between primary and secondary for DC power supply
Noise immunity	Conforms to IEC 61000-4-4. 2 kV (power supply line)	
Vibration resistance	Conforms to JIS C0040. 10 to 57 Hz, 0.075-mm amplitude, 57 to 150 Hz, acceleration: 9.8 m/s^2 in X, Y, and Z directions for 80 minutes each. Sweep time: 8 minutes x 10 sweeps = total time of 80 minutes)	
Shock resistance	Conforms to JIS C0041. 147 m/s^2 three times each in X, Y, and Z directions	
Ambient operating temperature	0 to 55°C	
Ambient humidity	10% to 90% (with no condensation)	
Ambient operating environment	No corrosive gas	
Ambient storage temperature	-20 to 75°C (Excluding battery.)	
Power holding time	10 ms min.	2 ms min.

Note: The above values are for a cold start at room temperature for an AC power supply, and for a cold start for a DC power supply.

- A thermistor (with low-temperature current suppression characteristics) is used in the inrush current control circuitry for the AC power supply. The thermistor will not be sufficiently cooled if the ambient temperature is high or if a hot start is performed when the power supply has been OFF for only a short time. In those cases the inrush current values may be higher (as much as two times higher) than those shown above. Always allow for this when selecting fuses and breakers for external circuits.
- A capacitor charge-type delay circuit is used in the inrush current control circuitry for the DC power supply. The capacitor will not be charged if a hot start is performed when the power supply has been OFF for only a short time, so in those cases the inrush current values may be higher (as much as two times higher) than those shown above.

CPU Units

Item		CP1L-M40 (40 points)	CP1L-M30 (30 points)	CP1L-L20 (20 points)	CP1L-L14 (14 points)
Models		CP1L-M40□□-□	CP1L-M30□□-□	CP1L-L20□□-□	CP1L-L14□□-□
Control method		Stored program method			
I/O control method		Cyclic scan with immediate refreshing			
Program language		Ladder diagram			
Function blocks		Maximum number of function block definitions: 128 Maximum number of instances: 256 Languages usable in function block definitions: Ladder diagrams, structured text (ST)			
Instruction length		1 to 7 steps per instruction			
Instructions		Approx. 500 (function codes: 3 digits)			
Instruction execution time		Basic instructions: 0.55 μs min. Special instructions: 4.1 μs min.			
Common processing time		0.4 ms			
Program capacity		10K steps		5K steps	
Number of tasks		288 (32 cyclic tasks and 256 interrupt tasks)			
	Scheduled interrupt tasks	1 (interrupt task No. 2, fixed)			
	Input interrupt tasks	6 (interrupt task No. 140 to 145, fixed)			4 (interrupt task No. 140 to 143, fixed)
		(Interrupt tasks can also be specified and executed for high-speed counter interrupts and executed.)			
Maximum subroutine number		256			
Maximum jump number		256			
I/O areas	Input bits	24: CIO 0.00 to CIO 0.11 and CIO 1.00 to CIO 1.11	18: CIO 0.00 to CIO 0.11 and CIO 1.00 to CIO 1.05	12: CIO 0.00 to CIO 0.11	8: CIO 0.00 to CIO 0.07
	Output bits	16: CIO 100.00 to CIO 100.07 and CIO 101.00 to CIO 101.07	12: CIO 100.00 to CIO 100.07 and CIO 101.00 to CIO 101.03	8: CIO 100.00 to CIO 100.07	6: CIO 100.00 to CIO 100.05
	1:1 Link Area	1,024 bits (64 words): CIO 3000.00 to CIO 3063.15 (CIO 3000 to CIO 3063)			
	Serial PLC Link Area	1,440 bits (90 words): CIO 3100.00 to CIO 3189.15 (CIO 3100 to CIO 3189)			
Work bits		8,192 bits (512 words): W000.00 to W511.15 (W0 to W511) CIO Area: 37,504 bits (2,344 words): CIO 3800.00 to CIO 6143.15 (CIO 3800 to CIO 6143)			
TR Area		16 bits: TR0 to TR15			
Holding Area		8,192 bits (512 words): H0.00 to H511.15 (H0 to H511)			
AR Area		Read-only (Write-prohibited): 7168 bits (448 words): A0.00 to A447.15 (A0 to A447) Read/Write: 8192 bits (512 words): A448.00 to A959.15 (A448 to A959)			
Timers		4,096 bits: T0 to T4095			
Counters		4,096 bits: C0 to C4095			
DM Area		32 Kwords: D0 to D32767		10 Kwords: D0 to D9999, D32000 to D32767	
Data Register Area		16 registers (16 bits): DR0 to DR15			
Index Register Area		16 registers (32 bits): IR0 to IR15			
Task Flag Area		32 flags (32 bits): TK0000 to TK0031			
Trace Memory		4,000 words (500 samples for the trace data maximum of 31 bits and 6 words.)			
Memory Cassette		A special Memory Cassette (CP1W-ME05M) can be mounted. **Note:** Can be used for program backups and auto-booting.			
Clock function		Supported. Accuracy (monthly deviation): -4.5 min to -0.5 min (ambient temperature: 55°C), -2.0 min to +2.0 min (ambient temperature: 25°C), -2.5 min to +1.5 min (ambient temperature: 0°C)			
Communications functions		One built-in peripheral port (USB 1.1): For connecting Support Software only.			
		A maximum of two Serial Communications Option Boards can be mounted.		A maximum of one Serial Communications Option Board can be mounted.	
Memory backup		Flash memory: User programs, parameters (such as the PLC Setup), comment data, and the entire DM Area can be saved to flash memory as initial values. Battery backup: The Holding Area, DM Area, and counter values (flags, PV) are backed up by a battery.			
Battery service life		5 years at 25°C. (Use the replacement battery within two years of manufacture.)			
Built-in input terminals		40 (24 inputs, 16 outputs)	30 (18 inputs, 12 outputs)	20 (12 inputs, 8 outputs)	14 (8 inputs, 6 outputs)
Number of connectable Expansion Units and Expansion I/O Units		CP-series Expansion Unit and Expansion I/O Units: 3 max.		CP-series Expansion Units and Expansion I/O Units: 1 max.	
Max. number of I/O points		160 (40 built in + 40 per Expansion (I/O) Unit × 3 Units)	150 (30 built in + 40 per Expansion (I/O) Unit × 3 Units)	60 (20 built in + 40 per Expansion (I/O) Unit × 1 Unit)	54 (14 built in + 40 per Expansion (I/O) Unit × 1 Unit)
Interrupt inputs		6 inputs (Response time: 0.3 ms)			4 inputs (Response time: 0.3 ms)
Interrupt inputs counter mode		6 inputs (Response frequency: 5 kHz max. for all interrupt inputs), 16 bits Up or down counters			4 inputs (Response frequency: 5 kHz max. for all interrupt inputs), 16 bits Up or down counters
Quick-response inputs		6 points (Min. input pulse width: 50 μs max.)			4 points (Min. input pulse width: 50 μs max.)
Scheduled interrupts		1			
High-speed counters		4 counters, 2 axes (24-VDC input) 4 inputs: Differential phases (4x), 50 kHz or Single-phase (pulse plus direction, up/down, increment), 100 kHz Value range: 32 bits, Linear mode or ring mode Interrupts: Target value comparison or range comparison			
Pulse outputs (models with transistor outputs only)	Pulse outputs	Trapezoidal or S-curve acceleration and deceleration (Duty ratio: 50% fixed) 2 outputs, 1 Hz to 100 kHz (CCW/CW or pulse plus direction)			
	PWM outputs	Duty ratio: 0.0% to 100.0% (specified in increments of 0.1% or 1%) 2 outputs, 0.1 to 6553.5 Hz or 1 to 32,800 Hz (Accuracy: ±5% at 1 kHz)			
Analog control		1 (Setting range: 0 to 255)			
External analog input		1 input (Resolution: 1/256, Input range: 0 to 10 V). Not isolated.			

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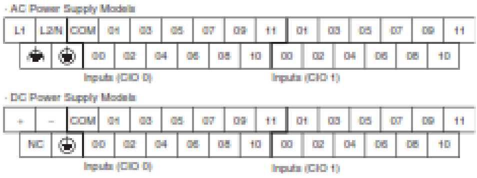
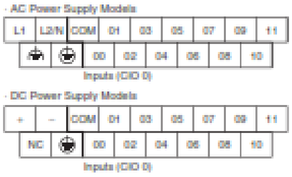
Input Terminal Block Arrangement (Top Block)

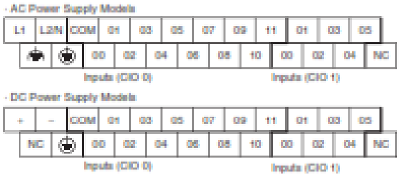
CP1L-M40



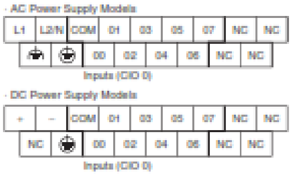
CP1L-L20



CP1L-M30



CP1L-L14



Built-in Input Area

CPU Units

Number of inputs	Input terminal block		Input operation			High-speed counter operation		Origin search
	Word	Bit	Normal inputs	Interrupt inputs	Quick-response inputs	Operation settings • High-speed counters enabled • Phase-Z signal reset		Origin searches enabled for pulse outputs 0 and 1
						Single-phase (increment pulse input)	Two-phase (differential phase x4, up/down, or pulse plus direction)	
14	CIO 0	00	Normal input 0	---	---	High-speed counter 0 (increment)	High-speed counter 0 (phase-A, increment, or count input)	---
		01	Normal input 1	---	---	High-speed counter 1 (increment)	High-speed counter 0 (phase-B, decrement, or count input)	---
		02	Normal input 2	---	---	High-speed counter 2 (increment)	High-speed counter 1 (phase-A, increment, or count input)	Pulse output 0: Origin proximity input signal (See note 1.)
		03	Normal input 3	---	---	High-speed counter 3 (increment)	High-speed counter 1 (phase-B, decrement, or count input)	Pulse output 01 Origin proximity input signal (See note 1.)
		04	Normal input 4	Interrupt input 0	Quick-response input 0	Counter 0, phase-Z/reset input	High-speed counter 0 (phase-Z/reset)	---
		05	Normal input 5	Interrupt input 1	Quick-response input 1	Counter 1, phase-Z/reset input	High-speed counter 1 (phase-Z/reset)	---
		06	Normal input 6	Interrupt input 2	Quick-response input 2	Counter 2, phase-Z/reset input		Pulse output 0: Origin input signal
		07	Normal input 7	Interrupt input 3	Quick-response input 3	Counter 3, phase-Z/reset input		Pulse output 1: Origin input signal
20		08	Normal input 8	Interrupt input 4	Quick-response input 4	---		---
		09	Normal input 9	Interrupt input 5	Quick-response input 5	---		---
		10	Normal input 10	---	---	---		Pulse output 0: Origin proximity input signal (See note 2.)
		11	Normal input 11	---	---	---		Pulse output 1: Origin proximity input signal (See note 2.)
30	CIO 1	00	Normal input 12	---	---	---		---
		01	Normal input 13	---	---	---		---
		02	Normal input 14	---	---	---		---
		03	Normal input 15	---	---	---		---
		04	Normal input 16	---	---	---		---
		05	Normal input 17	---	---	---		---
40		06	Normal input 18	---	---	---		---
		07	Normal input 19	---	---	---		---
		08	Normal input 20	---	---	---		---
		09	Normal input 21	---	---	---		---
		10	Normal input 22	---	---	---		---
		11	Normal input 23	---	---	---		---

Note 1. The origin proximity input signals for CPU Units with 14 points are bits 02 and 03 of CIO 0.
2. The origin proximity input signals for CPU Units with 20 points are bits 10 and 11 of CIO 0.

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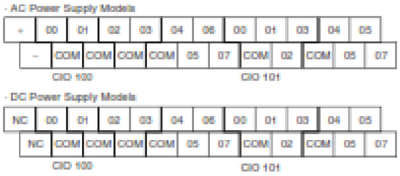
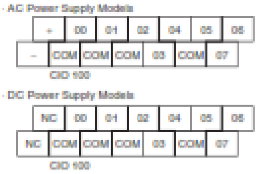
Output Terminal Block Arrangement (Bottom Block)

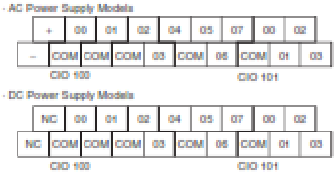
CP1L-M40



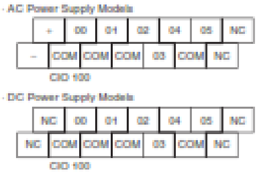
CP1L-L20



CP1L-M30



CP1L-L14

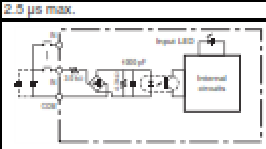
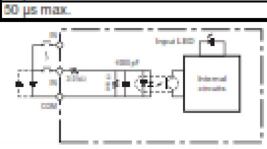
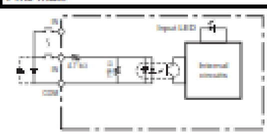


Built-in Output Area

CPU Units

Number of outputs	Output Terminal Block		When the instructions to the right are not executed	When a pulse output instruction (SPED, ACC, PLS2, or ORG) is executed		When the origin search function is set to be used in the PLC Setup, and an origin search is executed by the ORG instruction	When the PWM instruction is executed
	Word	Bit	Normal output	Fixed duty ratio pulse output			Variable duty ratio pulse output
				CW/CCW	Pulse plus direction	When the origin search function is used	PWM output
14	CIO 100	00	Normal output 0	Pulse output 0 (CW)	Pulse output 0 (pulse)	---	---
		01	Normal output 1	Pulse output 0 (CCW)	Pulse output 0 (direction)	---	PWM output 0
		02	Normal output 2	Pulse output 1 (CW)	Pulse output 1 (pulse)	---	---
		03	Normal output 3	Pulse output 1 (CCW)	Pulse output 1 (direction)	---	PWM output 1
		04	Normal output 4	---	---	Origin search 0 (Error counter reset output)	---
		05	Normal output 5	---	---	Origin search 1 (Error counter reset output)	---
20		06	Normal output 6	---	---	---	---
		07	Normal output 7	---	---	---	---
30	CIO 101	00	Normal output 8	---	---	---	---
		01	Normal output 9	---	---	---	---
		02	Normal output 10	---	---	---	---
		03	Normal output 11	---	---	---	---
40		04	Normal output 12	---	---	---	---
		05	Normal output 13	---	---	---	---
		06	Normal output 14	---	---	---	---
		07	Normal output 15	---	---	---	---

Input Specifications

ITEM	Specifications		
	High-speed counter inputs (phases A and B)	Interrupt inputs and quick-response inputs	Normal inputs
CP1L	CIO 0.00 to CIO 0.03	CIO 0.04 to CIO 0.09	CIO 0.10, CIO 0.11 and CIO 1.00 to CIO 1.11
Input voltage	24 VDC +10%/−15%		
Applicable sensors	2-wire sensors		
Input impedance	3.0 kΩ		4.7 kΩ
Input current	7.5 mA typical		5 mA typical
ON voltage	17.0 VDC min.		14.4 VDC min.
OFF voltage/current	1 mA max. at 5.0 VDC		
ON delay	2.5 μs max.	50 μs max.	1 ms max.
OFF delay	2.5 μs max.	50 μs max.	1 ms max.
Circuit configuration			

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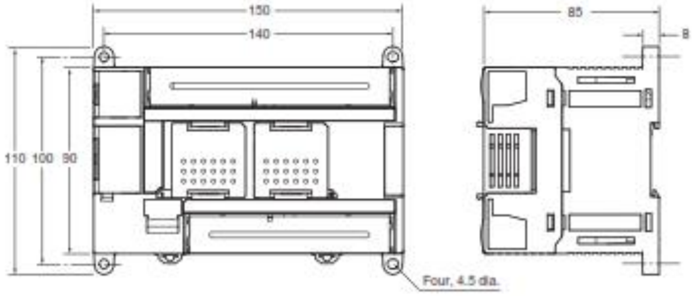
Dimensions

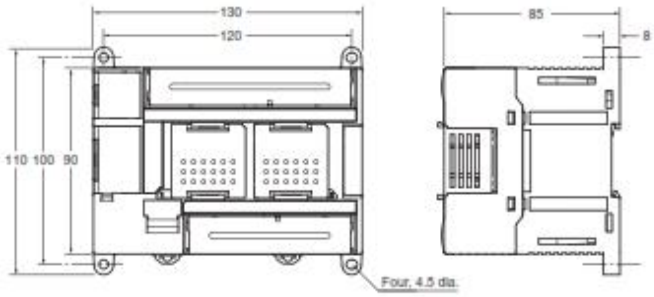
(Unit: mm)

CP1L CPU Units with 40 I/O Points



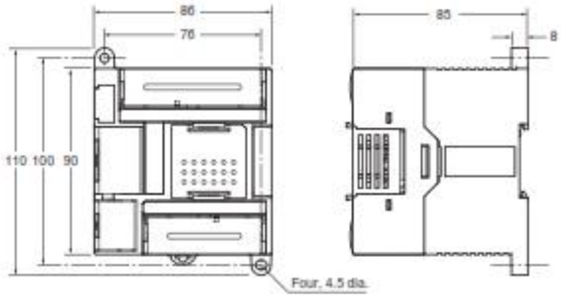
Weight:
675 g max.

CP1L CPU Units with 30 I/O Points



Weight:
610 g max.

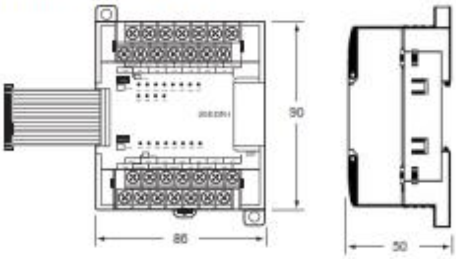
CP1L CPU Units with 14 or 20 I/O Points



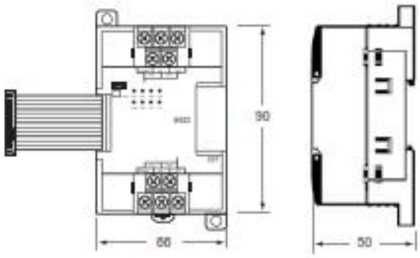
Weight:
380 g max.

Expansion Units and Expansion I/O Units

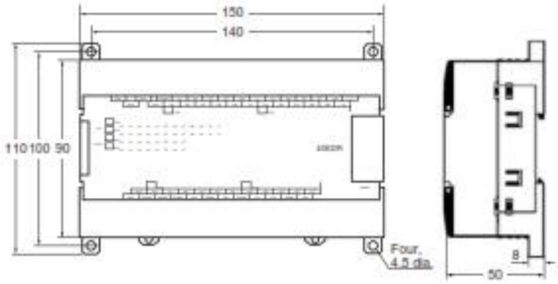
CP1W-20ED□
CP1W-16ER
CP1W-AD041/CP1W-DA041/CP1W-DA021
CP1W-MAD11/CP1W-TS□□□



CP1W-8E□□
CP1W-SRT21



CP1W-40ED□



Unit name	Model number	Weight
Expansion I/O Units	CP1W-40EDR	380 g
	CP1W-40EDT/-40EDT1	320 g
	CP1W-20EDR1/-20EDT/-20EDT1	300 g
	CP1W-16ER	280 g
	CP1W-8ED	200 g
	CP1W-8ER/-8ET/-8ET1	250 g
Analog Units	CP1W-AD041/-DA041/-DA021	200 g
	CP1W-MAD11	150 g
Temperature Sensor Units	CP1W-TS001/-TS002/-TS101/-TS102	250 g
CompoBus/S I/O Link Unit	CP1W-SRT21	200 g

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Ordering Information

CPU Units

International Standards

The standards indicated in the "Standards" column are those current for UL, CSA, cULus, NK, and Lloyd standards and EC Directives as of the end of April 2007. The standards are abbreviated as follows: U: UL, U1: UL (Class I Division 2 Products for Hazardous Locations), C: CSA, UC: cULus, UC1: cULus (Class I Division 2 Products for Hazardous Locations), CU: cUL, N: NK, L: Lloyd, and CE: EC Directives

Ask your OMRON representative for the conditions under which the standards were met.

CP1L CPU Units

CPU Unit	Specifications				Model	Standards
	Power supply	Output method	Inputs	Outputs		
CP1L-M CPU Units with 40 Points 	AC power supply	Relay output	24	16	CP1L-M40DR-A	UC1, N, L, CE
	DC power supply				CP1L-M40DR-D	
		Transistor output (sinking)			CP1L-M40DT-D	
		Transistor output (sourcing)			CP1L-M40DT1-D	
CP1L-M CPU Units with 30 Points 	AC power supply	Relay output	18	12	CP1L-M30DR-A	
	DC power supply				CP1L-M30DR-D	
		Transistor output (sinking)			CP1L-M30DT-D	
		Transistor output (sourcing)			CP1L-M30DT1-D	
CP1L-L CPU Units with 20 Points 	AC power supply	Relay output	12	8	CP1L-L20DR-A	
	DC power supply				CP1L-L20DR-D	
		Transistor output (sinking)			CP1L-L20DT-D	
		Transistor output (sourcing)			CP1L-L20DT1-D	
CP1L-L CPU Units with 14 Points 	AC power supply	Relay output	8	6	CP1L-L14DR-A	
	DC power supply				CP1L-L14DR-D	
		Transistor output (sinking)			CP1L-L14DT-D	
		Transistor output (sourcing)			CP1L-L14DT1-D	

Options for CPU Units

Name	Specifications	Model	Standards
RS-232C Option Board	For CPU Unit option port.	CP1W-CIF01	UC1, N, L, CE
RS-422A/485 Option Board	For CPU Unit option port.	CP1W-CIF11	
Memory Cassette	Can be used for backing up programs or auto-booting.	CP1W-ME05M	

Programming Devices

Name	Specifications		Model	Standards
CX-One FA Integrated Tool Package Ver. 2.0	CX-One is a package that integrates the Support Software for OMRON PLCs and components. CX-One runs on the following OS. OS:Windows 98SE, Me, NT 4.0 (Service Pack 6a), 2000 (Service Pack 3 or higher), or XP *CX-Thermo runs only on Windows 2000 (Service Pack 3 or higher) or XP. CX-One Ver. 2.0 includes CX-Programmer Ver. 7.□. For details, refer to the CX-One catalog (Cat. No. R134). *The software is provided on CDs for the CXONE-AL□□C-□EV2 and on DVD for the CXONE-AL□□D-□EV2. *Site licenses are available for users who must run the CX-One on many computers. Ask your OMRON representative for details.	1 license	CXONE-AL01C-EV2 CXONE-AL01D-EV2	---
		3 licenses	CXONE-AL03C-EV2 CXONE-AL03D-EV2	
		10 licenses	CXONE-AL10C-EV2 CXONE-AL10D-EV2	
		50 licenses	CXONE-AL50C-EV2 CXONE-AL50D-EV2	
USB Programming cable	A-type male to B-type male (Length: 1.8 m)		CP1W-CN221	---
Programming Device Connecting Cable for CP1W-CIF01 RS-232C Option Board	Connects DOS computers, D-Sub 9-pin (Length: 2.0 m)	For anti-static connectors	XW2Z-200S-CV	---
	Connects DOS computers, D-Sub 9-pin (Length: 5.0 m)		XW2Z-500S-CV	
	Connects DOS computers, D-Sub 9-pin (Length: 2.0 m)		XW2Z-200S-V	
	Connects DOS computers, D-Sub 9-pin (Length: 5.0 m)		XW2Z-500S-V	
USB-Serial Conversion Cable (See note)	USB-RS-232C Conversion Cable (Length: 0.5 m) and PC driver (on a CD-ROM disc) are included. Complies with USB Specification 1.1 On personal computer side: USB (A plug connector, male) On PLC side: RS-232C (D-sub 9-pin, male) Driver: Supported by Windows 98, Me, 2000, and XP		CS1W-CIF31	

Note: 1. Cannot be used with a peripheral USB port.
2. CP1L PLCs are supported by CX-Programmer version 7.1 or higher.

Expansion Units

Name	Output method	Inputs	Outputs	Model	Standards
Expansion I/O Units 	Relay	24	16	CP1W-40EDR	N, L, CE
	Transistor (sinking)			CP1W-40EDT	
	Transistor output (sourcing)			CP1W-40EDT1	
	Relay	12	8	CP1W-20EDR1	U, C, L, CE
	Transistor (sinking)			CP1W-20EDT	U, C, N, L, CE
	Transistor output (sourcing)			CP1W-20EDT1	
	Relay	---	16	CP1W-16ER	CE
	---	8	---	CP1W-8ED	U, C, N, L, CE
	Relay	---	8	CP1W-8ER	
	Transistor (sinking)	---	8	CP1W-8ET	
	Transistor output (sourcing)			CP1W-8ET1	
Analog Input Unit 	Analog (resolution: 1/6000)	4	---	CP1W-AD041	UC1, CE
Analog Output Unit 	Analog (resolution: 1/6000)	---	4	CP1W-DA041	UC1, CE
		---	2	CP1W-DA021	UC1, CE
Analog I/O Unit 	Analog (resolution: 1/6000)	2	1	CP1W-MAD11	U, C, N, CE
CompoBus/S I/O Link Unit 	---	8 (I/O link input bits)	8 (I/O link input bits)	CP1W-SRT21	U, C, N, L, CE
Temperature Sensor Unit 	2 thermocouple inputs			CP1W-TS001	U, C, N, L, CE
	4 thermocouple inputs			CP1W-TS002	
	2 platinum resistance thermometer inputs			CP1W-TS101	
	4 platinum resistance thermometer inputs			CP1W-TS102	

Optional Products, Maintenance Products and DIN Track Accessories

Name	Specifications	Model	Standards
Battery Set	For CP1L CPU Units (Use batteries within two years of manufacture.)	CJ1W-BAT01	CE
DIN Track	Length: 0.5 m; Height: 7.3 mm	PFP-50N	---
	Length: 1 m; Height: 7.3 mm	PFP-100N	
	Length: 1 m; Height: 16 mm	PFP-100N2	
End Plate	There are 2 stoppers provided with CPU Units and I/O Interface Units as standard accessories to secure the Units on the DIN Track.	PFP-M	

Motor DC

E type

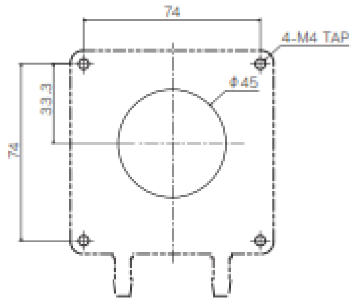
APPLICATION PRINTING PRESS ／ CHEMICAL LIQUID SUPPLYING EQUIPMENT etc.

Characteristics ／ Specification DC24V

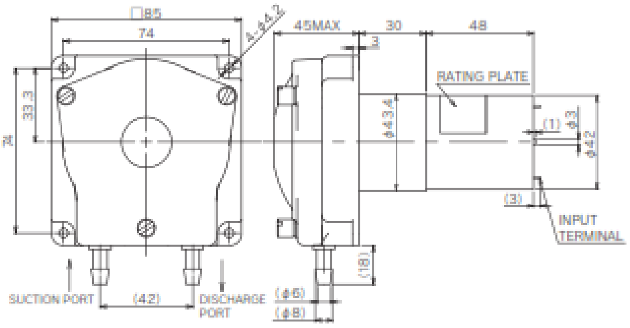
FLOW COVER RANGE	200 ～ 1000ml/min
FLOW PER ROTATION	2.1 ～ 3.8ml/r
APPLICABLE TUBE	P-PHARMED TUBE N-NORPRENE TUBE S-SILICONE TUBE
CONNECTING TUBE	INSIDE DIAMETER: φ6mm
CLAMP TYPE APPLICABLE TUBE	INSIDE DIA. φ6mm×OUTSIDE DIA. φ8mm POLYETHYLENE TUBE NYLON TUBE
DISCHARGE PRESSURE	0.1MPa

MODEL	FLOW (ml/min)		
PT-EP (24V)	350	500	1000
WEIGHT (g)	450	450	530

Setting metal working plan



Outline drawing



F type

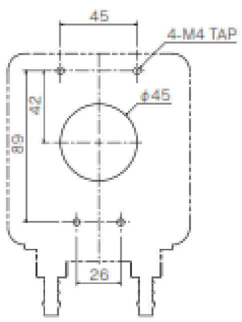
APPLICATION FILLING MACHINE ／ LAUNDRY ／ INK JET etc.

Characteristics ／ Specification DC24V

FLOW COVER RANGE	550 ～ 1400ml/min
FLOW PER ROTATION	7.5ml/r
APPLICABLE TUBE	P-PHARMED TUBE S-SILICONE TUBE
CONNECTING TUBE	INSIDE DIAMETER: φ8mm
DISCHARGE PRESSURE	0.1MPa

MODEL	FLOW (ml/min)		
PT-FP (24V)	550	1000	1400
WEIGHT (g)	780	780	780

Setting metal working plan



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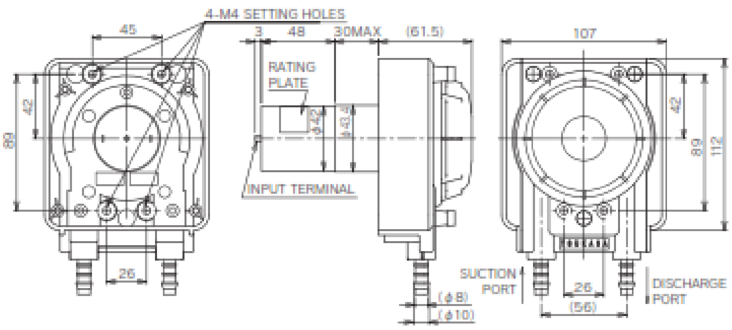

Power Supply Unit

WAVECOM

INSTRUMENTS

PS-3005 Programable
DC Power Supply

(0-30V, 0-5A)

Part of the PS-3000 Series

User Manual

Revision 2013-01

SPECIFICATION

Note: The specifications below are valid under test temperature of 25°C±5°C and after power supply warm-up for at least 20 minutes.

Model	PS-3005D/P
Voltage Range	0~30V
Current Range	0~5A
Load Regulation	
Voltage	≤ 0.01%+2mV
Current	≤ 0.1%+10mA
Line Regulation	
Voltage	≤ 0.01%+3mV
Current	≤ 0.1%+3mA
Setup Resolution	
Voltage	10mV
Current	1mA
Setup Accuracy (25℃+-5℃)	
Voltage	≤ 0.5%+20mV
Current	≤ 0.5%+10mA
Ripple(20Hz-20MHz)	
Voltage	≤2mV rms
Current	≤3mA rms
Temp. Coefficient	
Voltage	≤100ppm+10mV
Current	≤100ppm+5mA
Read Back Accuracy	

Voltage	10mV
Current	1mA
Read Back Temp. Coefficient	
Voltage	≤100ppm+10mV
Current	≤100ppm+5mA