

ONKYO® SERVICE MANUAL

SUPER SERVO OPERATION INTEGRATED STEREO AMPLIFIER MODEL A-7090

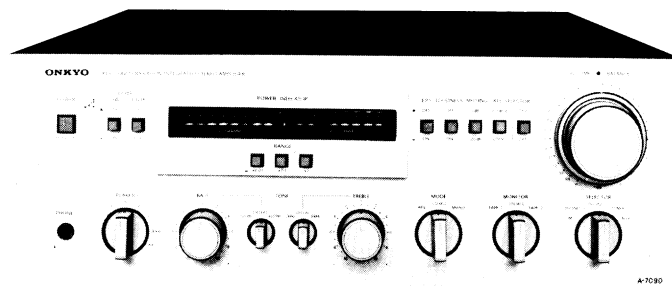


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ONKYO®
AUDIO COMPONENTS

SPECIFICATIONS

POWER AMPLIFIER SECTION

Power Output: 110 watts per channel minimum r.m.s. into 8 ohms, both channels driven from 20 Hz to 20,000 Hz, with no more than 0.018% total harmonic distortion.

Total Harmonic

Distortion: 0.018% at rated power
 (Aux. Input) 0.016% at 1 watt output
 IM Distortion: 0.018% at rated power
 (Aux. Input) 0.016% at 1 watt output
 (70 Hz: 7 kHz = 4:1)
 Frequency Response: 5 Hz ~ 80,000 Hz (± 1 dB)
 Damping Factor: 50 at 8 ohms
 Rated Input: 1.5 volts
 Input Impedance: 50 kohms
 Load Impedance: 4 ~ 16 ohms
 Power Indicator
 Ranges: $\times 1$, $\times 0.1$, $\times 0.01$

PRE-AMPLIFIER SECTION

Input Sensitivity &

Impedance: Phono MC: 250 μ V, 40 ohms
 Phone 1 & 2: 2.5 mV, 50 kohms
 Tuner: 150 mV, 50 kohms
 Aux: 150 mV, 50 kohms
 Tape Play 1 & 2: 150 mV,
 50 kohms

Total Harmonic

Distortion: 0.01% at rated output
 IM Distortion (Aux): 0.01% at rated output
 (70Hz: 7kHz = 4:1)
 Frequency Response: Phono: 20Hz~20,000Hz ± 0.2 dB
 Aux: 10Hz~50,000Hz +0, -1 dB
 Phono Overload: 250 mV r.m.s. at 1 kHz, 0.018% THD
 Signal-to-Noise Ratio: Phono MC: 68 dB (IHF A weighted)
 Phono MM: 78 dB (IHF A weighted)
 Aux: 90 dB (IHF A weighted)

Output Voltage: Pre out: 1.5 volts
 Rec out: 150 mV
 Output impedance: Pre out: 1.8 kohms
 Rec out: 3.3 kohms (PHONO)
 Tone Controls: Bass: ± 10 dB at 100 Hz
 (turnover at 400 Hz)
 Treble: ± 10 dB at 10 kHz
 (turnover at 2 kHz)
 Turnover Frequencies: Bass: 400 Hz, 125 Hz
 Treble: 2 kHz, 8 kHz
 Filters: High: 6 kHz (12 dB/oct)
 Subsonic: 15 Hz (12 dB/oct)
 Muting: -20 dB
 Loudness: +5 dB at 100 Hz
 +5 dB at 10 kHz

GENERAL

Outputs: Speakers A, B & C, Headphones,
 Tape Rec 1,2
 EPS out
 Inputs: Phono 1, 2 & MC
 Tuner
 Aux
 Tape Play 1 & 2
 EPS in
 AC Outlets: 2 switched 200 watt max.
 (only 120V model) 1 unswitched 100 watt max.
 Semiconductors: 8 FETs, 74 transistors, 41 diodes,
 6 ICs
 Power Supply: AC 120V, 60 Hz or AC 220V, 50 Hz
 Dimensions (WxHxD): 418 mm \times 155 mm \times 410 mm
 16-1/2" \times 6-1/8" \times 16-3/16"
 Weight: 18 kg, 39.6 lbs.

Specifications and features are subject to change without notice.

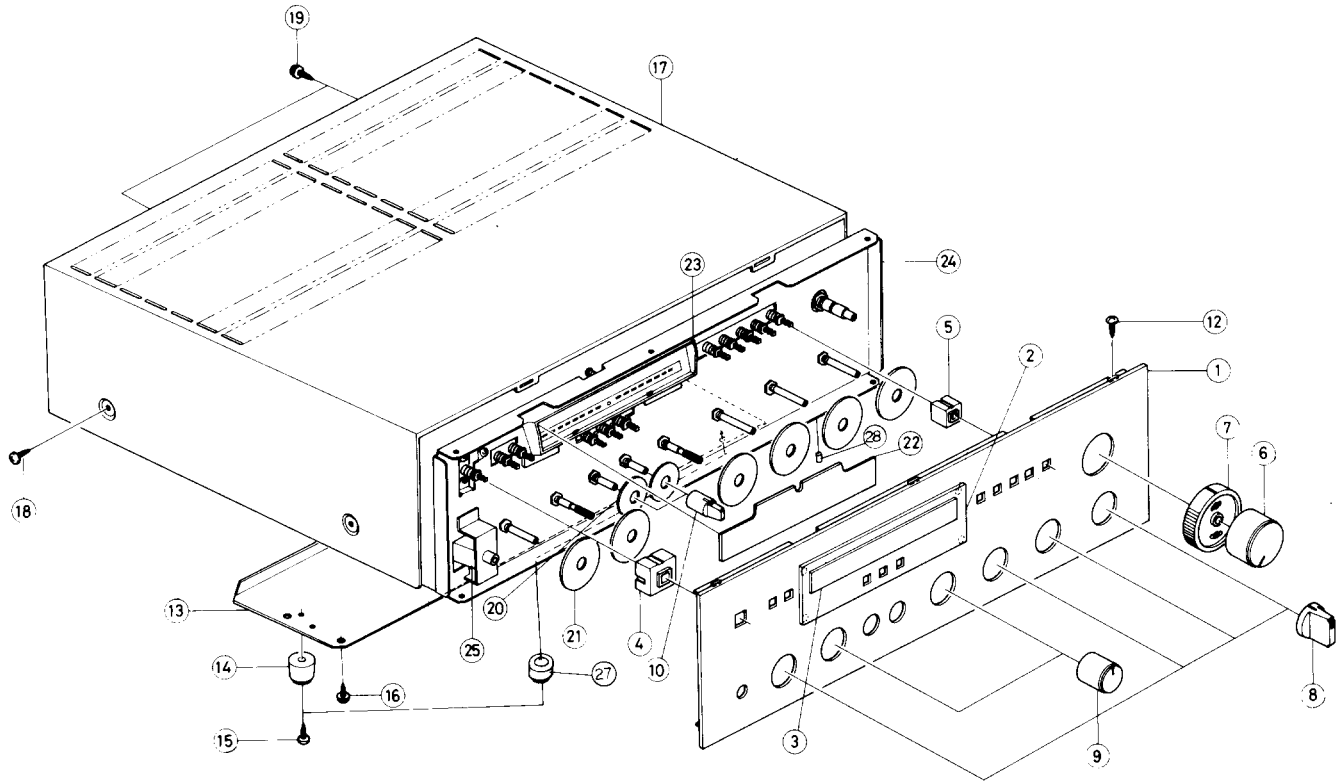
PRECAUTIONS

- For continued protection against fire hazard, replace only with same type and same rating fuse.

		PARTS NO.
AC fuse	5A (ST-6)	252050 (110/120V model)
	3A-T	252003 (220/240V model)

- Replacement for power amplifier transistors, if necessary, must be made from the same beta (h_{FE}) group as the original type.
- Always disconnect the chassis from power line when soldering.
 Turning the power switch OFF is not enough.
 Power line leakage passing through the heating element may destroy the transistors.

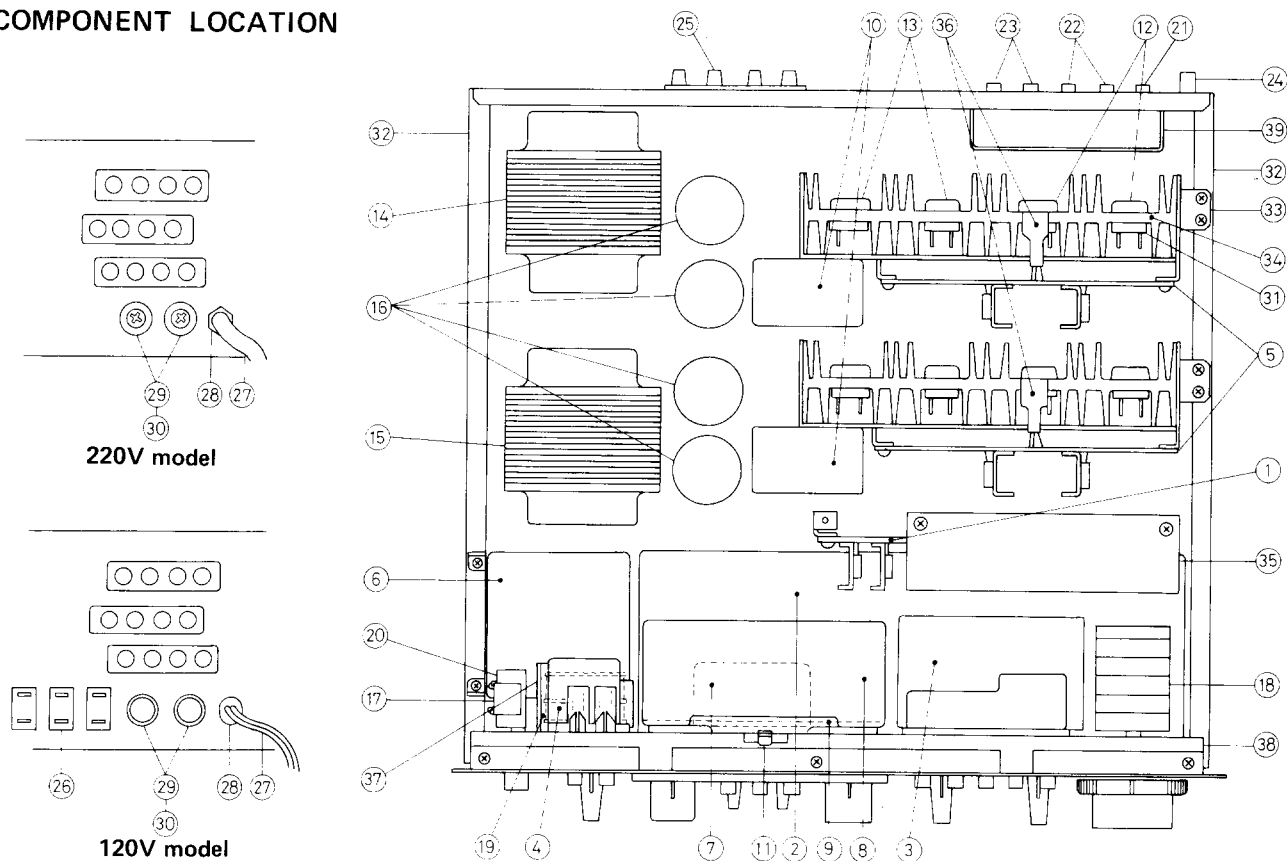
EXPLODED VIEW



EXPLODED VIEW – PARTS LIST

REF. NO.	PARTS NO.	DESCRIPTION
1	12649121	Front panel ass'y (120V model)
	12652121	Front panel ass'y (220V model)
2	27210120A	Front panel (S)
3	28191037	Indicator glass
4	13639126	Power switch ass'y
5	13639125	Push switch ass'y
6	28320310A	Knob, volume
7	28320311	Knob, balance
8	28320315	Knob, selector
9	28320313	Knob, tone
10	28320317A	Knob, shift
12	834130062	3STS+6BQ, Tapping screw
13	27170057	Bottom board
14	280899A	Leg
15	831130162	3STW+16BQ, Tapping screw
16	831130082	3STW+8BQ, Tapping screw
17	28184054A	Top cover
18	838440109	4TTB+10C(BC), Tap screw
19	834430062	3STS+6BQ (BC), Tapping screw
20	28140127	Cushion
21	28140185	Cushion
22	28130079	Output indicator plate
23	27190043	Holder
24	27110082A	Front bracket
25	25045018	LJ-100-H, Stereo headphone jack
	441723914	390Ω, 2W, Metal oxide film resistor
27	27175009	Leg
28	28330022	Cap

COMPONENT LOCATION



COMPONENT LOCATION – PARTS LIST

120V model

REF. NO.	CIRCUIT NO.	PARTS NO.	DESCRIPTION
1	U1	12649547	NAEP-647, MC amplifier p.c.b.
2	U2	12649548A	NASA-648a, Preamplifier p.c.b.
3	U3	12649549	NASW-649, Switch p.c.b.
4	U5	12649552	NASW-652, Switch p.c.b.
5	U6,U7	12649553	NAMS-653, Power amplifier p.c.b.
6	U8	12649554	NAPR-654, Protector circuit p.c.b.
7	U9	12649555	NAAB-655, Attenuator p.c.b.
8	U10	12659527	NAME-627, Output indicator drive circuit p.c.b.
9	U11	12659529	NADIS-629, Output indicator p.c.b.
10	U12,U13	12649556	NARC-656, Rectifier p.c.b.
11	PL001	210057	PL6.3V 0.15AW-1.5, Power indicator lamp
12	Q514,Q515 Q614,Q615	2200802 2200803	2SD551(R) or 2SD551(O) or Power amplifier transistor
13	Q517,Q617 Q516,Q616	2200812 2200813	2SB681(R) or 2SB681(O) or Power amplifier transistor
14	T001	230289	NPT-670D, Power transformer
15	T002	230290	NPT-671D, Power transformer
16	C009-C012	3504119	15,000µF, 63V, Elect. capacitor
17	C015,C016	3504012	UL125V103M, UL capacitor
18	R005-R008	5104080	N40DQL32C100KPT500KMN35H, Balance/Volume control variable resistor
19	S001	25030133	NRSM-226-35Y, Speaker selector switch
20	S002	25035061A	NPS-121-L26P, Power switch
21	P001	25045047	NPJ-2PRBL22, MC input terminal
22	P002	25045044	NPJ-4PRBL21, Phono input terminal
23	P004-P007	25045025	NPJ-4PRBL03, Tape/Aux/Tuner/Eps terminal
24	P009	25060008	Ground terminal
25	P011-P013	25060029	NTM-4PRMN05, Speaker terminal
26	P016-P018	25050032	S-I6444-01, AC outlet

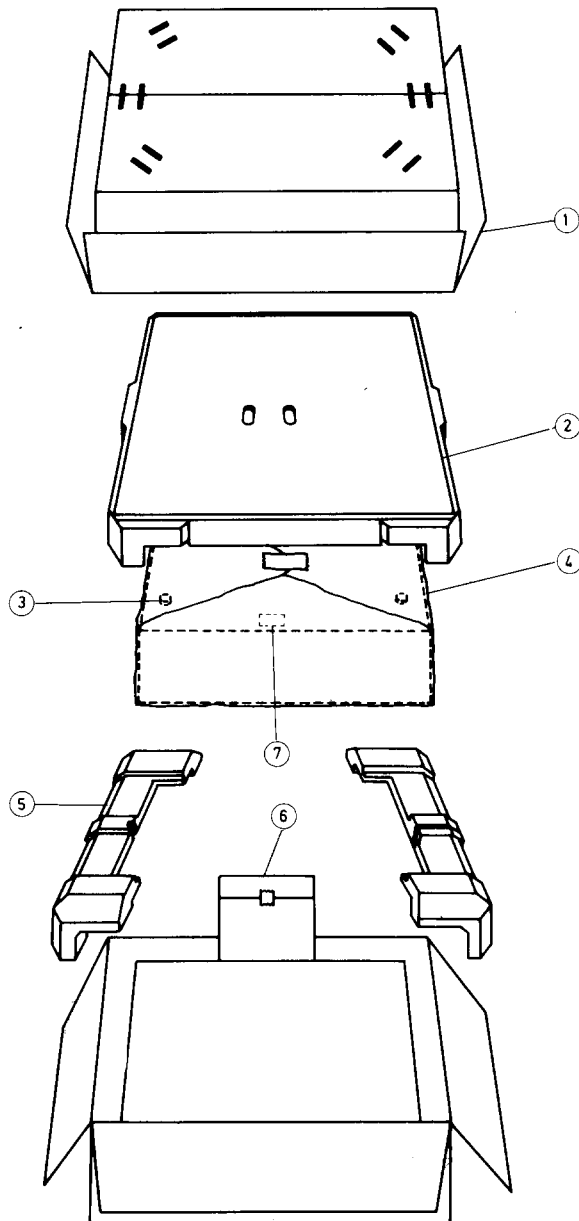
220V model

REF. NO.	CIRCUIT NO.	PARTS NO.	DESCRIPTION
1	U1	12649547	NAEP-647, MC amplifier p.c.b.
2	U2	12652548	NASA-648, Preamplifier p.c.b.
3	U3	12649549	NASW-649, Switch p.c.b.
4	U5	12649552	NASW-652, Switch p.c.b.
5	U6,U7	12649553	NAMS-653, Power amplifier p.c.b.
6	U8	12649554	NAPR-654, Protector circuit p.c.b.
7	U9	12649555	NAAB-655, Attenuator p.c.b.
8	U10	12659527	NAME-627, Output indicator drive circuit p.c.b.
9	U11	12659529	NADIS-629, Output indicator p.c.b.
10	U12,U13	12649556	NARC-656, Rectifier p.c.b.
11	PL001	210057	PL6.3V 0.15AW-1.5, Power indicator lamp
12	Q514,Q515 Q614,Q615	2200802 2200803	2SD551(R) or 2SD551(O) or Power amplifier transistor
13	Q517,Q617 Q516,Q616	2200812 2200813	2SB681(R) or 2SB681(O) or Power amplifier transistor
14	T001	230291	NPT-670G, Power transformer
15	T002	230292	NPT-671G, Power transformer
16	C009-C012	3504119	15,000µF, 63V, Elect. capacitor
17	C015,C016	3500052	PME271Y510CEE, IS capacitor
18	R005-R008	5104080	N40DQL32C100KPT500KMN35H, Balance/Volume control variable resistor
19	S001	25030133	NRSM-226-35Y, Speaker selector switch
20	S002	25035051	NPS-121-L16P, Power switch
21	P001	25045047	NPJ-2PRBL22, MC input terminal
22	P002	25045044	NPJ-4PRBL21, Phono input terminal
23	P004-P007	25045025	NPJ-4PRBL03, Tape/Aux/Tuner/Eps terminal
24	P009	25060008	Ground terminal
25	P011-P013	25060029	NTM-4PRMN05, Speaker terminal
27	W001	253088	AS-VDE-1, Power supply cord

REF. NO.	CIRCUIT NO.	PARTS NO.	DESCRIPTION
27	W001	253100	AS-UC-4, Power supply cord
28	W001a	270280	SR-4K-4, Strainrelief
29	F001,F002	252050	5A (ST-6), AC fuse
30	F001a, F002a	250080	S-N1301, Fuseholder
31	Q514-Q518a, Q614a-Q618a	250249	M-1614, Transistor socket
32		27115026B	Side bracket
33		27130152B	Bracket, radiator
34		27160053	Radiator
35		27225042	Shielded case
36		27140085A	Bracket
37		27150101	Shielded plate (F)
38		27120153A	Back panel
39		27225041A	Shielded case (B)

REF. NO.	CIRCUIT NO.	PARTS NO.	DESCRIPTION
28	W001a	25065018	Strainrelief
29	F001,F002	252003	3A-T, AC fuse
30	F001a, F002a	250100A	S-N2056, Fuseholder
31	Q514-Q518a, Q614a-Q618a	250249	M-1614, Transistor socket
32		27115026B	Side bracket
33		27130152B	Bracket, radiator
34		27160053	Radiator
35		27225042	Shielded case
36		27140085A	Bracket
37		27150101	Shielded plate (F)
38		27120154A	Back panel
39		27225041A	Shielded case (B)

PACKING PROCEDURES

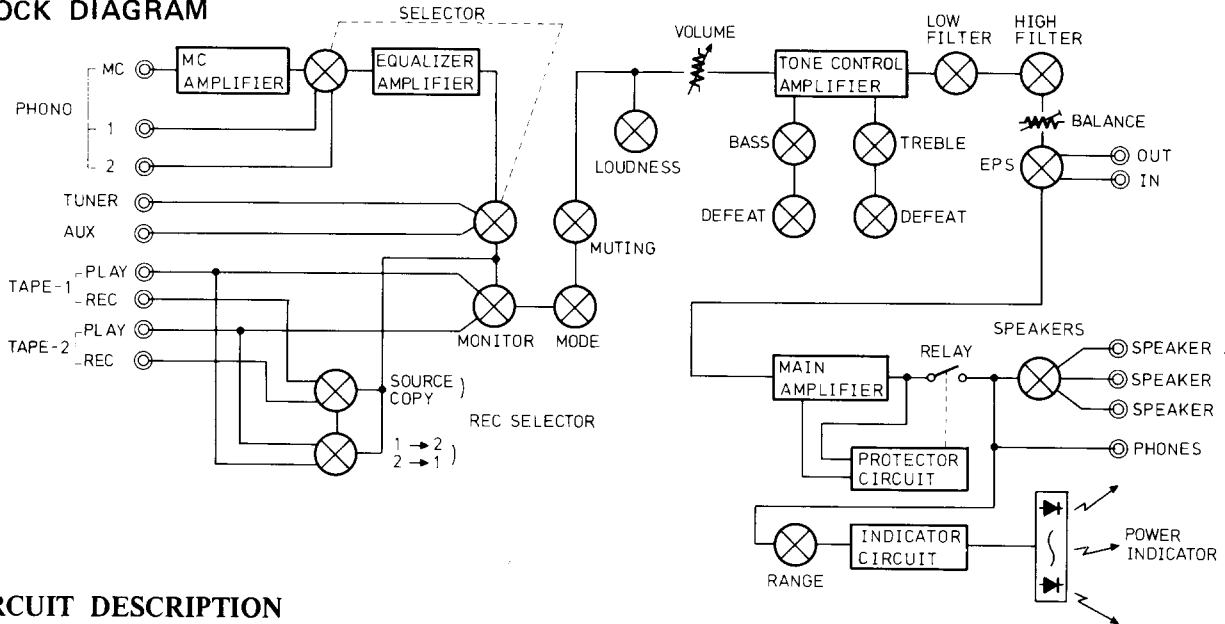


PACKING PROCEDURES – PARTS LIST

REF. NO.	PARTS NO.	DESCRIPTION
1	29050276	Carton box
2	29090401A	Pad B
3	29095115	500 x 1,100 mm, Protection sheet
4	29100034	850 x 650 mm, Poly bag
5	29090399	Pad U
6	29340331	Instruction manual (120V)
	29365006	Warranty card (U)
	29358002	Service station list (U)
	29100002	150 x 80 mm, Poly bag
	29100006	250 x 350 mm, Poly bag
	252050	5A-ST6, Fuse (120V)
	29340332	Instruction manual (220V)
	29365005-2	Warranty card (G)
	252003	3A-T, Fuse (220V)
7	29380040	Cabinet composition label (U)
	293041	Caution label (U)
	282969	Caution label A (U)

(U): Only U.S.A. model
 (120V): Only 120V model
 (G): Only Germany model
 (220V): Only 220V model

BLOCK DIAGRAM



CIRCUIT DESCRIPTION

1. SERVO OPERATIONAL AMPLIFIER

In order to achieve a greater degree of fidelity in waveform transmission, and to remove the large capacitance capacitors (which have questionable effect on the quality of sound) from the NFB, DC amplifier designs are being more and more widely used in amplifiers today. The A-7090, however, has advanced even further by adopting the recently developed Servo Operational Amplifier which features a truly superb quality of sound, and performs considerably better than the now conventional DC amplifiers.

The major circuit feature of the Servo Operational Amplifier (see outline in Fig. 1-1) is the servo feedback loop which has no effect whatsoever on the main signal. In other words, if the signal feedback factor is β_1 and the servo feedback factor β_2 , the $0 \approx \beta_2 \ll \beta_1 \ll 1$ relation holds true within the signal bandwidth, while $\beta_2 \gg 1$ holds true in the subsonic region down to DC. For this purpose, a servo feedback amplifier was necessary. And since it was also necessary to include a high-cut filter, and suppress signal amplifier drift at higher DC gain plus $1/f$ noise and other subsonic region components, a -6dB/oct high-cut mirror integrating circuit (see Fig. 1-2) has been employed. The V_{ref} in Fig. 1-1 serves as the input voltage required to keep the system output DC voltage at $0V$.

In the block diagram for the actual Servo Operational amplifier (see Fig. 1-3), R_f and R_B constitute the signal feedback loop, while A_2 and A_3 form the servo feedback loop.

Assuming that $A_1, A_2, A_3 \gg 1$, the input/output characteristics $T(\omega)$ may be expressed as,

$$T(\omega) = \frac{R_N(R_f + R_B)}{A_2 \cdot R_f \cdot R_B} \left[\frac{1 + \frac{j\omega}{\omega_1}}{1 + \frac{j\omega}{\omega_2}} \right]$$

where $\omega_0 = \frac{1}{CR}$, $\omega_1 = \frac{\omega_0}{A_2}$, $\omega_2 = \frac{R_F}{R_N} \omega_0$

The frequency response is as shown in Fig. 1.4, ω_2 being about $0.3\text{Hz} \sim 2\text{Hz}$. A_3 is phase inverted in order to prevent positive feedback in the DC region.

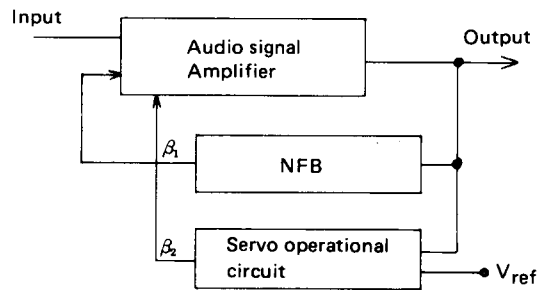


Fig. 1.1

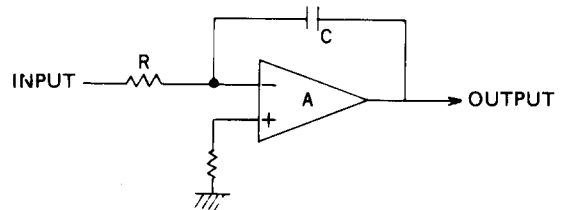


Fig. 1.2

Hence, the subsonic frequencies are effectively cut just as if by coupling capacitor. But unlike capacitors, the output impedance of the servo operational amplifier decreases at lower frequencies (coupling capacitor impedance increases at corresponding frequencies) due to a greater amount of feedback. Since, however, in actual circuits the second stage is driven at a suitable impedance level, and the output impedance of the amplifier itself is made sufficiently large enough (to improve stability) by connecting a resistance γ_o in series, the output impedance is kept constant at γ_a with coupling capacitors, on the other hand, the increased impedance at lower frequencies naturally results in an increase in thermal noise (directly related to effective impedance) in the low frequency region.

Although servo feedback circuit integrating capacitors of large leakage current, or high DC resistance and inductance are undesirable, the effects are nowhere near as serious as the insertion of a capacitor in the signal path.

2. OUTPUT INDICATOR DRIVER CIRCUIT

Q701 (Q702) and Q703 (Q704) are the power indicator driver ICs. The audio signal applied to pin no.3 of Q701 is first amplified and then applied to the comparator. The LEDs connected to the IC output terminals pin nos.9 ~ 13 are lit up in succession depending on the comparator level. With the inclusion of a second IC, Q703, in the A-7090 the number of power indicator LEDs has been increased to 8.

The Q701 amplifier output, pin no.14, is connected to pin no.14 of Q703, while pin no.6 of Q701 is connected to pin no.4 of Q703, thereby using the comparator divider resistance in a cascade connection. The amplifier circuit in Q703 is not required, so pin no.1 is left open, and pin nos.2 and 3 are connected to ground. The corresponding LEDs will thus light up in succession from D705, D707, and D709, again depending on the comparator level.

The connection from pin no.14 to pin no.1 in Q701 is part of a feedback loop where the feedback resistor R725 (22k Ω) determines the gain of the amplifier, and is consequently used in the adjustment of indicator level.

Pin no.2 of Q701 is connected to the protector circuit. So when the protector circuit is activated as a result of some abnormality in the amplifier circuitry, and for the first 4 seconds (approx.) after the power is switched on, the speaker relay is activated. All of the indicator LEDs light up in unison, and the audio output signal is muted.

3. SPEAKER PROTECTION CIRCUIT

The speaker protection circuit is operated:

- 1) When the B circuit is unstable when the power is turned ON (approximately 5 seconds).
- 2) When the speaker terminals are shorted and abnormal current has flowed in the power amplifier thru this low impedance.
- 3) When the center voltage has increased because of trouble at the differential amplifier, etc.
- 4) When the temperature of the heat sink has risen.

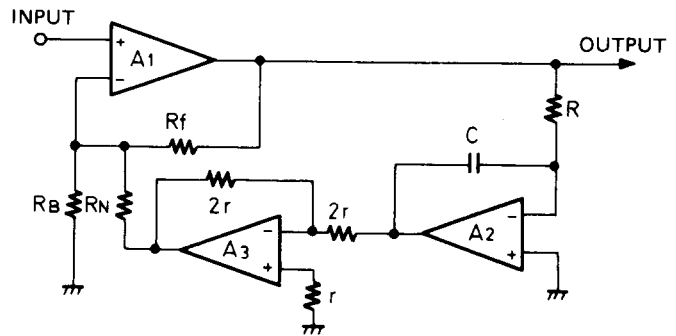


Fig 1.3

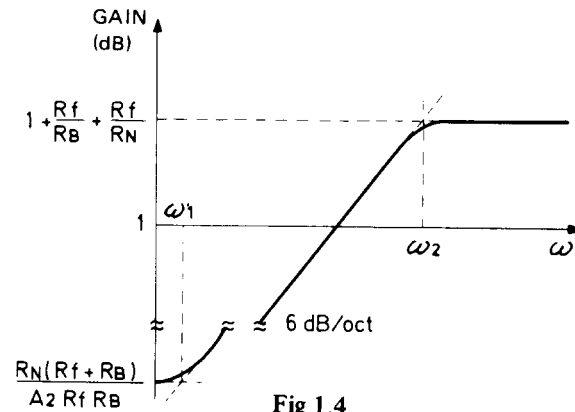
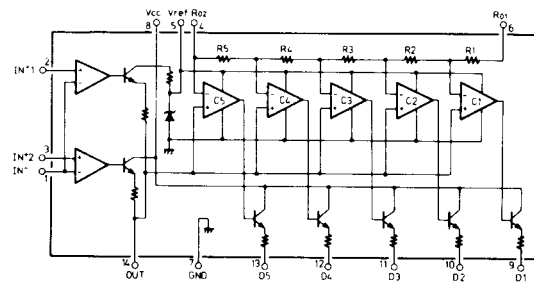
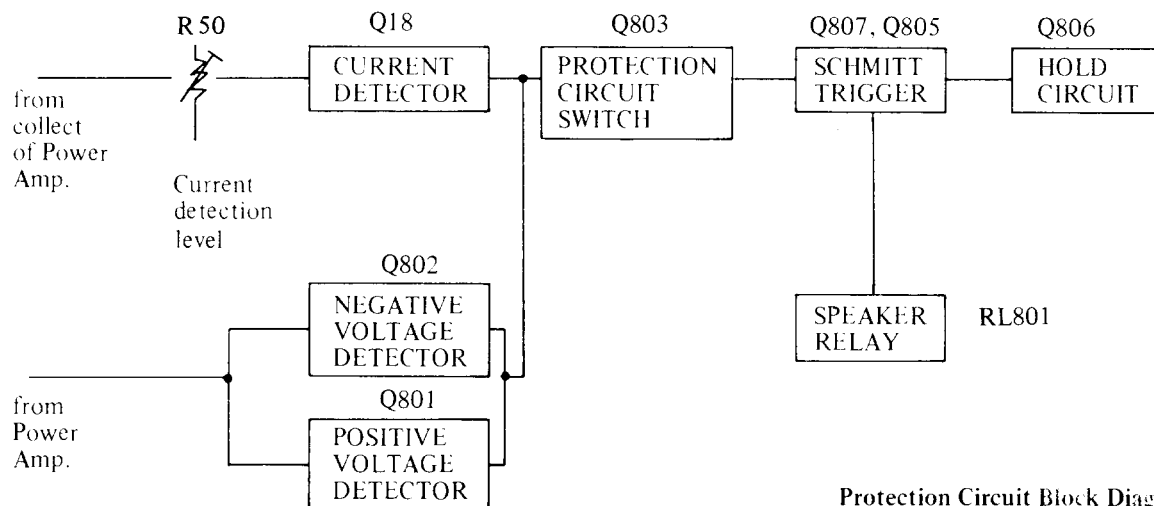


Fig 1.4



LB1416 EQUIVALENT DIAGRAM



Protection Circuit Block Diagram

When Q803 is turned on by voltage detection or current detection, Q807 is turned ON by the voltage drop across R806. Q807, Q805 constitute a digitalized, fast response Schmitt trigger circuit. When Q807 is turned ON, Q805 is turned OFF. Q805 is a relay drive transistor. When it is turned OFF, the relay is also turned OFF.

When the power switch is turned ON, charging current flows thru the loop C803 → R807 → R805, R806 and Q807 is turned ON by the voltage drop across R806. Consequently, Q805 and the relay are turned OFF until the charging current drops below a certain value. When the power switch is turned OFF, the B voltage falls and C803 is quickly discharged thru the loop C803 → R807 → D801. During normal operation, C803 is charged to almost the B voltage. But since the saturation resistance of Q803 is sufficiently low, when Q803 is turned ON, C803 is quickly discharged thru the loop C803 → R807 → Q803 and the relay is also turned OFF. The relay is not turned ON again thereafter until C803 is charged, even if the set should return to normal and Q803 is turned OFF.

HOLD CIRCUIT

The reference voltage is produced by R812, R813, Q806 is operated as a comparator. When Q805 has been turned OFF, the collector voltage of Q805 rises and C805 is charged. Therefore, when C805 is charged to above a certain voltage relative to the reference voltage at the junction of R812 and R813, Q806 is turned ON, Q803 is turned ON thru R814 and the circuit is hold.

CURRENT DETECTOR

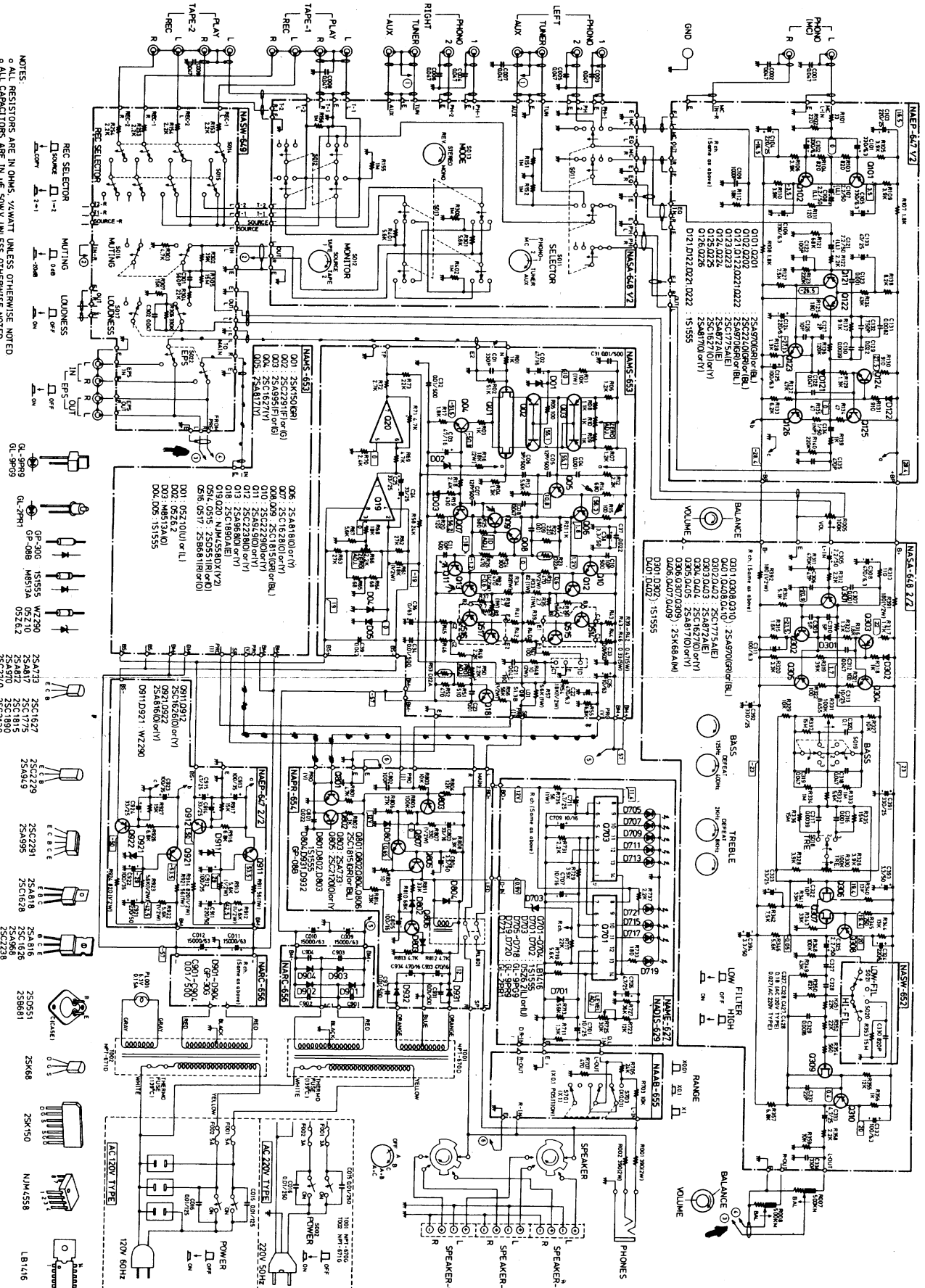
Q18 is turned ON by the voltage detected from the collector circuit of the power amplifier. C23 prevents erroneous operation, R50 sets the current detection level and thermister R53 controls changes in the current detection level caused by temperature rise.

When the impedance is low at a certain frequency of the speaker, the protection circuit may be unexpectedly actuated each time a large audio signal of that frequency has entered. However, when this occurs the relay is opened and the power amplifier current returns to normal. The power amplifier current is also automatically returned to normal in a like manner when the load has been inadvertently shorted momentarily.

When connected with the load shorted, the relay is repeatedly turned ON and OFF in load short → relay OFF (no load) → automatic reset (load short current detection) → relay OFF order. Since the OFF time is sufficiently longer than the relay ON time in this case, the voltage across C805 gradually increases until a voltage sufficient to turn Q806 is reached, at which time the relay is held OFF, thus protecting the power transistor against damage by a continuous overcurrent.

VOLTAGE DETECTOR

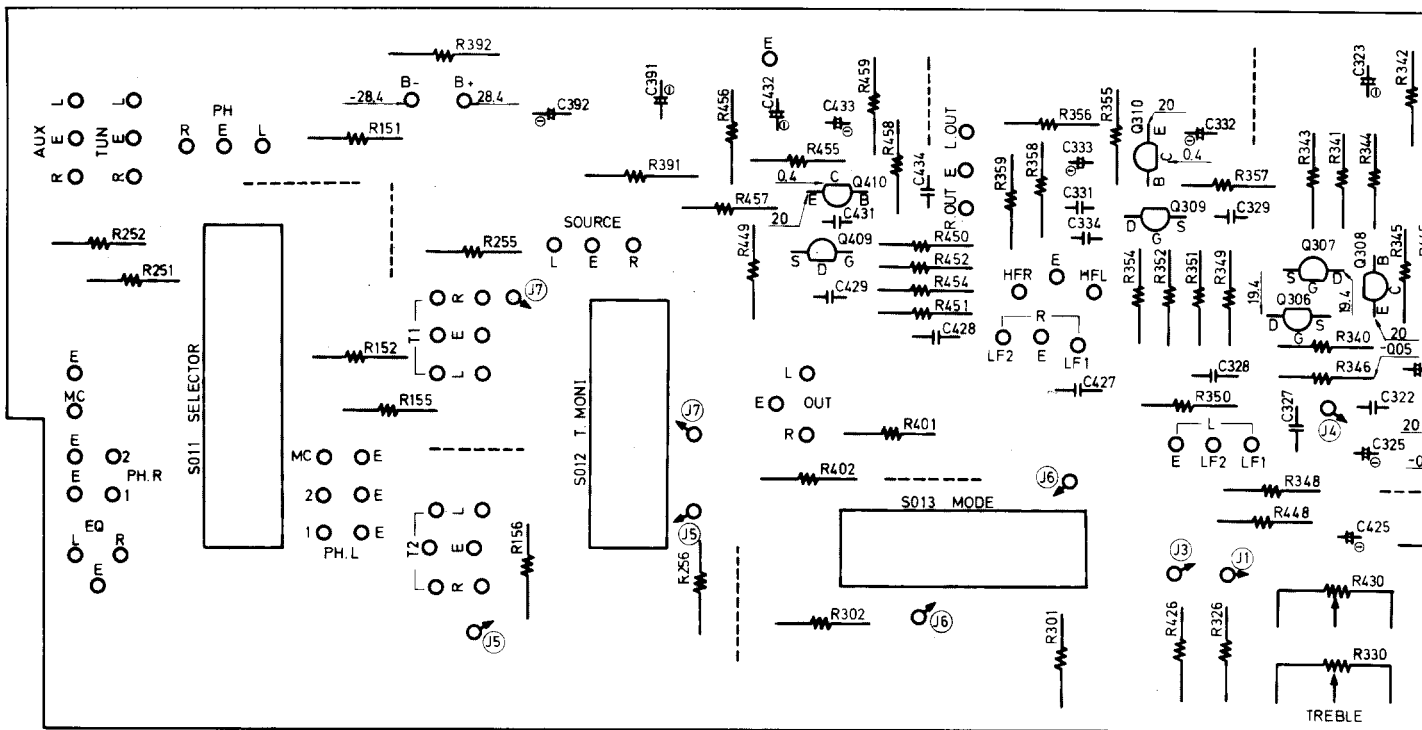
The voltage detection circuit is an OR circuit consisting of Q801, Q802. First, the Lch and Rch signals are mixed. When this voltage is minus, Q802 is turned ON and when this voltage is plus, Q801 is turned ON and the relay is turned OFF. Since the center voltage is unrelated to ON-OFF of the load, when an abnormal voltage has been detected, the relay remains off and the hold circuit is operated until the voltage returns to normal. Once the hold circuit has been actuated it is not reset until the power has been turned back on after the cause of the trouble has been corrected.



NOTES:
 ○ ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE NOTED
 ○ ALL CAPACITORS ARE IN μF UNLESS OTHERWISE NOTED
 ○ ELECTROLYTIC CAPACITORS (E) ARE IN μF/WV
 ○ DC VOLTAGE (MEASURED WITH VTM AT NO INPUT SIGNAL)
 ○ CIRCUIT IS SUBJECT TO CHANGE FOR IMPROVEMENT.

- REC SELECTOR
- MUTING
- LOUDNESS
- MONITOR
- PHONES
- SPEAKER-A
- SPEAKER-B
- SPEAKER-C
- AC 200V TYPE
- POWER
- 120V 60Hz

PRE. AMPLIFIER PC BOARD VIEW FROM BOTTOM SIDE



PREAMPLI. PC BOARD (NASA-648) - PARTS LIST

CIRCUIT NO.	PARTS NO.	DESCRIPTION
	Transistors	
Q301, Q401	2211395 or 2211396	2SA970(GR) or 2SA970(BL)
Q302, Q402	2210755	2SC1775A(E)
Q303, Q403	2211085	2SA872A(E)
Q304, Q404	2211413 or 2211414	2SC1627(O) or 2SC1627(Y)
Q305, Q405	2211423 or 2211424	2SA817(O) or 2SA817(Y)
Q306, Q406	2211303	2SK68A(M)
Q307, Q407	2211395 or 2211396	2SA970(GR) or 2SA970(BL)
Q308, Q408	2211395 or 2211396	2SA970(GR) or 2SA970(BL)
Q310, Q410	2211396	2SA970(BL)
Q309, Q409	2211303	2SK68A(M), F.E.T.
	Diodes	
D301, D302	223105	1S1555
D401, D402	223105	1S1555
	Capacitors	
C305, C405	392880227	2.2μF, 50V, LL
C308, C408	352724711	470μF, 6.3V, Elect.
C311, C411	352721011	100μF, 6.3V, Elect.
C313, C413	392851007	10μF, 25V, LL
C323, C423	352753301	33μF, 25V, Elect.
C324, C424	352722211	220μF, 6.3V, Elect.
C325, C425	392880227	2.2μF, 50V, LL
C332, C432	352721011	100μF, 6.3V, Elect.
C333, C433	392850477	4.7μF, 25V, LL
C391, C392	352753311	330μF, 25V, Elect.
C393, C394	352780331	3.3μF, 50V, Elect.
	Resistors	
R330, R430	5172056	N24RGL21C100KB35, Bass control variable
R331, R431	5172056	N24RGL21C100KB35, Treble control variable

CIRCUIT NO.	PARTS NO.	DESCRIPTION
	Switches	
S011	25030128	NRSM-145-35ZK, Selector
S012	25030129	NRSM-143-35ZK, Tape monitor
S013	25030130	NRSM-143-35ZL, Mode
S018	25030131	NRSM-143-20ZL, Treble tone shift
S019	25030132	NRSM-143-20ZL, Bass tone shift

SWITCH PC BOARD (NASW-649) - PARTS LIST

CIRCUIT NO.	PARTS NO.	DESCRIPTION
	Capacitors	
C302, C402	374124735	0.047μF±10%, 50V, DE
	Switches	
S014-S017, S022	25035116	NPS-322-242-L81

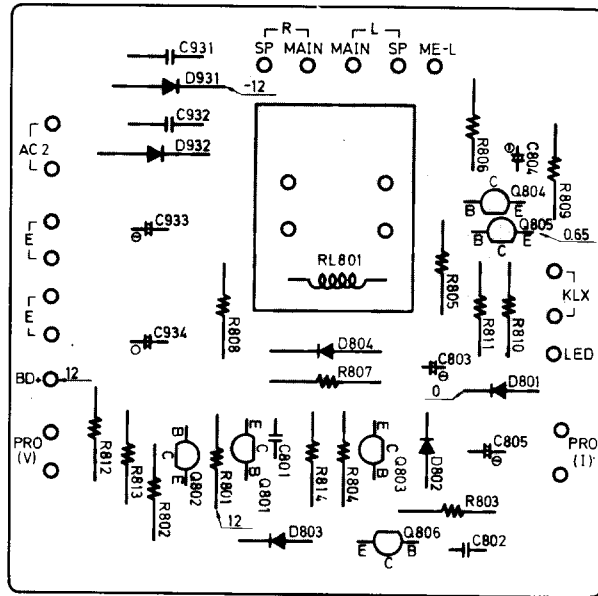
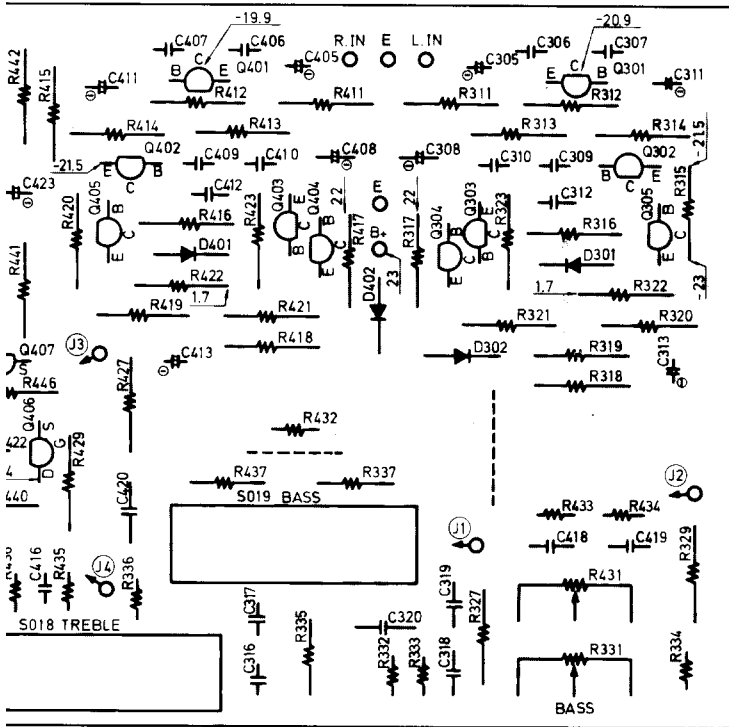
SWITCH PC BOARD (NASW-652) - PARTS LIST

CIRCUIT NO.	PARTS NO.	DESCRIPTION
C330, C430	372328214	820pF±5%, 50V, ST capacitor
S020, S021	25035117	NPS-222-L82, Low/High cut filter

OUTPUT INDICATOR DRIVER CIRCUIT PC BOARD (NAME-627) - PARTS LIST

CIRCUIT NO.	PARTS NO.	DESCRIPTION
	ICs	
Q701, Q702	222564	LB-1416ONK(R)
Q703, Q704	222539	LB-1416
	Diodes	
D701, D702	223105	1S1555
D703	224042	05Z6.2L
	224043	05Z6.2U

PROTECTION CIRCUIT PC BOARD
VIEW FROM BOTTOM SIDE



CIRCUIT NO.	PARTS NO.	DESCRIPTION
Capacitors		
C701, C702	352751001	10 μ F, 25V, Elect.
C705, C706	352750471	4.7 μ F, 25V, Elect.
C707-C710	352741001	10 μ F, 16V, Elect.
C711, C712	352750471	4.7 μ F, 25V, Elect.
Resistors		
R725, R726	5225089	N10HR30KBC, Indicator level adjustment variable
R735, R736	441625604	56 Ω , 1W, MOF

OUTPUT INDICATOR PC BOARD (NADIS-629) — PARTS LIST

CIRCUIT NO.	PARTS NO.	DESCRIPTION
L.E.Ds		
D705-D718	225028	GL-9PG59
D719, D720	225029	GL-9PR9
D921	225018	GL-2PR1
Holder		
	27190043A	

PROTECTOR CIRCUIT PC BOARD (NAPR-654) — PARTS LIST

CIRCUIT NO.	PARTS NO.	DESCRIPTION
Transistors		
Q801, Q802	2211255 or	2SC1815(GR) or
Q804, Q806	2211256	2SC1815(BL)

NOTE: Capacitor LL: Low leakage current type electrolytic capacitor
DE: Non-inductive polyester film capacitor

CAUTION: Replacement for Q304, Q305, Q404 and Q405 transistors, as necessary, must be made from the same beta (h_{FE}) group as the original type.

CIRCUIT NO.	PARTS NO.	DESCRIPTION
Q803	2210803	2SA733(P)
Q805	2211163	2SC2120(O)
	2211164 or	2SC2120(Y) or
Diodes		
D801-D803	223105	1S1555
D804, D931, D932	223848	GP-08B
Capacitors		
C803	352743301	33 μ F, 16V, Elect.
C804	352780331	3.3 μ F, 50V, Elect.
C805	352741011	100 μ F, 16V, Elect.
C933, C934	352744711	470 μ F, 16V, Elect.
Relay		
RL801	250166 or 25065037	NRS-2P5A-DC12 or NRL-2P5A-DC12-02

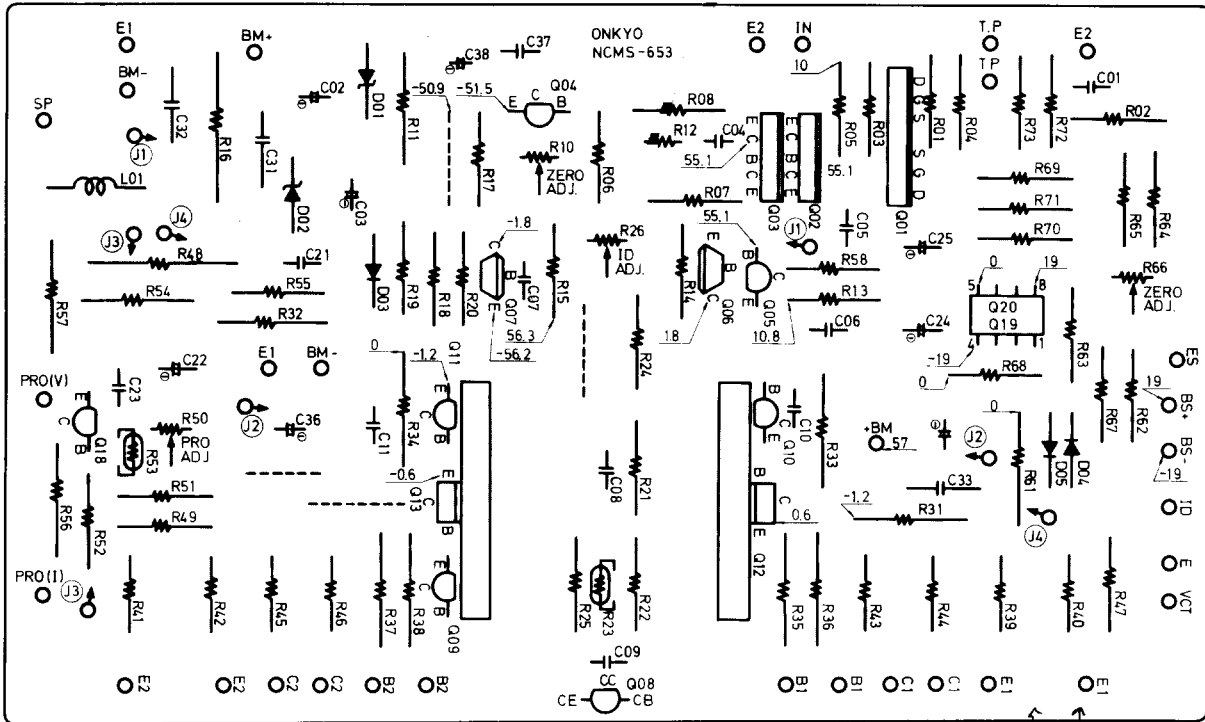
ATTENUATOR PC BOARD (NAAB-655) — PARTS LIST

CIRCUIT NO.	PARTS NO.	DESCRIPTION
S701-S703	25035118	NPS-322-L38, Output indicator sense

RECTIFIER PC BOARD (NARC-656) — PARTS LIST

CIRCUIT NO.	PARTS NO.	DESCRIPTION
D901-D904	223841	GP30G, Silicon diode

MAIN AMPLIFIER PC BOARD VIEW FROM BOTTOM



POWER AMPLI. PC BOARD (NAMS-653) - PARTS LIST

CIRCUIT NO.	PARTS NO.	DESCRIPTION	CIRCUIT NO.	PARTS NO.	DESCRIPTION
	Transistors				
Q01	2211475	2SK150(GR), F.E.T.	D01	224052	05Z10L or
Q02	2211445	2SC2291(F)		224053	05Z10U or
	2211446	2SC2291(G) or	D02	224042	05Z6.2L
Q03	2211515	2SA995(F)	D03	4000031	M8513A(O)
	2211516	2SA995(G) or	D04, D05	223105	1S1555
Q04	2211414	2SC1627(Y)			Coil
Q05	2211424	2SA817(Y)	L01	231001	S-1.3B
Q06	2210772	2SA818(O) or			Capacitors
	2210774	2SA818(Y) or	C02, C03	352744701	47μF, 16V, Elect.
Q07	2210782	2SC1628(O) or	C21	374134735	0.047μF±10%, 100V, DE
	2210784	2SC1628(Y) or	C24, C25	392853307	33μF, 25V, LL
Q08	2210746	2SC945A(P)	C35, C36	352771001	10μF, 63V, Elect.
Q09	2211255	2SC1815(GR) or	C38	352780331	3.3μF, 50V, Elect.
	2211256	2SC1815(BL) or			Resistors
Q10	2211633	2SC2229(O) or	R10	5221024	N10HR1KBEM, Center voltage adjust. variable
	2211634	2SC2229(Y) or	R11	441621034	10kΩ, 1W, MOF
Q11	2211353	2SA949(O) or	R16	441721834	18kΩ, 2W, MOF
	2211354	2SA949(Y) or	R23	4000003	D22A, Thermistor
Q12	2200863	2SC2238(O) or	R26	5221023	N10HR470BEM, Idling current adjustment variable
	2200864	2SC2238(Y) or	R31, R32	441524714	470Ω, 1/2W, MOF
Q13	2200873	2SA968(O) or	R33, R34	441628204	82Ω, 1W, Metal
	2200874	2SA968(Y) or	R35-R38	451630274	2.7Ω, 1W, Metal
Q514, Q515	2200802	2SD551(R) or	R39-R42	4000047	0.47Ω, 5W, Metal plate
Q614, Q615	2200803	2SD551(O) or	R43-R46	4000034	0.33Ω, 5W, Metal plate
Q516, Q517	2200812	2SB681(R) or	R48	451731004	10Ω, 2W, Metal
Q617, Q618	2200813	2SB681(O) or	R50	5221007	R-HK2.2KB3S, Protector level adjustment variable
Q18	2210795	2SC1890A(E)	R53	4000003	D22A, Thermistor
Q19, Q20	222502	NJM-4558D-X	R57	451630564	5.6Ω, 1W, Metal
			R66	5221025	N10HR2.2KBEM, Servo adjustment variable
					Radiator
				27160011	RAD-05

CAUTION: Replacement for power transistors, if necessary, must be made from the same beta group (h_{FE}) as the original type.

NOTES: Capacitor LL: Low leakage current type electrolytic capacitor
 DE: Non-inductive polyester film capacitor
 Resistor MOF: Metal oxide film resistor

MAIN AMPLIFIER ADJUSTMENT

1. SET THE ALL CONTROL KNOBS TO STANDARD POSITION.

Standard knob position

SELECTOR	AUX
TAPE MONITOR, REC. SELECTOR	SOURCE
VOLUME	MAXIMUM
BALANCE, BASS/TREBLE	CENTER (FLAT)
MODE	STEREO
EPS, LOUDNESS, LOW-OUT FIL./HI-CUT FIL.	OFF
BASS/TREBLE SHIFT	DEFEAT
SPEAKER	A
MUTING	0dB
RANGE	x1

2. IDLING CURRENT ADJUSTMENT

1. Connect the DC voltmeter between I_{ID} and V_{CT} terminals.
2. Adjust the voltage to $19 \pm 2mV$ with semi-fixed resistor of R26.

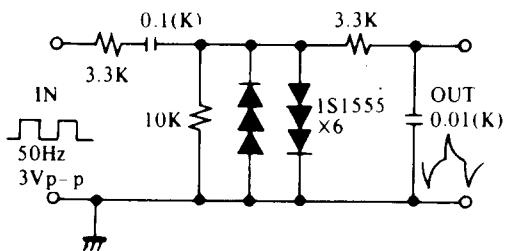
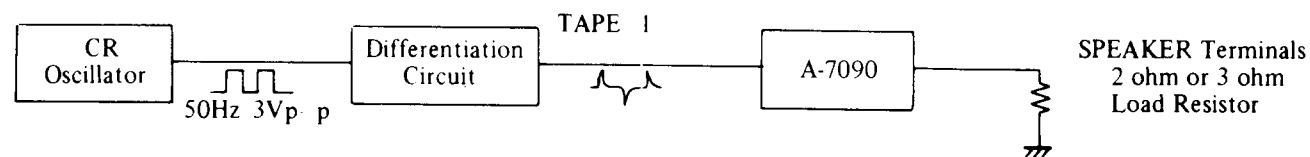
NOTES: Adjust after switching on for 5 minutes.

VOLUME Minimum, Open load.

3. SERVO OPERATIONAL AMPLIFIER ADJUSTMENT

1. Place the short circuit across TP terminals of servo operational circuit.
2. Connect the DC voltmeter between V_{CT} and E terminals and adjust the voltage to $0 \pm 50mV$ with R10.
3. Remove the short circuit.
4. Adjust the voltage to $0 \pm 1mV$ with semi-fixed resistor of R66.

4. CURRENT DETECTOR LEVEL ADJUSTMENT



Differentiation Circuit

Apply a tone burst signal to the TAPE-1 terminal, connect a 2 ohms hollow resistor to the speaker terminals and adjust the variable resistor R50 so that the relay is operated at maximum volume. Confirm that the relay is not operated when the 3 ohms hollow resistor is connected.

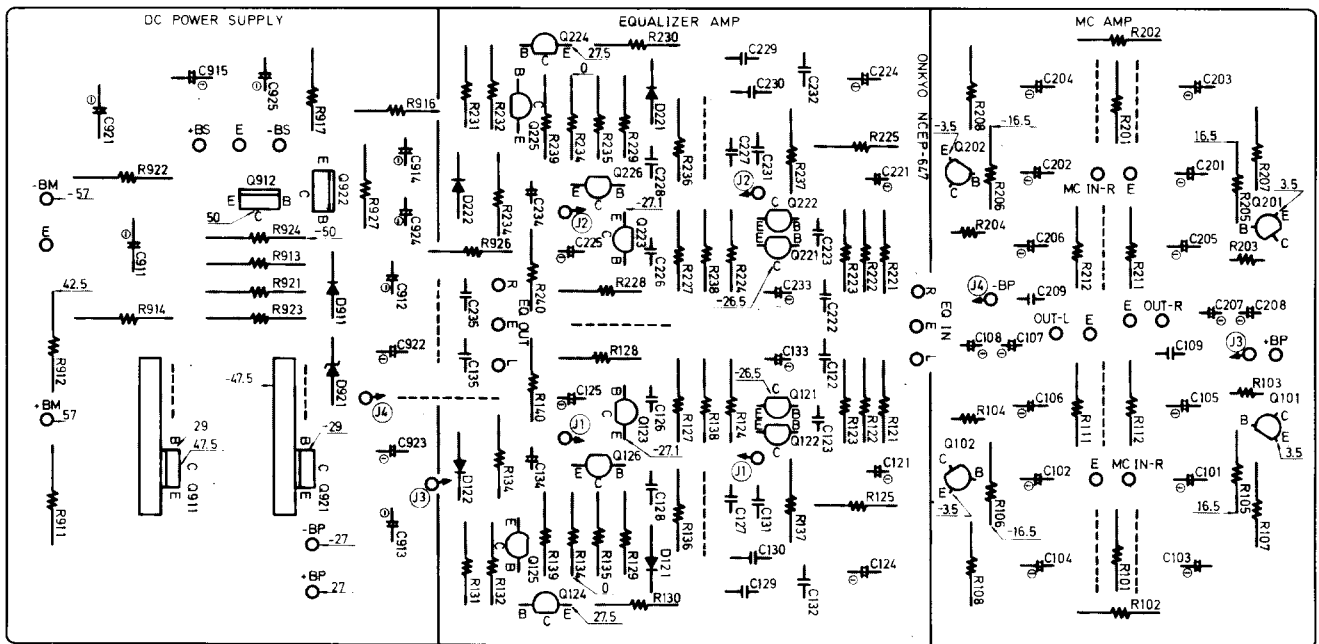
NOTES: Adjust after switching on for 5 minutes.

VOLUME Maximum

5. OUTPUT INDICATOR LEVEL ADJUSTMENT

1. Connect the AF oscillator across AUX terminal and AC voltmeter across speaker terminals.
2. Connect the hollow resistor of 8 ohms across speaker terminal (A).
3. Set the AF oscillator output to 100mV, 1kHz.
4. Adjust the output voltage to 29.6V with volume control.
5. Then adjust the semi-fixed resistor of R725 and R726 to light up 7th L.E.D.

MC/EQUALIZER AMPLI. AND RECTIFIER PC BOARD VIEW FROM BOTTOM SIDE



MC. AMPLI. PC BOARD (NAEP-647)
 — PARTS LIST

CIRCUIT NO.	PARTS NO.	DESCRIPTION	CIRCUIT NO.	PARTS NO.	DESCRIPTION
Transistors					
Q101, Q201	2211395	2SA970(GR)	C105, C205	352723311	330 μ F, 6.3V, Elect.
	2211396 or	2SA970(BL) or	C106, C206		
Q102, Q202	2211405	2SC2240(GR) or	C107, C207	392880227	2.2 μ F, 50V, LL
	2211406 or	2SC2240(BL) or	C108, C208		
Q121, Q122	2211395	2SA970(GR) or	C121, C221	392880227	2.2 μ F, 50V, LL
Q221, Q222	2211396	2SA970(BL) or	C124, C224	352722211	220 μ F, 6.3V, Elect.
Q123, Q223	2210755	2SC1775A(E)	C125, C225	352721011	100 μ F, 6.3V, Elect.
Q124, Q224	2211085	2SA827A(E)	C128, C228	374124737	0.047 μ F \pm 20%, 50V, DE
Q125, Q225	2211413	2SC1627(O) or	C129, C229	374122234	0.022 μ F \pm 5%, 50V, DE
	2211414 or	2SC1627(Y) or	C131, C231	374128224	0.0082 μ F \pm 5%, 50V, DE
Q126, Q226	2211423	2SA817(O) or	C132, C232	372327514	750pF \pm 5%, 50V, ST
	2211424 or	2SA817(Y) or	C133, C233	352754701	47 μ F, 25V, Elect.
Q911, Q912	2200663	2SC1626(O) or	C134, C234	352980106	1 μ F, 50V, NP
	2200664 or	2SC1626(Y) or	C911, C921	352782211	220 μ F, 50V, Elect.
Q921, Q922	2200673	2SA816(O) or	C912, C913	352761011	100 μ F, 35V, Elect.
	2200674 or	2SA816(Y) or	C922, C923		
Diodes					
D121, D122	223105	1S1555	C914, C924	352753301	33 μ F, 25V, Elect.
D221, D222			C915, C925	352754701	47 μ F, 25V, Elect.
D911, D921	223942	WZ-290	Resistors		
Capacitors					
C101, C201	352723311	330 μ F, 6.3V, Elect.	R911, R921	441625604	56 Ω , 1W, MOF
C102, C202			R914, R924	441528214	820 Ω , 1/2W, MOF
C103, C203	352752211	220 μ F, 25V, Elect.	Radiator		
C104, C204			27160011		RAD-05

NOTES: Capacitor
 LL: Low leakage current type electrolytic capacitor
 ST: Polystyrene film capacitor
 DE: Non-inductive polyester film capacitor
 NP: Non-polar electrolytic capacitor

CAUTION: Replacement for mc. and equalizer amplifier transistors, if necessary, must be made from the same beta (h_{FE}) group as the original type.