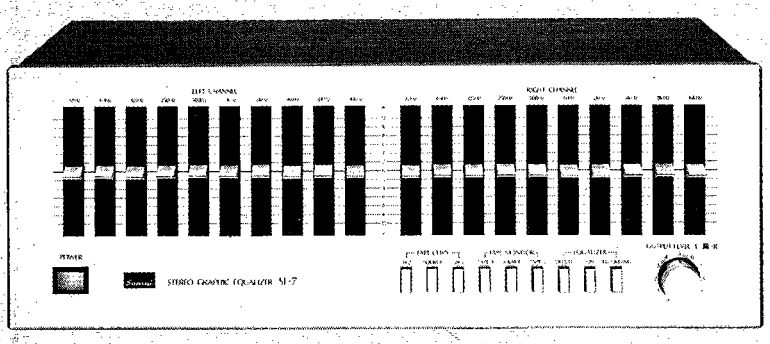
# SERVICE MANUAL

## STEREO GRAPHIC EQUALIZER

# SANSUI SE-5/7



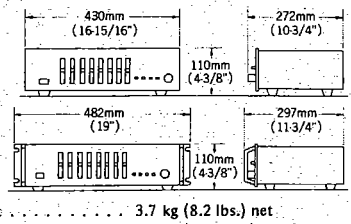
Sansui

SANSUI ELECTRIC CO., LTD.

## SPECIFICATIONS

<SE-5>

Input impedance (1,000 Hz)
INPUT . . . . . 30 kilohms
Output level and impedance (1,000 Hz)
OUTPUT . . . . . 1 V into 47 kilohms at 1 V input/ 600 ohms
(Maximum output level: 5 V at 0.5 % total harmonic distortion)
Total harmonic distortion (20 Hz to 20 kHz)
INPUT . . . . . less than 0.008 %
Frequency response (at rated output, Equalizer controls: "0" position) . . . . 10 to 100,000 Hz, +0 dB, –1 dB
Equalizer frequency . . 80 Hz, 160 Hz, 315 Hz, 630 Hz, 1.25 kHz, 2.5 kHz, 5 kHz, 10 kHz
Level variation range . . ±12 dB
Hum and noise (short-circuit, A-network)
. . . . . 110 dB
Gain (1,000 Hz, Equalizer controls: "0" position)
. . . . . 0 dB
Power requirements
Power voltage . . . . 100, 120, 220, 240 V (50/60 Hz)
For USA and Canada
. . . . . 120 V (60 Hz)
Power consumption
Rated consumption
. . . . . 7 watts
Dimensions . . . . . .

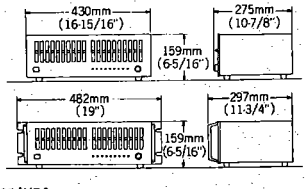



Weight . . . . . 3.7 kg (8.2 lbs.) net
4.9 kg (10.8 lbs.) packed

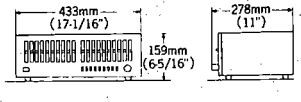
<SE-7>

Input impedance (1,000 Hz)
INPUT . . . . . 30 kilohms
Output level and impedance (1,000 Hz)
OUTPUT . . . . . 1 V into 47 kilohms at 1 V input/ 600 ohms
(Maximum output level: 5 V at 0.5 % total harmonic distortion)
Total harmonic distortion (20 Hz to 20 kHz)
INPUT . . . . . less than 0.008 %
Frequency response (at rated output, Equalizer controls: "0" position) . . . . 10 to 100,000 Hz, +0 dB, –1 dB
Equalizer frequency . . 32 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, 16 kHz
Level variation range . . ±12 dB
Hum and noise (short-circuit, A-network)
. . . . . 110 dB
Gain (1,000 Hz, Equalizer controls: "0" position)
. . . . . 0 dB
Power requirements
Power voltage . . . . 100, 120, 220, 240 V (50/60 Hz)
For USA and Canada
. . . . . 120 V (60 Hz)
Power consumption
Rated consumption
. . . . . 7 watts
Dimensions . . . . . .

Black type



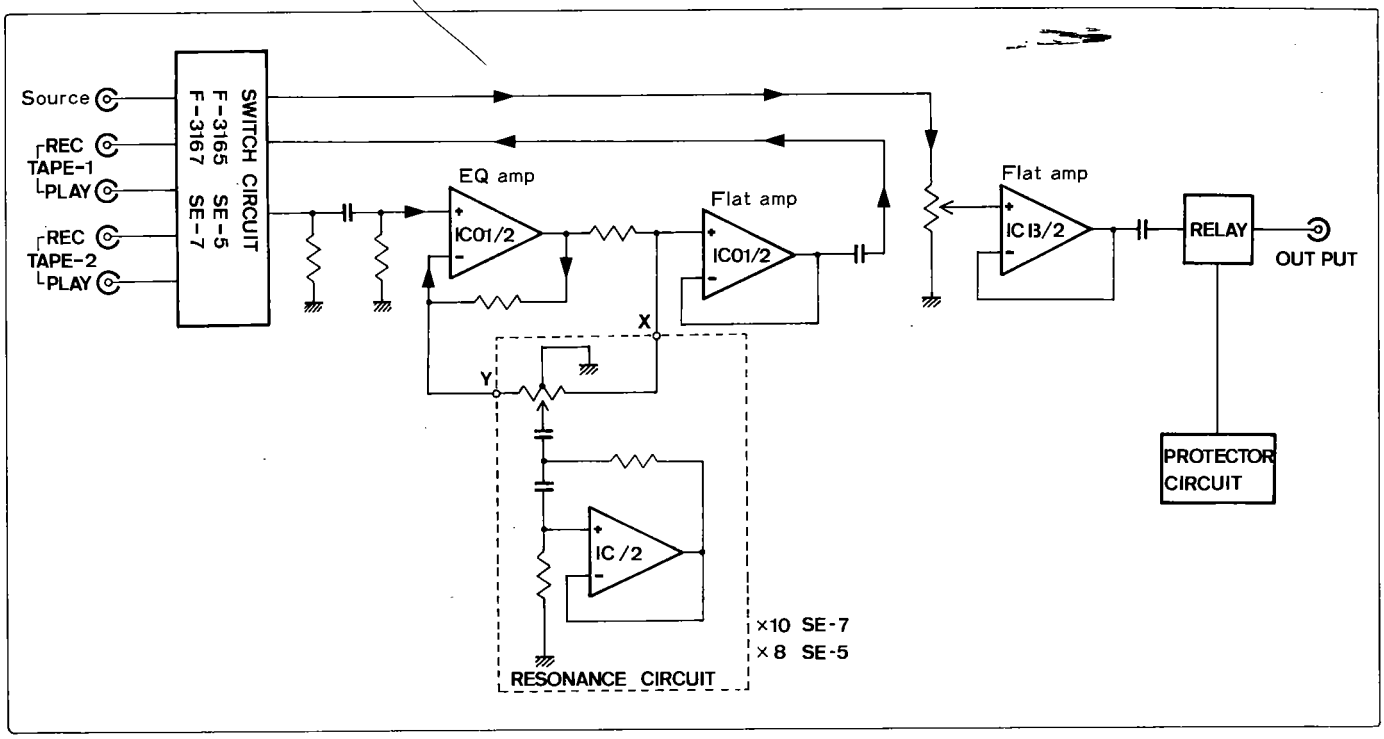

Silver type




Weight
Black type . . . . . 4.5 kg (9.9 lbs.) net
6.0 kg (13.2 lbs.) packed
Silver type . . . . . 4.0 kg (8.8 lbs.) net
5.2 kg (11.5 lbs.) packed

* Design and specifications subject to changes without notice for improvements.
* In order to simplify the explanation illustrations may sometimes differ from the originals.

# 1. BLOCK DIAGRAM




# 2. OPERATION

## 2-1. Outline (See block diagram.)

The graphic equalizers, Models SE-5 and SE-7, consist of a plurality of resonance circuits (8 units for SE-5, 10 units for SE-7) using a semiconductor inductor, an EQ amplifier using the resonance circuit, and flat amplifiers.

## 2-2. Basic Operation of Resonance Circuit and OP Amp. (Operational Amplifier)

The resonance circuit (Fig. 2-1) is built with an OP amp, resistors, and capacitors, having an equivalent circuit as shown in Fig. 2-2. It is customary that an OP amp in any circuit is handled as an ideal one for convenience. In this case, the OP amp meets the following requirements:

1. Voltage gain : Infinity
2. Band width : Infinity
3. Input impedance Zin : Infinity
4. Offset, Drift : Zero
5. Output impedance Zout : Zero
6. Common mode rejection ratio : Infinity

Thus, when a signal voltage is applied to the inversion input terminal of the OP amp as shown in Fig. 2-3, current flows through the resistors $R_D$ and Rf, but none flows into the inversion input terminal because the input impedance of ideal OP amp is infinity. The voltage at inversion input is 0V because the non-inversion terminal is grounded and input difference voltage (Vd) between the two input terminals of OP amp is always 0V (since the inversion input is always at the same potential as the non-inversion input, the inversion input is said to be at virtual ground.)

Applying Ohm's law to the above, the voltages $V_0$ and $V_1$ are:

$V_0 = -I_2 \times Rf$

$V_1 = I_1 \times R_D$

Fig. 2-1 Resonance Circuit

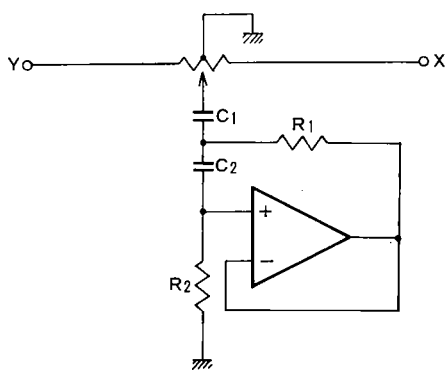
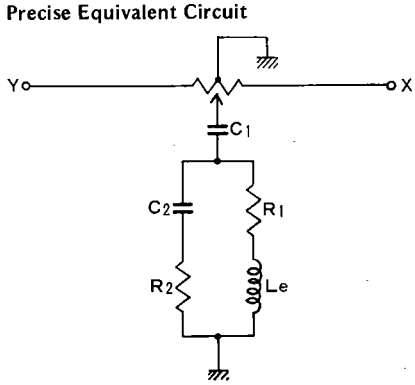



Fig. 2-2 Precise Equivalent Circuit



Furthermore, since no current flows through the OP amp. $I_1 = I_2 = I$ and thus the voltage gain Av is:

$$Av = \frac{V_0}{V_1} = \frac{-I \times Rf}{I \times R_D} = -\frac{Rf}{R_D}$$

Similarly, when a signal voltage is applied to the non-inversion terminal as shown in Fig. 2-4, the voltage at the inversion input terminal and non-inversion input terminal are the same . Thus,

$$V_0 = I_2 \times (R_D + Rf)$$

$$V_1 = I_1 \times R_D$$

$$Av = \frac{V_0}{V_1} = \frac{I \times (R_D + Rf)}{I \times R_D} = (1 + \frac{Rf}{R_D})$$

In the OP amp of the resonance circuit (Fig. 2-5) used in SE-5 and SE-7, Rf = 0 and $R_D = \infty$. The reason for the former is that a signal voltage is applied to the non-inversion input terminal and a feedback is directly given from the output terminal to the inversion input terminal. That for the latter is that no resistance for voltage division is connected to the inversion input terminal. Using the formula determined for an OP amp with a non-inverted input, the voltage gain is:

$$Av = 1 + \frac{Rf}{R_D} = 1 + \frac{0}{\infty} = 1$$

## 2-3. Resonance Circuit

This means the input voltage $V_{in}$ appears at the output terminal as an output voltage $V_0$ equal to it.

In Fig. 2-5, the voltage $V_S$ applied to the Point Ⓐ produces the currents $I_2$ flowing through the capacitor $C_2$ and resistor $R_2$, and $I_1$ flowing through the resistor $R_1$, voltages $V_{C2}$, $V_{R2}$ ($V_{in}$), and $V_{R1}$ developing across $C_2$, $R_2$, and $R_1$ respectively. (Here, recall that the OP amp is an ideal one, and its input impedance is of infinity and therefore no current flows through it.) Since the voltage gain of this OP amp is 1, the voltage $V_{in}$ is equal to the voltage $V_0$.

Here, consider the current $I_2$ flowing through $C_2$ and $R_2$ coupled in series. If the frequency of $V_S$ applied to point Ⓐ is increased without varying its magnitude, the impedance of the series circuit ($C_2$ and $R_2$) decreases. Therefore, current $I_2$ flowing the series circuit increases, which causes voltage decrease across $C_2$ ($V_{C2}$) and voltage increase across $R_2$ ($V_{in}$). The voltage of $V_{C2}$ added to $V_{in}$ equals $V_S$, $V_{in}$ is the same potential of $V_0$, and $V_{R1}$ added to $V_0$ equals $V_S$ that $V_{R1}$ always equals $V_{C2}$.

Similarly, consider the current $I_1$. If frequency of $V_S$ is increased, $V_{C2}$ decreases and so does $V_{R1}$ because $V_{C2}$ equals $V_{R1}$.

This means that $I_1$ is decreased because $R_1$ has no frequency characteristic, and $V_0$ (voltage between point Ⓑ and ground) is increased, since the magnitude of $V_S$ is fixed and $V_S$ equals $V_{R1}$ plus $V_0$.

Therefore viewing the OP amp from point Ⓑ, the characteristic of the OP amp is equavalent to an element of which characteristic is that the higher the applied frequency becomes, the smaller the flowing current and the higher the voltage across the element become, namely equavalent to a coil connected between point Ⓑ and ground.

From the above, the circuit shown in Fig. 2-5 is equal to the equavalent circuit of Fig. 2-2 and if the current flowing the series circuit ($C_2$ and $R_2$) is negligible, Fig. 2-2 becomes series resonance circuit as Fig. 2-6.

These relations are shown by the following equations (Fig. 2-5):

$$Vs = I_1R_1 + V_0 \quad \cdots\cdots 1$$

$$Vs = I_2X_{C2} + I_2R_2 \quad \cdots\cdots 2$$

$$V_0 = Vin = I_2R_2 \quad \cdots\cdots 3$$

Substitution of Eq. 3 into Eq. 1 gives:

$$Vs = I_1R_1 + I_2R_2 \quad \cdots\cdots 4$$

Eliminating $I_2R_2$ by Eqs. 2 and 4 gives:

$$I_2 = \frac{R_1}{X_{C2}} I_1 \quad \cdots\cdots 5$$

Substitution of Eq. 5 into 4 gives:

$$I_1 = \frac{Vs}{R_1 + \frac{R_1R_2}{X_{C2}}} \quad \cdots\cdots 6$$

When $I_2$ is negligibly smaller than $I_1$, the impedance viewing from the point A is:

$$Z = \frac{Vs}{I_1} = R_1 + \frac{R_1R_2}{X_{C2}} \quad \cdots\cdots 7$$

Since $X_{C2} = \frac{1}{j\omega C_2}$, Eq. 7 becomes:

$$Z = R_1 + j\omega C_2R_1R_2 \quad \cdots\cdots 8$$

This Z is equivalent to the impedance of the circuit through which $I_1$ flows. (Fig. 2-5) In Eq. 8 , let $j\omega Le$ stand for $j\omega C_2R_1R_2$. Then, Eq. 8 is:

$$Z = R_1 + j\omega Le$$

This means that the circuit consists of a resistor $R_1$ and a coil (with a reactance of Le) connected in series with each other.

The resonance frequency ($f_0$) can be obtained by the following equation

$$f_0 = \frac{1}{2\pi\sqrt{C_1C_2R_1R_2}}$$

Fig. 2-3 Inversion OP Amp.

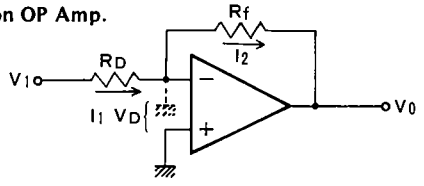



Fig. 2-4 Non-inversion OP Amp.

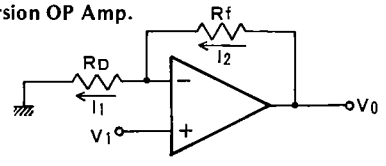



Fig. 2-5 Resonance Circuit

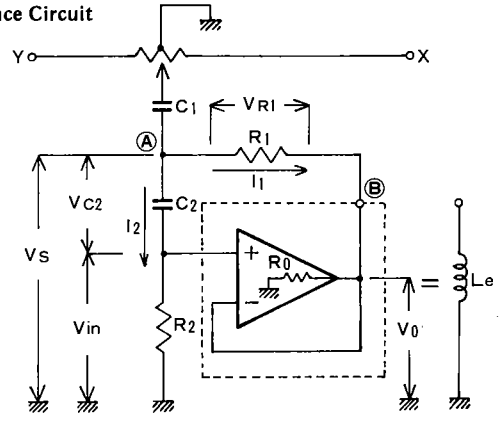
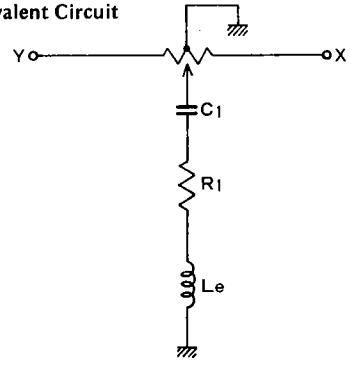



Fig. 2-6 Equivalent Circuit



## 2-4. EQ amplifier

As shown in Fig. 2-7, the EQ amplifier comprises a resonance circuit using a Semiconductor Inductor and an OP amp.

Suppose that the input signal voltage Vin applied to the EQ amplifier has the resonance frequency $f_0$.

When the resonance circuit is grounded, that is, when the variable resistor is set to the mid-point (b) as shown in Fig. 2-7, the voltage gain $Av_1$ of the EQ amplifier can be determined from the formula used for non-inversion amplifier as follows:

$$Av_1 = 1 + \frac{Rf}{r_1}$$

Thus, the output voltage $V_0$ is $(1 + \frac{Rf}{r_1})$ times the input voltage Vin.

When the variable resistor is set to the leftmost position (point a), the impedance Z of the resonance circuit includes only an R component due to the input signal with the resonance frequency fo, and therefore, $r_1$ and R form a parallel circuit. When R is negligibly smaller than $r_1$, it can be supposed that only R is connected to the non-inversion input terminal of the EQ amplifier. Thus, the voltage gain is:

$$Av_2 = 1 + \frac{Rf}{R}$$

Since $r_1 > R$, $Av_1 < Av_2$.

When the resonance circuit is connected leftwards from the point b of the variable resistor, the output voltage $V_0$ is divided by $R_1$ and $r_2$ and appears as Vx at the point Ⓧ.

$$Vx = \frac{r_2}{R_1 + r_2} V_0$$

When the resonance circuit is connected to the rightmost point c, $V_0$ is divided by $R_1$ and $\frac{r_2 Z}{r_2 + Z}$ (impedance of the parallel circuit comprising $r_2$ and Z).

From the above, the following relation can be found:

Vxa (Vx for resonance circuit connected to the point a) > Vxb > Vxc

This shows the "peak characteristic" of the EQ amplifier as Fig. 2-8.

Fig. 2-7 EQ Amp.

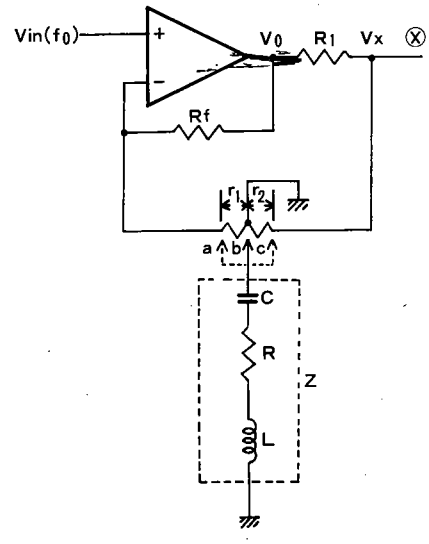
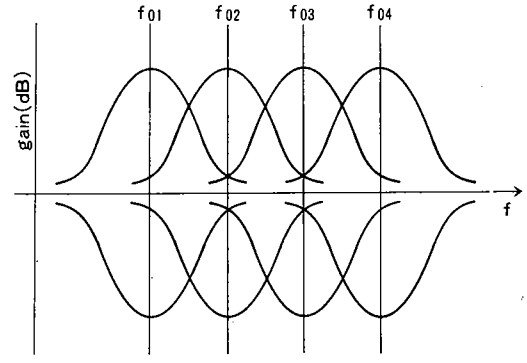



Fig. 2-8 Peaking Characteristics

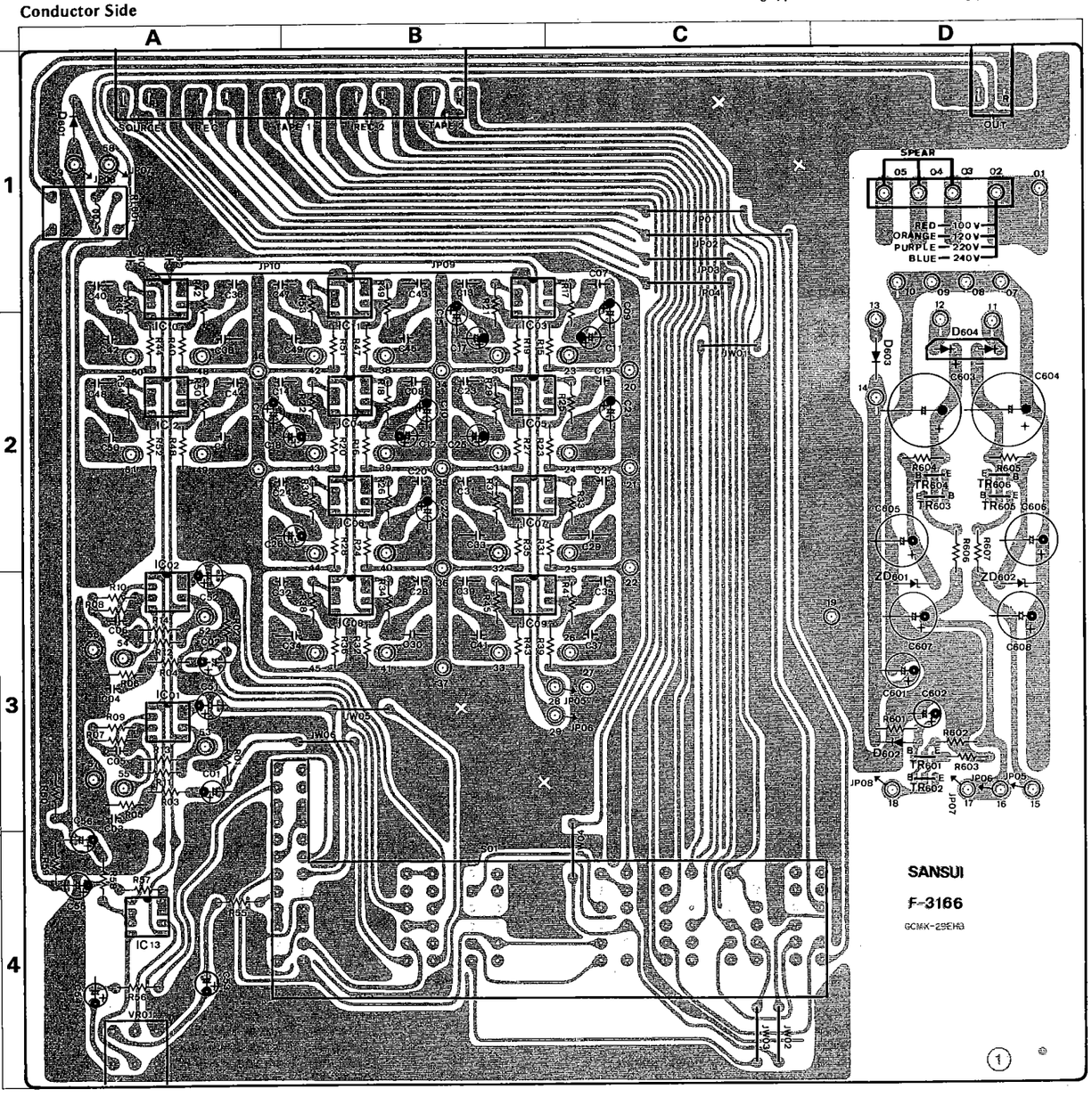


# 3. PARTS LOCATION & PARTS LIST

- Since some of capacitors and resistors are omitted from parts lists in this Service Manual, refer to the new Common Parts List for capacitors & resistors.
- As the stock number in the parts list on this service manual is indicated in 8 digit to differ from ordinary 7 digit, please be careful when ordering parts.

## 3-1. F-3166 Main Circuit Board (Stock No. 75632801 = SE-7)

Conductor Side



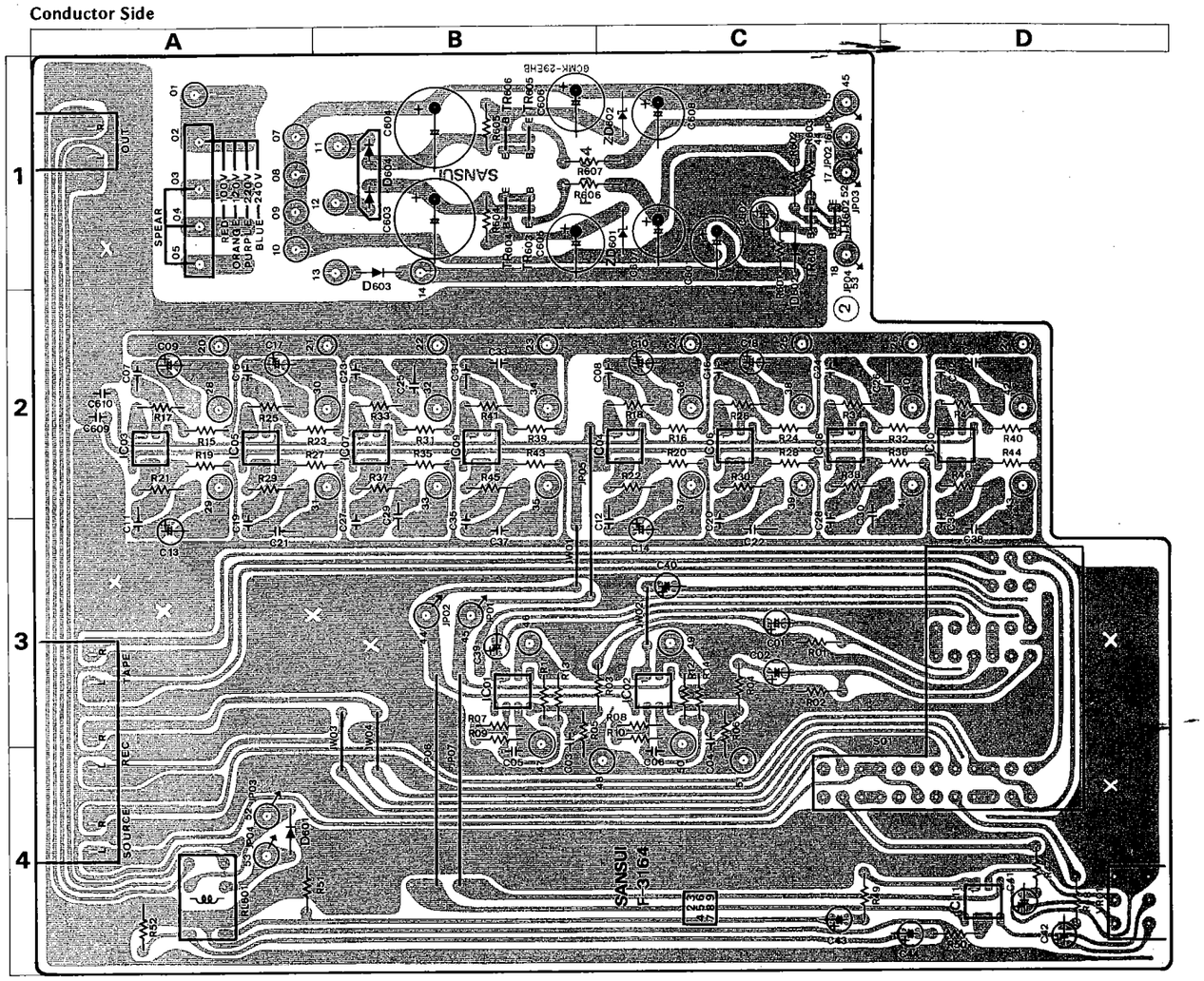

### Parts List

| Parts No. | Stock No. | Description |
|---|---|---|
| •Transistor | | |
| TR601 | 03062900, 1 | 2SC1400-1 E, U |
| TR602 | 03008900, 1 | 2SA750-3 E, U |
| TR603 | 03086101, 2 | 2SD357 D, E |
| TR604 | 03062900, 1 | 2SC1400 E, U |
| TR605 | 03034401, 2 | 2SB527 D, E |
| TR606 | 03008900 | 2SA750 E, U |
| •IC | | |
| IC01, 02 | 03613800 | NJM4559D D |
| IC03 ~ 13 | 03607700 | NJM4558D |
| •Diode | | |
| D601 | 03103400 | 10D1 |
| D602 | 03111800 | 1S1588 |
| D603 | 03103400 | 10D1 |
| D604 | 03117000 | RB-152 |
| •Zener Diode | | |
| ZD601 | 03160000 | EQA01-16R |
| ZD602 | 03160000 | EQA01-16R |
| VR01 | 10250500 | Volume 50kΩ (A) x 2 |
| S01 | 11323400 | Push Switch, TAPE COPY |
| RL601 | 11505100 | Relay |

| Parts No. | Stock No. | Description |
|---|---|---|
| | 22007200 | Input Terminal, source, tape 1, rec 1 |
| | 22007100 | Input Terminal, tape 2, rec 2 |
| | 22007000 | Output Terminal |

## 3-2. F-3164 Main Circuit Board (Stock No. 75632901 = SE-5)

Conductor Side



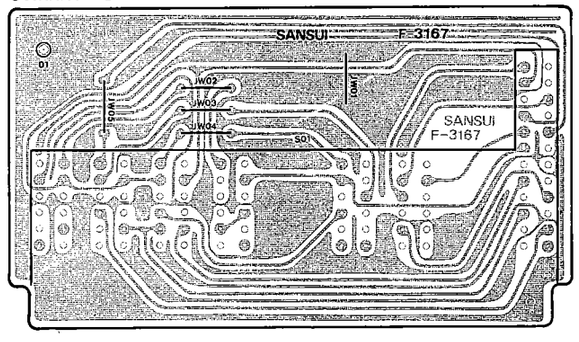

### Parts List

| Parts No. | Stock No. | Description |
|---|---|---|
| •Transistor | | |
| TR601 | 03062900, 1 | 2SC1400-1 E, U |
| TR602 | 03008900, 1 | 2SA750-3 E, U |
| TR603 | 03086101, 2 | 2SD357 D, E |
| TR604 | 03062900, 1 | 2SC1400-1 E, U |
| TR605 | 03034401, 2 | 2SB527 D, E |
| TR606 | 03008900, 1 | 2SA750-3 E, U |
| •IC | | |
| IC01, 02 | 03613800 | NJM4559D D |
| IC03, 12 | 03607700 | NJM4558D |
| •Diode | | |
| D601 | 03103400 | 10D1 |
| D602 | 03111800 | 1S1588 |
| D603 | 03103400 | 10D1 |
| D604 | 03117000 | RB-152 |
| •Zener Diode | | |
| ZD601 | 03160000 | EQA01-16R |
| ZD602 | 03160000 | EQA01-16R |
| VR01 | 10156500 | Volume 50kΩ, Output Level |
| S01 | 11323300 | Push Switch, Equalizer, Tape Monitor |
| RL601 | 11505100 | Relay |

- The circuit boards, F-3167, F-3165 & F-3168 are not supplied as the assembled.

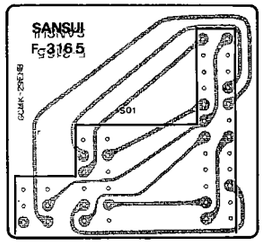
## 3-3. F-3167 Switch Circuit Board (SE-7)

Conductor Side



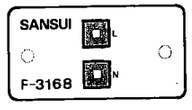

## 3-4. F-3165 (SE-5)

Conductor Side




## 3-5. F-3168 (SE-5)

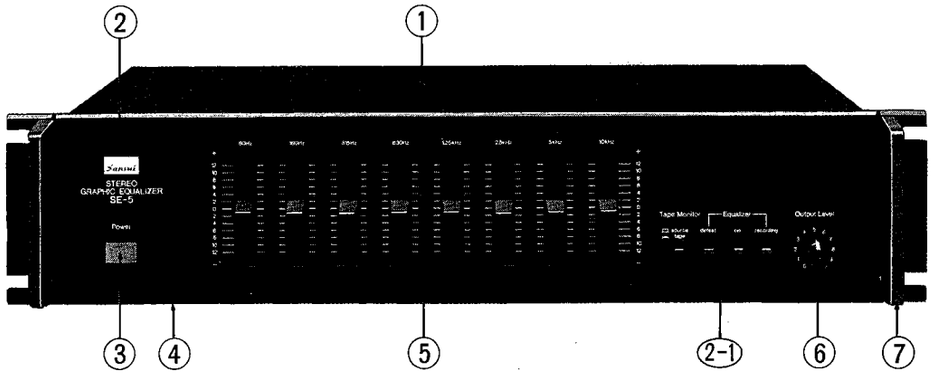
Conductor Side



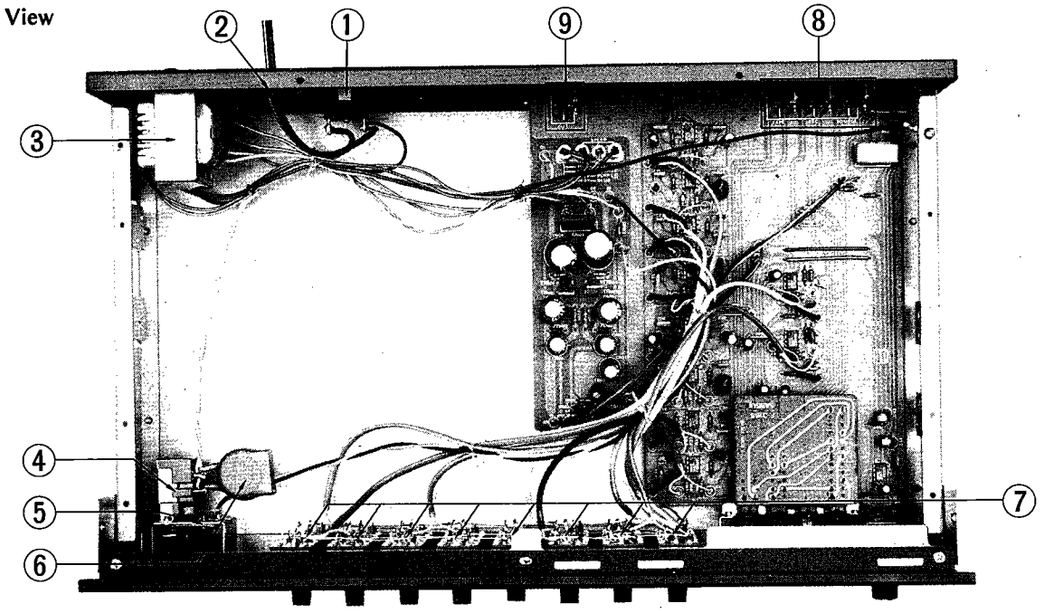
# OTHER PARTS

## SE-5

### Front View




### Top View




### Parts List <Front View>

| No. | Parts No. | Stock No. | Description |
|---|---|---|---|
| 1 | | 50069830 | Bonnet |
| 2 | | 70085910 | Front Panel Ass'y |
| | | 50048700 | Masking Sheet |
| | | 50485000 | Masking Plate |
| 2-1 | | 71061500 | Knob Ass'y, equalizer, tape monitor |
| 3 | S701 | 11318900 | Power Switch |
| | | 77262300 | Indicator Ass'y (with lamp) |
| | | 71063910 | Knob, power switch |
| 4 | | 55170700 | Leg |
| 5 | | 53269000 | Knob, slide volume |
| 6 | | 53189400 | Knob, output level |
| 7 | | 53967000 | Rack Mounting Adaptor |

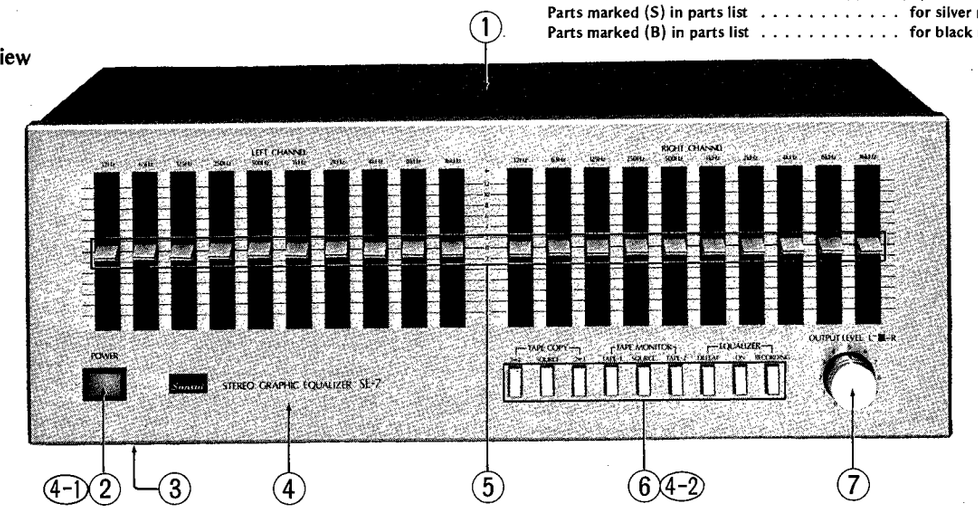
### Parts List <Top View>

| No. | Parts No. | Stock No. | Description |
|---|---|---|---|
| 1 | | 24501100 | AC Outlet |
| 2 | | 38004700 | AC Cord |
| | | 39106000 | Strain Relief |
| 3 | | 40033300 | Power Transformer |
| 4 | S701 | 11318900 | Power Switch |
| 5 | | 77262300 | Indicator Ass'y (with lamp) |
| 6 | | 00386000 | 0.01μF 50V C.C. |
| 7 | VR701 ~09 | 10401700 | Slide Volume |
| 8 | | 22007200 | Pin Terminal, tape, rec, source |
| 9 | | 22007000 | Pin Terminal, output |

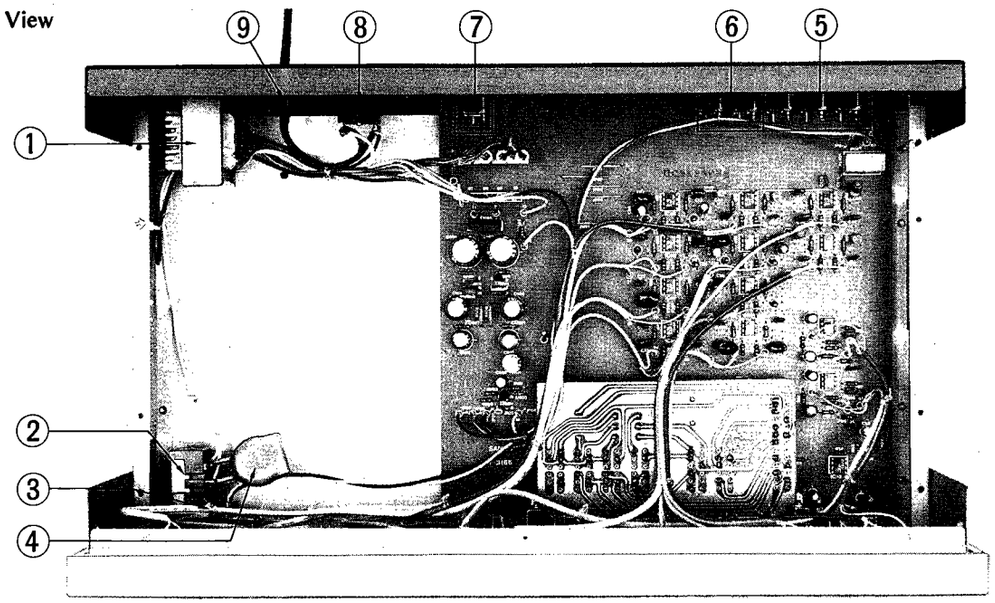
●Since there are black & silver models in SE-7, please pay attention when ordering parts.
Parts marked (S) in parts list . . . . . for silver model only
Parts marked (B) in parts list . . . . . for black model only

## 4-2. SE-7

### A) Front View




### B) Top View



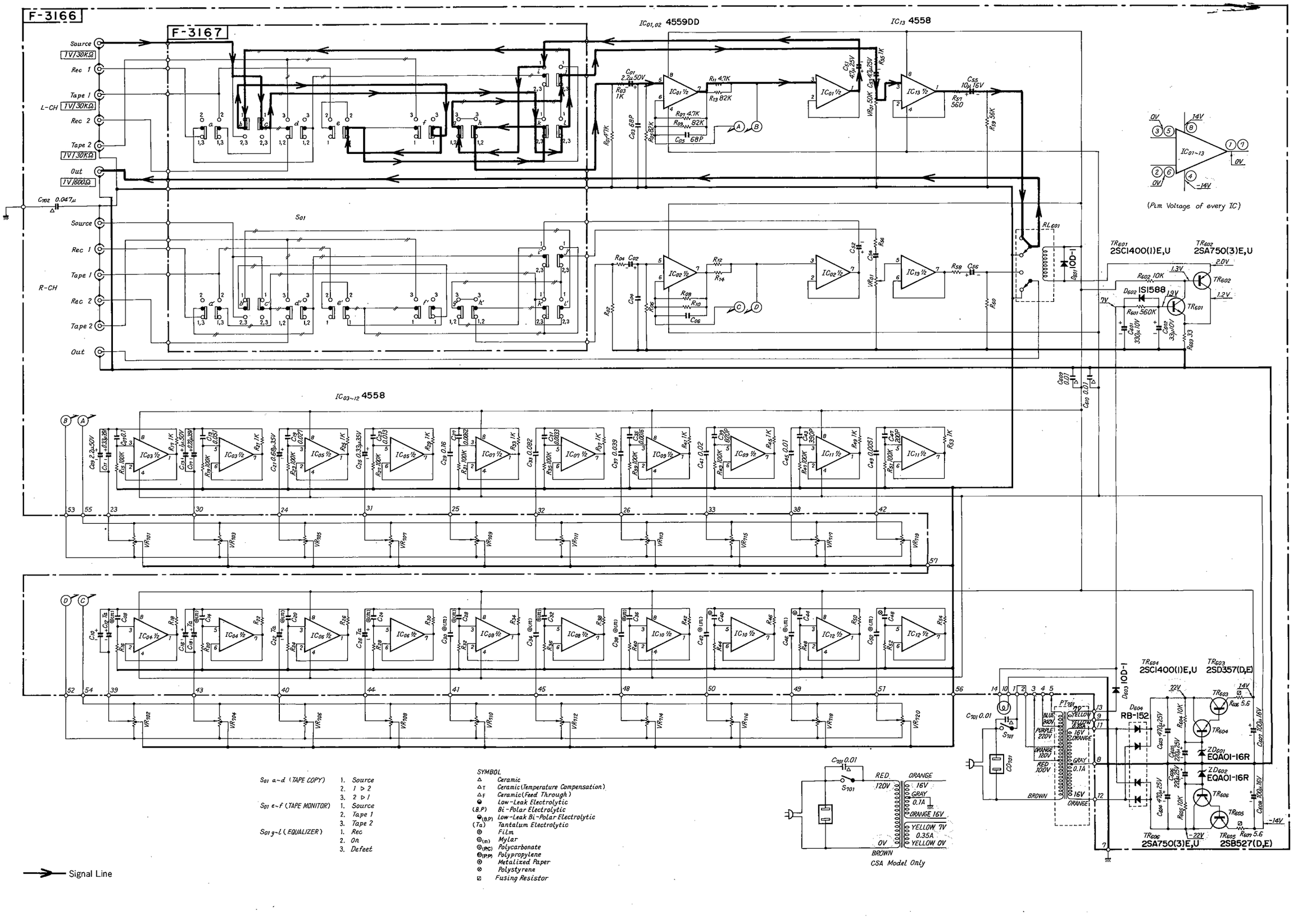

### Parts List <Front View>

| No. | Parts No. | Stock No. | Description |
|---|---|---|---|
| 1 | | 57272800 | Wood Bonnet (S) |
| | | 50070200 | Bonnet (B) |
| | | 11318900 | Power Switch |
| 2 | | 71063910 | Knob Ass'y, power switch |
| | | 77262300 | Indicator Ass'y |
| 3 | | 55170700 | Leg |
| 4 | | 70085710 | Front Panel Ass'y (S) |
| | | 70085810 | Front Panel Ass'y (B) |
| | | 50485500 | Masking Sheet (S) |
| | | 07515400 | Masking Sheet (B) |
| 4-1 | | 52813910 | Knob Guide, power switch |
| 4-2 | | 71061500 | Knob Ass'y, EQ, tape copy, tape monitor (B) |
| 5 | VR701 | 10401600 | Slide Volume |
| | ~ 720 | 53269100 | Knob, slide volume (S) |
| | | 53269000 | Knob, slide volume (B) |
| 6 | | 53194910 | Push Knob, EQ, tape copy, tape monitor (S) |
| | | 52803300 | Knob Holder, EQ, tape copy, tape monitor (S) |
| 7 | | 53196100 | Knob, (L) output level (S) |
| | | 53189510 | Knob, (L) output level (B) |
| | | 53196000 | Knob, (R) output level (S) |
| | | 53191900 | Knob, (R) output level (B) |

### Parts List <Top View>

| No. | Parts No. | Stock No. | Description |
|---|---|---|---|
| 1 | | 40033300 | Power Transformer |
| 2 | | 11318900 | Power Switch |
| | | 71063910 | Knob Ass'y, power switch |
| 3 | | 77262300 | Indicator Ass'y |
| 4 | C701 | 00386000 | 0.01μF 50V C.C. |
| 5 | | 22007200 | Input Terminal, source, tape 1, rec 1 |
| 6 | | 22007100 | Input Terminal, tape 2, rec 2 |
| 7 | | 22007000 | Output Terminal, |
| 8 | | 24501100 | AC Outlet |
| 9 | | 38004700 | AC Cord |
| | | 39106000 | Strain Relief |

# SCHEMATIC DIAGRAM 5-1. SE-7




2SA-750
2SC-1400

NJM-4559D
NJM-4558D

2SB-527

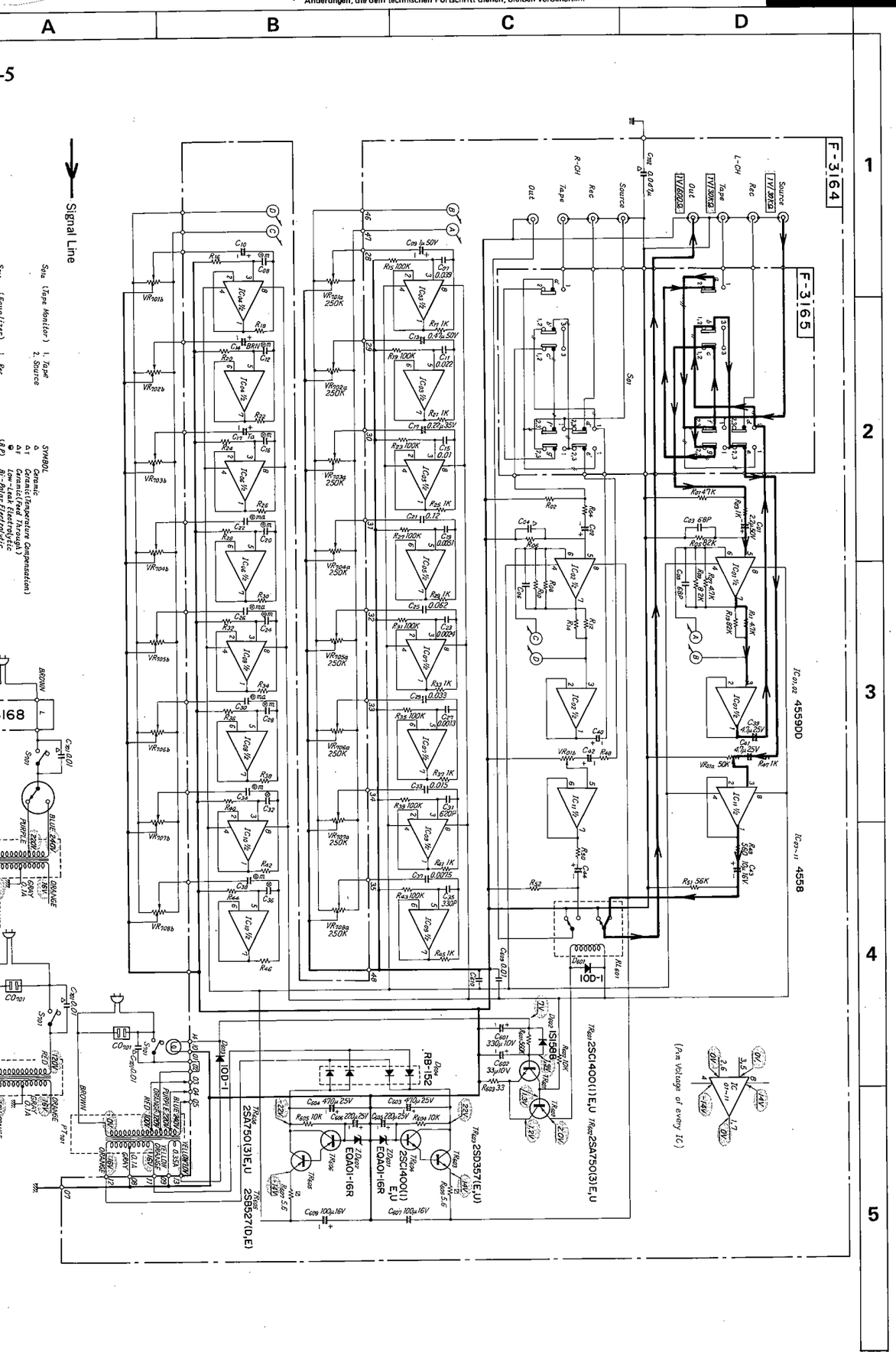
2SD-357

1S-1588
10D-1

EQA01-16R

RB-1588

1 2 3 4 5 6



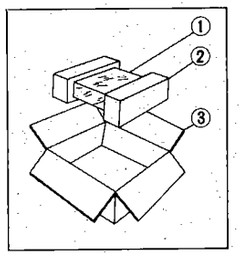

# 6. PACKING LIST

## 6-1. SE-5

| Parts No. | Stock No. | Description |
|---|---|---|
| 1 | 91167600 | Vinyl Bag |
| 2 | 90281010 | Styrofoam Packing |
| 3 | 90564300 | Carton Case |

## 6-2. SE-7

| Parts No. | Stock No. | Description |
|---|---|---|
| 1 | 91166910 | Vinyl Bag |
| 2 | 90284300 | Styrofoam Packing |
| 3 | 90564200 | Carton Case (SE-7S) |
| | 90564100 | Carton Case (SE-7B) |




# 7. ACCESSORY PARTS LIST

## 7-1. SE-5

| Stock No. | Description |
|---|---|
| 92049400 | Operating Instructions |
| 92385100 | Schematic Diagram |
| 38103300, 1 | PJP Cord |
| 07193400 | PJP Cord |
| 53967000 | Rack Mounting Adaptor |

## 7-2. SE-7

| Stock No. | Description |
|---|---|
| 92049200 | Operating Instructions |
| 92385000 | Schematic Diagram |
| 38103300, 1 | PJP Cord |
| 07193400 | PJP Cord |
| 53967100 | Rack Mounting Adaptor (SE-7B) |

●Since there are black & silver models in SE-7, please pay attention when ordering parts.
Parts marked (S) in parts list . . . . . for silver model only
Parts marked (B) in parts list . . . . . for black model only


Sansui

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