



# SERVICE MANUAL

## CM-60A

MULTI-CHARGER

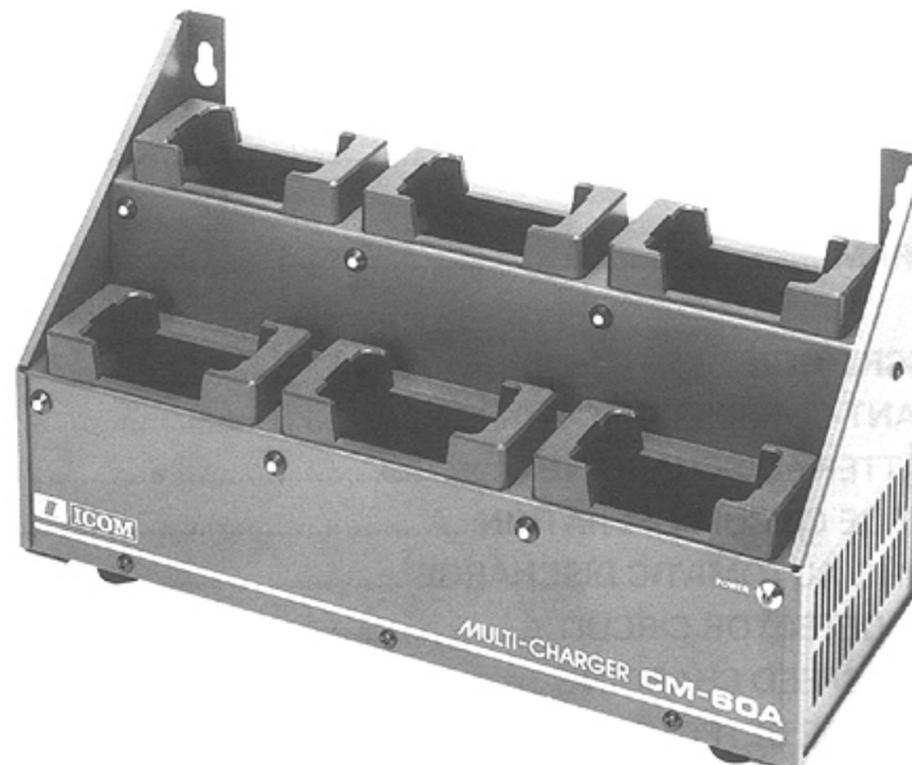
ICOM INCORPORATED

## INTRODUCTION

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The **CM-60A MULTI-CHARGER** simultaneously charges up to six NiCd battery packs.

This manual contains information for servicing **CM-60A**.



## VERSIONS

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ICOM makes five versions of CM-60A:

VERSION	POWER SUPPLY REQUIREMENTS	
#01 (Japan)	100V	50/60Hz
#02 (USA)	117V	50/60Hz
#03 (Europe)	240V	50/60Hz
#04 (Germany)	220V	50Hz
#05 (Australia)	240V	50/60Hz

This manual covers all versions. Please consult this manual before servicing CM-60A.

Should you have a question about using or servicing CM-60A, please contact an authorized ICOM dealer or ICOM Service Center.

## ORDERING PARTS

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When ordering parts from your dealer or ICOM Service Center, please supply all of the following information:

1. Equipment model and serial number (e.g., CM-60A, No. 0001)
2. Printed circuit board name and number (e.g., MAIN UNIT B-1428B)
3. Schematic part identification (e.g., IC101)
4. Part number and name (e.g.,  $\mu$ PC317, IC)
5. Quantity (e.g., 2pcs)

Remember to include your name and address in your letter.

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## SECTION 1 SPECIFICATIONS

Number of battery packs charged simultaneously	: 6
Charging method	: Regular speed charge 0.3 ~ 0.16C Trickle charge 0.07 ~ 0.03C
Power supply requirement	: 117, 220 or 240V 50 or 60Hz
Full charge detector circuit	: $-\Delta V$ detector
Protection circuitry	: Built-in recharge prevention Built-in overcharge prevention
Dimensions	: 310(W) × 148(H) × 120(D) mm (wall mount brackets not included)
Weight	: 2.95kg
Operating temperature range	: 0°C ~ 35°C

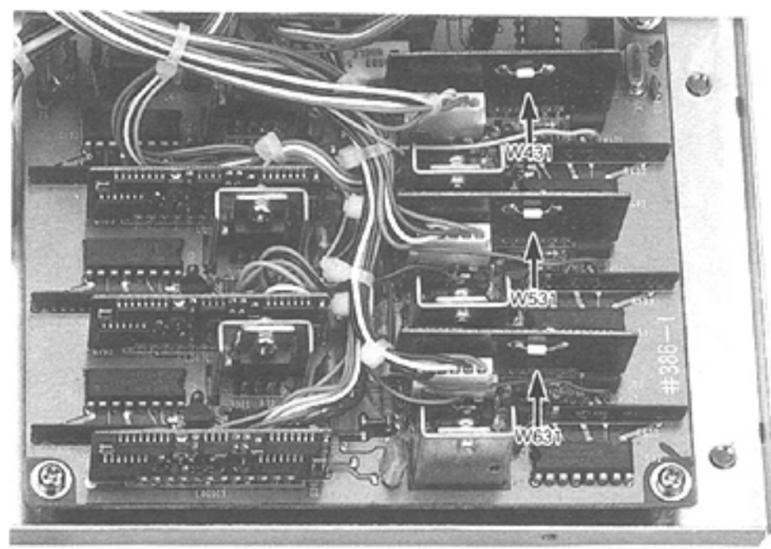
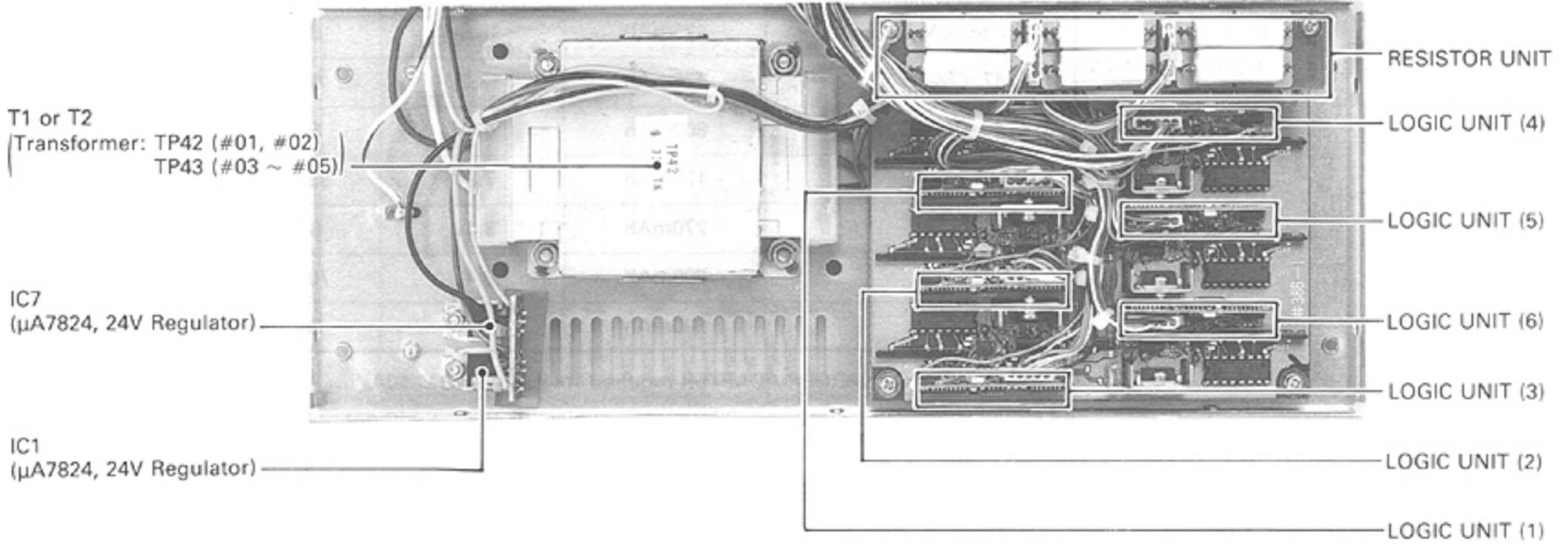
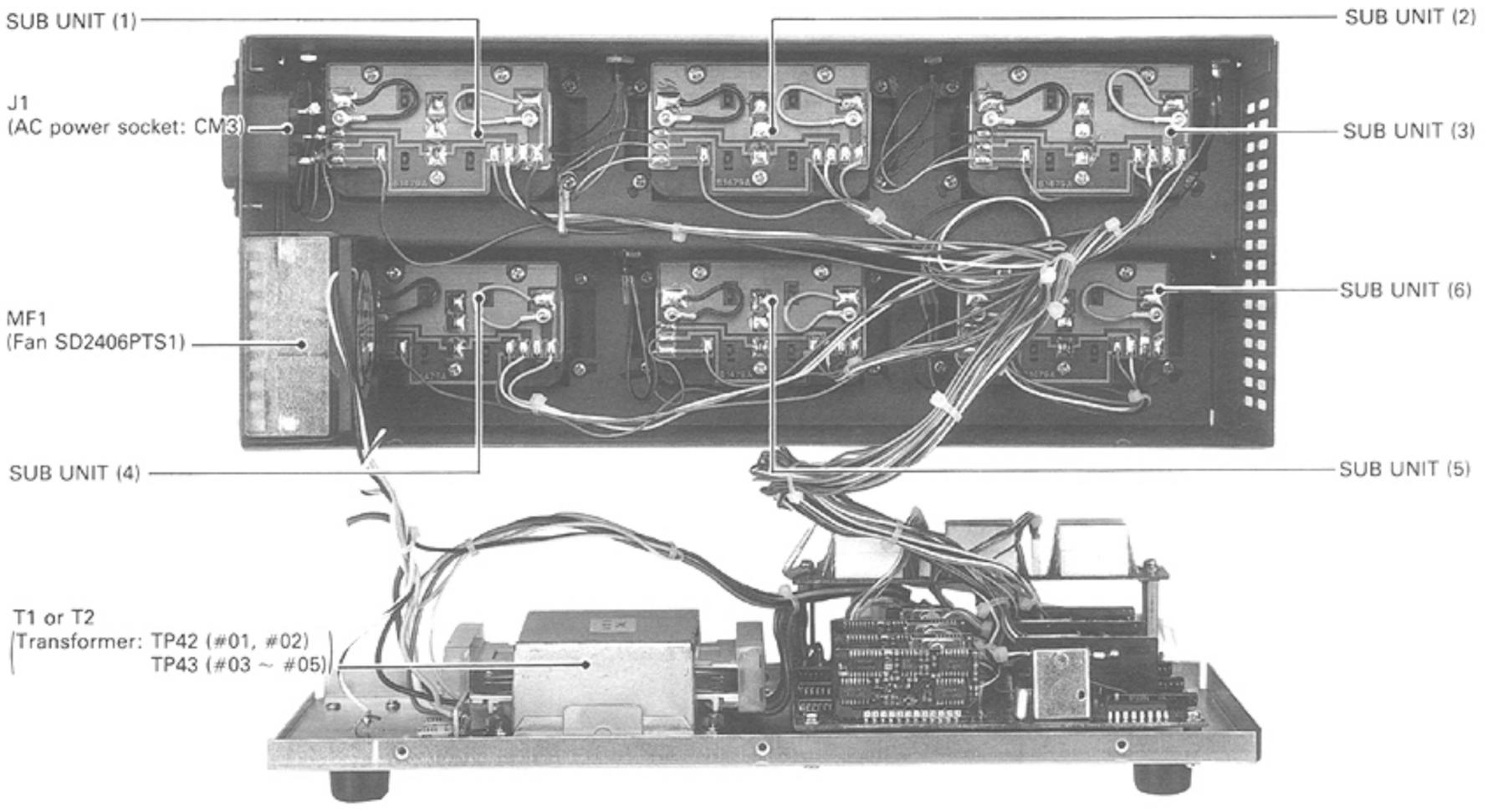
Charging time

MODEL	BATTERY CAPACITY	OUTPUT VOLTAGE	HEIGHT	CHARGING TIME
IC-CM2, CM-2G	425mAh	7.2V	39mm	5hrs.
IC-CM3, CM-3G	270mAh	8.4V	39mm	3.5hrs.
IC-CM5, CM-5G	425mAh	10.8V	60mm	5hrs.
IC-CM5A, CM-5AG	425mAh	10.8V	80mm	5hrs.
IC-CM7, CM-7G	425mAh	13.2V	80mm	5hrs.
IC-CM8, CM-8G	800mAh	8.4V	80mm	9.5hrs.
* CM-21	120mAh	7.2V	32.5mm	2hrs.
* CM-22	270mAh	8.4V	62mm	3.5hrs.
* CM-23	600mAh	8.4V	70.5mm	7hrs.
* CM-24	600mAh	10.8V	85mm	7hrs.

\* Optional AD-10 CHARGER ADAPTER required for use with CM-60A.

All stated specifications are approximate and subject to change without notice or obligation.

**SECTION 2 INSIDE VIEWS**

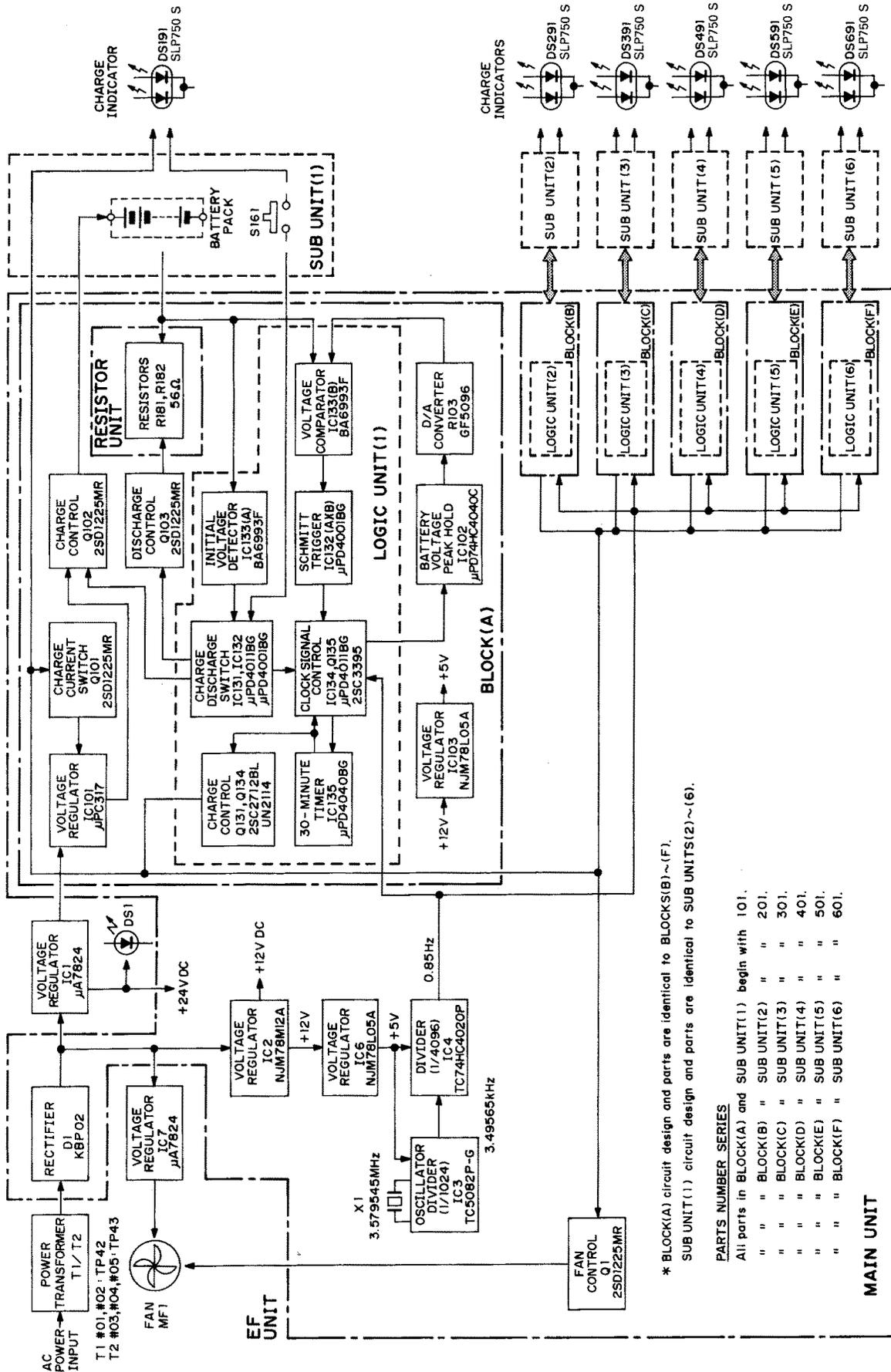


Each LOGIC UNIT has a jumper wire.

**EXAMPLE:**  
W431 is the jumper wire in LOGIC UNIT (4).

**NOTE:**  
W131, W231 and W331 are not visible in this photograph.

SECTION 3 BLOCK DIAGRAM



\* BLOCK(A) circuit design and parts are identical to BLOCKS(B)~(F).  
 SUB UNIT(1) circuit design and parts are identical to SUB UNITS(2)~(6).

PARTS NUMBER SERIES

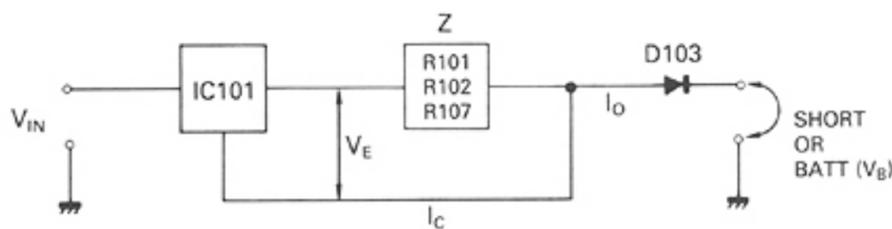
- All parts in BLOCK(A) and SUB UNIT(1) begin with 101.
- " " BLOCK(B) " SUB UNIT(2) " " 201.
- " " BLOCK(C) " SUB UNIT(3) " " 301.
- " " BLOCK(D) " SUB UNIT(4) " " 401.
- " " BLOCK(E) " SUB UNIT(5) " " 501.
- " " BLOCK(F) " SUB UNIT(6) " " 601.

## SECTION 4 CIRCUIT DESCRIPTION

### 4 - 1 CONSTANT-CURRENT CIRCUIT

This circuit consists of IC101, Q101, Q102, R101, R102, R107 and D103.

The constant-current circuit uses a 3-pin 1.25V regulator. Short the charge terminals between the cathode of D103 and ground to make the following equivalent circuit:



The current,  $I_O$ , between D103 and ground is obtained from the formula:

$$I_O = \frac{V_E}{Z}$$

where  $V_E$  is the output voltage of IC101, and  $Z$  is the impedance.

$I_C$  at maximum is 0.1mA, and can be disregarded. Because  $V_E$  is regulated to be 1.25V,  $I_O = 1.25V/Z$ , regardless of the battery output voltage and the battery capacity. Hence, the current is held constant.

During regular charge, Q101 is ON, and R101 is disabled. During trickle charge, Q101 is OFF, so that  $Z$  increases by the value of R101 (56  $\Omega$ ), producing a current equal to 2.5% ~ 5% of the battery's capacity.

Using the formula, we can calculate the regular speed charge current and the trickle charge current:

$$\begin{aligned} \text{Regular charge current: } I_O &= \frac{V_E}{Z_1} \approx 135\text{mA} \\ V_E &= 1.25\text{V} \\ Z_1 &= \frac{R102 \times R107}{R102 + R107} = 9 \Omega \end{aligned}$$

$$\begin{aligned} \text{Trickle charge current: } I_O &= \frac{V_E}{Z_2} \approx 20\text{mA} \\ V_E &= 1.25\text{V} \\ Z_2 &= Z_1 + R101 = 9 \Omega + 56 \Omega \\ &= 65 \Omega \end{aligned}$$

### 4 - 2 NiCd BATTERY DISCHARGING

NiCd batteries should be fully discharged before recharging. Shallow discharging lowers battery capacity.

#### 4 - 2 - 1 DISCHARGE CIRCUIT OPERATION

CM-60A has an automatic discharge circuit which fully discharges the battery before recharging. This circuit can be activated by disconnecting the jumper wires (see p.2 for location).

When a battery pack is inserted in an insertion slot, two voltages are applied to IC133(A), the comparator. The battery voltage (BATT-V) is applied at pin 2, and a reference voltage of 1V is applied at pin 3. When the jumper wires are disconnected, and when the voltage at pin 2 is greater than that at pin 3, pin 1 output switches from HIGH to LOW.

At the same time, the base of the battery pack closes S161. Because the anode of D131 is grounded through S161, no voltage is applied to IC131 pin 12 through the time constant circuit, R138 and C131.

When IC132 pin 11 outputs LOW, Q133 is turned OFF, and Q103 is turned ON. The battery pack voltage is then discharged through R181 and R182.

Discharging decreases the battery voltage. When the voltage at IC133 pin 2 is lower than that at pin 3, output pin 1 switches from LOW to HIGH. This turns Q103 OFF, and discharging stops.

#### 4 - 2 - 2 DISABLING AUTOMATIC DISCHARGE

If you do not require automatic discharge, do not disconnect the jumper wires.

When the jumper wires are connected, 5V is constantly applied to IC133 pin 3. Hence, the voltage at pin 3 will always be greater than that at pin 2. The voltage of pin 2 is approximately 20% of the battery output voltage, and the highest voltage of the battery pack is 13.2V. Hence, IC133 pin 1 remains HIGH. Even if 5V is applied to IC132 pin 13 through the RC time constant circuit, IC132 pin 11 continues to output HIGH.

The output of IC132 pin 11 turns ON Q133, and Q103 turns OFF. The battery voltage will not be discharged.

### 4 - 3 CHARGE DETECTOR CIRCUIT

When the battery is completely discharged, the HIGH of IC132 pin 11 is applied to IC131 at pin 6. Because both IC131 pins 1 and 2 are LOW, IC131 pin 4 output switches from HIGH to LOW. Q132 then turns OFF, and Q102 turns ON. The constant current flows into the battery pack and charging begins.

#### 4 - 3 - 1 REGULAR SPEED CHARGING

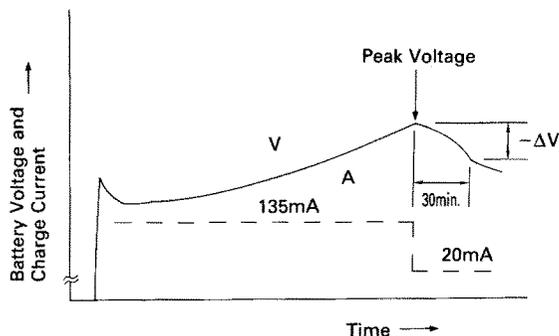
During discharge, IC134 pin 3 outputs HIGH, resetting IC135 internal data to 0 (zero).

The result of this is that IC135 pins 14 and 15 output LOW immediately after charging begins. Q131 turns ON, and 24V DC are applied through Q134, R105 and D101 to the base of Q101 to turn Q101 ON. R101 is shorted by Q101 and the constant current flows to the battery pack through Q102 for regular speed charging.

In addition, IC131 pin 4 output switches from HIGH to LOW. IC102 pin 11 becomes LOW, and counts the clock signals generated by IC3. The output from IC102 passes through ladder resistor R103 which converts the signals from digital to analog. The resulting voltage is applied to IC133 at pin 6 as the D/A voltage.

#### 4 - 3 - 2 FULL CHARGE DETECTOR

CM-60A has a  $-\Delta V$  detection control circuit to detect a full charge and to prevent overcharging. When a NiCd battery reaches full charge, its voltage peaks, and then tapers off.



CM-60A detects the peak voltage in order to switch the charging speed from regular to trickle. (See Section 4 - 3 - 3 for trickle charging.)

During charging, the D/A voltage increases. The comparator IC chip, IC133, compares BATT-V to the D/A voltage over pins 5 and 6. If the voltage at pin 6 exceeds that at pin 5, output pin 7 switches from HIGH to LOW.

When IC134 pin 11 stops outputting clock signals, the D/A voltage increases, and pin 11 becomes HIGH. The battery pack is fully charged.

#### 4 - 3 - 3 TRICKLE CHARGING

When IC134 pin 3 output is LOW, the 30 minute timer begins counting clock signals generated by IC3. As clock signals from IC134 pin 4 are applied to IC135 at pin 10, the internal data of IC135 increases.

Approximately 30 minutes later, IC135 pins 14 and 15 become HIGH, and IC134 output pin 10 switches from HIGH to LOW. When IC134 pin 4 stops outputting clock signals, IC135 stops counting the internal data.

When IC134 pin 10 becomes LOW, Q131, Q134 and Q101 turn OFF, and a trickle charge of about 20mA flows through R101.

### 4 - 4 INDICATOR CONTROL CIRCUIT

During discharge and regular speed charge, the collector of Q134 outputs 24V DC. This voltage passes through D106 and R106, causing LED DS191 to light in red. Passing through D105, the voltage is applied to the base of Q104, turning OFF Q104. The green LED is not lighted.

During trickle charging, the collector of Q134 turns OFF, and current flows from the base of Q104 through R109. The collector outputs 24V, which applied to LED DS191, lights it in green.

The collector of Q134 makes a circuit with D107. During discharge and regular speed charging, the voltage passes through R6, turning ON Q1 and MF1, the cooling fan. During standby, the voltage through R137 causes the emitter of Q131 to become HIGH, turning OFF Q131, Q134 and MF1.

### 4 - 5 CLOCK SIGNAL GENERATOR

IC3 oscillates X1. IC4 divides the oscillated signals and outputs the signals through pin 1 to each insertion slot. In this way, the clock signals provide the information required to control regular speed and trickle charge switching.

### 4 - 6 POWER SUPPLY CIRCUIT

D1 rectifies the voltage which has been stepped down by T1 (Versions #01, #02) or T2 (Versions #03, #04, #05). The stable voltage from IC1 is applied to each insertion slot. The battery is then charged through the constant-current circuit.

The rectified voltage from D1 is also applied at IC7 to drive MF1, the cooling fan.

After rectification at D1, the voltage is applied to IC2 to obtain regulated 12V DC through R5. The voltage is applied to IC103 ~ IC603 at each insertion slot to obtain regulated 5V DC. The 5V are used by the ICs in the control circuitry.

## SECTION 5 MAINTENANCE

### DANGER: HIGH VOLTAGE

TO PREVENT A LETHAL SHOCK, TURN OFF THE POWER AND DETACH THE AC CORD BEFORE SERVICING.

### 5 - 1 BEFORE SERVICING

- (1) Make sure that the malfunction is NOT external.
- (2) Follow the instructions EXACTLY.
- (3) DO NOT short circuit components.

### 5 - 3 PERFORMANCE ASSESSMENT

	CONDITION CHECK LIST	STATUS/REMARKS	CHECK POINT
1	POWER INDICATOR lights when the power is turned ON.		DS1
2	Cooling fan starts and stops when a battery pack is inserted and withdrawn from an insertion slot.		MF1
3	Each charge indicator lights in the color corresponding to each charge function.  Regular speed charging Trickle charging Standby	Red Green Unlighted	DS191 DS291 DS391 DS491 DS591 DS691
4	The voltage over the charge terminals falls within the specified range.	20 ~ 25V	Over the terminals of each insertion slot.
5	Each battery pack model reaches full charge in the specified time. Fully discharge each pack before charging. Measure the time each indicator remains lighted in red.  IC-CM2, CM-2G IC-CM3, CM-3G IC-CM5, CM-5G IC-CM5A, CM-5AG IC-CM7, CM-7G IC-CM8, CM-8G	5hrs. 3.5hrs. 5hrs. 5hrs. 5hrs. 9.5hrs.	DS191 DS291 DS391 DS491 DS591 DS691
6	The regular speed charge current at each insertion slot is as specified.	Refer to TABLE A.	At each charge terminal.
7	The trickle charge current at each insertion slot is as specified.	Refer to TABLE A.	At each charge terminal.
8	The cooling fan stops during trickle charging for each insertion slot.		MF1

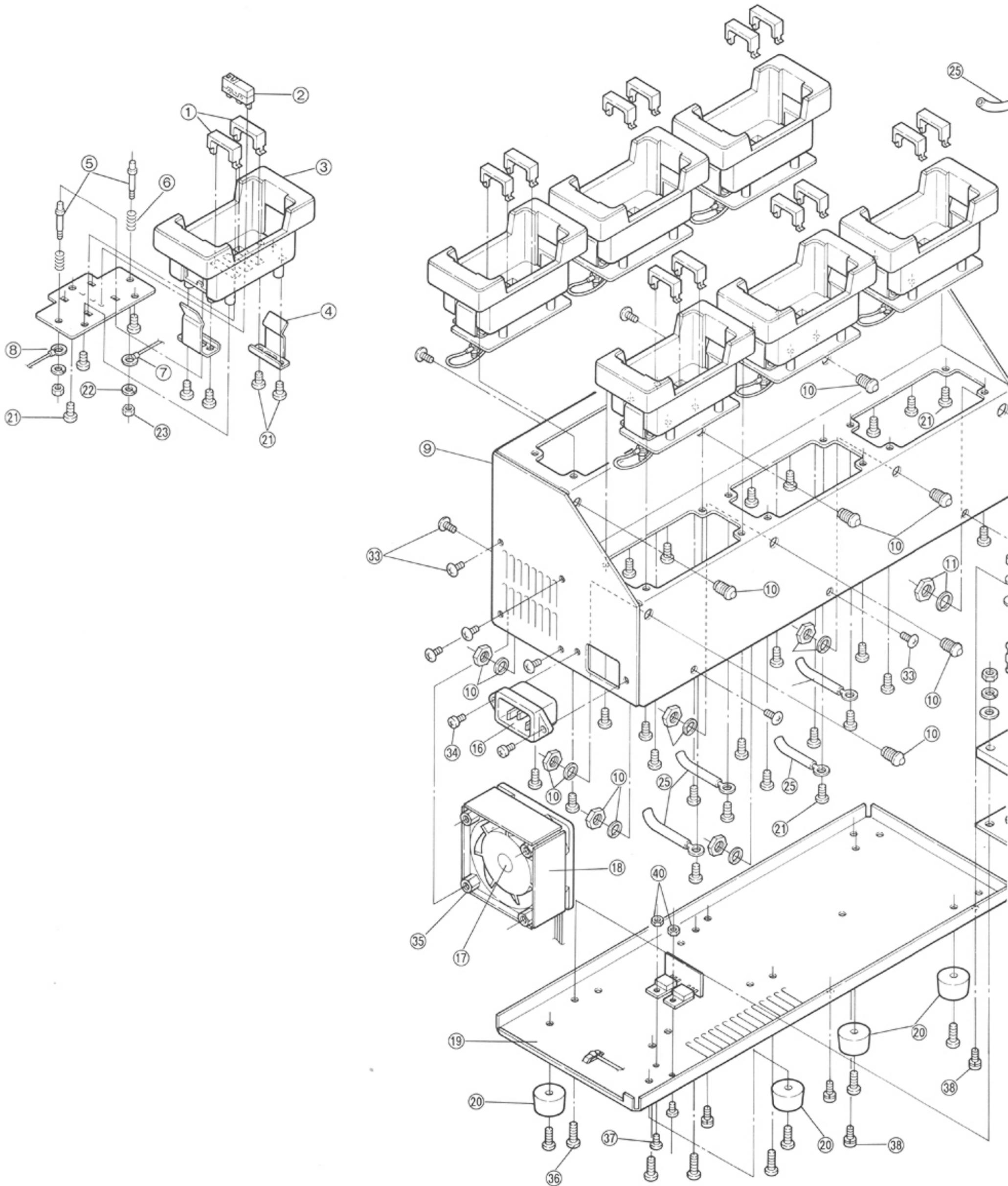
■ TABLE A: CHARGE CURRENT CHARACTERISTICS

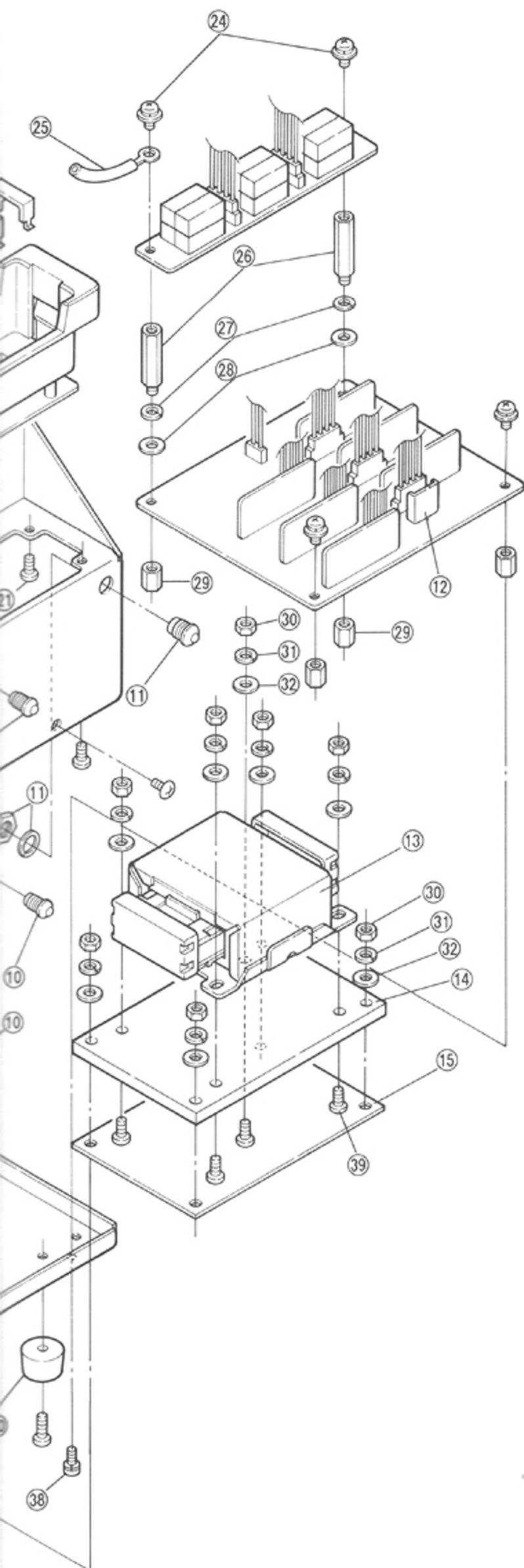
BATTERY PACK MODEL	RATED CHARGE VOLTAGE (V)	REGULAR SPEED CHARGING CURRENT (mA)	TRICKLE CHARGING CURRENT (mA)
IC-CM2, CM-2G	8.4	109.4 ~ 155.4	22.9 ~ 28.0
IC-CM3, CM-3G IC-CM8, CM-8G	9.8	108.2 ~ 154.0	22.3 ~ 27.3
IC-CM5, CM-5G IC-CM5A, CM-5AG	12.6	105.8 ~ 151.3	21.1 ~ 26.0
IC-CM7, CM-7G	15.4	103.3 ~ 148.7	19.9 ~ 24.6

### 5 - 2 AFTER SERVICING

- (1) CONFIRM that
  - a) all mechanical parts are returned to their proper positions.
  - b) solder joints are clean and tight.
  - c) components do not touch.
- (2) Turn the power ON to confirm that servicing has corrected the malfunction.

SECTION 6 MECHANICAL PARTS AND DISASSEMBLY

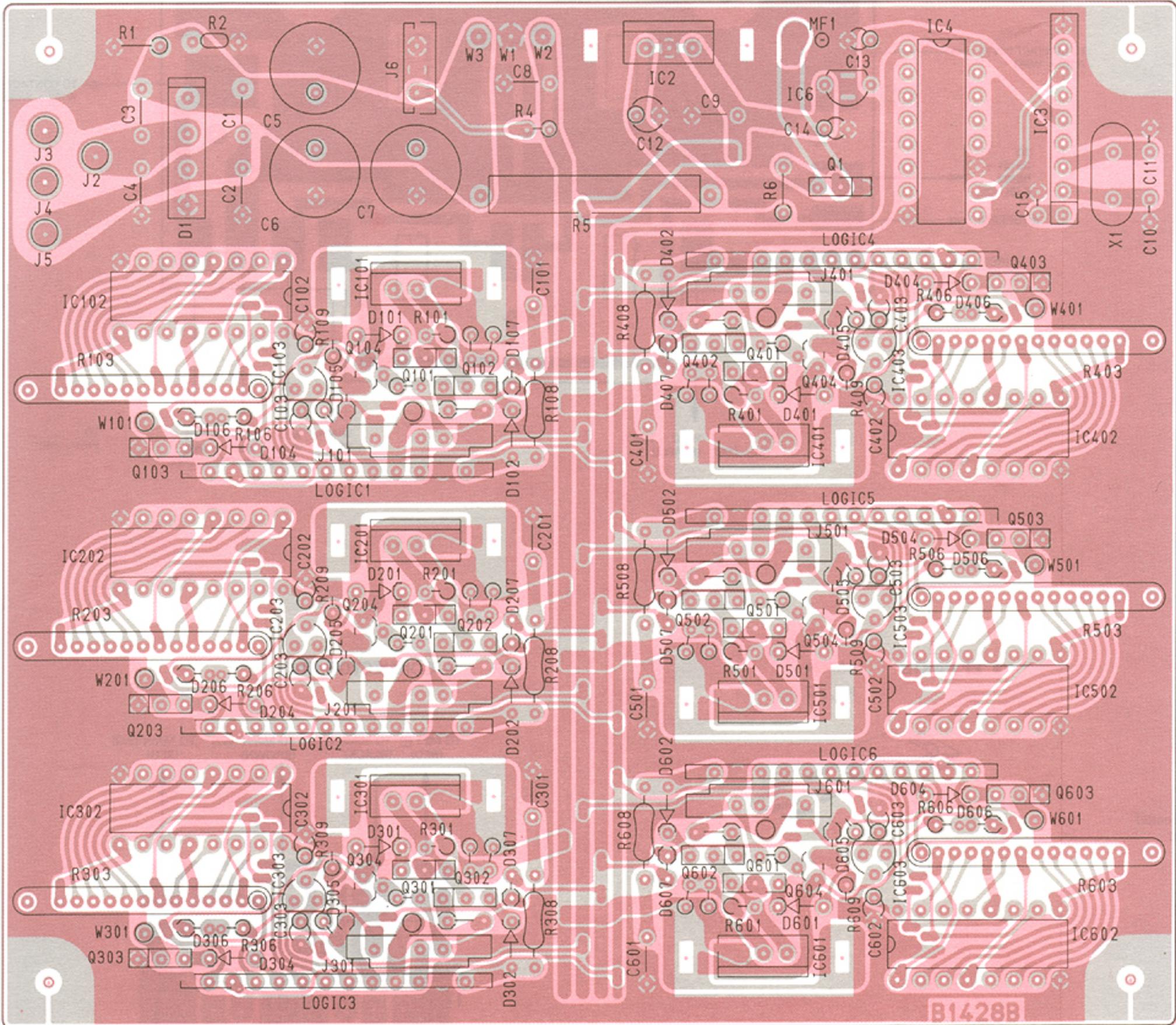




No.	DESCRIPTION	PCS.
①	Hole cover (43738)	12
②	Switch D2MS	6
③	Charge stand (30389)	6
④	Spring lock plate (41836)	12
⑤	Contact pin (41837)	12
⑥	Spring (A)-1 (42765)	12
⑦	Wire crimped lug (red) 15/02/050/W02/D31	6
⑧	Wire crimped lug (black) 15/00/050/W02/D31	6
⑨	Top cover (20209)	1
⑩	LED green/red (incl. nut, washer) SLP750S	6
⑪	LED red (incl. nut, washer) SLP710F	1
⑫	AF heatsink (41607)	7
⑬	Transformer TP42 (#01, #02 versions) TP43 (#03 ~ #05 versions)	1 1
⑭	Transformer base (C) (#03 ~ #05 versions only)	1
⑮	Transformer base (D) (#03 ~ #05 versions only)	1
⑯	AC socket CM-3	1
⑰	Fan SD2406PTS1	1
⑱	Isolator seat (Al) (42916)	4
⑲	Bottom cover-3 (30407)	1
⑳	Rubber foot (A) (42229)	4
㉑	Self-tapping screw B1 M3 × 6	66
㉒	Spring washer M2.6	12
㉓	Nut M2.6	12
㉔	Set screw (C) 3 × 6	4
㉕	Cable tie 59TC4772 Vinyl tube (d = 2 mm; l = 35 mm)	5
㉖	Standoff (S) (l = 28 mm) (40955)	2
㉗	Spring washer M3	2
㉘	Flat washer M3	2
㉙	Thread spacer (G) (l = 9.5 mm) (40274)	2
㉚	Nut M4 (#01, #02)	4
	(#03 ~ #05)	8
㉛	Spring washer M4 (#01, #02)	4
	(#03 ~ #05)	8
㉜	Flat washer M4 (#01, #02)	4
	(#03 ~ #05)	8
㉝	ICOM screw (B)-5	10
㉞	Self-tapping binding head screw S-tight M3 × 8 Ni	2
㉟	Standoff (AP) (l = 6 mm) (43874)	4
㊱	Panhead screw M4 × 8 (#01, #02)	4
	M4 × 14 (#03 ~ #05)	4
㊲	Panhead screw M3 × 6	4
㊳	Set screw (A) 3 × 6	4
㊴	Panhead screw M4 × 10 (#03 ~ #05)	4
㊵	Nut M3	2

SECTION 7 BOARD LAYOUTS

7 - 1 MAIN UNIT



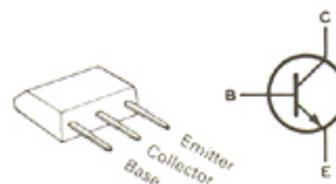
2SA1348

Q104, Q204, Q304,  
Q404, Q504, Q604



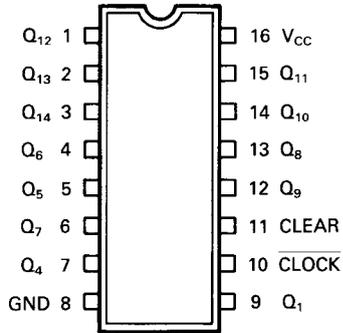
2SD1225M R

Q1, Q101~Q103, Q201~Q203,  
Q301~Q303, Q401~Q403,  
Q501~Q503, Q601~Q603



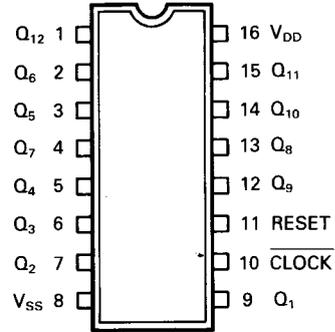
**TC74HC4020P**

IC4



**μPD74HC4040C**

IC102, IC202, IC302,  
IC402, IC502, IC602



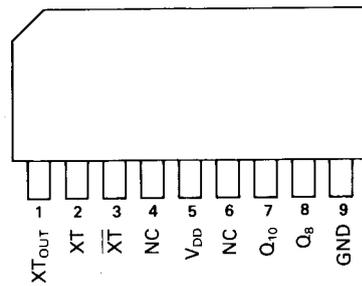
**NJM78L05A**

IC6, IC103, IC203, IC303,  
IC403, IC503, IC603



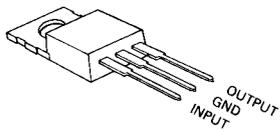
**TC5082P-G**

IC3



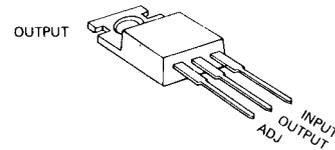
**NJM78M12A**

IC2

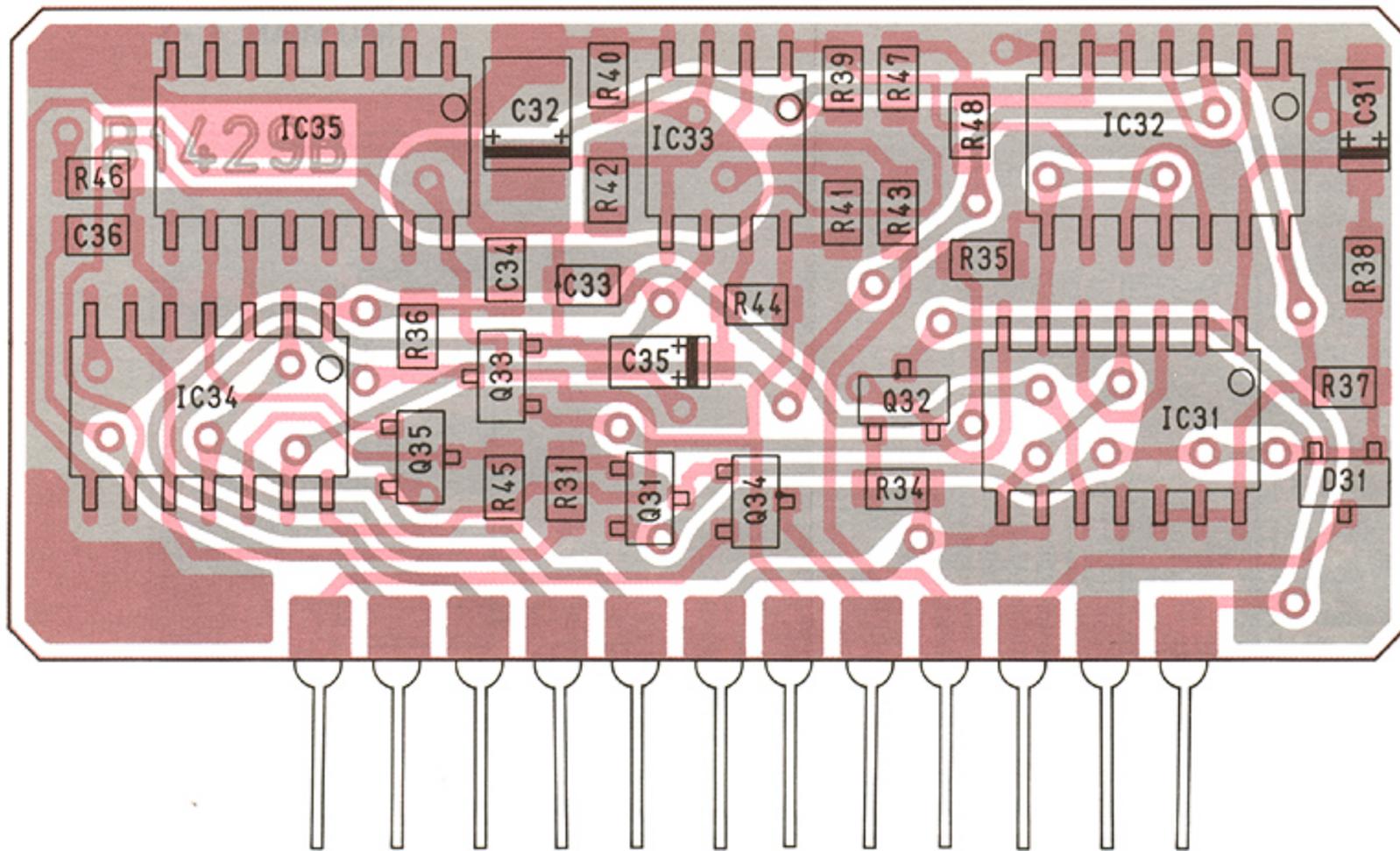


**μPC317**

IC101, IC201, IC301,  
IC401, IC501, IC601

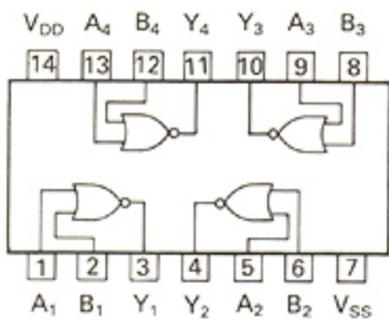


7 - 2 LOGIC UNIT



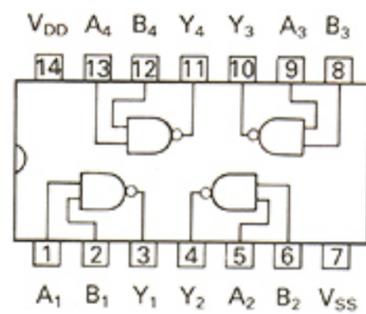
**μPD4001BG**

IC132, IC232, IC332,  
IC432, IC532, IC632



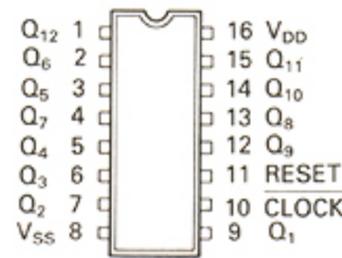
**μPD4011BG**

IC131, IC134, IC231, IC234,  
IC331, IC334, IC431, IC434,  
IC531, IC534, IC631, IC634



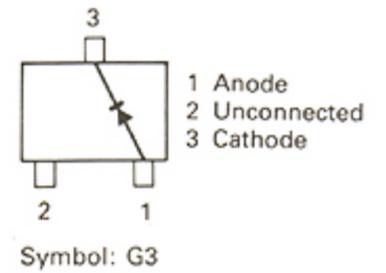
**μPD4040BG**

IC135, IC235, IC335,  
IC435, IC535, IC635



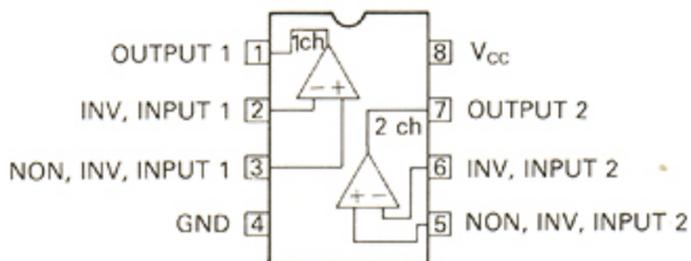
**1SS196**

D131, D231, D331,  
D431, D531, D631



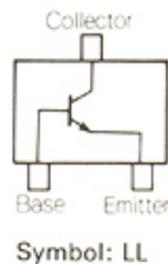
**BA6993F**

IC133, IC233, IC333,  
IC433, IC533, IC633



**2SC2712 BL**

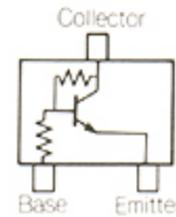
Q131~Q133, Q231~Q233,  
Q331~Q333, Q431~Q433,  
Q531~Q533, Q631~Q633



Symbol: LL

**2SC3395**

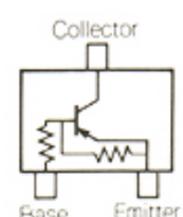
Q135, Q235,  
Q335, Q435,  
Q535, Q635



Symbol: BY

**UN2114**

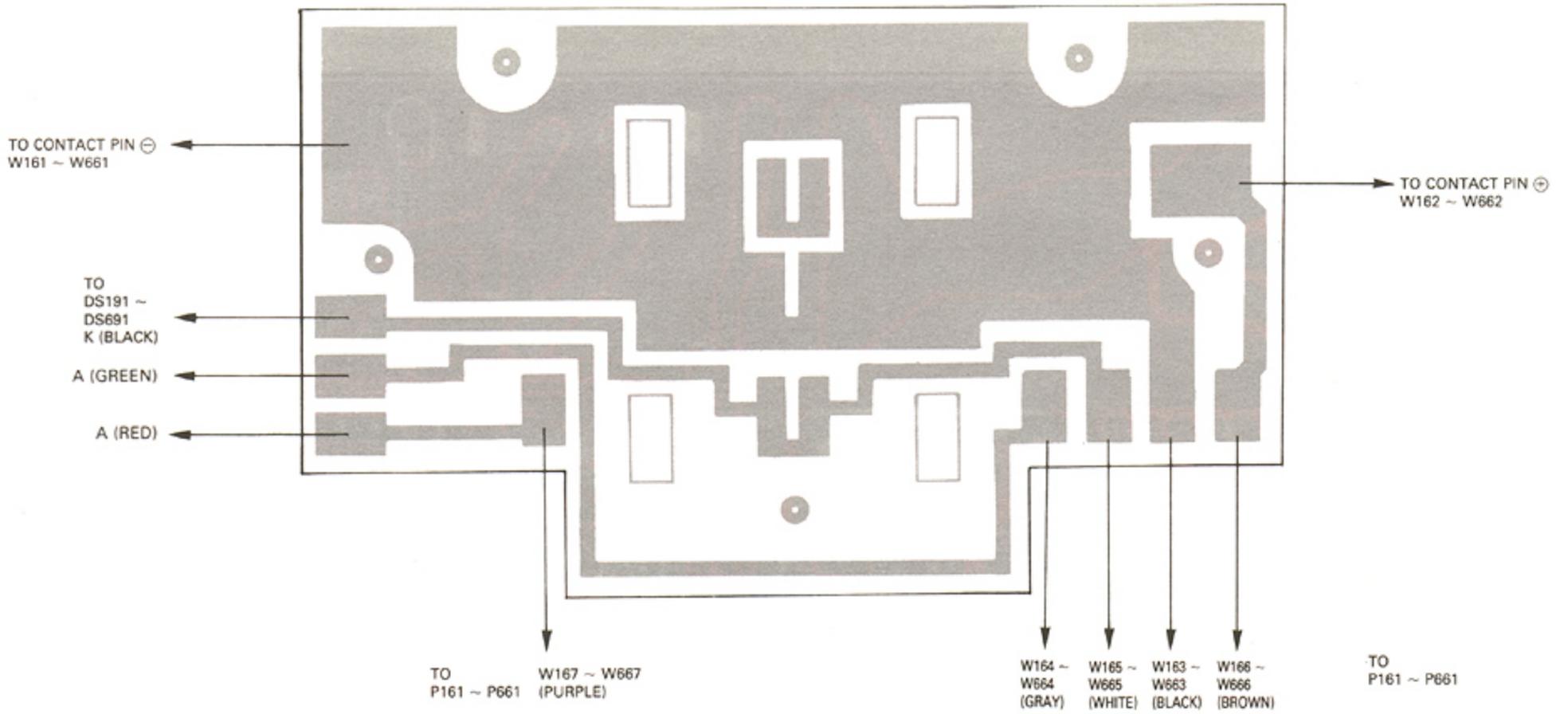
Q134, Q234,  
Q334, Q434,  
Q534, Q634



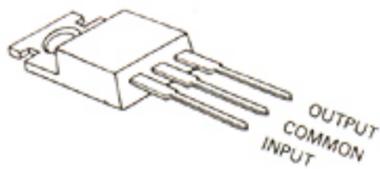
Symbol: 6D

7 - 3 OTHERS

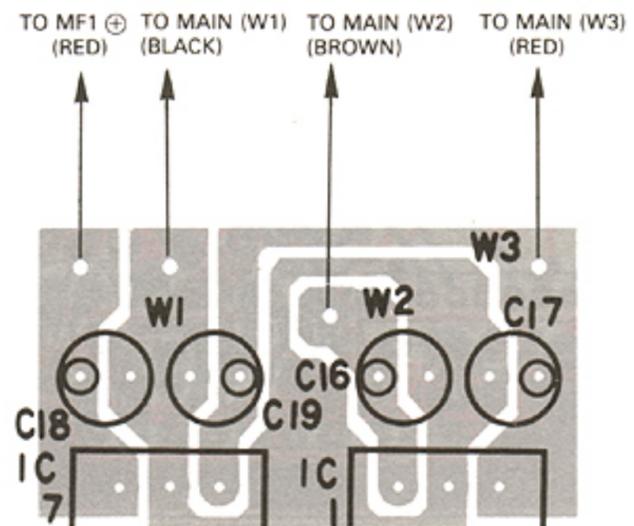
• SUB UNITS (1) - (6)



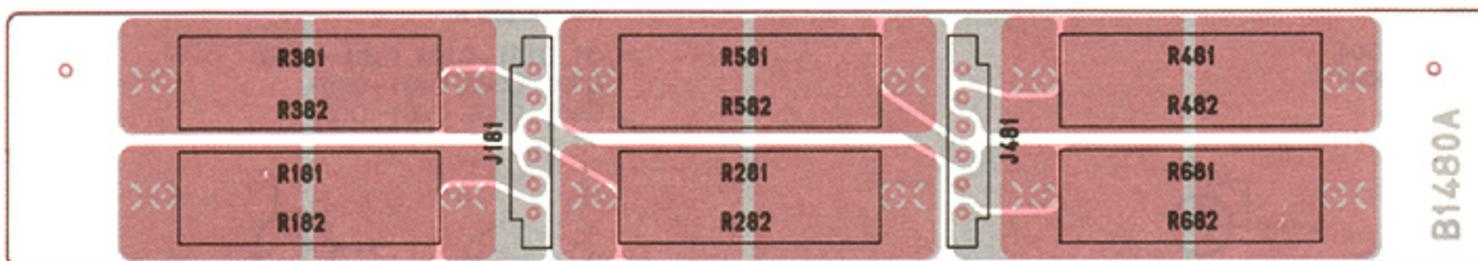
• EF PARTS      $\mu$ A7824  
IC1, IC7



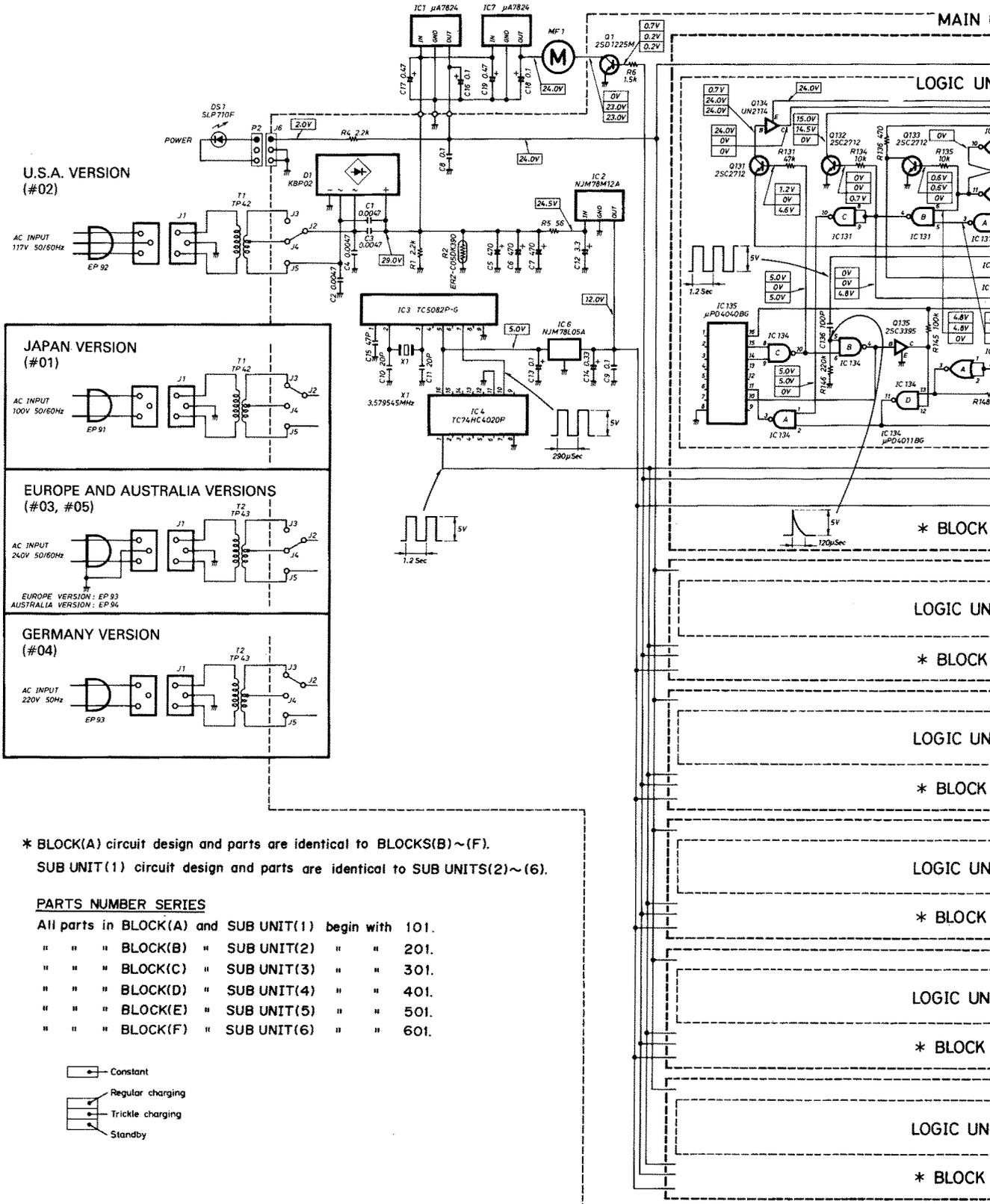
• CONNECTOR UNIT



• RESISTOR UNIT



SECTION 8 VOLTAGE DIAGRAM



U.S.A. VERSION (#02)

JAPAN VERSION (#01)

EUROPE AND AUSTRALIA VERSIONS (#03, #05)

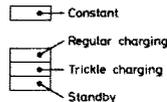
GERMANY VERSION (#04)

\* BLOCK(A) circuit design and parts are identical to BLOCKS(B)~(F).  
 SUB UNIT(1) circuit design and parts are identical to SUB UNITS(2)~(6).

PARTS NUMBER SERIES

All parts in BLOCK(A) and SUB UNIT(1) begin with 101.

"	"	"	BLOCK(B)	"	SUB UNIT(2)	"	"	201.
"	"	"	BLOCK(C)	"	SUB UNIT(3)	"	"	301.
"	"	"	BLOCK(D)	"	SUB UNIT(4)	"	"	401.
"	"	"	BLOCK(E)	"	SUB UNIT(5)	"	"	501.
"	"	"	BLOCK(F)	"	SUB UNIT(6)	"	"	601.





## SECTION 9 PARTS LIST

## [MAIN UNIT]

REF. NO.	DESCRIPTION	PART NO.
IC2	IC	NJM78M12A
IC3	IC	TC5082P-G
IC4	IC	TC74HC4020P
IC6	IC	NJM78L05A
IC101	IC	μPC317
IC102	IC	μPD74HC4040C
IC103	IC	NJM78L05A
IC201	IC	μPC317
IC202	IC	μPD74HC4040C
IC203	IC	NJM78L05A
IC301	IC	μPC317
IC302	IC	μPD74HC4040C
IC303	IC	NJM78L05A
IC401	IC	μPC317
IC402	IC	μPD74HC4040C
IC403	IC	NJM78L05A
IC501	IC	μPC317
IC502	IC	μPD74HC4040C
IC503	IC	NJM78L05A
IC601	IC	μPC317
IC602	IC	μPD74HC4040C
IC603	IC	NJM78L05A
Q1	Transistor	2SD1225M R
Q101	Transistor	2SD1225M R
Q102	Transistor	2SD1225M R
Q103	Transistor	2SD1225M R
Q104	Transistor	2SA1348
Q201	Transistor	2SD1225M R
Q202	Transistor	2SD1225M R
Q203	Transistor	2SD1225M R
Q204	Transistor	2SA1348
Q301	Transistor	2SD1225M R
Q302	Transistor	2SD1225M R
Q303	Transistor	2SD1225M R
Q304	Transistor	2SA1348
Q401	Transistor	2SD1225M R
Q402	Transistor	2SD1225M R
Q403	Transistor	2SD1225M R
Q404	Transistor	2SA1348
Q501	Transistor	2SD1225M R
Q502	Transistor	2SD1225M R
Q503	Transistor	2SD1225M R
Q504	Transistor	2SA1348
Q601	Transistor	2SD1225M R
Q602	Transistor	2SD1225M R
Q603	Transistor	2SD1225M R
Q604	Transistor	2SA1348
D1	Rectifier	KBP02M
D101	Diode	1SS211
D102	Diode	1SS211
D103	Diode	1S954
D104	Diode	1SS211
D105	Diode	1SS211
D106	Diode	1SS211
D107	Diode	1SS211
D201	Diode	1SS211
D202	Diode	1SS211
D203	Diode	1S954

## [MAIN UNIT]

REF. NO.	DESCRIPTION	PART NO.
D204	Diode	1SS211
D205	Diode	1SS211
D206	Diode	1SS211
D207	Diode	1SS211
D301	Diode	1SS211
D302	Diode	1SS211
D303	Diode	1S954
D304	Diode	1SS211
D305	Diode	1SS211
D306	Diode	1SS211
D307	Diode	1SS211
D401	Diode	1SS211
D402	Diode	1SS211
D403	Diode	1S954
D404	Diode	1SS211
D405	Diode	1SS211
D406	Diode	1SS211
D407	Diode	1SS211
D501	Diode	1SS211
D502	Diode	1SS211
D503	Diode	1S954
D504	Diode	1SS211
D505	Diode	1SS211
D506	Diode	1SS211
D507	Diode	1SS211
D601	Diode	1SS211
D602	Diode	1SS211
D603	Diode	1S954
D604	Diode	1SS211
D605	Diode	1SS211
D606	Diode	1SS211
D607	Diode	1SS211
X1	Crystal	FAA (3.579545MHz)
R1	Resistor	2.2kΩ ELR25
R2	Absorber	ERZ-C05DK390
R4	Resistor	2.2kΩ ELR20
R5	Resistor	56Ω RGB3
R6	Resistor	1.5kΩ ELR25
R101	Resistor	56Ω ELR20
R102	Resistor	18Ω ELR20
R103	Array	GF5096
R104	Resistor	1.2kΩ ELR20
R105	Resistor	2.2kΩ ELR20
R106	Resistor	1.8kΩ ELR20
R107	Resistor	18Ω ELR20
R108	Resistor	2.2kΩ R25
R109	Resistor	2.7kΩ ELR20
R201	Resistor	56Ω ELR20
R202	Resistor	18Ω ELR20
R203	Array	GF5096
R204	Resistor	1.2kΩ ELR20
R205	Resistor	2.2kΩ ELR20
R206	Resistor	1.8kΩ ELR20
R207	Resistor	18Ω ELR20
R208	Resistor	2.2kΩ R25
R209	Resistor	2.7kΩ ELR20
R301	Resistor	56Ω ELR20
R302	Resistor	18Ω ELR20

## [MAIN UNIT]

REF. NO.	DESCRIPTION	PART NO.	
R303	Array	GF5096	
R304	Resistor	1.2k $\Omega$	ELR20
R305	Resistor	2.2k $\Omega$	ELR20
R306	Resistor	1.8k $\Omega$	ELR20
R307	Resistor	18 $\Omega$	ELR20
R308	Resistor	2.2k $\Omega$	R25
R309	Resistor	2.7k $\Omega$	ELR20
R401	Resistor	56 $\Omega$	ELR20
R402	Resistor	18 $\Omega$	ELR20
R403	Array	GF5096	
R404	Resistor	1.2k $\Omega$	ELR20
R405	Resistor	2.2k $\Omega$	ELR20
R406	Resistor	1.8k $\Omega$	ELR20
R407	Resistor	18 $\Omega$	ELR20
R408	Resistor	2.2k $\Omega$	R25
R409	Resistor	2.7k $\Omega$	ELR20
R501	Resistor	56 $\Omega$	ELR20
R502	Resistor	18 $\Omega$	ELR20
R503	Array	GF5096	
R504	Resistor	1.2k $\Omega$	ELR20
R505	Resistor	2.2k $\Omega$	ELR20
R506	Resistor	1.8k $\Omega$	ELR20
R507	Resistor	18 $\Omega$	ELR20
R508	Resistor	2.2k $\Omega$	R25
R509	Resistor	2.7k $\Omega$	ELR20
R601	Resistor	56 $\Omega$	ELR20
R602	Resistor	18 $\Omega$	ELR20
R603	Array	GF5096	
R604	Resistor	1.2k $\Omega$	ELR20
R605	Resistor	2.2k $\Omega$	ELR20
R606	Resistor	1.8k $\Omega$	ELR20
R607	Resistor	18 $\Omega$	ELR20
R608	Resistor	2.2k $\Omega$	R25
R609	Resistor	2.7k $\Omega$	ELR20
C1	Ceramic	0.0047 $\mu$ F	50V
C2	Ceramic	0.0047 $\mu$ F	50V
C3	Ceramic	0.0047 $\mu$ F	50V
C4	Ceramic	0.0047 $\mu$ F	50V
C5	Electrolytic	470 $\mu$ F	35V TWSS
C6	Electrolytic	470 $\mu$ F	35V TWSS
C7	Electrolytic	470 $\mu$ F	35V TWSS
C8	Mylar	0.1 $\mu$ F	50V
C9	Mylar	0.1 $\mu$ F	50V
C10	Ceramic	20pF	50V
C11	Ceramic	20pF	50V
C12	Electrolytic	3.3 $\mu$ F	50V
C13	Tantalum	0.1 $\mu$ F	35V DN
C14	Tantalum	0.33 $\mu$ F	35V DN
C15	Ceramic	47pF	50V
C101	Mylar	0.1 $\mu$ F	50V
C102	Tantalum	0.1 $\mu$ F	35V DN
C103	Tantalum	0.33 $\mu$ F	35V DN
C201	Mylar	0.1 $\mu$ F	50V
C202	Tantalum	0.1 $\mu$ F	35V DN
C203	Tantalum	0.33 $\mu$ F	35V DN
C301	Mylar	0.1 $\mu$ F	50V
C302	Tantalum	0.1 $\mu$ F	35V DN
C303	Tantalum	0.33 $\mu$ F	35V DN
C401	Mylar	0.1 $\mu$ F	50V
C402	Tantalum	0.1 $\mu$ F	35V DN

## [MAIN UNIT]

REF. NO.	DESCRIPTION	PART NO.	
C403	Tantalum	0.33 $\mu$ F	35V DN
C501	Mylar	0.1 $\mu$ F	50V
C502	Tantalum	0.1 $\mu$ F	35V DN
C503	Tantalum	0.33 $\mu$ F	35V DN
C601	Mylar	0.1 $\mu$ F	50V
C602	Tantalum	0.1 $\mu$ F	35V DN
C603	Tantalum	0.33 $\mu$ F	35V DN
J2	Terminal	TM201	
J3	Terminal	TM201	
J4	Terminal	TM201	
J5	Terminal	TM201	
J6	Connector	B03B-EH-S	
J101	Connector	TL25P-05-V1	
J201	Connector	TL25P-05-V1	
J301	Connector	TL25P-05-V1	
J401	Connector	TL25P-05-V1	
J501	Connector	TL25P-05-V1	
J601	Connector	TL25P-05-V1	
P102	Connector	TL25H-06-B1	
P402	Connector	TL25H-06-B1	
EP1	P. C. Board	B-1428B	
EP4	Crystal Seat		
W1	Wire	13/00/310/W07/W07	
W2	Wire	13/01/310/W07/W07	
W3	Wire	13/02/310/W07/W07	
W4	Jumper	72/98/015/X98/X98	
W101	Wire	23/01/170/C01/C21	
W102	Wire	23/07/150/C01/C21	
W201	Wire	23/02/185/C01/C21	
W202	Wire	23/08/165/C01/C21	
W301	Wire	23/03/210/C01/C21	
W302	Wire	23/09/190/C01/C21	
W401	Wire	23/04/160/C01/C21	
W402	Wire	23/00/135/C01/C21	
W501	Wire	23/05/190/C01/C21	
W502	Wire	23/01/170/C01/C21	
W601	Wire	23/06/210/C01/C21	
W602	Wire	23/02/190/C01/C21	

## [LOGIC UNIT (1)]

REF. NO.	DESCRIPTION	PART NO.	
IC131	IC	μPD4011BG	
IC132	IC	μPD4001BG	
IC133	IC	BA6993F	
IC134	IC	μPD4011BG	
IC135	IC	μPD4040BG	
Q131	Transistor	2SC2712 BL	
Q132	Transistor	2SC2712 BL	
Q133	Transistor	2SC2712 BL	
Q134	Transistor	UN2114	
Q135	Transistor	2SC3395	
D131	Diode	1SS196	
R131	Chip	47kΩ	MCR10
R134	Chip	10kΩ	MCR10
R135	Chip	10kΩ	MCR10
R136	Chip	470Ω	MCR10
R137	Chip	10kΩ	MCR10
R138	Chip	470kΩ	MCR10
R139	Chip	10kΩ	MCR10
R140	Chip	27kΩ	MCR10
R141	Chip	100kΩ	MCR10
R142	Chip	56kΩ	MCR10
R143	Chip	220kΩ	MCR10
R144	Chip	220kΩ	MCR10
R145	Chip	100kΩ	MCR10
R146	Chip	220kΩ	MCR10
R147	Chip	100kΩ	MCR10
R148	Chip	1MΩ	MCR10
C131	Chip Tantalum	2.2μF	10V SV
C132	Chip Tantalum	6.8μF	6.3V SV
C133	Monolithic	0.0047μF	GRM40
C134	Monolithic	0.1μF	GRM40 F
C135	Chip Tantalum	1μF	16V SV
C136	Monolithic	100pF	GRM40
J131	Leadframe	VD2.54-0.7-7	
EP131	P. C. Board	B-1429B	
W131	Jumper	JPW-01 R-01	

## [LOGIC UNIT (2)]

REF. NO.	DESCRIPTION	PART NO.	
IC231	IC	μPD4011BG	
IC232	IC	μPD4001BG	
IC233	IC	BA6993F	
IC234	IC	μPD4011BG	
IC235	IC	μPD4040BG	
Q231	Transistor	2SC2712 BL	
Q232	Transistor	2SC2712 BL	
Q233	Transistor	2SC2712 BL	
Q234	Transistor	UN2114	
Q235	Transistor	2SC3395	
D231	Diode	1SS196	
R231	Chip	47kΩ	MCR10
R234	Chip	10kΩ	MCR10
R235	Chip	10kΩ	MCR10
R236	Chip	470Ω	MCR10
R237	Chip	10kΩ	MCR10
R238	Chip	470kΩ	MCR10
R239	Chip	10kΩ	MCR10
R240	Chip	27kΩ	MCR10
R241	Chip	100kΩ	MCR10
R242	Chip	56kΩ	MCR10
R243	Chip	220kΩ	MCR10
R244	Chip	220kΩ	MCR10
R245	Chip	100kΩ	MCR10
R246	Chip	220kΩ	MCR10
R247	Chip	100kΩ	MCR10
R248	Chip	1MΩ	MCR10
C231	Chip Tantalum	2.2μF	10V SV
C232	Chip Tantalum	6.8μF	6.3V SV
C233	Monolithic	0.0047μF	GRM40
C234	Monolithic	0.1μF	GRM40 F
C235	Chip Tantalum	1μF	16V SV
C236	Monolithic	100pF	GRM40
J231	Leadframe	VD2.54-0.7-7	
EP231	P. C. Board	B-1429B	
W231	Jumper	JPW-01 R-01	

**[EF PARTS]**

REF. NO.	DESCRIPTION	PART NO.	
IC1	IC	μA7824	
IC7	IC	μA7824	
C16	Tantalum	0.1μF	35V DN
C17	Electrolytic	0.47μF	50V SS
C18	Tantalum	0.1μF	35V DN
C19	Electrolytic	0.47μF	50V SS
J1	Connector	CM-3	
P2	Connector	EHR-03	
DS1	LED	SLP710 F	
DS191	LED	SLP750 S	
DS291	LED	SLP750 S	
DS391	LED	SLP750 S	
DS491	LED	SLP750 S	
DS591	LED	SLP750 S	
DS691	LED	SLP750 S	
MF1	Fan	SD2406PTS1	
EP3	P. C. Board	B-1559	
T1	Transformer	TP42 (#01, #02)	
T2	Transformer	TP43 (#03, #04, #05)	

**[G PARTS]**

REF. NO.	DESCRIPTION	PART NO.	
W91	Wire	13/26/190/X07/X07	
W92	Wire	23/00/420/W02/B06	
W93	Wire	23/02/420/W02/B06	
W191	Wire	23/00/080/W02/W02	
W192	Wire	23/02/080/W02/W02	
W193	Wire	23/05/080/W02/W02	
W291	Wire	23/00/080/W02/W02	
W292	Wire	23/02/080/W02/W02	
W293	Wire	23/05/080/W02/W02	
W391	Wire	23/00/080/W02/W02	
W392	Wire	23/02/080/W02/W02	
W393	Wire	23/05/080/W02/W02	
W491	Wire	23/00/080/W02/W02	
W492	Wire	23/02/080/W02/W02	
W493	Wire	23/05/080/W02/W02	
W591	Wire	23/00/080/W02/W02	
W592	Wire	23/02/080/W02/W02	
W593	Wire	23/05/080/W02/W02	
W691	Wire	23/00/080/W02/W02	
W692	Wire	23/02/080/W02/W02	
W693	Wire	23/05/080/W02/W02	

**[Y PARTS]**

REF. NO.	DESCRIPTION	PART NO.	
EP91	AC Cord	OPC-041 (#01)	
EP92	AC Cord	OPC-034 (#02)	
EP93	AC Cord	OPC-048A (#03, #04)	
EP94	AC Cord	OPC-085 (#05)	

## [LOGIC UNIT (3)]

REF. NO.	DESCRIPTION	PART NO.	
IC331	IC	μPD4011BG	
IC332	IC	μPD4001BG	
IC333	IC	BA6993F	
IC334	IC	μPD4011BG	
IC335	IC	μPD4040BG	
Q331	Transistor	2SC2712 BL	
Q332	Transistor	2SC2712 BL	
Q333	Transistor	2SC2712 BL	
Q334	Transistor	UN2114	
Q335	Transistor	2SC3395	
D331	Diode	1SS196	
R331	Chip	47kΩ	MCR10
R334	Chip	10kΩ	MCR10
R335	Chip	10kΩ	MCR10
R336	Chip	470Ω	MCR10
R337	Chip	10kΩ	MCR10
R338	Chip	470kΩ	MCR10
R339	Chip	10kΩ	MCR10
R340	Chip	27kΩ	MCR10
R341	Chip	100kΩ	MCR10
R342	Chip	56kΩ	MCR10
R343	Chip	220kΩ	MCR10
R344	Chip	220kΩ	MCR10
R345	Chip	100kΩ	MCR10
R346	Chip	220kΩ	MCR10
R347	Chip	100kΩ	MCR10
R348	Chip	1MΩ	MCR10
C331	Chip Tantalum	2.2μF	10V SV
C332	Chip Tantalum	6.8μF	6.3V SV
C333	Monolithic	0.0047μF	GRM40
C334	Monolithic	0.1μF	GRM40 F
C335	Chip Tantalum	1μF	16V SV
C336	Monolithic	100pF	GRM40
J331	Leadframe	VD2.54-0.7-7	
EP331	P. C. Board	B-1429B	
W331	Jumper	JPW-01 R-01	

## [LOGIC UNIT (4)]

REF. NO.	DESCRIPTION	PART NO.	
IC431	IC	μPD4011BG	
IC432	IC	μPD4001BG	
IC433	IC	BA6993F	
IC434	IC	μPD4011BG	
IC435	IC	μPD4040BG	
Q431	Transistor	2SC2712 BL	
Q432	Transistor	2SC2712 BL	
Q433	Transistor	2SC2712 BL	
Q434	Transistor	UN2114	
Q435	Transistor	2SC3395	
D431	Diode	1SS196	
R431	Chip	47kΩ	MCR10
R434	Chip	10kΩ	MCR10
R435	Chip	10kΩ	MCR10
R436	Chip	470Ω	MCR10
R437	Chip	10kΩ	MCR10
R438	Chip	470kΩ	MCR10
R439	Chip	10kΩ	MCR10
R440	Chip	27kΩ	MCR10
R441	Chip	100kΩ	MCR10
R442	Chip	56kΩ	MCR10
R443	Chip	220kΩ	MCR10
R444	Chip	220kΩ	MCR10
R445	Chip	100kΩ	MCR10
R446	Chip	220kΩ	MCR10
R447	Chip	100kΩ	MCR10
R448	Chip	1MΩ	MCR10
C431	Chip Tantalum	2.2μF	10V SV
C432	Chip Tantalum	6.8μF	6.3V SV
C433	Monolithic	0.0047μF	GRM40
C434	Monolithic	0.1μF	GRM40 F
C435	Chip Tantalum	1μF	16V SV
C436	Monolithic	100pF	GRM40
J431	Leadframe	VD2.54-0.7-7	
EP431	P. C. Board	B-1429B	
W431	Jumper	JPW-01 R-01	

## [LOGIC UNIT (5)]

REF. NO.	DESCRIPTION	PART NO.	
IC531	IC	μPD4011BG	
IC532	IC	μPD4001BG	
IC533	IC	BA6993F	
IC534	IC	μPD4011BG	
IC535	IC	μPD4040BG	
Q531	Transistor	2SC2712 BL	
Q532	Transistor	2SC2712 BL	
Q533	Transistor	2SC2712 BL	
Q534	Transistor	UN2114	
Q535	Transistor	2SC3395	
D531	Diode	1SS196	
R531	Chip	47kΩ	MCR10
R534	Chip	10kΩ	MCR10
R535	Chip	10kΩ	MCR10
R536	Chip	470Ω	MCR10
R537	Chip	10kΩ	MCR10
R538	Chip	470kΩ	MCR10
R539	Chip	10kΩ	MCR10
R540	Chip	27kΩ	MCR10
R541	Chip	100kΩ	MCR10
R542	Chip	56kΩ	MCR10
R543	Chip	220kΩ	MCR10
R544	Chip	220kΩ	MCR10
R545	Chip	100kΩ	MCR10
R546	Chip	220kΩ	MCR10
R547	Chip	100kΩ	MCR10
R548	Chip	1MΩ	MCR10
C531	Chip Tantalum	2.2μF	10V SV
C532	Chip Tantalum	6.8μF	6.3V SV
C533	Monolithic	0.0047μF	GRM40
C534	Monolithic	0.1μF	GRM40 F
C535	Chip Tantalum	1μF	16V SV
C536	Monolithic	100pF	GRM40
J531	Leadframe	VD2.54-0.7-7	
EP531	P. C. Board	B-1429B	
W531	Jumper	JPW-01 R-01	

## [LOGIC UNIT (6)]

REF. NO.	DESCRIPTION	PART NO.	
IC631	IC	μPD4011BG	
IC632	IC	μPD4001BG	
IC633	IC	BA6993F	
IC634	IC	μPD4011BG	
IC635	IC	μPD4040BG	
Q631	Transistor	2SC2712 BL	
Q632	Transistor	2SC2712 BL	
Q633	Transistor	2SC2712 BL	
Q634	Transistor	UN2114	
Q635	Transistor	2SC3395	
D631	Diode	1SS196	
R631	Chip	47kΩ	MCR10
R634	Chip	10kΩ	MCR10
R635	Chip	10kΩ	MCR10
R636	Chip	470Ω	MCR10
R637	Chip	10kΩ	MCR10
R638	Chip	470kΩ	MCR10
R639	Chip	10kΩ	MCR10
R640	Chip	27kΩ	MCR10
R641	Chip	100kΩ	MCR10
R642	Chip	56kΩ	MCR10
R643	Chip	220kΩ	MCR10
R644	Chip	220kΩ	MCR10
R645	Chip	100kΩ	MCR10
R646	Chip	220kΩ	MCR10
R647	Chip	100kΩ	MCR10
R648	Chip	1MΩ	MCR10
C631	Chip Tantalum	2.2μF	10V SV
C632	Chip Tantalum	6.8μF	6.3V SV
C633	Monolithic	0.0047μF	GRM40
C634	Monolithic	0.1μF	GRM40 F
C635	Chip Tantalum	1μF	16V SV
C636	Monolithic	100pF	GRM40
J631	Leadframe	VD2.54-0.7-7	
EP631	P. C. Board	B-1429B	
W631	Jumper	JPW-01 R-01	

**[SUB UNIT (1)]**

REF. NO.	DESCRIPTION	PART NO.
P161	Connector	TL25H-05-B1
S161	Switch	D2MS
EP161	P. C. Board	B-1479A
W161	Wire	15/00/050/W02/D31
W162	Wire	15/02/050/W02/D31
W163	Wire	23/00/550/W02/C01
W164	Wire	23/08/550/W02/C01
W165	Wire	23/09/550/W02/C01
W166	Wire	23/01/550/W02/C01
W167	Wire	23/07/600/W02/C01

**[SUB UNIT (4)]**

REF. NO.	DESCRIPTION	PART NO.
P461	Connector	TL25H-05-B1
S461	Switch	D2MS
EP461	P. C. Board	B-1479A
W461	Wire	15/00/050/W02/D31
W462	Wire	15/02/050/W02/D31
W463	Wire	23/00/550/W02/C01
W464	Wire	23/08/550/W02/C01
W465	Wire	23/09/550/W02/C01
W466	Wire	23/01/550/W02/C01
W467	Wire	23/07/600/W02/C01

**[SUB UNIT (2)]**

REF. NO.	DESCRIPTION	PART NO.
P261	Connector	TL25H-05-B1
S261	Switch	D2MS
EP261	P. C. Board	B-1479A
W261	Wire	15/00/050/W02/D31
W262	Wire	15/02/050/W02/D31
W263	Wire	23/00/550/W02/C01
W264	Wire	23/08/550/W02/C01
W265	Wire	23/09/550/W02/C01
W266	Wire	23/01/550/W02/C01
W267	Wire	23/07/600/W02/C01

**[SUB UNIT (5)]**

REF. NO.	DESCRIPTION	PART NO.
P561	Connector	TL25H-05-B1
S561	Switch	D2MS
EP561	P. C. Board	B-1479A
W561	Wire	15/00/050/W02/D31
W562	Wire	15/02/050/W02/D31
W563	Wire	23/00/550/W02/C01
W564	Wire	23/08/550/W02/C01
W565	Wire	23/09/550/W02/C01
W566	Wire	23/01/550/W02/C01
W567	Wire	23/07/600/W02/C01

**[SUB UNIT (3)]**

REF. NO.	DESCRIPTION	PART NO.
P361	Connector	TL25H-05-B1
S361	Switch	D2MS
EP361	P. C. Board	B-1479A
W361	Wire	15/00/050/W02/D31
W362	Wire	15/02/050/W02/D31
W363	Wire	23/00/550/W02/C01
W364	Wire	23/08/550/W02/C01
W365	Wire	23/09/550/W02/C01
W366	Wire	23/01/550/W02/C01
W367	Wire	23/07/600/W02/C01

**[SUB UNIT (6)]**

REF. NO.	DESCRIPTION	PART NO.
P661	Connector	TL25H-05-B1
S662	Switch	D2MS
EP661	P. C. Board	B-1479A
W661	Wire	15/00/050/W02/D31
W662	Wire	15/02/050/W02/D31
W663	Wire	23/00/550/W02/C01
W664	Wire	23/08/550/W02/C01
W665	Wire	23/09/550/W02/C01
W666	Wire	23/01/550/W02/C01
W667	Wire	23/07/600/W02/C01

**[RESISTOR UNIT]**

REF. NO.	DESCRIPTION	PART NO.	
R181	Resistor	56Ω	RGB3
R182	Resistor	56Ω	RGB3
R281	Resistor	56Ω	RGB3
R282	Resistor	56Ω	RGB3
R381	Resistor	56Ω	RGB3
R382	Resistor	56Ω	RGB3
R481	Resistor	56Ω	RGB3
R482	Resistor	56Ω	RGB3
R581	Resistor	56Ω	RGB3
R582	Resistor	56Ω	RGB3
R681	Resistor	56Ω	RGB3
R682	Resistor	56Ω	RGB3
J181	Connector	TL25P-06-V1	
J481	Connector	TL25P-06-V1	
EP2	P. C. Board	B-1480A	



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