

Micom Car Rally Kit

# Sensor Board Assembly Manual

TLN119 Version

1.00E Edition  
19/06/2006

Japan Micom Car Rally Executive Committee

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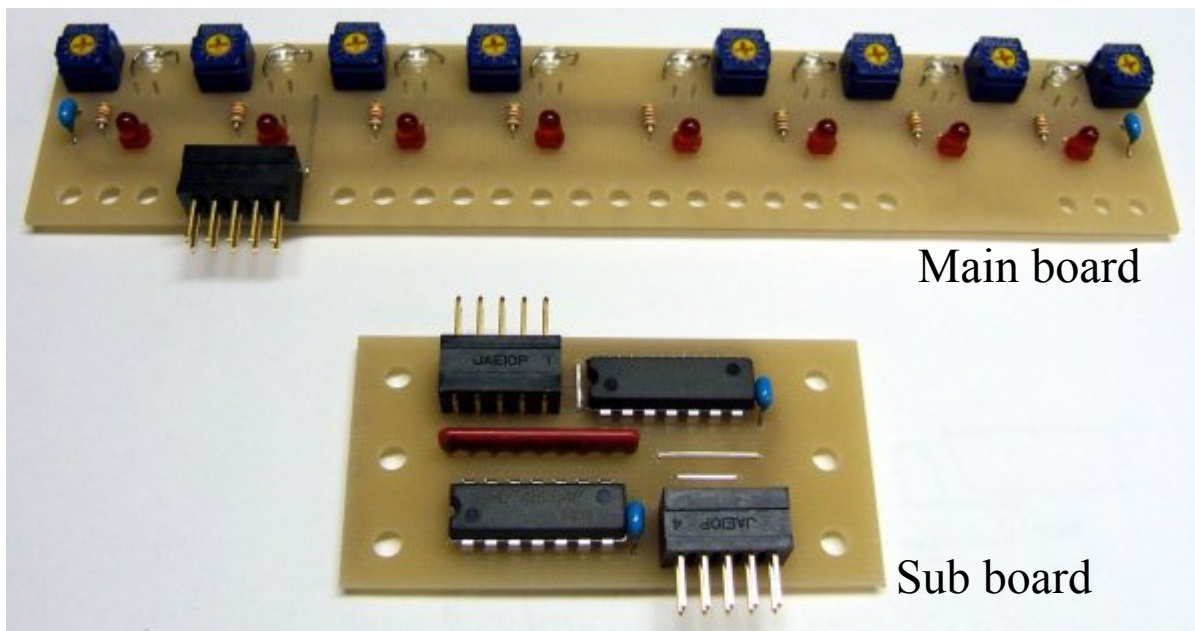
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## 1. Outline

This is the assembly manual for the new micro car rally sensor board designed in 2002. However, the TLN113 infrared LED, used initially, was discontinued and the new TLN119 infrared LED was used. **It was re-created as TLN119 sensor board assembly manual in November 2005. This is the said manual.**

The board is divided into the main board to which sensor is attached and the sub board to which NOT circuit is attached. Main board is small and lighter than the old type sensor board as it is divided into NOT circuit part and sensor board. As the infrared LED is embedded in the board, the possibility of damage due to impact, etc. is minimized during operation. The sub board logically reverses the output signal from sensor board with the NOT circuit IC (74HC04) in a waveform. White and black logic is same as in the old sensor board when the sub board is used.

Though the sensor position and the CPU read bit are reverse (opposite) in the old sensor board and the present sensor board, the substitution from the old type sensor board is easily possible as the bit replacement can be done easily with a program.

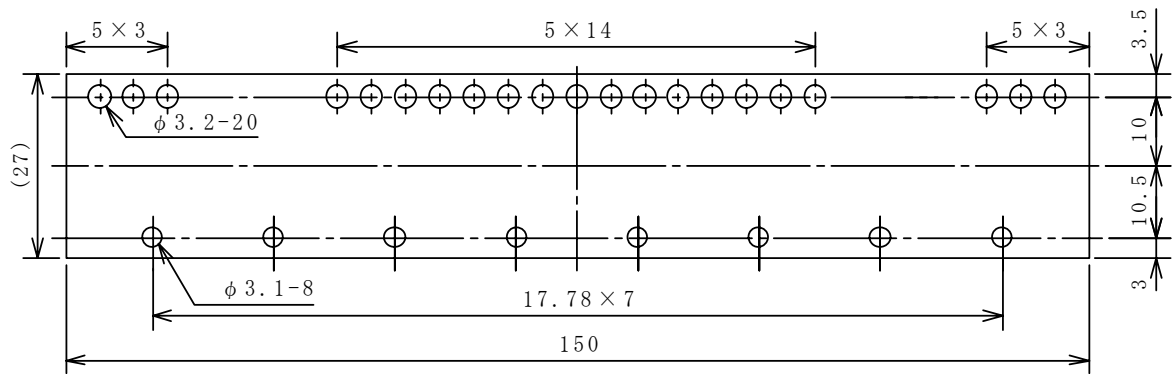


## 2. Specifications

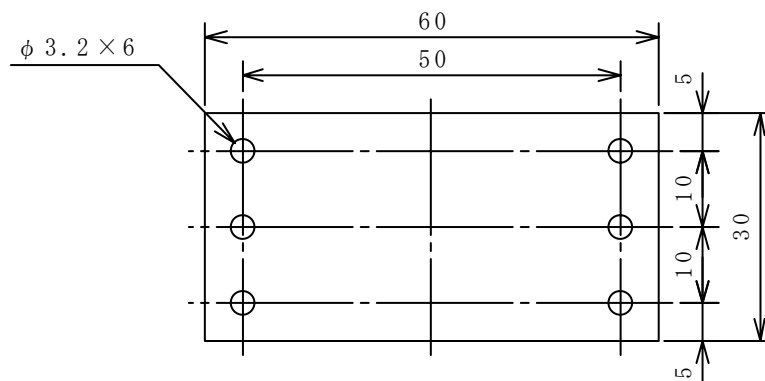
### 2.1. Detailed specifications

Content	Main board	Sub board
Function	White, black information in the sensor is converted into digital signal of “0”, “1”.	With the main board signal as the input, it is reversed with 74HC04 (NOT circuit), and is output to CPU board.
Operation voltage	DC5.0V $\pm$ 5%	DC5.0V $\pm$ 5%
Size (Measurement)	Maximum W150 X D33 X H10mm (actual measurement)	Maximum W60X D37X H10mm (actual measurement)
Connector	10 pin connector for sensor signal output – 1 No	10-pin connector for signal input from main board – 1 No 10-pin connector for signal output to CPU board – 1 No
Signal	<ul style="list-style-type: none"> <li>• If it is black under the sensor, LED is turned off by the high impedance output.</li> <li>• If it is white under the sensor, LED is turned on with 0V output (“0”).</li> </ul>	<ul style="list-style-type: none"> <li>• High impedance signal is converted into 5V(“1”) by the pull-up resistor in the board.</li> <li>• Input signal is reversed and output.</li> </ul>
Weight	About 20g (measurement of finished product) Note: It may change as per the quantity of lead wire and solder.	About 10g (measurement of finished product) Note: It may change as per the quantity of lead wire and solder.

## 2.2. Main board size (Measurement)

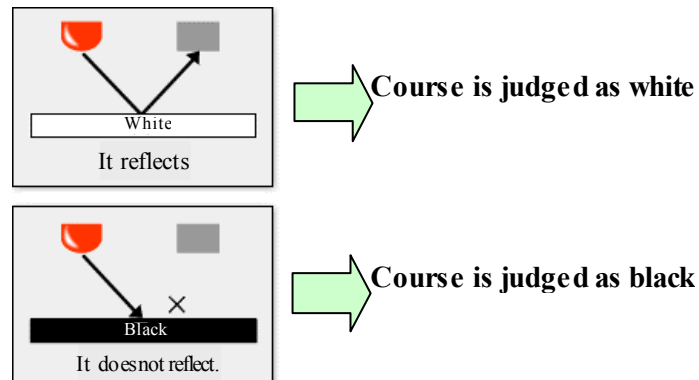


## 2.3. Sub board size (Measurement)



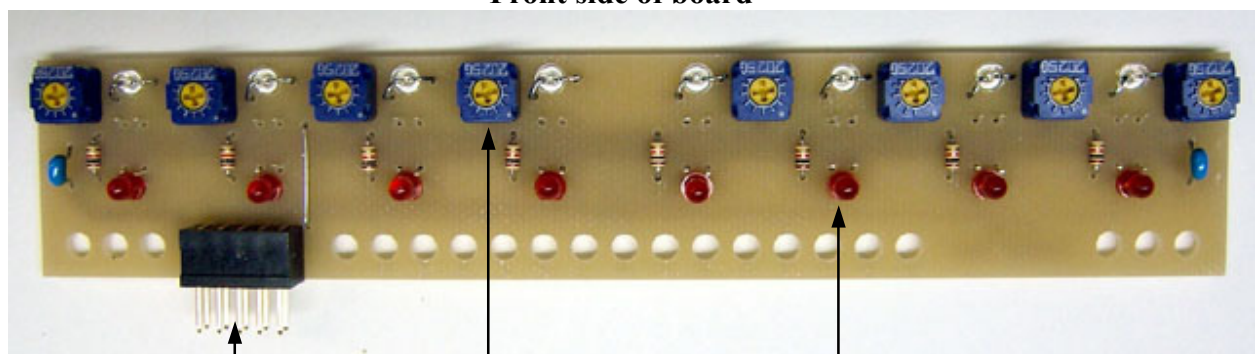
## 2.4. Main board function

8 sets of light emitting elements and light receiving elements are installed in the main board. Using the concept that “White reflects light” and “Black absorbs light”, the light emitted from the light-emitting element is applied in the course of the micro car. This light is judged as “White” if it can be detected by light receiving element and “Black” if it cannot be detected.



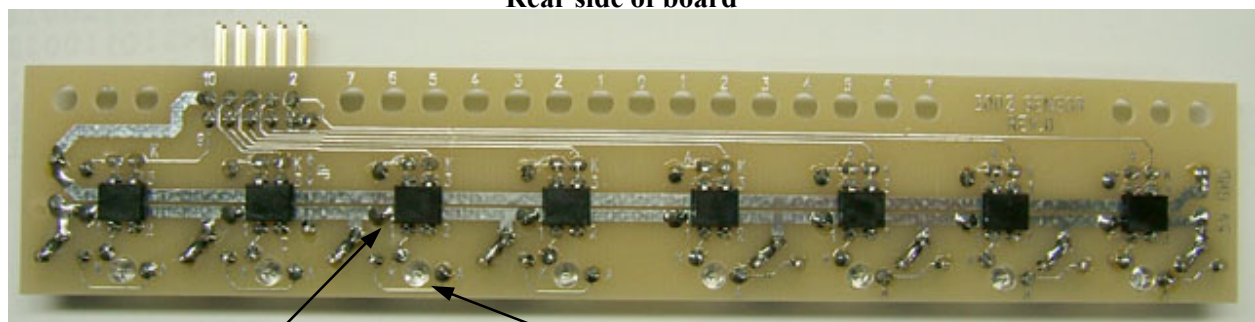
Quantity of emitted light can be adjusted in volume. There is gray color in the course of micro car. Whether gray color should be judged as “White” or should be judged as “Black” can be adjusted by changing the sensitivity of volume. In standard program it is judged as “White”.

### Front side of board



Sensor signal output connector  
Sensor sensitivity adjustment volume  
Sensor sensitivity confirmation LED

### Rear side of board



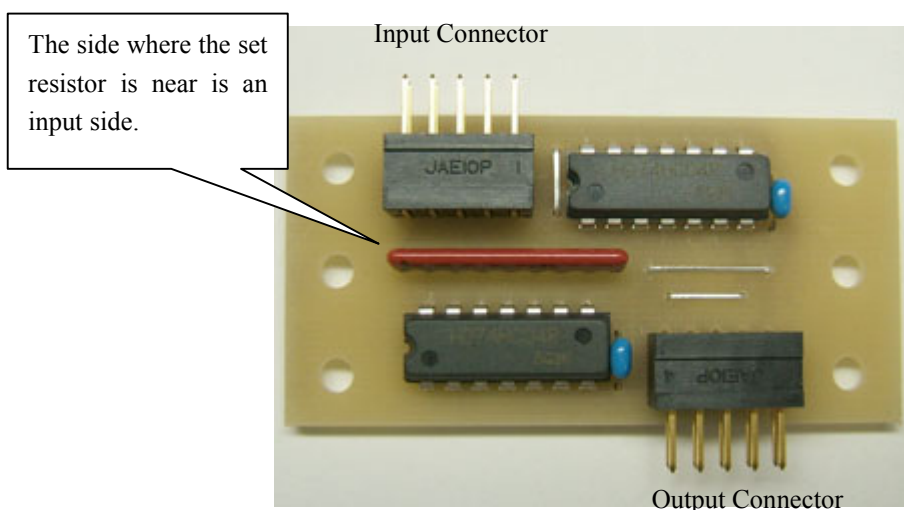
Modulation-type photo sensor  
Infrared rays LED

Contents	Details
Infra-red LED	The element, TLN119 made by Toshiba Corporation (Inc.) is used. It emits infrared rays. As they are infrared rays, they are not visible to humans (naked eyes). There are eight such LEDs.
Modulation-type photo sensor	The element named S7136 made by Hamamatsu Photonics K K (Inc.) is used. The infrared rays emitted by infrared LED are received by this element. The course is considered as white when light is received and as black when light is not received.
Connector for sensor signal output	If the lower side of the sensor is white, then “0” (0V), and if black then the high impedance signal (It is “1” when pull-up resistor is connected.) is output from this connector.
Volume for sensor sensitivity adjustment	It adjusts the amount of the light emitted from infrared LED. In the course of the micro car, there is a gray line. It is possible to adjust the gray color to “white” or “black” by changing the sensitivity of the volume. Standard program suggests that it is preferable to keep as “white”.
LED for sensor sensitivity confirmation	It is judged as “White” when LED is On and “Black” when LED is Off. The sensitivity can be adjusted by volume by confirming this LED.

## 2.5. Sub-board function

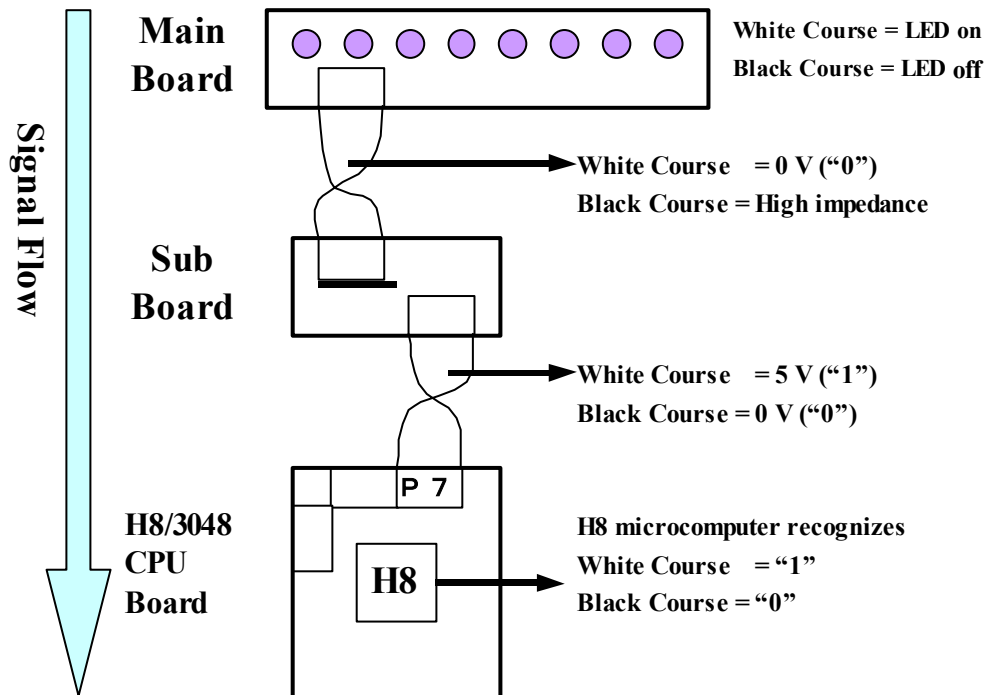
The sub-board,

- Receives the signal from main sensor board by input connector.
- Converts black to “1” and white to “0” using pull up resistor since black is high impedance and white is “0” output for the main sensor board signal.
- Inverts the logic using NOT circuit (74HC04).
- Outputs the signal from output connector.





Main board, sub board, and signal flow to CPU board are shown in the figure below.



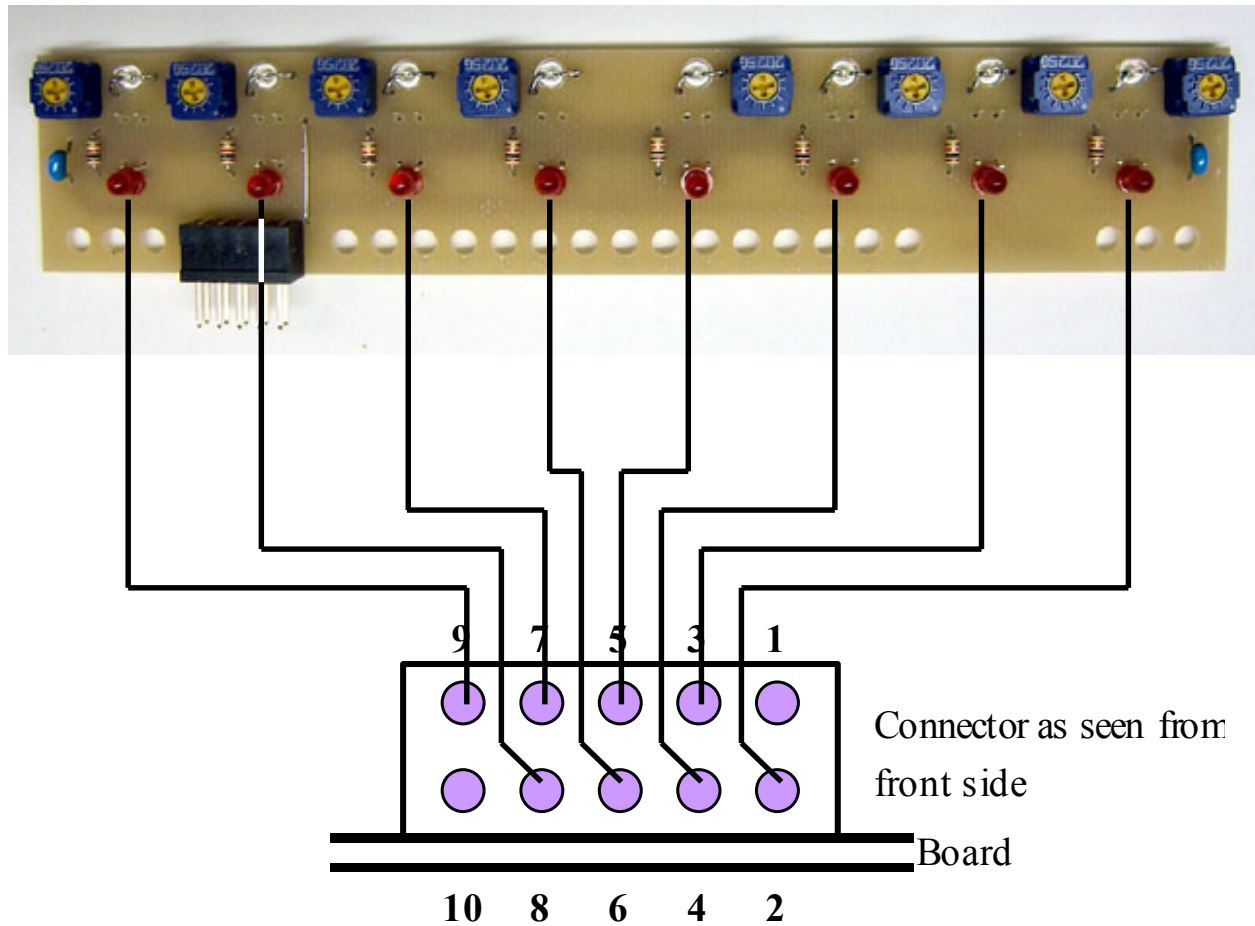
For instance, if sensor becomes "White Black Black Black White White Black Black" from left,

```
unsigned char c;  
...  
c = P7DR;
```

then,  $c = (0011\ 0001)_2 = 0x31$  is substituted for variable  $c$ .

Note: "White Black Black Black White White Black Black" is "10001100" when converted into a digital value, and when microcomputer reads data from the port, to change right and left places, value becomes "00110001" (For the convenience of wiring). Change in right and left places is very difficult to understand. Therefore, it changes to "10001100" in program, on replacing right and left for micro car. For details, refer to "Program Explanation Manual".

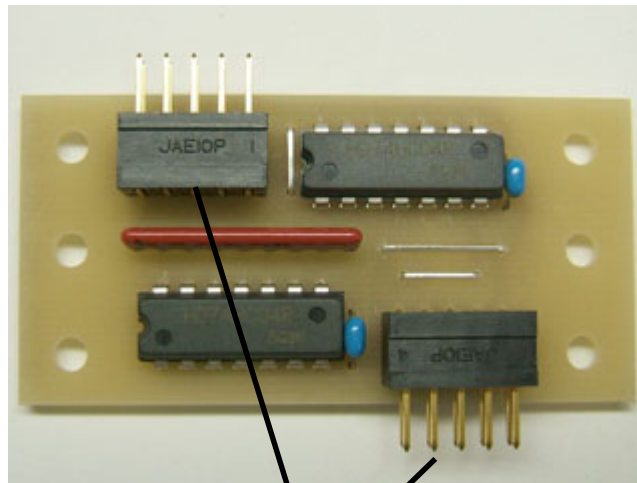
## 2.6 10-pin connector of Main board



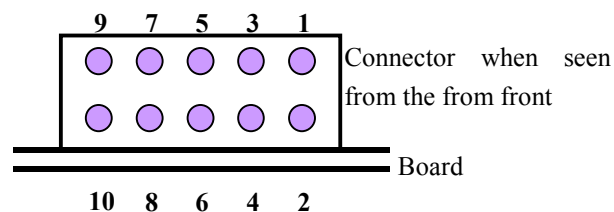
Number	Direction	Description	“0” (0V)	“1” (High impedance)
1	–	+5V		
2	OUT	1 <sup>st</sup> Sensor output signal from right direction	White	Black
3	OUT	2 <sup>nd</sup> Sensor output signal from right direction	White	Black
4	OUT	3 <sup>rd</sup> Sensor output signal from right direction	White	Black
5	OUT	4 <sup>th</sup> Sensor output signal from right direction	White	Black
6	OUT	5 <sup>th</sup> Sensor output signal from right direction	White	Black
7	OUT	6 <sup>th</sup> Sensor output signal from right direction	White	Black
8	OUT	7 <sup>th</sup> Sensor output signal from right direction	White	Black
9	OUT	8 <sup>th</sup> Sensor output signal from right direction	White	Black
10	–	GND		

## 2.7. Sub-board connectors

Input connector



Output connector



Input Connector

Input side number	Direction	Input signal
1	+5V	Signal from main board of sensor
2	IN7	
3	IN6	
4	IN5	
5	IN4	
6	IN3	
7	IN2	
8	IN1	
9	IN0	
10	GND	



Output Connector

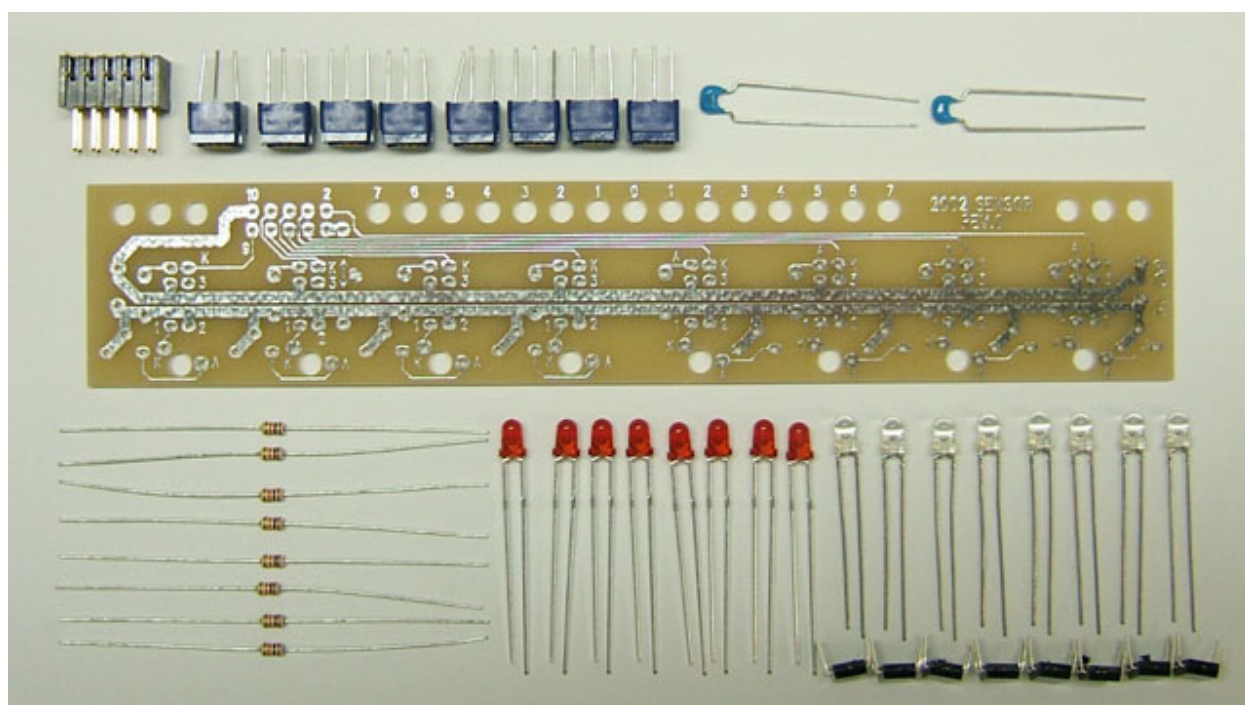
Output side number	Direction	Output signal	CPU Board connection destination
1	+5V		+5V
2	OUT7	Reverse signal of input signal	P77
3	OUT6	Reverse signal of input signal	P76
4	OUT5	Reverse signal of input signal	P75
5	OUT4	Reverse signal of input signal	P74
6	OUT3	Reverse signal of input signal	P73
7	OUT2	Reverse signal of input signal	P72
8	OUT1	Reverse signal of input signal	P71
9	OUT0	Reverse signal of input signal	P70
10	GND		GND

Note: P70 signifies Port 7 and Bit 0 of H8 microcomputer. P71-P77 is also similar.

### 3. Assembly of Main Board

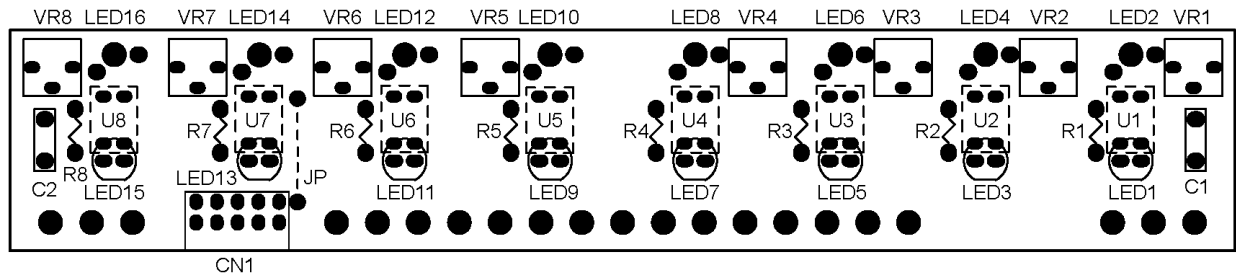
#### 3.1. Parts list

Part number	Name	Type	Manufacturer	Quantity
	Main board	Width 150mm×length 27mm × thickness 1.6mm		1
U1 ~ 8	Modulation-type photo sensor	S7136	Hamamatsu photonics (Inc.)	8
CN1	10-pin right angle connector	PS-10PE-D4LT1-PN1	Japan Aviation Electronics Industry, Limited (Inc.)	1
LED1,3,5,7, 9,11,13,15	LED	Any of the following or any compatible alternative		8
		EBR3338S	Stanley Electric Co., Ltd. (Inc.)	
		TLR123 red	(Inc.) Toshiba Corporation	
LED2,4,6,8, 10,12,14,16	Infrared LED	TLN119 (or compatible)	(Inc.) Toshiba Corporation	8
C1,2	Multiplayer ceramic capacitor	0.1uF	Various manufactures	2
R1 ~ 8	Resistor	1kΩ 1/8W	Various manufactures	8
VR1 ~ 8	Volume	CT-6P 2kΩ	Nidec Copal electron, Ltd. (Inc.)	8
	Jumper	Resistor piece is used		



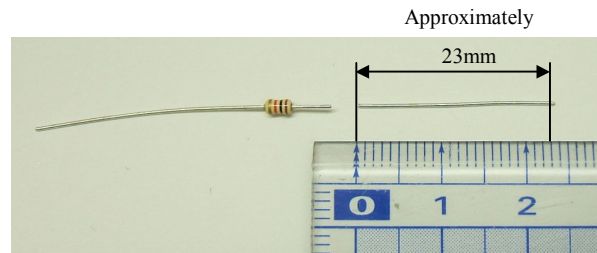
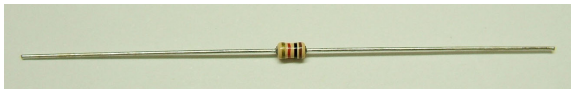
### 3.2. Part mounting (installation) location

Part mounting (installation) diagram of the board is given below. This mounting (installation) diagram is seen from component side (side without pattern). A skilled person may be able to solder by referring to component chart and below mentioned mounting (installation) diagram, but refer to details of the items given hereafter as the infrared LEDs (LED 2, 4, 6, 8, 10, 12, 14, 16) must be mounted (installed) in a particular way. Modulation photo sensor is also soldered from soldered side.



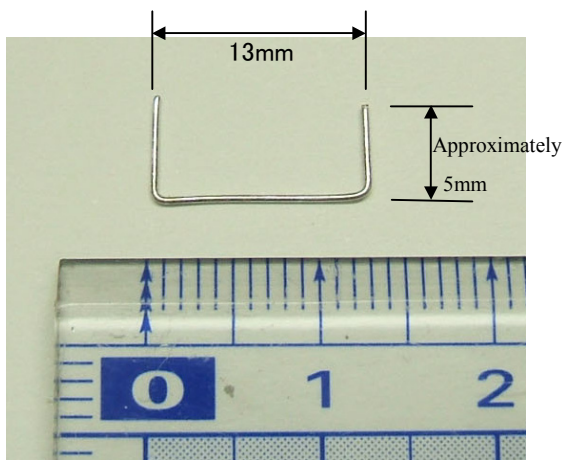
### 3.3. Installation (Mounting) of jumper

Part number	Name	Type	Manufacturer	Quantity
	Jumper	Piece of resistor is used		

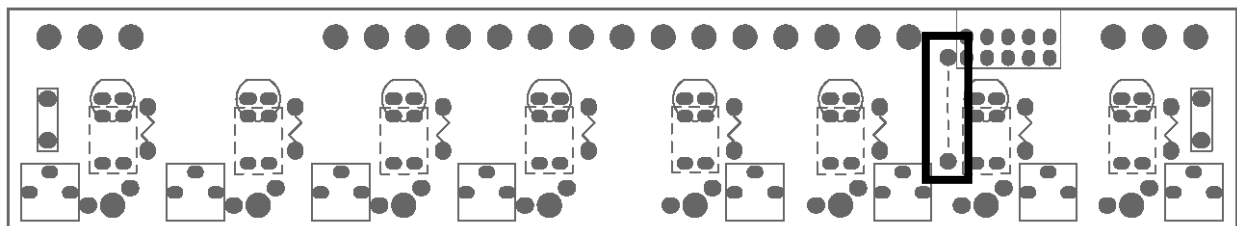


1. First of all, prepare 1 resistor.

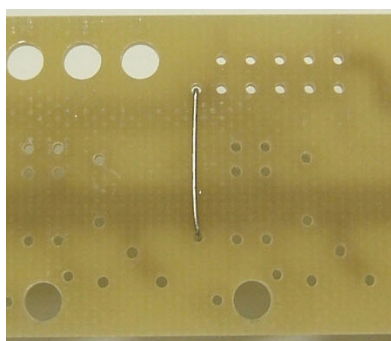
2. Cut it to approximately 23mm. Care should be taken so that it is not cut too long, as it may result in damaging the resistor. Keep aside the resistor for later use.



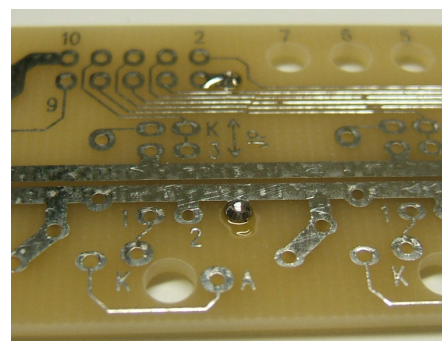
3. Adjust the reverse C shaped part as shown in picture, to 13mm. Generally, the height is assumed to be approximately 5mm.



4. Install (mount) on the portion enclosed with ☐ and solder.



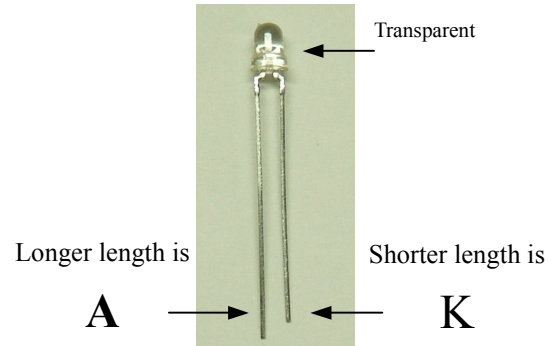
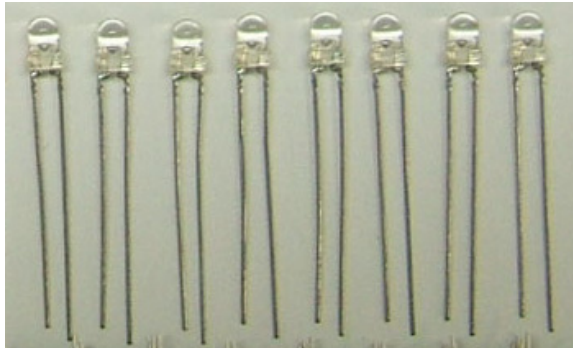
5. It is mounted.



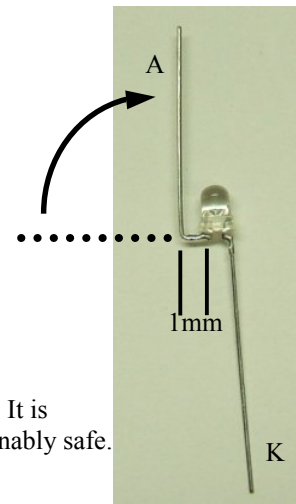
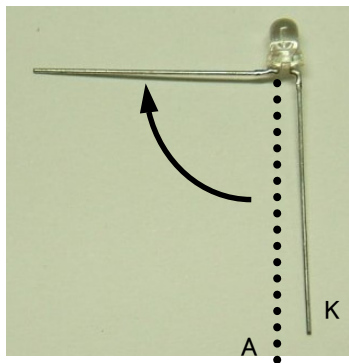
6. After soldering is complete, cut the lead wire from the soldered base. Here, all the parts are similar.

## 3.4. Installation (Mounting) of infrared LED (transparent)

Part number	Name	Type	Manufacturer	Quantity
LED2, 4, 6, 8, 10, 12, 14, 16	Infrared LED	TLN119 (Or any other compatible LED)	(Inc.) Toshiba Corporation	8

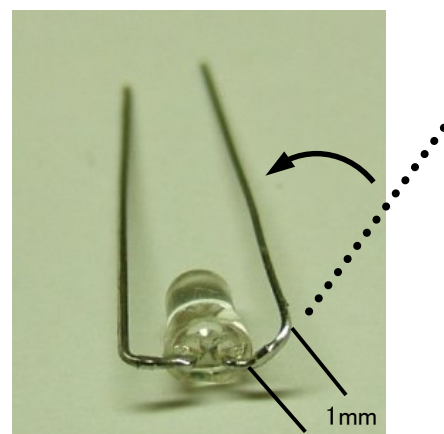
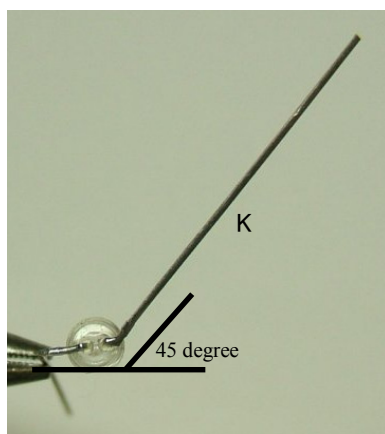


1. Prepare 8 infrared LEDs. **The shining part is transparent LED. It is not red.**
2. There is a polarity in infrared LED. Longer side is A (anode); the shorter is K (cathode).



Note: It is reasonably safe.

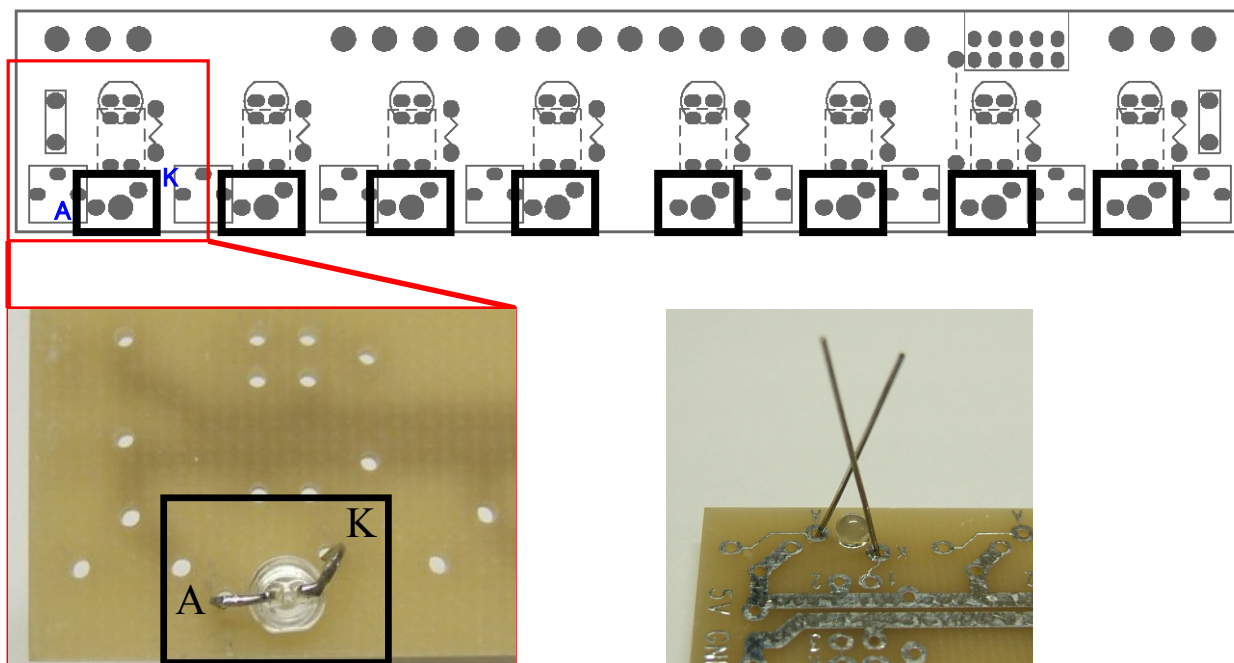
3. Bend the A side at 90 degrees as shown in the photograph.
4. With 1mm from the base, lift the remaining part upwards, as shown in the photograph.



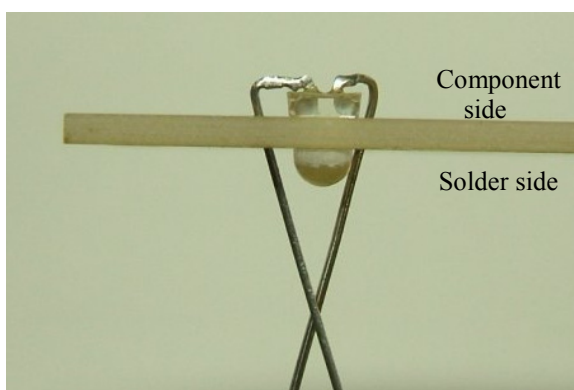
Note: It is reasonably safe.

5. This time, bend the K side upwards at 45 degrees as shown in photograph.
6. Similar to A side, lift the remaining part of the K side upwards, with 1mm from the base, as shown in the photograph.

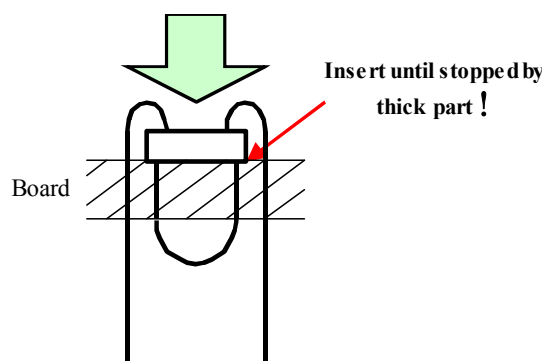




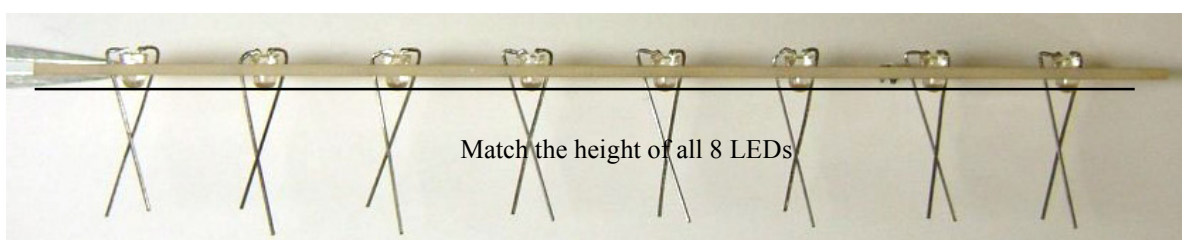
7. Mount on the portion enclosed with □ and solder.



8. This is the side view.



9. It stops at thick part when the infrared LED is inserted. Insert all the 8 LED's up to this position.

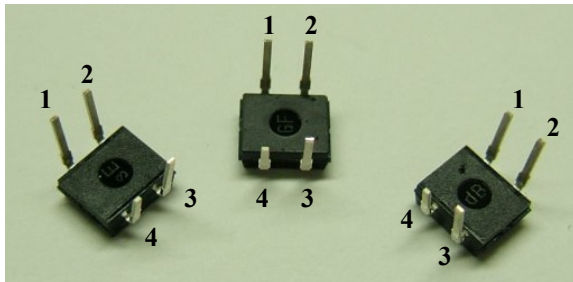


10. 8 LEDs are mounted. The picture shows the side view. Matching the height is mandatory. As shown before, height will match when inserted until it stops. Care should be taken **while soldering; such that the LED does not get burned because of the resin solder coating in the infrared LED.**

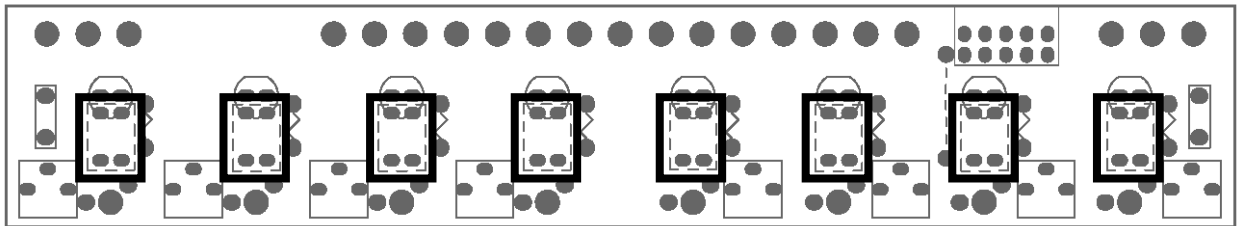


## 3.5. Installation (Mounting) of modulated type photo sensor

Component number	Name	Model	Manufacturer	Quantity
U1~8	Modulated type photo sensor	S7136	Hamamatsu Photonics (Inc.)	8

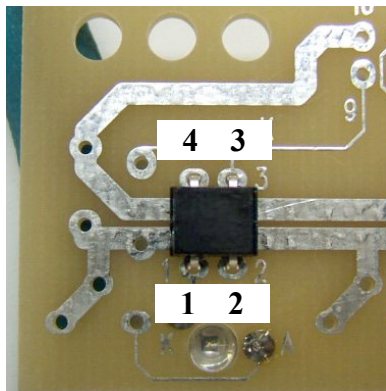


1. Next, prepare 8 modulated type photo sensors. They are with 4 pins. The fourth pin is the shortest.

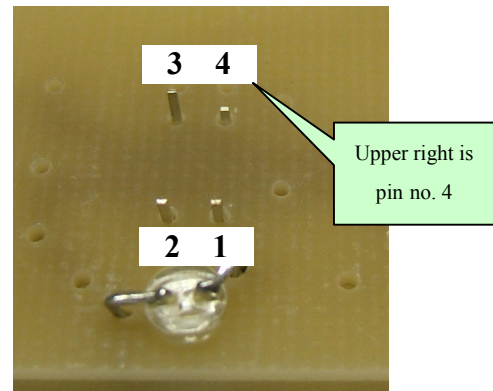


2. Solder it by mounting on the parts enclosed with □. This board diagram is seen from the component side.

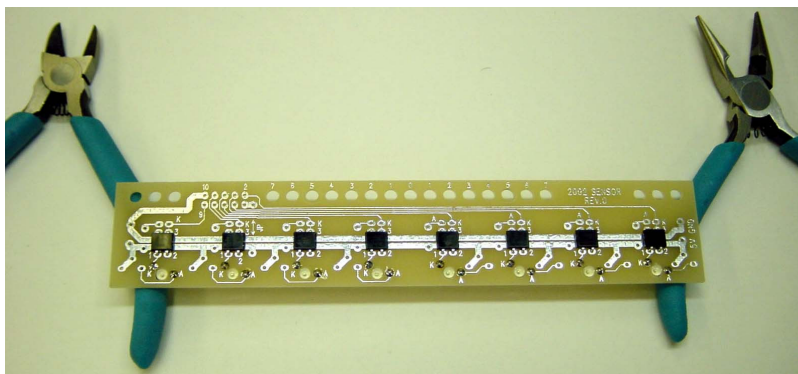
**Solder modulated type photo sensor by mounting on the solder side (with respect to the pattern).**



3. Solder modulated type photo sensor by mounting on the solder side (side having pattern). Should be matched with the pin numbers that are written on the pattern. Insert in the same manner until infrared LED stops.



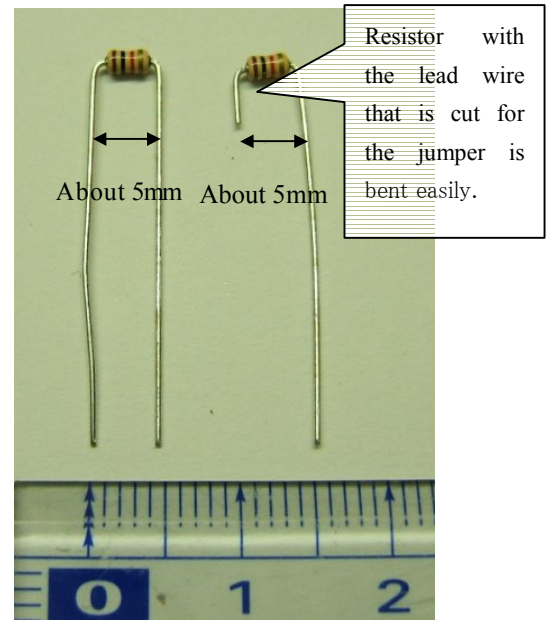
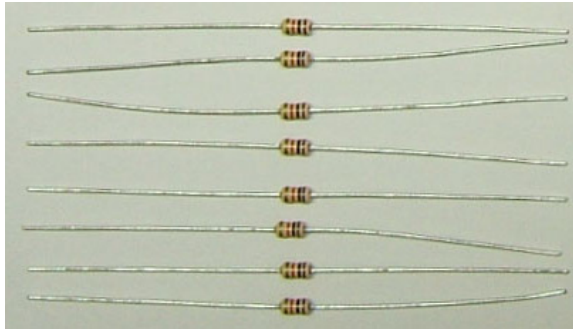
4. If component side is seen, infrared LED is on the lower side and the upper right is the shortest pin 4. Confirm that all the 8 sensors are mounted in this manner.



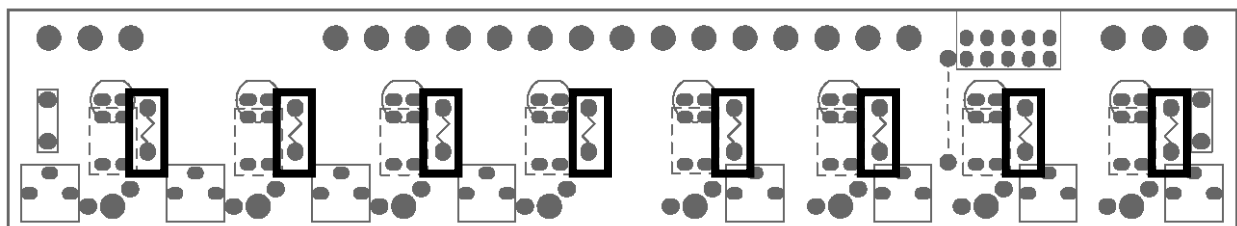
5. During soldering, the board is kept as it is on the worktable, with the tips of the modulated type photo sensor projecting out, and the photo sensor is inserted deep inside floats. It is soldered by keeping the object at a height by keeping some object on the left and right side of the board. In the photograph, small cutting pliers and pincers are put on both sides. However, soldering is easy since the lead wire projecting out of the component side is bent such that it does not float.

### 3.6 Resistor Mounting

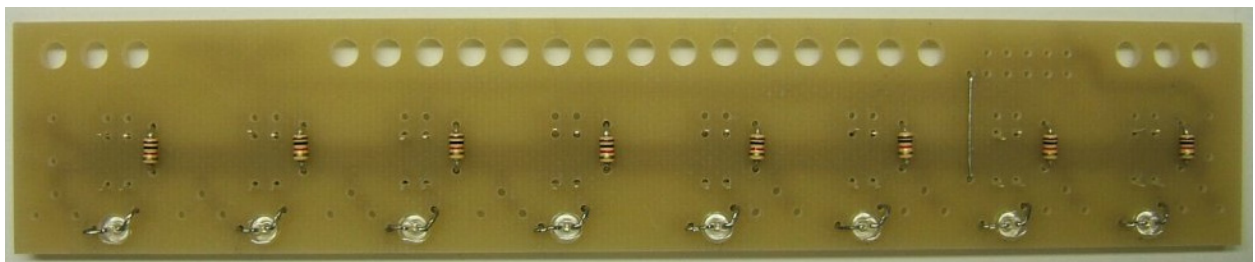
Part Number	Name	Type	Manufacturer	Quantity
R1~8	Resistor	1k $\Omega$ 1/8W	Various Manufacturers	8



1. Take 8 resistors. The value of all the resistors is 1K $\Omega$  according to color code “Brown, Black, Red, and Gold”.
2. Bend the lead wire of all 8 resistors to have about 5mm width between the leads as shown in the figure. Bend a width of roughly 5mm from the base of the resistor. However, do not bend it with force as resistor surface may crack.



3. Mount on the portion enclosed with ☐ and solder it.

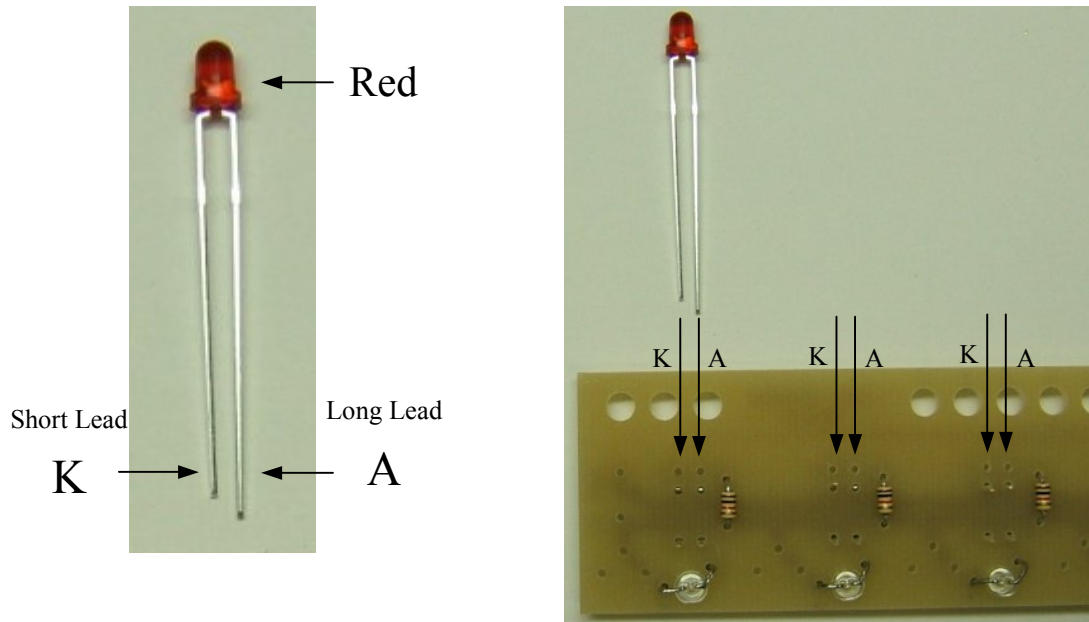


4. Resistor Mounting completed.

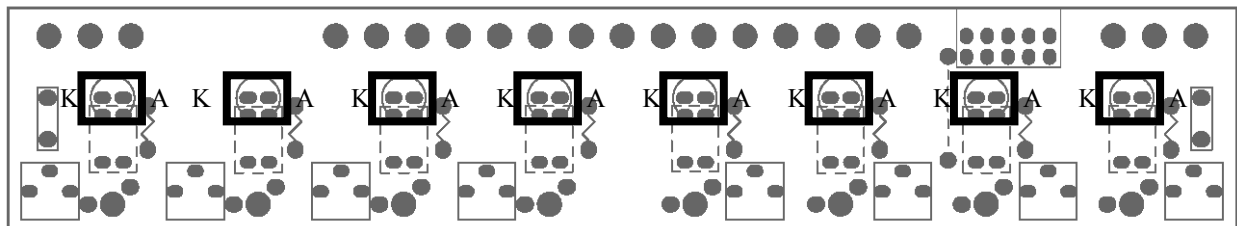
## 3.7 LED (Red) Mounting

Part Number	Name	Type	Manufacturer	Quantity
LED 1, 3, 5, 7, 9, 11, 13, 15	LED	EBR3338S or TLR123 Red	Stanley Electric Co., Ltd. (Inc.) or (Inc.)Toshiba	8

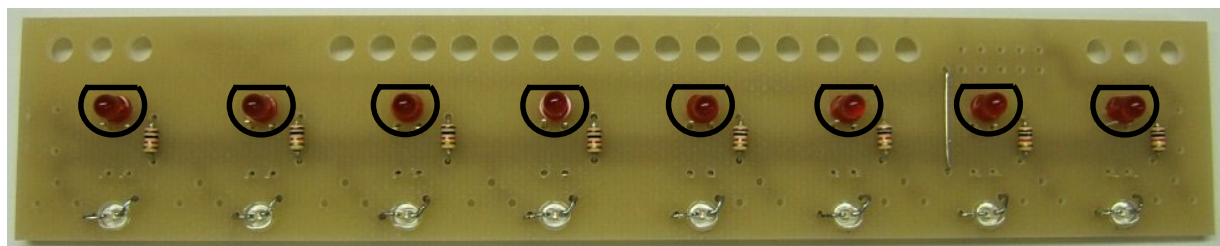
Note: The above-mentioned components or other compatible components can be used.



1. Take 8 LEDs. **These are the LEDs with red luminous portion and are not transparent.** LED has polarity. The long side is A (anode) and short side is K (cathode).
2. Mount the LED in the direction as shown in picture.



3. Mount on the portion enclosed with ☐ and solder it.



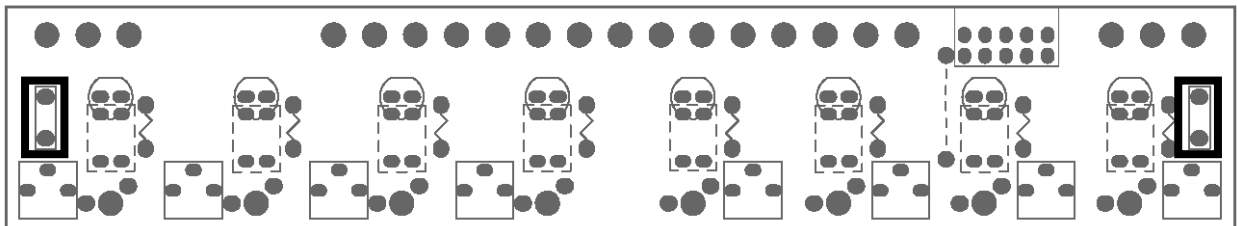
4. After mounting, the top portion of the LED sits flat (directly) on the board as shown in the picture. Check whether all the 8 LED's are same after soldering.  
Note: Leave behind the three or more lead wires cut here. They are used when the sub-board is manufactured.

### 3.8 Mounting Multi-layer Ceramic Capacitor

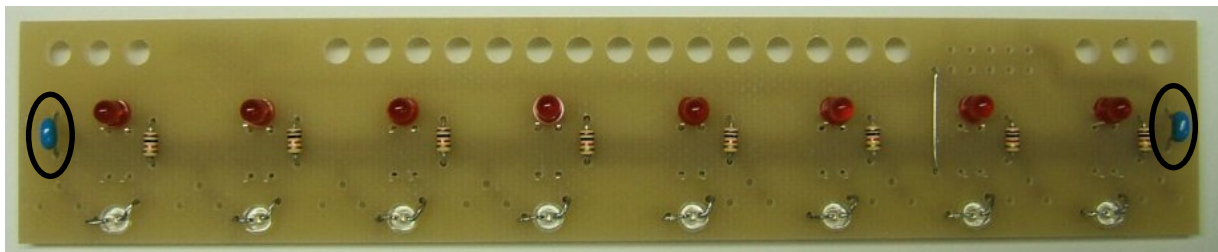
Part Number	Name	Type	Manufacturer	Quantity
C 1, 2	Multi-layer Ceramic Capacitor	0.1 uF	Various Manufacturers	2



1. Take 2 multi-layer ceramic capacitors. It is easier to read the capacitor value (capacity) when the side on which “104” is written is pointing outwards. Here, “104” means  $10 \times 10^4$  [pF]=100,000[pF]=0.1 [μF].



2. Mount on the portion enclosed with  $\square$  and solder it.

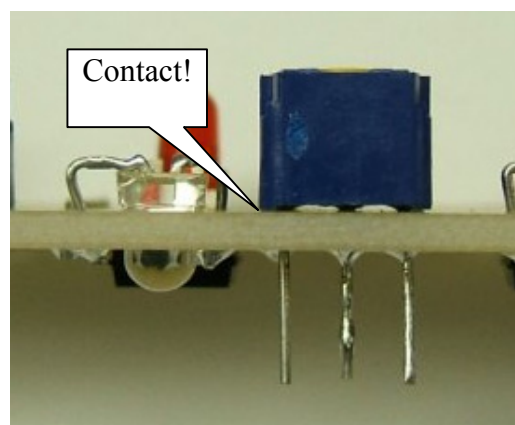


3. It looks like this after mounting multiplayer ceramic capacitor.

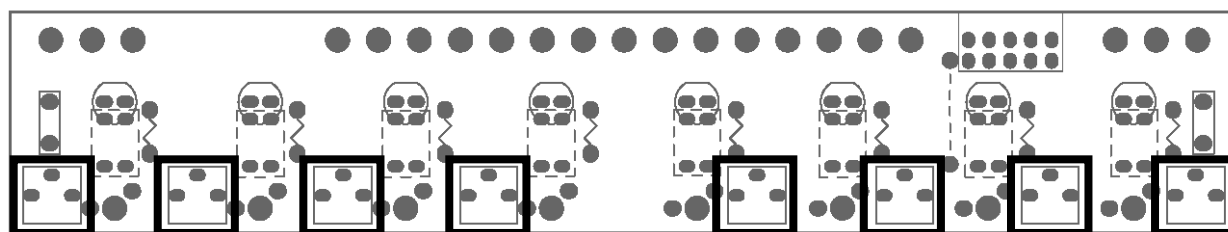


## 3.9 Volume (Control Knob) Mounting

Part Number	Name	Type	Manufacturer	Quantity
VR1~ 8	Volume	CT-6P 2k $\Omega$	Nidec Corporation Copal Electron Co. (Inc.)	8



1. Take 8-volume units. "202" is written on it. Here, "202" means  $20 \times 10^2 [\Omega] = 2,000 [\Omega] = 2 [\text{K}\Omega]$ .
2. It is mounted such that it touches the board as shown in the picture.



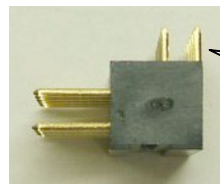
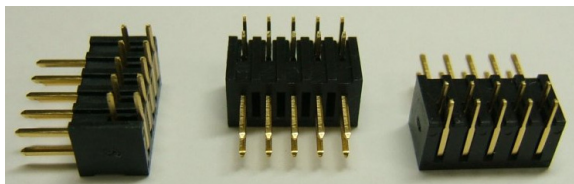
3. Mount on the portion enclosed with  $\square$  and solder it.



4. It looks like this after mounting volume unit.

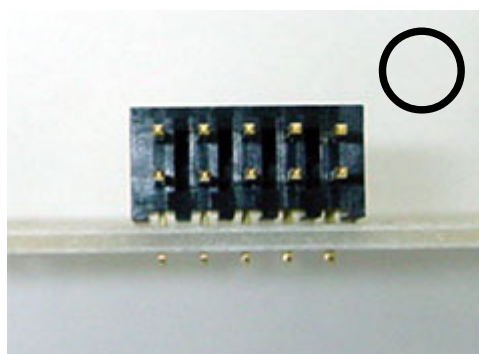
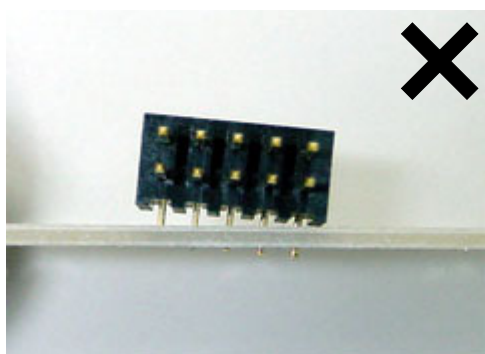
## 3.10 10-Pin Right Angle Connector Mounting

Part Number	Name	Type	Manufacturer	Quantity
CN1	10 pin right angle connector	PS-10PE-D4LT1-PN1	Japan Aviation Electronics Industry, Limited (Inc.)	1

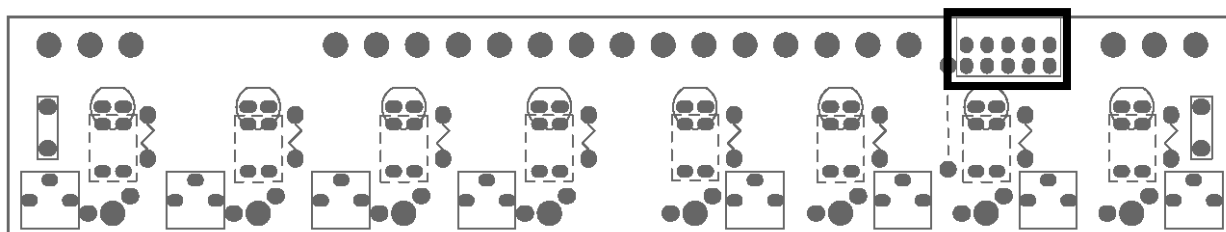


This side is soldered.

1. Take single 10-pin right angle connector (Only single unit is used though picture shows 3 units which is for explanation purpose.)
2. The shorter lead side is soldered. Note that it is not the long side.

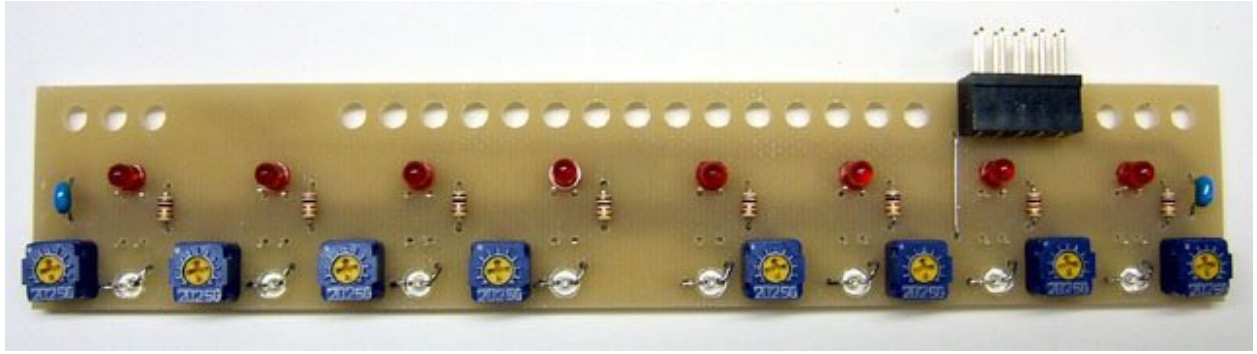


3. Insert all the 10 pins of the connector till the end. Pattern part gets loaded and the pattern is broken (damaged) when the connector is soldered in the floating state, and is pulled many times. However, even though it may not pose a problem, malfunctioning and contact failure due to run time vibrations should be seriously considered, as visual inspection is not sufficient for detection.
4. Solder it in the way shown here.



5. Mount on the portion enclosed with □ and solder it.

### 3.11. Completion

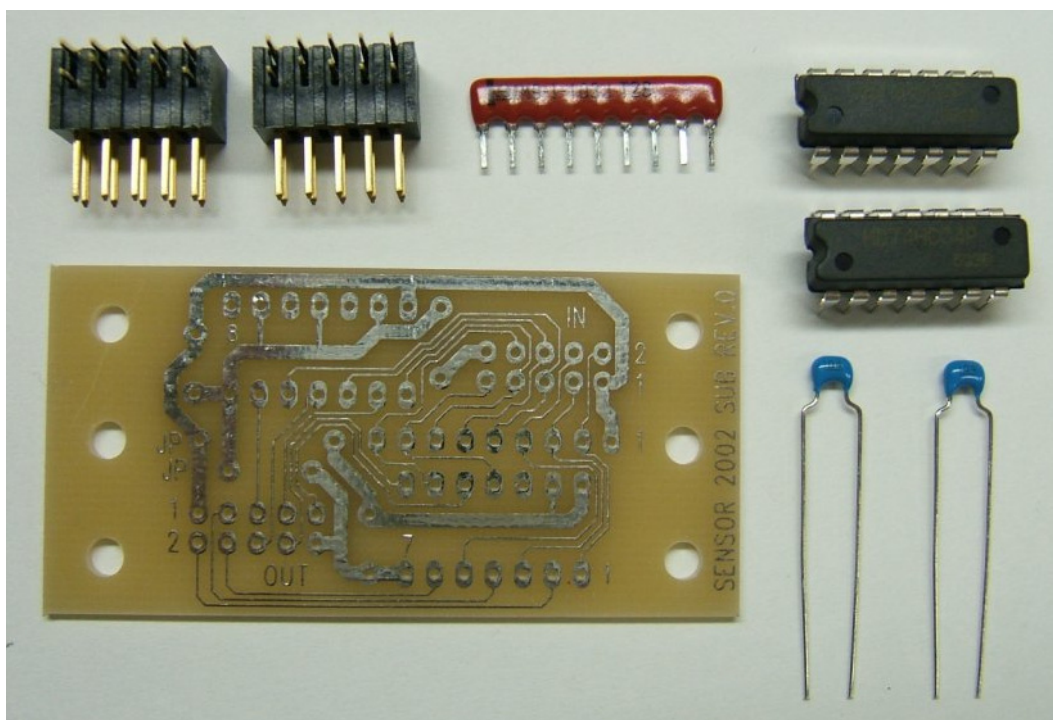


Now it is completed. Confirm the solder defects and component mounting errors by (visually) inspecting the board once again. Operation test is performed by 'operation confirmation manual' using a kit.

## 4. Assembly of sub board

### 4.1. List of components

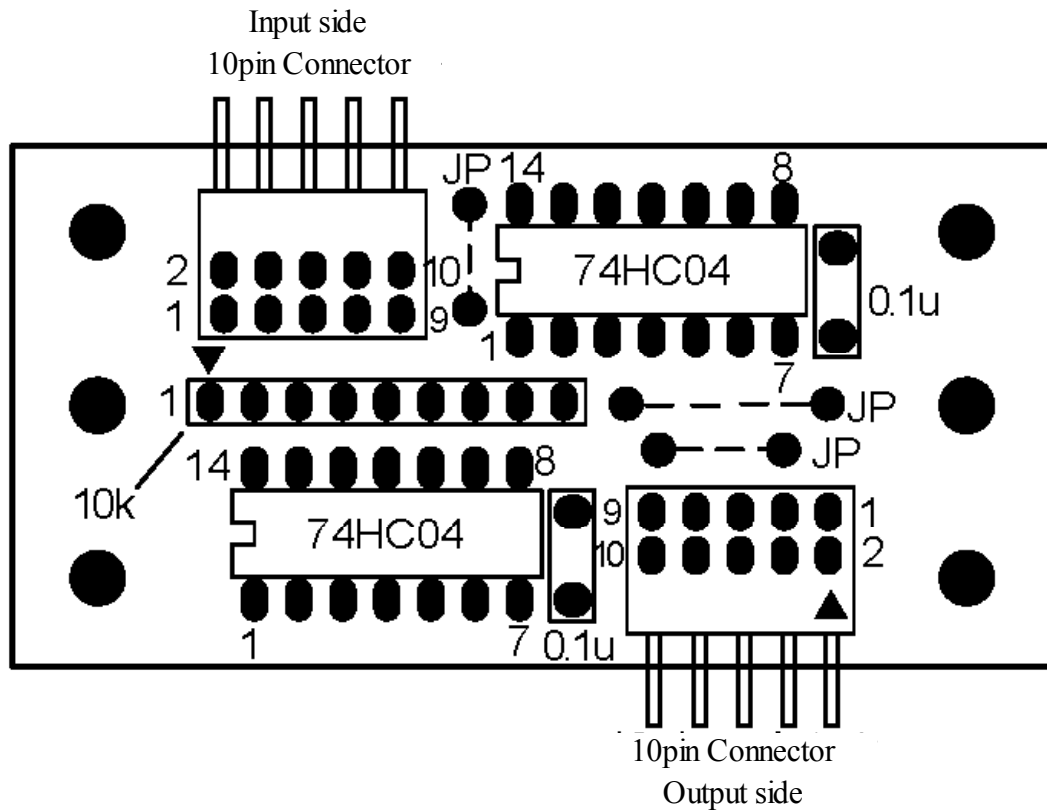
Component number	Name	Model	Manufacturer	Quantity
	Sub board	Width 60mm X Height 30mm X Thickness 1.6mm		1
U11,12	Logic IC	74HC04	All companies	2
CN11,12	10 pin right angle male connector	PS-10PE-D4LT1-PN1	Japan Aviation Electronics Industry (Inc.)	2
C11,12	Laminated ceramic condenser	0.1uF	All companies	2
RA11	Set resistance	M9-1 8 component 1 common 10kΩ	B.I. Technology Japan (Inc.)	1
	Jumper	Cut-off piece of LED etc. is used		





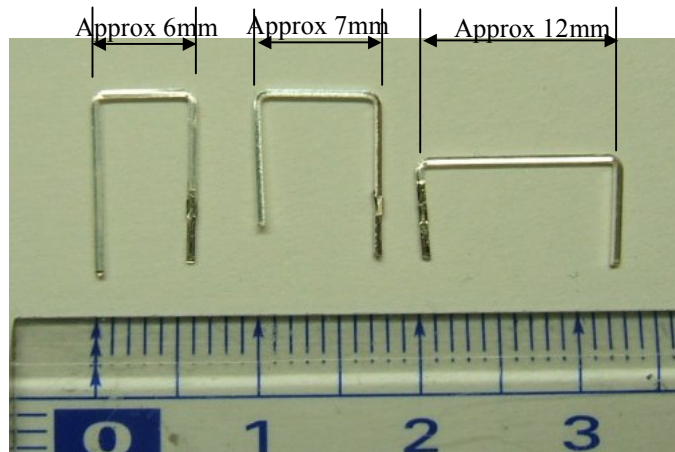
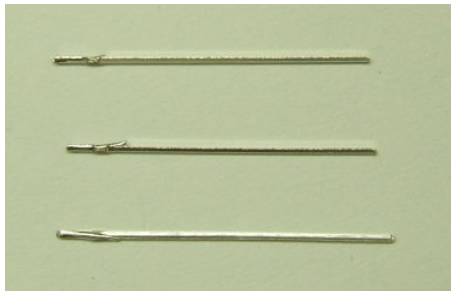
#### 4.2. Part mounting (installation) location

Part mounting (installation) diagram of the board is given below. This mounting (installation) diagram is seen from the component side (side without pattern). Though a skilled person may be able to solder by referring to component chart and below mentioned mounting (installation) diagram, a detailed method of mounting is explained in the following paragraphs.

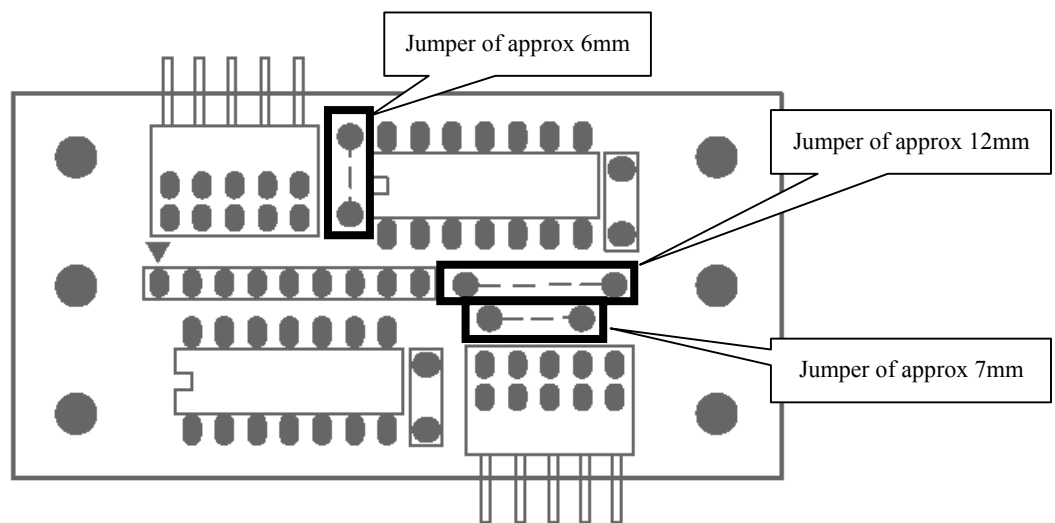


### 4.3. Mounting of jumper

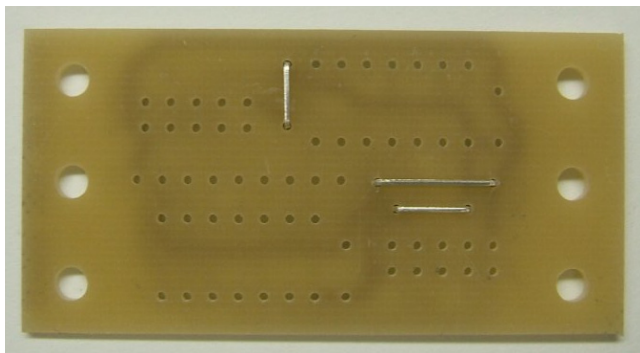
Component number	Name	Model	Manufacturer	Quantity
	Jumper	Cut-off piece of LED etc. is used		3



1. Prepare 3 cut-off pieces of the lead of LED reserved at the time of manufacturing of main unit.
2. Make "C" shape as shown in the picture. Adjust the length of sides to approximately 6mm, 7mm, and 12mm.



3. Solder it by mounting the parts enclosed with□.



4. 3 jumper wires are installed on the board.

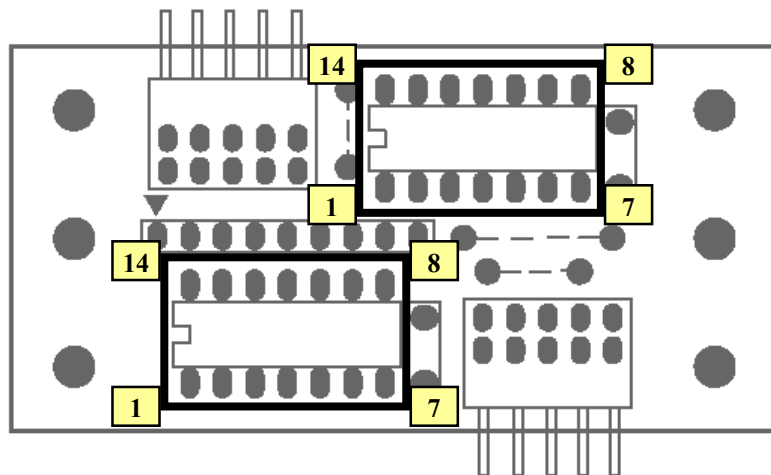
#### 4.4. Mounting of logic IC

Component number	Name	Model	Manufacturer	Quantity
U11,12	Logic IC	74HC04	All companies	2

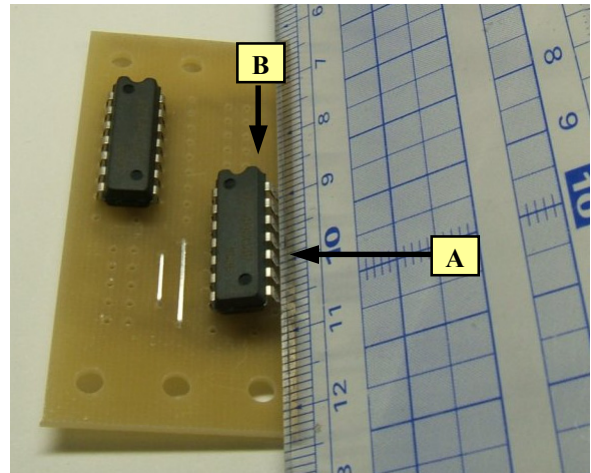
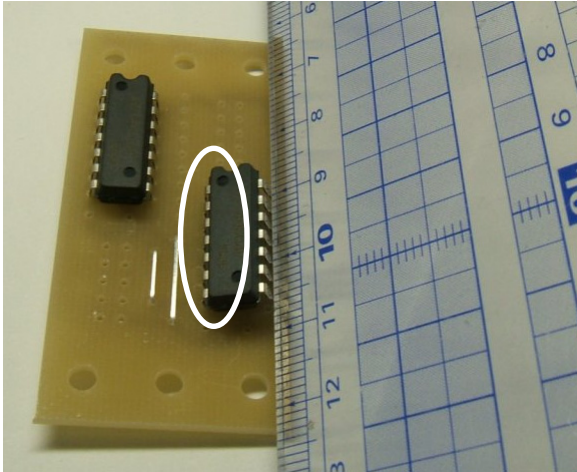
U shaped part



1. Next, prepare 2 logic ICs 74HC04. Keep the U shaped part on the left and the 1st pin on the lower left. Moving anti clockwise 2nd pin, 3rd pin and 14<sup>th</sup> pin in the end on the upper left.

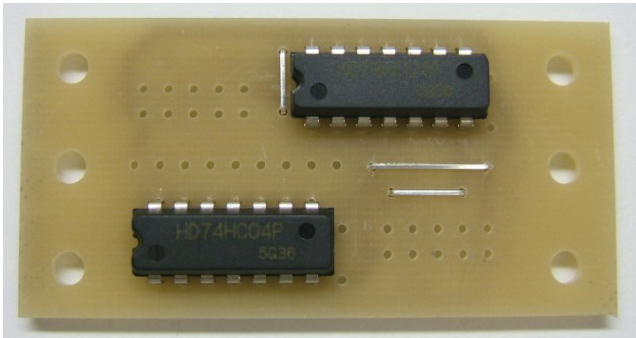


2. Solder it by mounting the parts enclosed with□.



3. All pins cannot be inserted at the same time since IC opens in the inverted V shape. First insert one side. In the photograph, 1-7 pin side is inserted.

4. Next, it is **A** for 8-14 pins side, which are not inserted in the hole. And **B** while pushing with a hard object like a ruler. Push IC softly from above. All pins of IC enter the holes in the place where the pin is suitable for the hole. Push up to end.

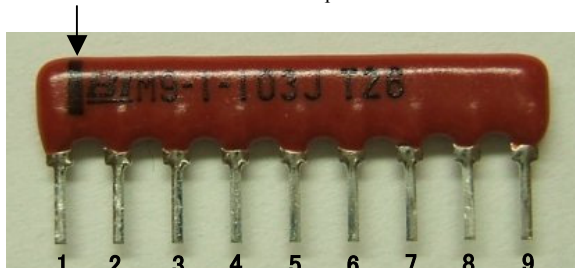


5. Mounting is complete.

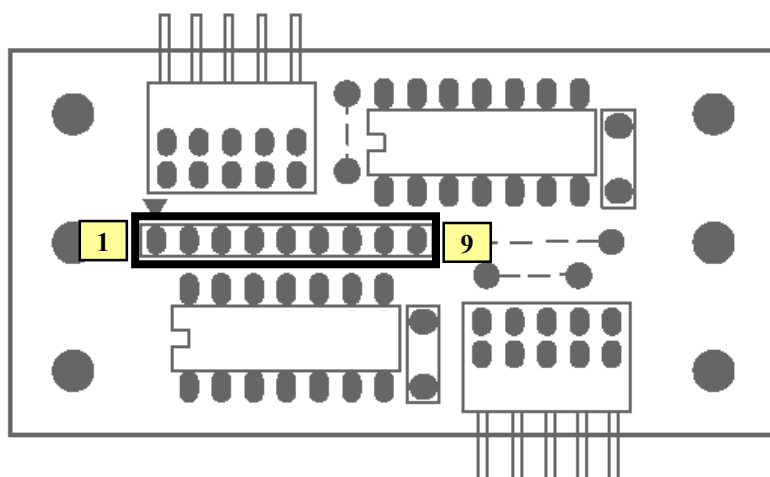
## 4.5. Mounting of set resistance

Component number	Name	Model	Manufacturer	Quantity
RA11	Set resistance	M9-1 8 component 1 common 10kΩ	B. I. Technology Japan (Inc.)	1

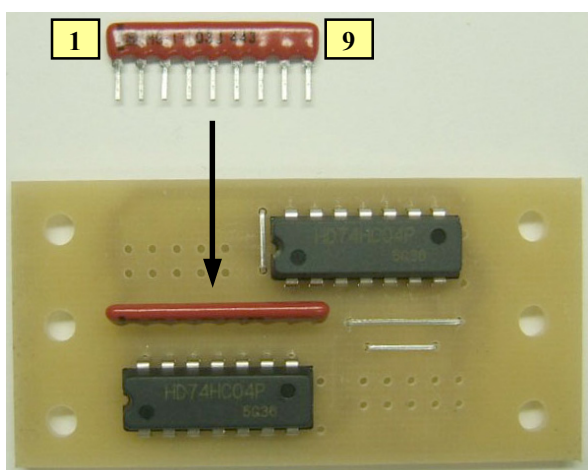
The side with the vertical line is 1 no. pin.



1. Next, Prepare 1 resistor. It is referred to as “103”.  
Here,  $103$  is  $10 \times 10^3 [\Omega] = 10,000[\Omega] = 10[\text{k}\Omega]$ .



2. Solder it by mounting the parts enclosed with□. Take care since the direction is important.



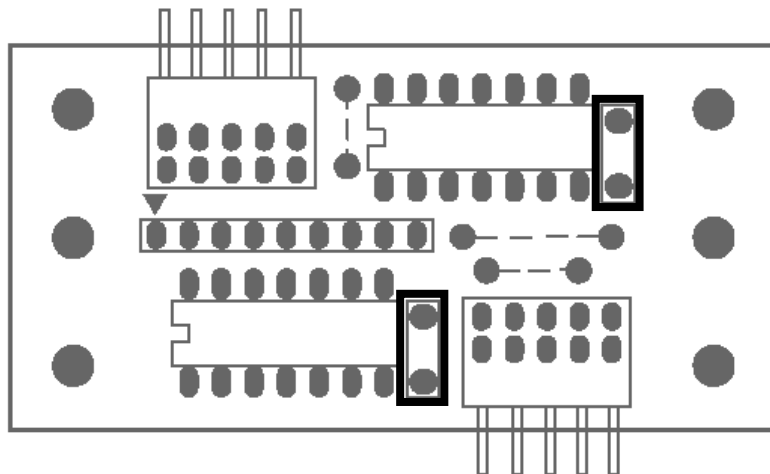
3. Mounting is complete.

## 4.6. Mounting of multi layer ceramic condenser

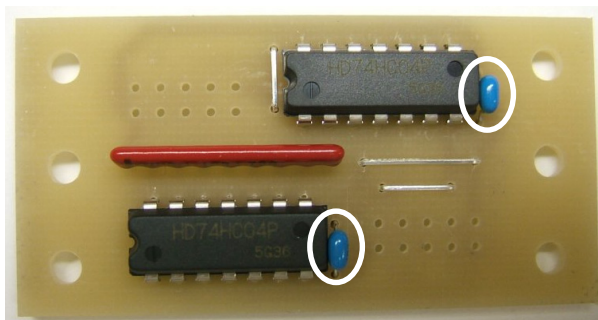
Part number	Name	Type	Manufacturer	Quantity
C11,12	Multi layer ceramic condenser	0.1uF	Various manufacturers	2



1. Prepare 2 multi layer ceramic condensers. As “104” is written on it, if the written side is kept towards the outer side, it is easy to read the capacity of the condenser afterwards. “104” becomes  $10 \times 10^4 \text{ pF} = 100,000 \text{ pF} = 0.1 \text{ }\mu\text{F}$ .



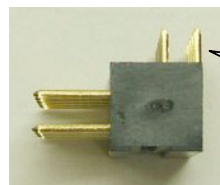
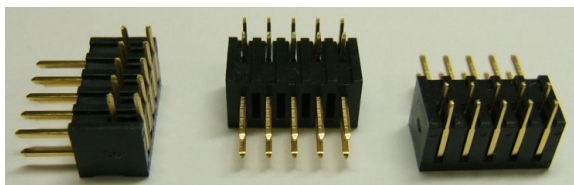
2. Mount it on the portion enclosed with  $\square$  and solder.



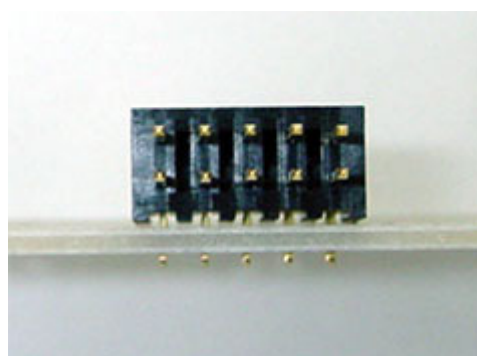
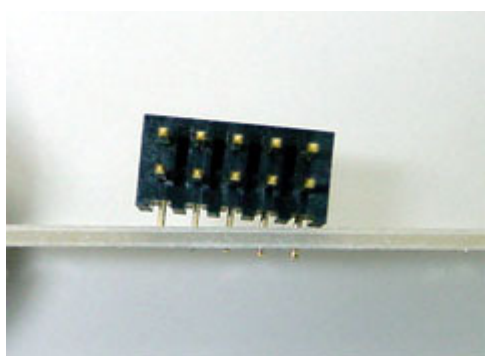
3. It is mounted.

## 4.7. Mounting of 10-pin right angle connector

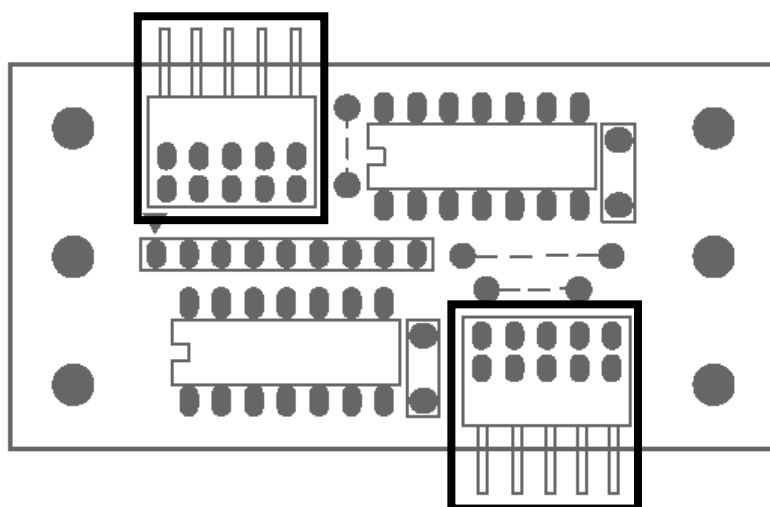
Part number	Name	Type	Manufacturer	Quantity
CN11,12	10 pins right angle connector	PS-10PE-D4LT1-PN1	Japan Aviation Electronics Industry, Limited (corp.)	2



1. Prepare 2 10-pins right angle connectors. There are 3 connectors in the photograph but here only 2 are used.
2. Solder the short lead side. Take care as there is no long side.



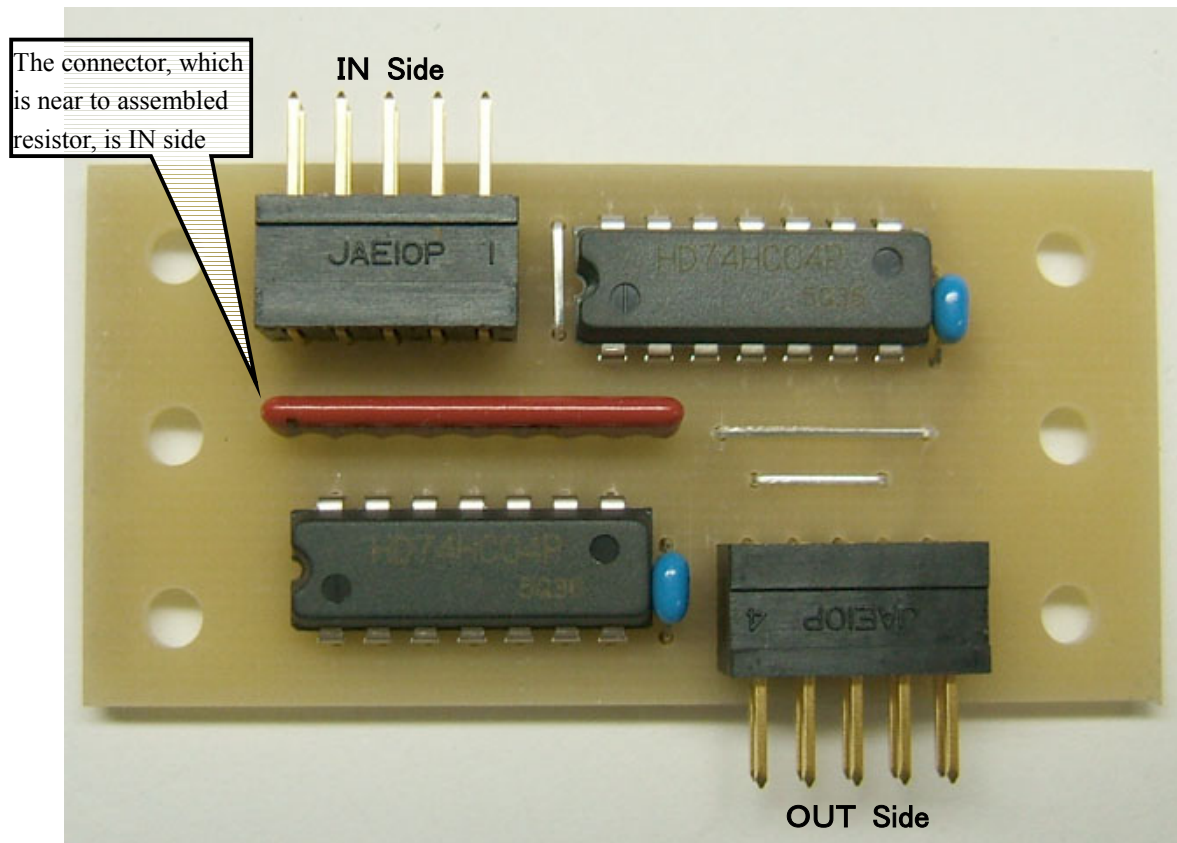
3. Press the 10-pin connector firmly till the end. If it is soldered in floating state as shown in photograph, the lead hangs in the pattern part when the connector is pulled out and opened many times later and incorrect pattern is cut. It is alright if it is cut completely, but a loose connection or malfunctioning may occur due to the vibration of micro car.
4. Solder it in this state.



5. Mount it in the portion enclosed with ☐ and solder.



#### 4.8. Completion

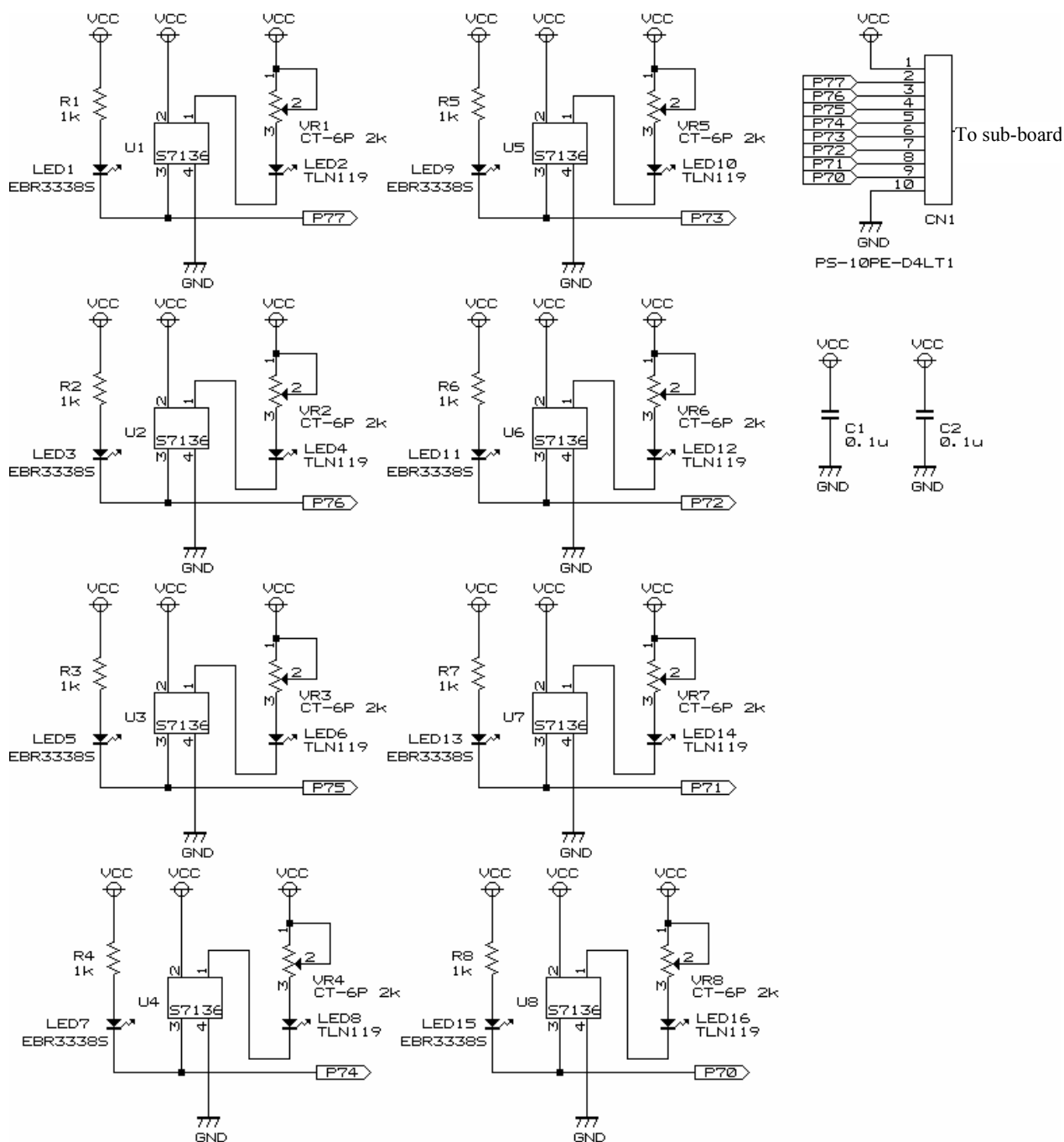


Now, mounting is completed. Confirm that there are no soldered defects and component mounting errors by observing the board once again. Perform the operation test using the kit as per the 'operation confirmation manual'.

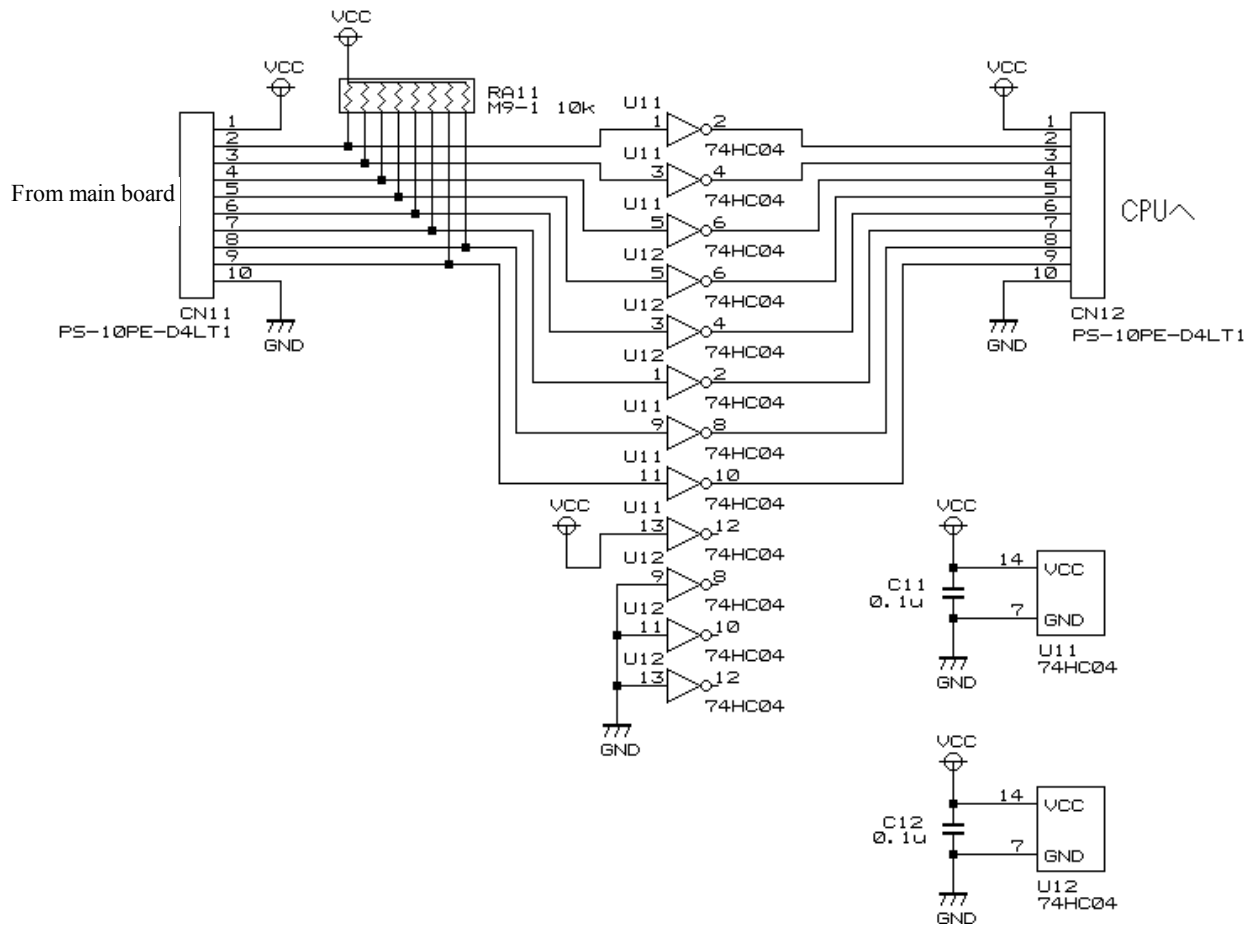


## 5. Circuit diagram

### 5.1. Main Unit Board

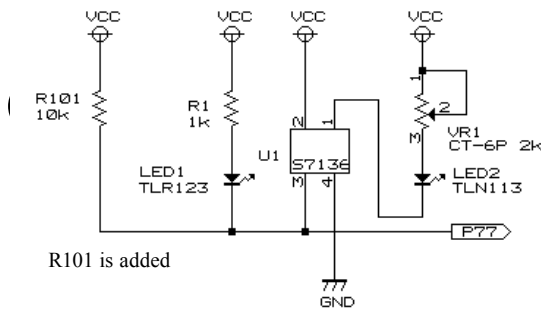


## 5.2. Sub Board

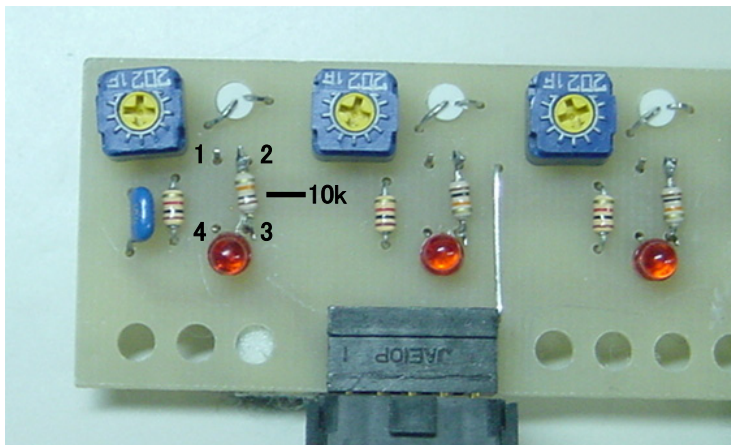


## 6. Appendix

### 5.1. When sub board is not used .....



Though it is recommended to insert the sub board in wave form shape to prevent malfunction, when only the main board is to be installed, insert the pull-up resistor of about 10kΩ between the 3-pin S7136 and Vcc as shown in the following circuit diagram. As the output of S7136 is O/C (open collector), the voltage does not rise in the pull-up due to LED1 and R1. All 3-pin of U1-8 are connected with Vcc.



As pin2 of S7136 is Vcc, resistor of 10Ω is inserted between pin2 and pin3 of S7136 and if resistor is soldered, the installation can be more compact.

For instance, if it is program of kit and if “Tilde” is added as follows, it is OK.

```
unsigned char sensor_inp(unsigned char mask)
{
    unsigned char sensor;
    sensor = P7DR;
    syncopation
}
```

↓

```
unsigned char sensor_inp(unsigned char mask)
{
    unsigned char sensor;
    sensor = ~P7DR;
    syncopation
}
```

Tilde is added!