



# *7<sup>th</sup> International Abilympics*

## *Vocational Skills Contest*

### **V13. Electronic Circuit Connecting Techniques**

#### **1. Task**

The aim is to assemble a printed board and chassis according to the specifications in “4” below.

#### **2. Allocated time**

3 hours

#### **3. Instructions**

- 1) Contestants should first confirm that the items, quantities, etc. of the provided materials are those specified in Section 5 (Materials to be provided on site).
- 2) Contestants who find defects in provided materials should notify the judge.
- 3) If any wires or parts are damaged or short, the relevant contestant should notify the judge.
- 4) Materials other than those provided must not be used.
- 5) Tools, etc. other than those specified in Sections 6 and 7 must not be used.
- 6) Contestants are not allowed to lend or borrow tools, etc.
- 7) Contestants must make sure that they do not leave fingerprints or create flaws on the surface of the chassis, printed circuit board (hereafter, printed board), etc. If the chassis is covered with protective film, the film must be removed before using it.
- 8) When doing crimping work, contestants must use the crimping tools provided on site.
- 9) Clothing, etc., to be worn during the contest should be suitable for the work. When soldering, contestants are recommended to wear eye protection, although this will not apply to those who regularly wear prescription glasses.
- 10) Contestants must not write notes on the task sheet or bring onto the site any other papers with notes, reference books, etc.
- 11) Contestants must notify the judge when they finish the task.
- 12) When the end of the contest is announced, contestants must immediately stop their work and follow the instructions given by the judge.
- 13) When the contest is finished, contestants should clean the worktable, etc. following the instructions given by the judge.

<Note>

The circuit to be assembled will not have the functions of an electrical circuit.

## 4. Specifications

Please refer to the following specifications. Please note that the shape of each item described below is subject to change.

### 4-1 Assembly of the printed circuit board (hereafter, printed board)

Connect each item shown in Section 5-1 (Materials to be provided), based on the assembly drawing for the printed board (PC1) (page 6) according to the following specifications.

#### 4-1-1 Direction of connection and indication of parts

- Those shown in the Assembly Drawing for Printed Board (PB1) shall be applied to polarized parts.
- The carbon film resistor (R7) to be placed in an upright position shall be mounted in a way that the color code can be read from the bottom upward (Fig. 1-1). Also, the diode (D5) shall be mounted according to the assembly drawing for the printed board (PB1).
- The suffix of the diode's rating (D1–D4) and metal film resistor (R19, R20) shall be mounted in a way that the indication of the part can be seen from above.
- Parts other than those above (film capacitor, ceramic capacitor and resistor) shall be mounted in a way that their rating can be read from the bottom upward and left to right (Fig. 1-2).
  - The capacitor (C) shall be mounted in a way that the rating can be read in the direction of the arrow.
  - The resistor (R) shall be mounted in a way that the color code (or the rating) can be read in the direction of the arrow.
- The cup terminals shall be fixed in one direction.

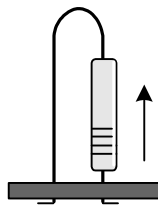


Fig. 1-1 Carbon film resistor (R7)

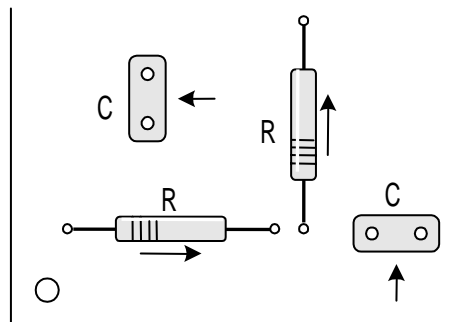


Fig. 1-2

#### 4-1-2 Mounting of parts on the printed board

- The lead wires on the right and left sides of the resistor and diode shall be mounted in a well-balanced way, and forcible power shall not be applied, as illustrated in the following figure:



Example of incorrect mounting

Fig. 2-1

b. Carbon film resistors (R1–R6, R8, R9, R11–R14, R18), solid resistors (R10, R17), diodes (D1–D4, D6–D11), electrolytic capacitors (C1, C2), and integrated circuits (IC1, IC6–IC9) shall be mounted adherently on the printed board.

The maximum uplift allowance shall be as specified in the following figures:

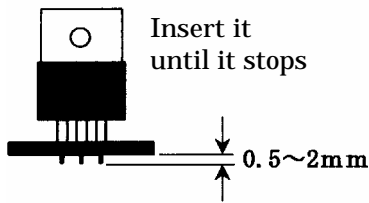


Fig. 2-2 Integrated circuit (IC1)

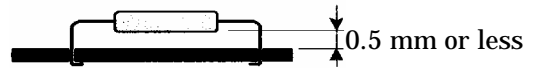


Fig. 2-3 Carbon film resistor (R1–R6, R8, R9, R11–R14, R18), solid resistor (R10, R17) diode (D1–D4, D6–D11)

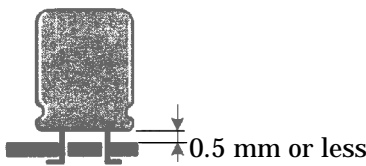


Fig. 2-4 Electrolytic capacitor (C1, C2)



Fig. 2-5 Integrated circuit (IC6–IC9)

c. Metal film resistors (R19, R20), diode (D5), carbon film resistors (R7), light-emitting diodes (LED1, LED2), transistors (TR1–TR4), film capacitors (C3, C4) and ceramic capacitors (C5–C8) shall be mounted in a way that they must be lifted up. In addition, for light-emitting diodes, transistors, film capacitors and ceramic capacitors, the lead wire shall be covered with insulation tube.

The uplift allowance shall be as specified in the following figures:

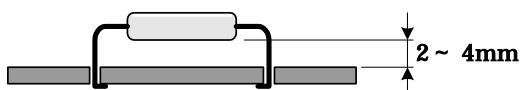


Fig. 2-7 Metal film resistor (R19, R20)

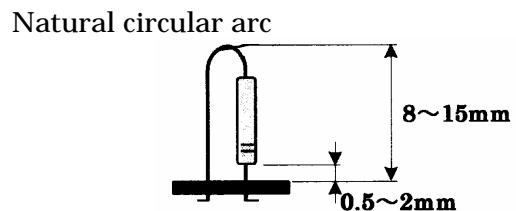


Fig. 2-8 Diode (D5)  
Carbon film resistor (R7)

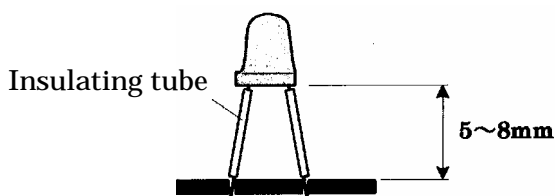


Fig. 2-9 Light-emitting diode (LED1, LED2)

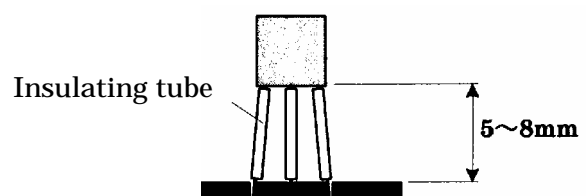


Fig. 2-10 Transistor (TR1–TR4)

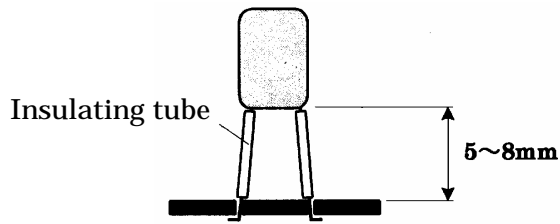


Fig. 2-11 Film capacitor (C3, C4) Ceramic capacitor (C5-C8)

- d. Cylindrical terminals (T1-T7), cup terminals (T8-T12) and forked terminals (T13-T16) shall be mounted in a way that the gap between the terminals and the printed board is 0.5 mm or less.

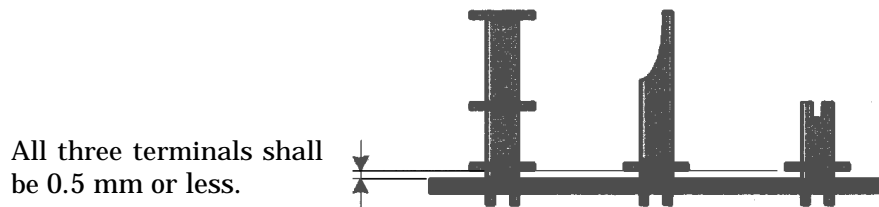


Fig. 2-12 Cylindrical terminals (T1-T7)  
Cup terminals (T8-T12)  
Forked terminals (T13-T16)

- e. Solid resistors (R15, R16) shall be adherently attached to the groove of the forked terminal and soldered. The maximum protrusion allowance of the lead wire shall be as specified in the following figure:

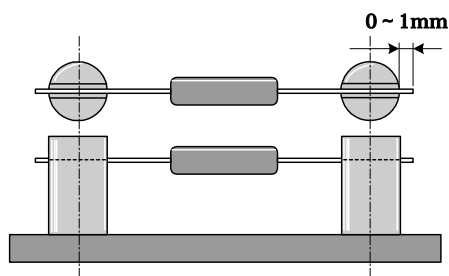


Fig. 2-13 Solid resistor (R15, R16)

f. Integrated circuits (IC2–IC5, IC10, IC11) shall be mounted referring to the following figure. Note that they shall not come in contact with the neighboring land (pattern) or other parts.

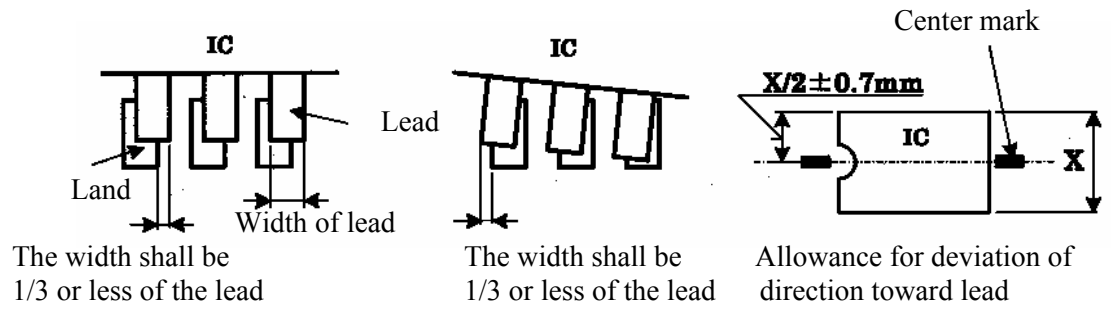


Fig. 2-14 Deviation allowance for position of integrated circuits (IC2–IC5, IC10, IC11) against land and for direction toward lead

#### 4-1-3 Bending of lead wires

Lead wires shall be bent along the soldering surface of the printed board within the land as illustrated below. However, the lead wires of IC (IC1, IC6–IC9) shall not be bent.

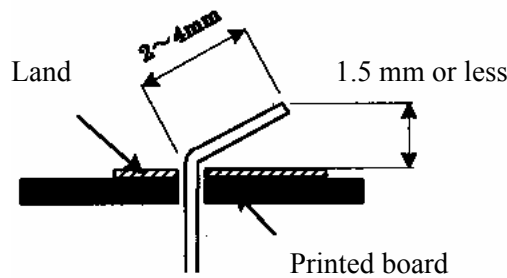


Fig. 3-1

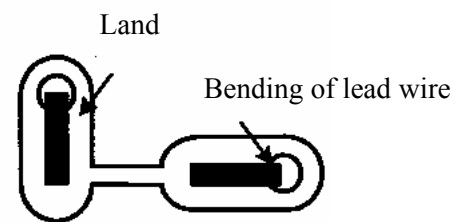


Fig. 3-2

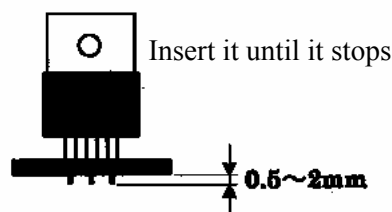
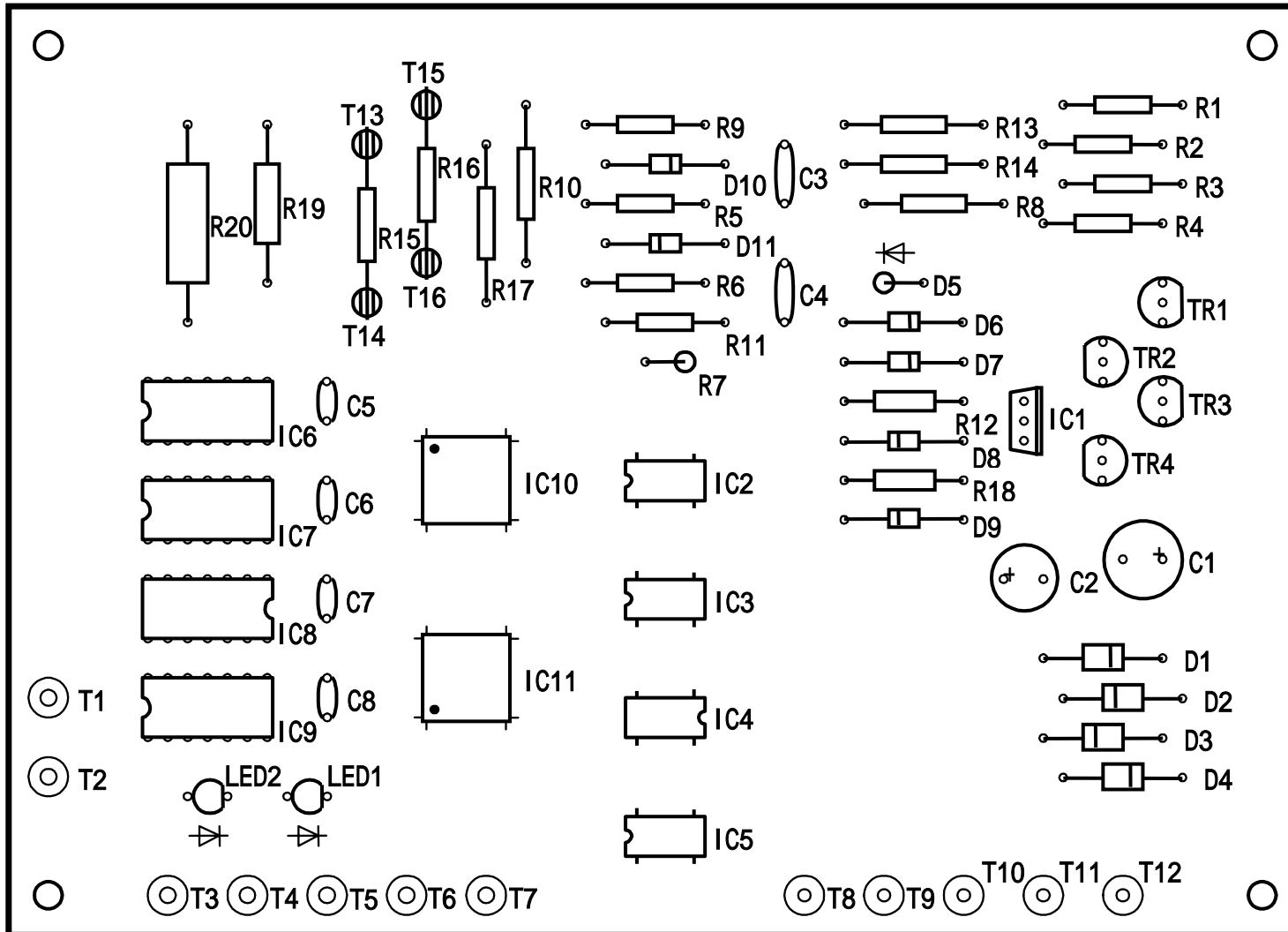


Fig. 3-3 Integrated circuit (IC1, IC6–IC9)

Assembly Drawing for Printed Board (PB1)



4-2 Assembly of the chassis

The items to be provided on site, which are specified in Section 5, shall be mounted by screw tightening and crimping connection based on the Assembly Drawing for the Chassis in accordance with the following specifications.

4-2-1 Connection by tightening screws

All screws except M3 shall be tightened sufficiently to ensure that they would not become loosened and damaged. Note that the lower and upper limits of the appropriate tightening torque value for M3 shall be as specified in the following table:

Nominal diameter of screw	Appropriate tightening torque value N·m (kgf·cm)	
	Lower limit	Upper limit
M3	0.43 (4.4)	0.58 (5.9)

4-2-2 Mounting of parts on the chassis

a. Mounting of the relay terminal blocks (TB1, TB2)

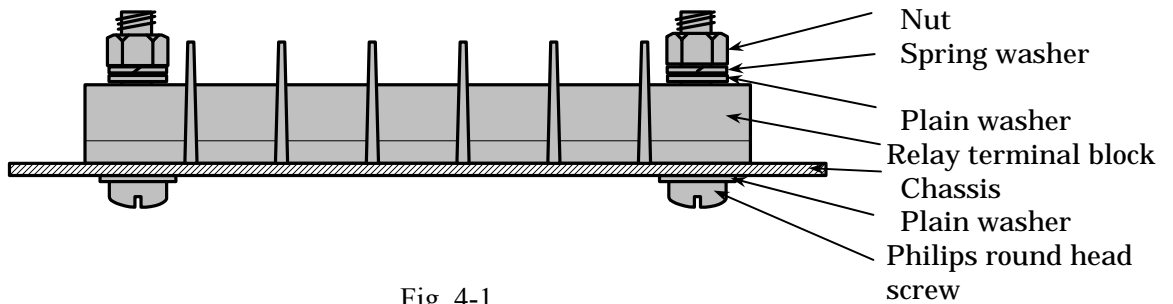


Fig. 4-1

b. Mounting of the terminals (J1, J2)

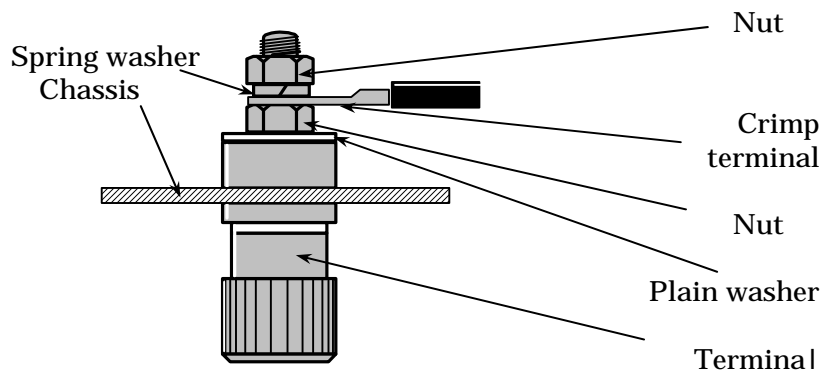
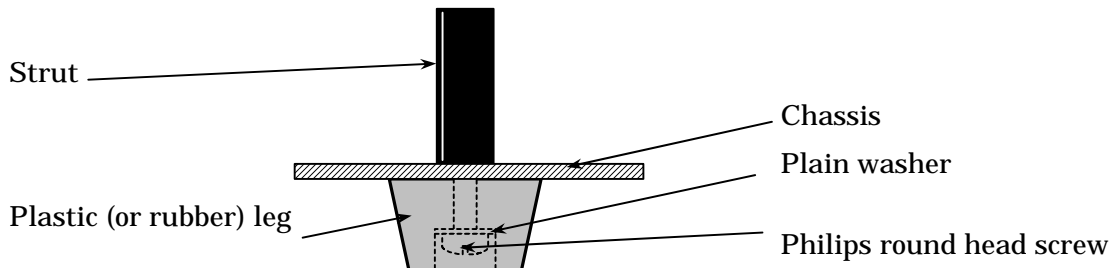


Fig. 4-2

c. Mounting of the plastic (or rubber) leg



(Note) Screws and spring washer (if any) attached to the strut shall not be used.

Fig. 4-3

d. Mounting of the Teflon terminal (T17-T21)

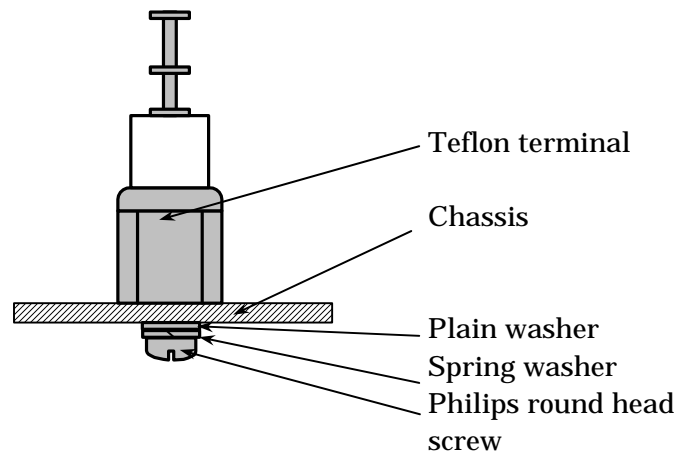


Fig. 4-4



## 4-3 Wiring

### 4-3-1 Connection to the terminals

a. Crimp terminals shall maintain the quality specified in the following figure after crimping.

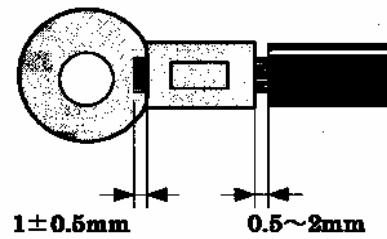


Fig. 5-1 Protrusion of the lead wire and the gap between the coating and the terminal

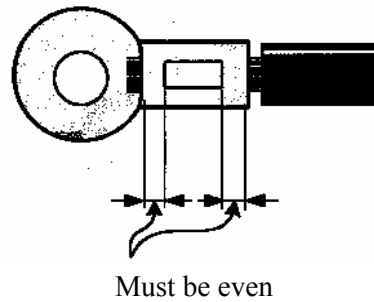


Fig. 5-2 Bell mouth

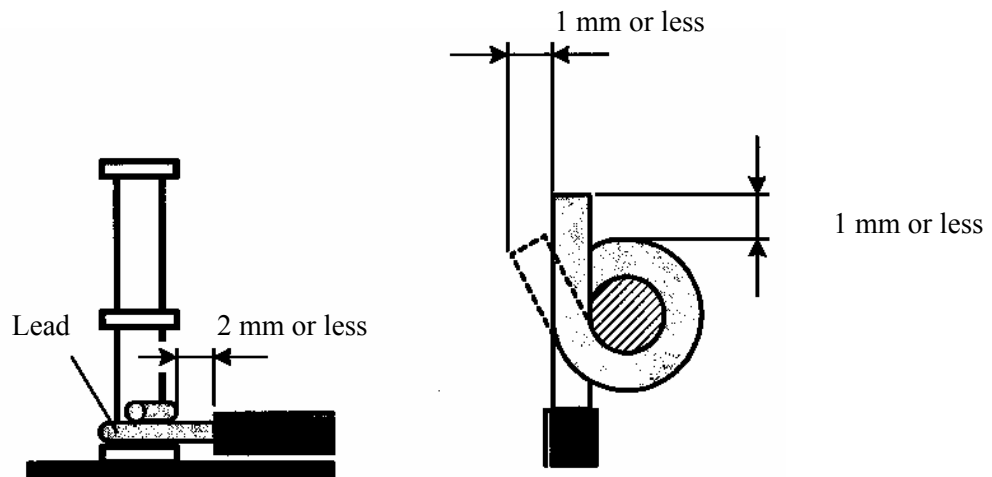


Fig. 5-3 Cylindrical terminal and Teflon terminal (winding)

- b. The Teflon electric wires shall be connected to the cup terminal and cylindrical terminal and shall have an appropriate amount of slack so that tensile force is not applied. Note that the height limit for the Teflon electric wires (W7–W11) shall be 35 mm or lower than the chassis surface. For the Teflon electric wires (W2–W6), the following Fig. 5-6 shall be used for reference.

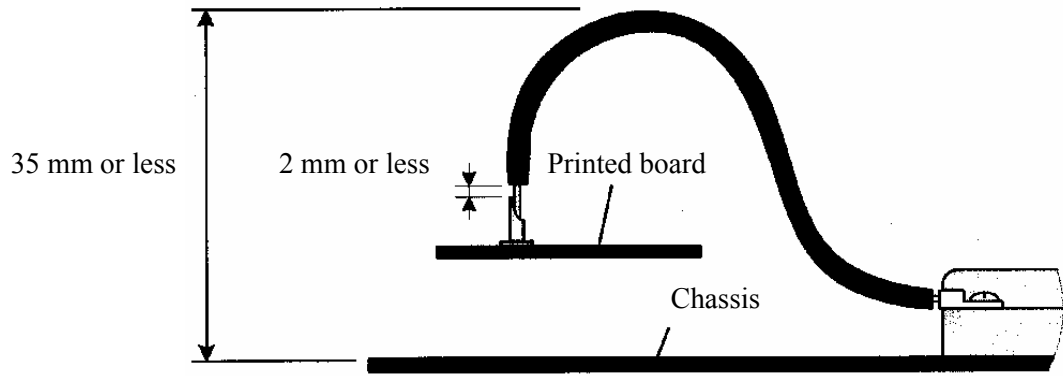


Fig. 5-5

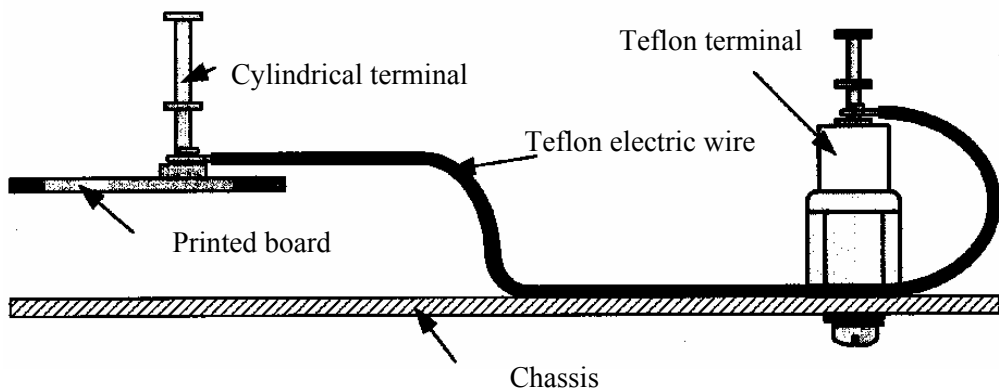


Fig. 5-6

#### 4-3-2 Wiring instructions

a. Wiring should be arranged based on the following Table 2.

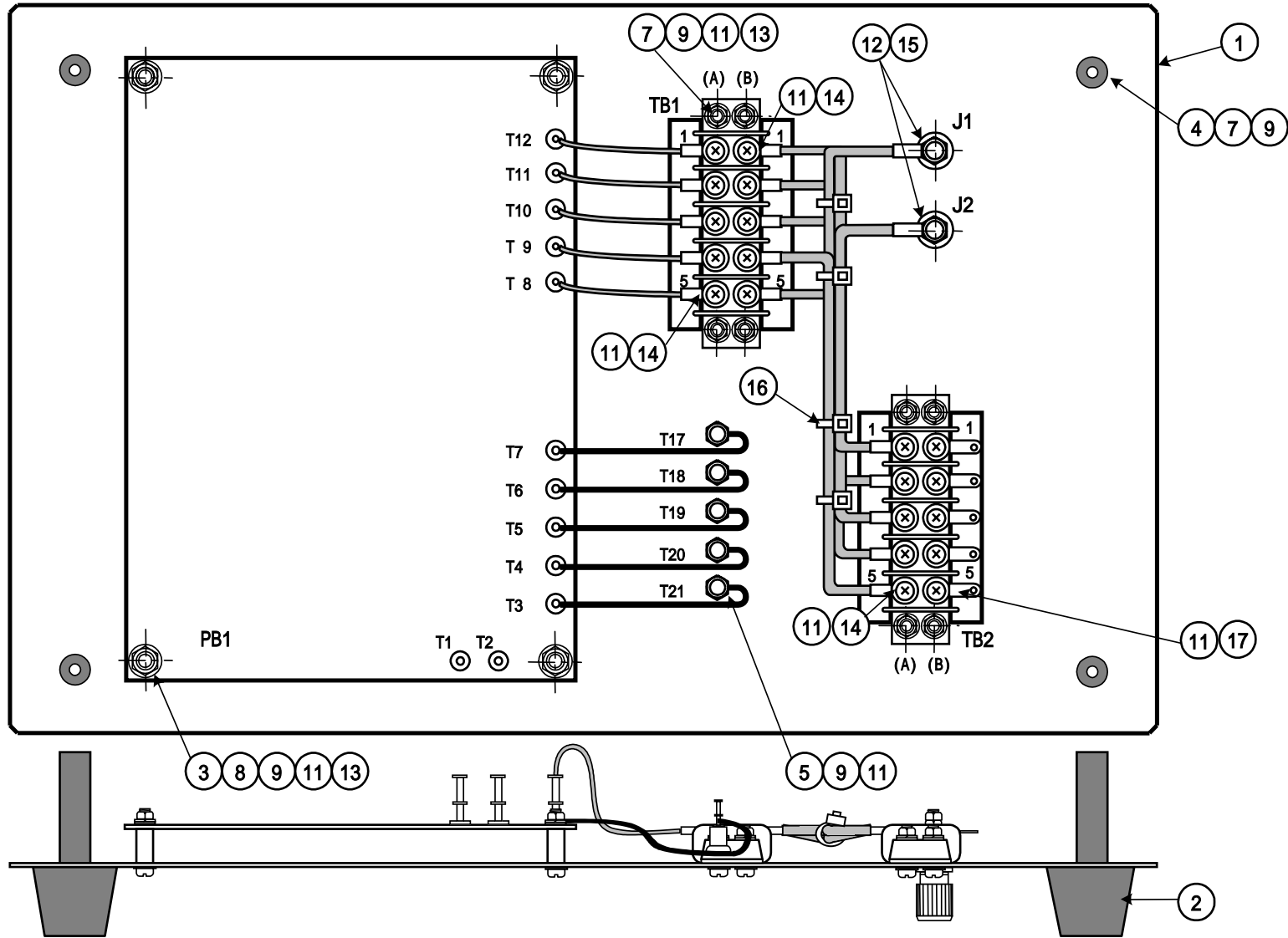
Table 2

No.	From	Terminal	To	Terminal	Wire type
W2	PB1-T7	WT-2-3	T17	FN-1-1	AWG22 (Yellow)
W3	PB1-T6	WT-2-3	T18	FN-1-1	AWG22 (Yellow)
W4	PB1-T5	WT-2-3	T19	FN-1-1	AWG24 (Blue)
W5	PB1-T4	WT-2-3	T20	FN-1-1	AWG24 (Blue)
W6	PB1-T3	WT-2-3	T21	FN-1-1	AWG24 (Blue)
W7	TB1(A)-1	1.25-3	PB1-T12	WT-8-3	AWG22 (Red)
W8	TB1(A)-2	1.25-3	PB1-T11	WT-8-3	AWG22 (Black)
W9	TB1(A)-3	1.25-3	PB1-T10	WT-8-3	AWG22 (Red)
W10	TB1(A)-4	1.25-3	PB1-T9	WT-8-3	AWG22 (Red)
W11	TB1(A)-5	1.25-3	PB1-T8	WT-8-3	AWG22 (Red)
W12	TB1(B)-1	1.25-3	TB2(A)-2	1.25-3	VSF 0.75 mm <sup>2</sup> (Red)
W13	TB1(B)-2	1.25-3	TB2(A)-3	1.25-3	VSF 0.75 mm <sup>2</sup> (Red)
W14	TB1(B)-3	1.25-3	TB2(A)-4	1.25-3	VSF 0.75 mm <sup>2</sup> (Red)
W15	TB1(B)-5	1.25-3	J1	1.25-4	VSF 0.75 mm <sup>2</sup> (Green )
W17	TB1(B)-4	1.25-3	TB2(A)-5	1.25-3	VSF 0.75 mm <sup>2</sup> (Green)
W16	TB2(A)-1	1.25-3	J2	1.25-4	VSF 0.75 mm <sup>2</sup> (Green)

#### 4-3-3 Bundling band

The bundling band shall be tightened referring to the Assembly Drawing of Chassis for the position and direction of tightening.

Assembly Drawing for Chassis



#### 4-4 Soldering

Soldering shall be performed based on the following specifications:

<Note>

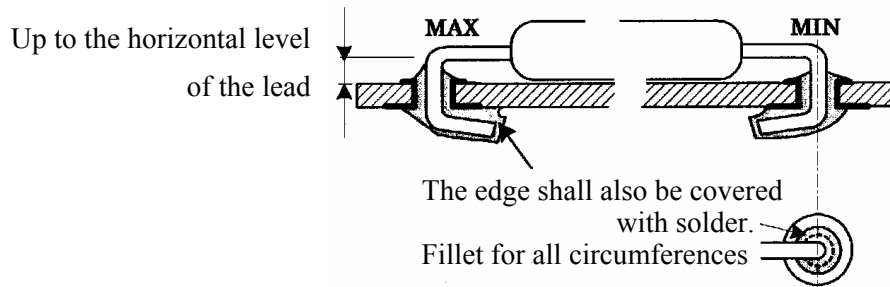
1. "Good condition" means that all the bending and cutting parts of the lead, the hooking part of the wire, and the cutting edge of the wire are covered with solder, yet the shape of each wire can be identified.
2. "Insufficient" means that not all parts of the wire and land and the cutting part of the lead (except SOP, QFP) are covered with solder.
3. "Excessive" means that so much solder was used that the shape of the wire cannot be identified.

##### 4-4-1 Adhesiveness of solder

- a. It shall be totally fused.
- b. The surface shall be smooth.

4-4-2 The standard for soldering and the extent of spreading shall be as specified in the following drawing.

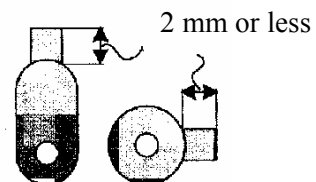
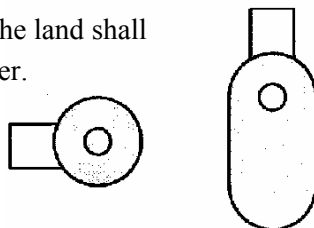
- a. Standard for soldering the land



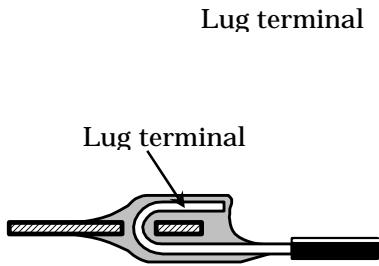
(Note) The through-hole shall be 100% filled with solder.

Fig. 6-1

The front face of the land shall be filled with solder.



b. Standard for soldering the terminal



There shall be no hole.

Fig. 6-4 Lug terminal

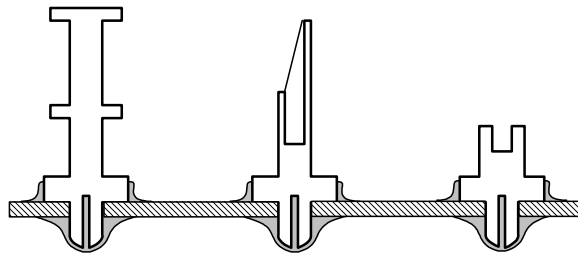
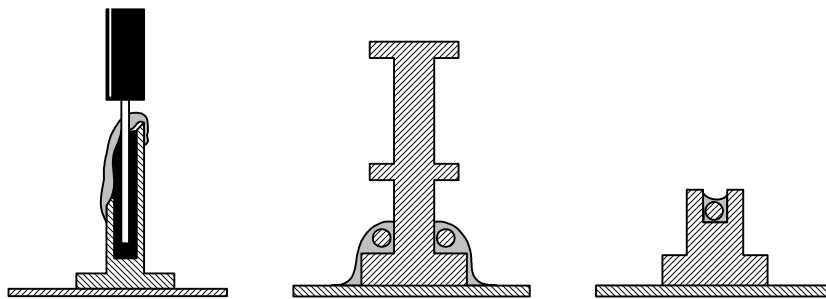


Fig. 6-5 Printed board and terminal

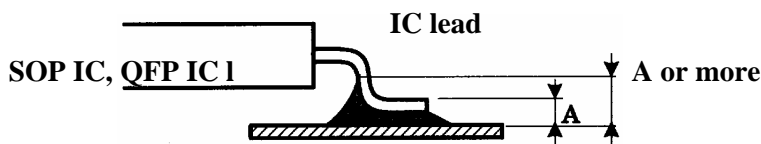


(Note) Film solder may be attached on the exterior wall of the cup.

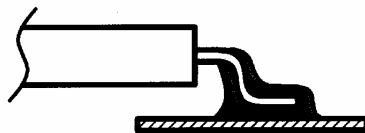
Fig. 6-6 Lead wire and terminal

4-4-3 The amount of solder for surface mounting shall be as specified in the following drawing.

a. Standard for allowable solder amount for SOP IC and QFP IC



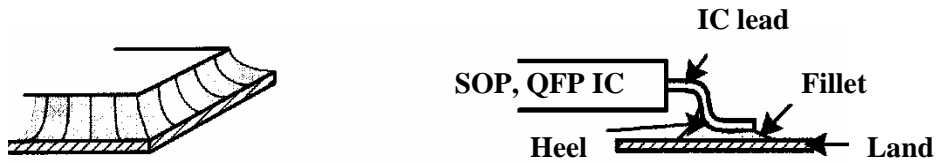
Example of incorrect soldering to IC lead



(Note) Solder shall not flow to the molded component of the SOP and QFP, and the shape of the lead shall be visible.

Fig. 6-7

b. Solder fillet for SOP IC and QFP IC

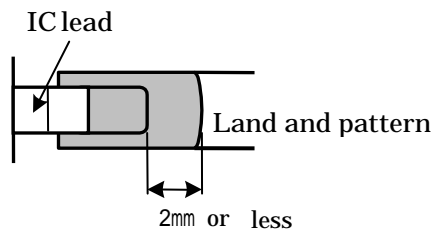


(Note)

The lead and land shall be connected by smooth solder fillet. Note that since the tip of the lead shall be a cutting surface, the wettability shall not be specified. In addition, although the lead is transformed, it is acceptable if a fillet is formed at the tip of the lead (except at the cutting surface) and heel.

Fig. 6-8

c. Extent of the spread of solder at the lead of SOP IC and QFP IC



(Note) The extent of the spread of solder shall be within 2 mm from the tip of the IC lead.

Fig. 6-9

## 5. Materials to be provided on site

### 5-1 Materials to be used for the printed board

No.	Item	Rating, purpose	Qty	Remarks
IC1	Integrated circuit	5V1A, three-terminal regulator	1	7805CT or similar
IC2, 4	Integrated circuit	HEXINVER (SOP14-P-300mil)	2	4069UB or similar
IC3, 5	Integrated circuit	DRIVER (SOP14-P-300mil)	2	74HC02F or similar
IC6, 8	Integrated circuit	14-pin type	2	74HC04P or similar
IC7, 9	Integrated circuit	14-pin type	2	74HC00P or similar
IC10, 11	Integrated circuit	44-pin type	2	TO TMP87C447LU or similar
LED1	Light-emitting diode (yellow)	Reverse voltage: 4 V or more, forward current: 35 mA or more	1	TLY143 or similar
LED2	Light-emitting diode (red)	Reverse voltage: 4 V or more, forward current: 35 mA or more	1	TLR143 or similar
TR1, 2	Transistor	Mold type TO-92, 2SA type	2	2SA1015 or similar
TR3, 4	Transistor	Mold type TO-92, 2SC type	2	2SC1815 or similar
D1-4	Diode	For rectification, forward current: 1A or more	4	10E-1 or similar
D5-11	Diode	For switching	7	1S1588 or similar
C1	Electrolytic capacitor	CE04W, 470 $\mu$ F, 16 V	1	
C2	Electrolytic capacitor	CE04W, 220 $\mu$ F, 35 V	1	
C3, 4	Film capacitor	0.1 $\mu$ F, 50 V, $\pm$ 10%	2	
C5, 7	Ceramic capacitor	0.022 $\mu$ F, 50 V, $\pm$ 10%	2	
C6, 8	Ceramic capacitor	0.01 $\mu$ F, 50 V, $\pm$ 10%	2	
R1, 13	Carbon film resistor	1/4 W, 100 k $\Omega$ , $\pm$ 5%	2	
R2, 14	Carbon film resistor	1/4 W, 30 k $\Omega$ , $\pm$ 5%	2	
R3, 8	Carbon film resistor	1/4 W, 51 k $\Omega$ , $\pm$ 5%	2	
R4, 9	Carbon film resistor	1/4 W, 470 k $\Omega$ , $\pm$ 5%	2	
R5, 11, 18	Carbon film resistor	1/4 W, 300 k $\Omega$ , $\pm$ 5%	3	
R6, 12	Carbon film resistor	1/4 W, 10 k $\Omega$ , $\pm$ 5%	2	
R7	Carbon film resistor	1/4 W, 1.2 k $\Omega$ , $\pm$ 5%	1	
R15	Solid resistor	1/2 W, 2.2 k $\Omega$ , $\pm$ 5%	1	
R16	Solid resistor	1/2 W, 220 k $\Omega$ , $\pm$ 5%	1	
R10, 17	Solid resistor	1/2 W, 47 k $\Omega$ , $\pm$ 5%	2	
R19	Metal film resistor	1 W, 22 $\Omega$ , $\pm$ 5%	1	
R20	Metal film resistor	2 W, 100 $\Omega$ , $\pm$ 5%	1	
T1-7	Cylindrical terminal	WT-2-3	7	MAC8
T8-12	Cup terminal	WT-8-3	5	
T13-16	Forked terminal	AT-1-2	4	
PB1	Printed board	117.5 $\times$ 162.5 T1.6	1	Yamato Print
	Insulating tube	$\phi$ 1.0 mm	0.3 m	
Solder (thick)	RH60	$\phi$ 0.8 mm	2 m	
Solder (thin)	RH60	$\phi$ 0.4 mm	1 m	

Note: Lead-free solder shall be used.



## 5-2 Materials to be used for the chassis

No.	Item	Rating, purpose	Qty	Remarks
T17-21	Teflon terminal	FN-1-1	5	MAC8
TB1, 2	Relay terminal block	5P type	2	H01 or similar, screws attached
J1, 2	Terminal	φ12, 33 long or similar (plain, spring nuts attached)	2	T375 or similar
[1]	Chassis	A5052P 300×190 T2	1	
[2]	Plastic (or rubber) leg	20 long, φ20 or similar	4	For chassis
[3]	Spacer	φ6×10, φ3.5 hole	4	For mounting FB1
[4]	Strut	φ8×40, M3 tap attached	4	For mounting [2]
[5]	Philips round head screw	M3×6 (Bs)	5	For mounting T17-21
[7]	Philips round head screw	M3×16 (Bs)	12	For mounting [2], [4], TB
[8]	Philips round head screw	M3×20 (Bs)	4	For mounting PB1
[9]	Plain washer	Polished round × 3	33	
[11]	Spring washer	No.2 × 3	37	
[12]	Spring washer	No.2 × 4	2	
[13]	Nut	M3	12	
[14]	Bare crimping terminal	1.25-3	15	Round
[15]	Bare crimping terminal	1.25-4	2	Round
[16]	Bundling band	80-100 mm or similar	4	
[17]	Lug terminal	Nominal diameter 3	5	For TB2-1 to 5
W2, 3	Teflon electric wire	AWG22 (yellow)	0.3	
W4-6	Teflon electric wire	AWG24 (blue)	0.4	
W7, 9-11	Teflon electric wire	AWG22 (red)	0.5	
W8	Teflon electric wire	AWG22 (black)	0.2	
W12-14	Vinyl electric wire	VSF 0.75 mm <sup>2</sup> (red)	0.6	
W15-17	Vinyl electric wire	VSF 0.75 mm <sup>2</sup> (green)	0.6	

## 6. Items to be brought by each contestant

Item	Standard	Qty	Remarks
Precision Pliers		Set	
Wire cutter			
Wire stripper		1-3	
Phillips screwdriver	3 mm, No.2, e.t.c	2	
Nut box screwdriver	5.5, 5	2	For 3 mm
	7	1	For 4 mm
Spanner	5.5		1
	7		For 4 mm
Monkey spanner		As	
Soldering iron		1-2	Including iron tip, soldering iron stand, temperature controller, thermometer, desoldering tools, etc.
Ruler		As appropriate	
Tweezers			
Cutting knife		1	
Tool for tightening the bundling band			
Printed board support table		As appropriate	Outside dimensions of printed board: 162.5 × 117.5 mm Mounting hole $\phi$ 3.5 pitch 152.5 mm (long side) 107.5 mm (short side)
Multimeter		1	
Power strip			
Cleaning tools		As appropriate	
Gloves			
Glasses for eye protection		1	Except for those who wear glasses

<Note>

1. Contestants who wish to bring their own tools are asked to prepare a list of such tools and present it to the organizer for approval in advance. The organizer reserves the right to reject the use of any tools that are considered to give the contestant an unfair advantage.
2. Tools converted for a contestant's own use shall not be allowed in principle, but this will not apply to tools specially converted according to the contestant's disability conditions.
3. Contestants are recommended to bring glasses for eye protection and wear it during the contest.

## 7. Tools, etc. to be prepared on site

Item	Standard
Crimp tools	Manual crimping tool with ratchet attached, whereby bare crimping terminals 1.25, 2 mm <sup>2</sup> can be crimped.
Working table	
Chair	
Desk light	
Writing utensils	A set of utensils

## 8. Grading criteria

The items to be evaluated and marks allocated are defined as follows.

Items to be evaluated		Marks allocated
Product	[1] Appearance, cleaning and removal of protective film	17
	[2] Mounting of parts (printed board)	14
	[3] Mounting of parts (chassis)	13
	[4] Wiring and bundling	19
	[5] Soldering (printed board and other than the printed board), soldering ( SOPIC and QFPIC parts )	25
Re-provision of materials and/or work attitude		12
Total		100

<Note>

In case of equal evaluation of plural contestants, the time to finish the assigned task will be taken into account.