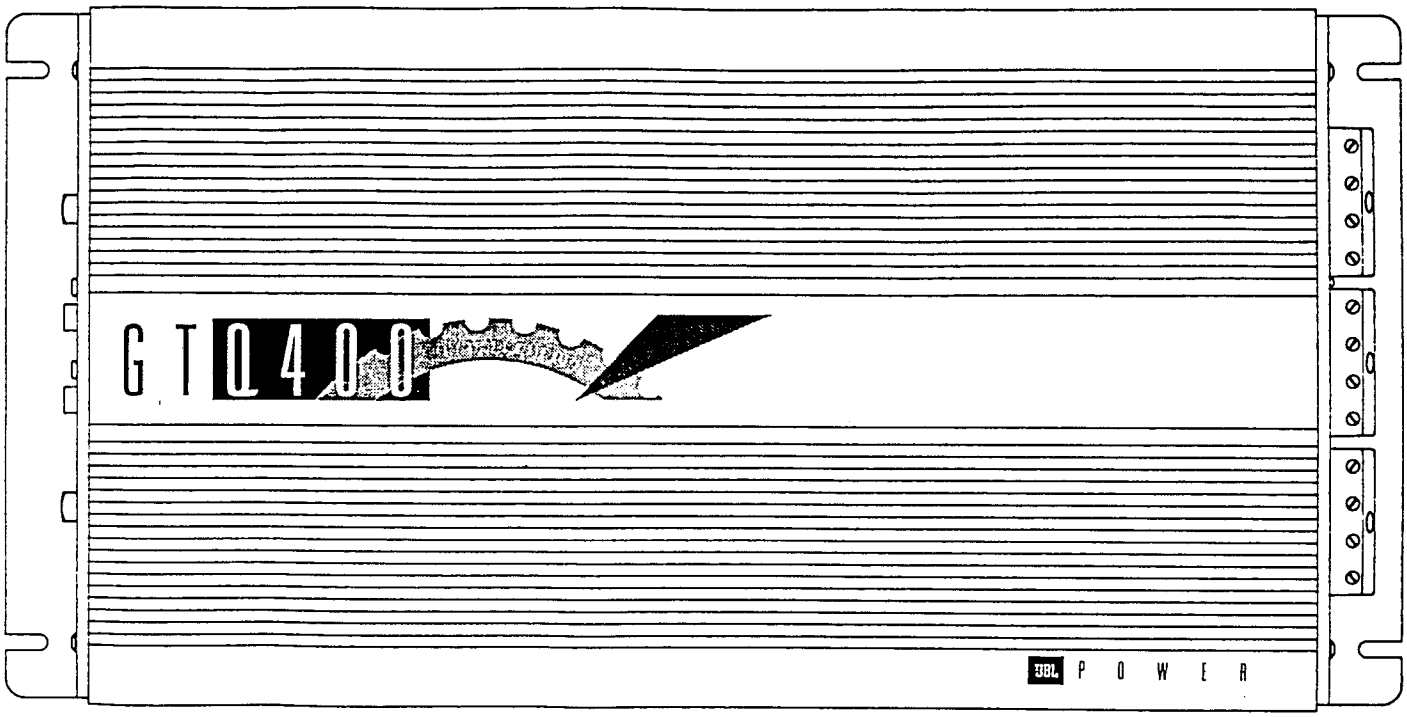
GTQ400
4/3/2 CHANNEL AUTOMOTIVE POWER AMPLIFIER
TECHNICAL MANUAL



JBL Consumer Products Inc.
240 Crossways Park West
Woodbury, NY 11797
800-645-7484

GTQ400 TABLE OF CONTENTS

JBL GTQ400 POWER AMPLIFIER FEATURES

Minimal Negative Feedback

All amplifiers require some form of negative feedback to minimize distortion and stabilize the amplifier. Too much feedback, however, increases the Transient Intermodulation Distortion (T.I.M.), and reduces its musicality. JBL's Minimal Negative Feedback design provides just enough feedback to stabilize the amplifier., remove DC offset, and offer excellent Total Harmonic Distortion (T.H.D.) characteristics.

No Current Limiting

Current Limiting circuitries used in conventional power amplifiers may cause premature clipping and inferior transient response under demanding conditions. The absence of current limiters in the audio sections of JBL power amplifiers ensures low Transient Intermodulation Distortion, excellent transient response, and superb sonic quality.

Built-in Bi-amp Crossover

A built-in switchable electronic crossover network at 80 Hz, 12dB per octave, configures one pair of the amplifiers channels into a low-pass subwoofer driver, while setting up the other pair to power a pair of high-pass tweeter/midrange satellites. The network can be switched off to allow full-range signal amplification.

4/3/2 Channel Operation

These amps can be used as a:

a) 4 channel set-up, driving 4 full-range speakers, or a bi-amped system powering a pair of subwoofers and a dual satellite system.

b) 3 channel system, producing its stereo rated power into one pair of its channels, and its bridged power into the third channel. This combination is perfect for a single subwoofer, dual tweeter/midrange satellite set-up.

c) 2 channel amplifier, producing its bridged power rating per channel. The amplifier can be used as full range, or crossed over (using a JBL GTX4 or GTX2 electronic crossover).

Quiet Start Circuitry

Special turn on and turn off circuitry have been implemented to prevent amplifier turn on and turn off pops.

Pulse Width Modulation (PWM) DC-to-DC Switching Mode Power Supplies

Provides excellent power output throughout the audio bandwidth. Its' soft clipping characteristics ensure superb transient response and musicality.

Third Order (18dB per octave) Capacitive/Inductive Power Supply Input and Output Filtering

For low radio frequency interference (RFI) and excellent immunity to system noises such as alternator whine.

Fully Complementary, Discrete Output Circuitry

The use of independent output transistors in the audio and power supply section provide excellent reliability and high current capability for accurate transient response. A fully complementary audio section offers superb sonic performance.

Forced Air Cooling System

A fan system moves fresh, cool air over various components of the amplifier. This accomplishes even, effective, and quiet cooling.

Full Protection Circuitry

All JBL amplifiers are protected against over-temperature, over-current, over-voltage, input overload, and DC offset. These special circuitries protect the amplifier from installation errors and unfriendly environmental conditions. However, none of these protection systems is in the signal path. They cannot interfere with the sonic performance of the amplifier.

JBL GTQ400 POWER AMPLIFIER SPECIFICATIONS

1. Minimum Power Output into 4 ohms, 4-channel mode, 1% THD:

20 Hz: 75 Watts x 4
1 kHz: 75 Watts x 4
20 kHz: 75 Watts x 4

2. Minimum Power Output into 2 ohms, 4-channel mode, 1% THD:

1 kHz: 100 Watts x 4

3. Minimum Power Output into 4 ohms, 2-channel bridged mode, 1% THD:

1 kHz: 200 Watts x 2

4. Maximum THD at 1 watt into 4 ohms, 4-channel mode:

20 Hz: 0.3% (30 kHz LPF)
1 kHz: 0.3% (400 Hz HPF, 30 kHz LPF)
20 kHz: 0.3% (400 Hz HPF, 30 kHz LPF)

5. Minimum Signal-to-Noise Ratio into 4 ohms, inputs shorted, Gain Controls at Min., 4-channel mode:

90 dBA

6. Input Sensitivity, Gain Control at maximum:

150 mV ±25%

7. Minimum Channel Separation, referenced to 75 watts into 4 ohms, 4-channel mode:

1 kHz: 45 dB

8. Gain Control Range, from MIN to MAX, 1 watt, 4-channel mode:

1 kHz: 20 dB ± 20%

9. Output Level Deviation into 4 ohms, 1 watt, 1 kHz reference, 4-channel mode:

20 Hz: -3 dB or less
1 kHz: 0 dB (reference)
20 kHz: -3 dB or less

10. Crossover Cutoff Frequency, into 4 ohms, 4-channel mode, -3 dB point:

High-pass (reference 1 kHz): 80 Hz ±15%
Low-pass (reference 30 Hz): 80 Hz ±15%

11. Current Consumption, 4 ohms, 4-channel mode, 1 kHz signal, 14.4V battery:

75 Watts x 4: 50 A or less
No Input Signal: 3 A or less

GTQ400 DISASSEMBLY PROCEDURE

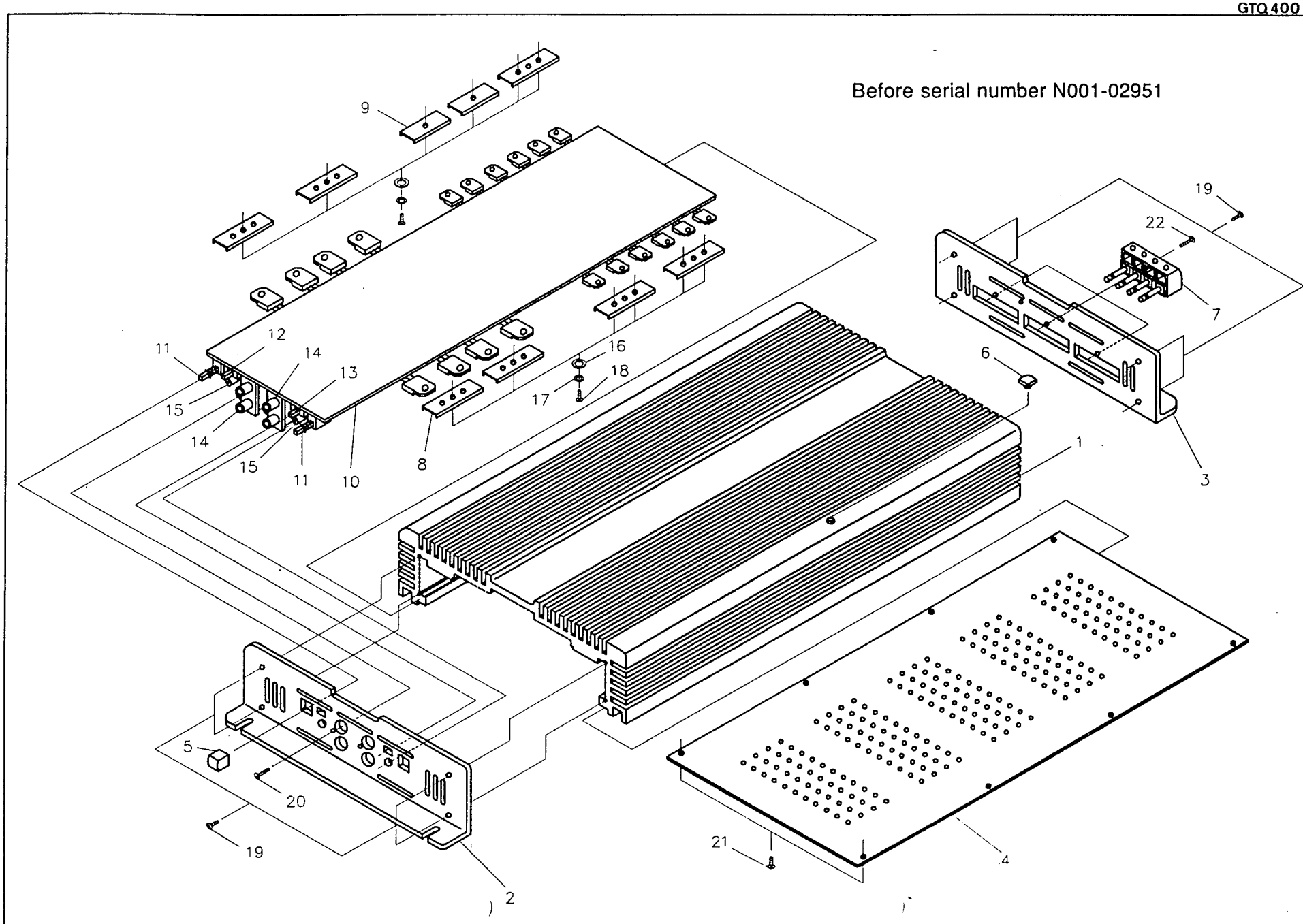
Note: REFER TO EXPLODED VIEW FOR PARTS DESIGNATION.

1. Remove 8 screws (21) securing bottom plate.

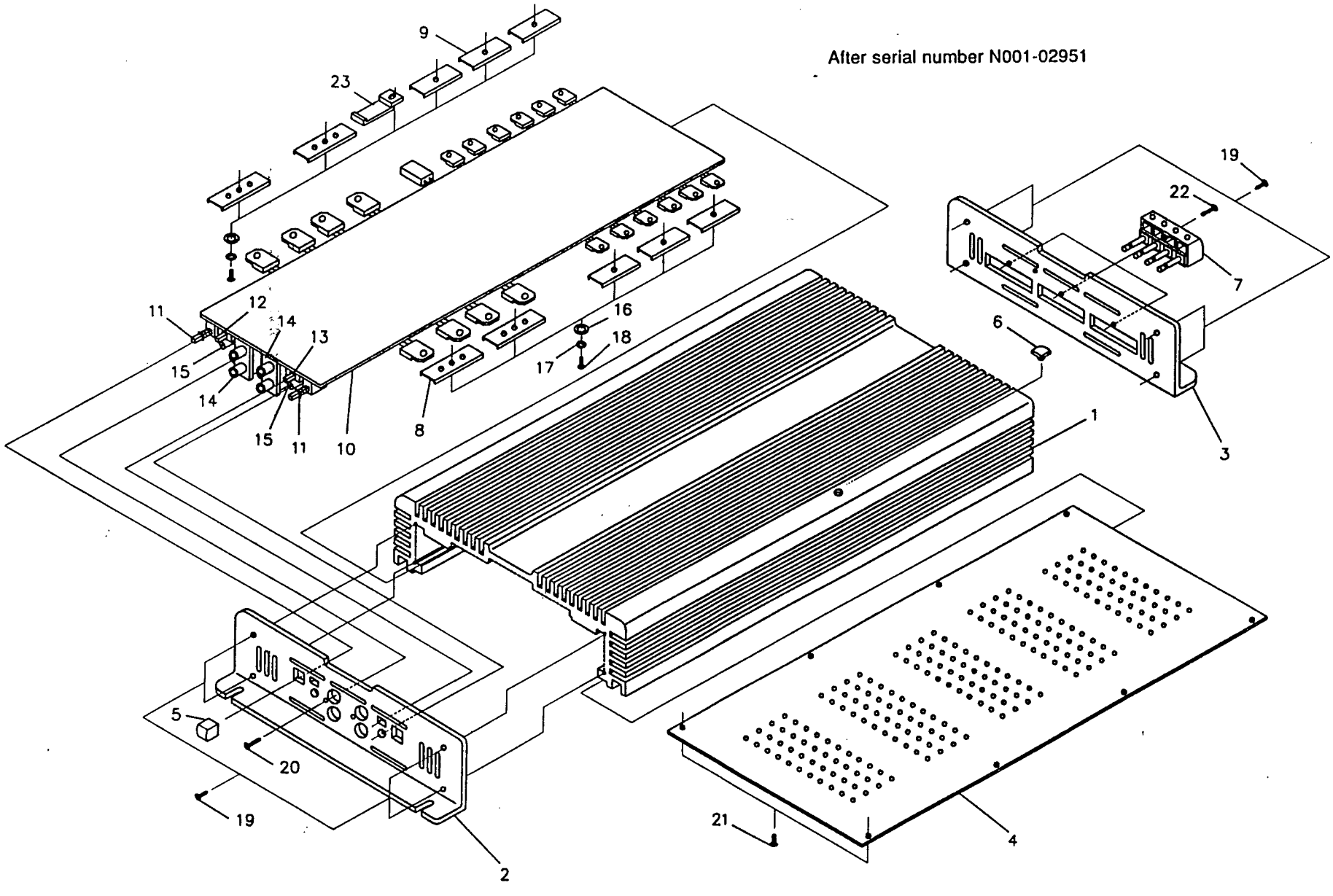
2. Remove bottom plate (4) to expose main P.C. board assembly.

3. To remove main P.C. board assembly from chassis/heat sink assembly:

   a) Remove 2 phillips screws (20) from RCA input jacks.
   b) Remove 4 T-10 torx screws (19) from opposite end of chassis (3).
   c) Remove 12 screws (18) that secure heat sink brackets (8, 9) to chassis.
   d) Main P.C. board will now lift out of chassis. Care should be taken to protect leads of red L.E.D. that extend beyond P.C. board. During reassembly, align the red L.E.D. to the correct position before securing panel.


Before serial number N001-02951
9
11
12
14
13
15
14
15
11
10
8
16
17
18
19
22
7
6
1
3
5
20
19
2
21
4

After serial number N001-02951



GTQ400 Idling Current Adjustment Procedure:

1. To perform this test, you will need a AC-to-DC Power Supply (adjustable for voltages of 0 to +15 volts, and capable of at least 3A current draw), a DVM (digital voltmeter), and a Phillips head jeweler's screwdriver set.

2. Disconnect all speaker wiring from the amp. This adjustment is made without any speakers or loads.

3. Laying the amplifier down on its back, Remove the bottom cover of the amplifier.

4. Before you connect the amp to the DC power supply, turn the power supply on, and adjust its voltage to approximately 14.40 volts. Make sure that the current adjustment knob (if equipped), is at its maximum (no current protection).

5. Turn off the power supply, and connect BAT(+) and REM terminals of the amp to the (+) terminal of your power supply. Use an external 3A fuse on the battery line for protection. Connect the GND terminal of the amp to the (–) terminal of your power supply.

6. Turn on the power supply, and make sure the amp is turned on. Using the DVM, check that the voltage between the BAT(+) and GND terminals of the amp is 14.40 volts DC.

7. To re-set the idling current, you will need to adjust one of the four variable resistors that control idling current (VR2, VR3, VR5, VR6), one at a time. Please use the proper Phillips head jeweler's screwdriver. These potentiometers are very delicate. Do not force them past their stops in either direction. Furthermore, allow the amp 30 seconds between adjustments to stabilize.

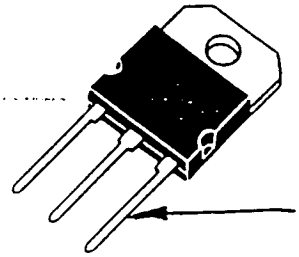


FIG. 1

8. Connect the voltmeter's positive (+) probe to the emitter leg of Q2. Connect the negative (–) probe of the DVM to the emitter leg of Q3. The emitter is the rightmost leg on these transistors when their bare metal tabs are pointing up (see Fig. 1).

9. Let the amp stabilize, make sure that the BAT(+)-to-GND voltage is still 14.40V DC, and check the idling voltage reading. If necessary, slowly adjust VR2 so that the reading is between 10 and 14 mV. After making adjustment, let the amp stabilize again, and recheck/readjust as necessary.

10. Connect the voltmeter's positive (+) probe to the emitter leg of Q6. Connect the negative (–) probe of the DVM to the emitter leg of Q7. The emitter is the rightmost leg on these transistors when their bare metal tabs are pointing up (see Fig. 1).

11. Let the amp stabilize, make sure that the BAT(+)-to-GND voltage is still 14.40V DC, and check the idling voltage reading. If necessary, slowly adjust VR3 so that the reading is between 10 and 14 mV. After making adjustment, let the amp stabilize again, and recheck/readjust as necessary.

12. Connect the voltmeter's positive (+) probe to the emitter leg of Q9. Connect the negative (–) probe of the DVM to the emitter leg of Q11. The emitter is the rightmost leg on these transistors when their bare metal tabs are pointing up (see Fig. 1).

13. Let the amp stabilize, make sure that the BAT(+)-to-GND voltage is still 14.40V DC, and check the idling voltage reading. If necessary, slowly adjust VR5 so that the reading is between 10 and 14 mV. After making adjustment, let the amp stabilize again, and recheck/readjust as necessary.

14. Connect the voltmeter's positive (+) probe to the emitter leg of Q14. Connect the negative (–) probe of the DVM to the emitter leg of Q15. The emitter is the rightmost leg on these transistors when their bare metal tabs are pointing up (see Fig. 1).

15. Let the amp stabilize, make sure that the BAT(+)-to-GND voltage is still 14.40V DC, and check the idling voltage reading. If necessary, slowly adjust VR6 so that the reading is between 10 and 14 mV. After making adjustment, let the amp stabilize again, and recheck/readjust as necessary.

REV: O MODEL: GTQ400 REVISE DATE : SEPT. 21, 1992

PART NO.	REFERENCE NO.	CODE	DESCRIPTIONS	QTY
			*** P.C.B. SECTION ***	
1-18-147	R139,R140,R145,R146, R143,R148,R149,R125,R142	RES	1/4W+-5% PS 47 OHM	9
1-18-310	R2,R12,R17,R32,R42,R47, R62,R72,R77,R92,R102, R107,R123,R124,R138,R141, R144,R147,R150		1/4W+-5% PS 1K OHM	19
1-18-318	R14,R44,R74,R104		1/4W+-5% PS 1.8K OHM	4
1-18-324	R137		1/4W+-5% PS 2.4K OHM	1
1-18-330	R5,R16,R35,R46,R65,R95		1/4W+-5% PS 3K OHM	6
1-18-333	R76,R106,R133,R153		1/4W+-5% PS 3.3K OHM	4
1-18-347	R23,R24,R53,R54,R83,R84, R113,R114		1/4W+-5% PS 4.7K OHM	8
1-18-351	R13,R43,R73,R103,R30, R60,R90,R120		1/4W+-5% PS 5.1K OHM	8
1-18-391	R4,R64		1/4W+-5% PS 9.1K OHM	2
1-18-410	R3,R6,R7,R27,R33,R36, R37,R57,R63,R66,R67,R87, R93,R96,R97,R117,R122, R126,R151,R127,R128,R129, R132,R121		1/4W+-5% PS 10K OHM	24
1-18-412	R1,R31,R61,R91		1/4W+-5% PS 12K OHM	4
1-18-413	R8,R68		1/4W+-5% PS 13K OHM	2
1-18-416	R15,R34,R38,R45,R75,R98, R105		1/4W+-5% PS 16K OHM	7
1-18-418	R34,R94		1/4W+-5% PS 18K OHM	2
1-18-427	R131		1/4W+-5% PS 27K OHM	1
1-18-456	R11,R18,R22,R26,R41,R48, R52,R56,R71,R78,R82,R86, R101,R108,R112,R116		1/4W+-5% PS 56K OHM	16
1-18-462	R134		1/4W+-5% PS 62K OHM	1
1-18-510	R130,R152		1/4W+-5% PS 100K OHM	2
1-18-547	R21,R25,R51,R55,R81,R85, R111,R115		1/4W+-5% PS 470K OHM	8
1-31-443	R9,R39,R69,R70,R99,R100		1/4W+-1% METAL FILM 43K OHM	6
1-31-488	R10,R40		1/4W+-1% METAL FILM 88K OHM	2
1-19-110	R29,R59,R89,R119,R135		1/2W+-5% PS 10 OHM	5
1-19-210	R136		1/2W+-5% PS 100 OHM	1
1-20-110	R28,R58,R88,R118		1W+-5% METAL OXIDE 10 OHM	4
1-23-022	R19,R20,R50,R49,R79,R80, R109,R110		5W+-5% WIRE WOUND 0.22 OHM	8
1-16-022	C114,C115,C116,C117	C.CAP	50V+-10% 22PF	4
1-16-033	C25,C75		50V+-10% 33PF	2
1-16-047	C4,C5,C24,C54,C55,C74, C15,C35,C65,C85		50V+-10% 47PF	10
1-16-122	C109,C110,C111,C112		50V+-10% 220PF	4
1-16-147	C2,C11,C22,C31,C52,C61, C72,C81		50V+-10% 470PF	8
1-10-333	C8,C9,C28,C29,C41, C42,C43,C44,C59,C79	M.CAP	100V+-10% 0.033UF	10
1-10-368	C58,C78		100V+-10% 0.068UF	2
1-10-456	C107		100V+-10% 0.0056UF	1

REV: 0 MODEL: GTQ400 REVISE DATE : SEPT. 21, 1992

PART NO.	REFERENCE NO.	CODE	DESCRIPTIONS	QTY
			*** P.C.B. SECTION ***	
1-12-010	C14,C34,C64,C84	E.CAP	50V+-20% 5x11 1UF	4
1-12-110	C1,C3,C7,C10,C20,C21, C23,C27,C30,C40,C51,C53 C57,C60,C70,C71,C73,C77 C80,C90		16V+-20% 5x11 10UF	20
1-12-110A	C45		35V+-20% 5x11 10UF	1
1-12-210	C92		16V+-20% 6x11 100UF	1
1-12-220	C12,C32,C62,C82		16V+-20% 8x12 220UF	4
1-12-247	C6,C26,C56,C76,C105		16V+-20% 8x14 470UF	5
1-12-247A	C113		25V+-20% 10x16 470UF 105c	1
1-12-522	C47,C48,C49,C50		35V+-20% 16x30 2200UF 105c	4
1-12-522B	C93,C94,C95,C98,C99,C100		40V+-20% 18x30 2200UF 85c	6
1-14-091	C13,C16,C17,C18,C19, C33,C36,C37,C38,C39, C46,C63,C66,C67,C68, C69,C83,C86,C87,C88, C89,C91,C96,C97,C101, C102,C103,C104,C106,C108	MONO	50V+-20% 0.1UF(ECO4WD0104M)	30
1-04-010	L4,L5,L6,L7	COIL	SPRING COIL 1mmx13Ts 6.35mm	4
1-09-022	IC1,IC6	IC	LM833	2
1-09-421	IC2,IC3,IC7,IC8		BA4560	4
1-09-561	IC11		GL494 / TL594	1
1-09-021	IC4,IC5,IC9,IC10		UPC1298	4
1-07-004	Q19	TRA	9014C	1
1-07-005	Q18		9015C	1
1-07-103	Q1,Q5,Q10,Q13		2N3904	4
1-07-107	Q4,Q8,Q12,Q16		MPS A06	4
1-07-109	Q17,Q20,Q26,Q23,Q29		MPS A56	5
1-08-150	Q36	P.TRA	BD137/BD139	1
1-06-005	D1,D8,D15,D22,D29	ZENER	1/2W+-5% 15V	5
1-06-107	D33		1/2W+-5% 12V	1
1-05-001	D2,D3,D9,D10,D16,D17, D23,D24,D30	DIODE	IN4001	9
1-05-006	D38		IN5400	1
1-05-009	D4,D5,D6,D7,D11,D12,D13, D14,D18,D19,D20,D21,D25, D26,D27,D28,D31,D32,D34, D35,D36,D37		IN4148	22
1-01-330A	L2,L3	COIL	D=1mm 12Tsx1 w/ B50FT25 CHC.	2
1-01-330B	L1	COIL	D=1.6mm 12Tsx2 w/ B50FT25 CHC.	1
1-01-405B	T1,T2	COIL	EE-41 FERRITE CHC, (NK041)	2
1-05-007	Q33,Q35	RECT	CTU-21R	2
1-05-008	Q32,Q34		CTU-21S	2
1-09-023	Q21,Q22,Q24,Q25,Q27, Q28,Q30,Q31	P.TRA.	MTP50N06E	8
1-08-112	Q2,Q6,Q9,Q14	P.TRA.	SGS D100	4
1-08-113	Q3,Q7,Q11,Q15		SGS D200	4
1-25-150	LD1	LED	MRB31D RED LED	1
1-26-350	VR2,VR3,VR5,VR6	RES	SEMI-FIXED 5KR MURATA HORI	4
1-27-405	TH1		THERMO SW.17AM203A5-4	1
1-03-201	FAN	DC	FANAD0612HS-C70 60x60x20 12VDC	1

MECHANICAL PARTS LIST

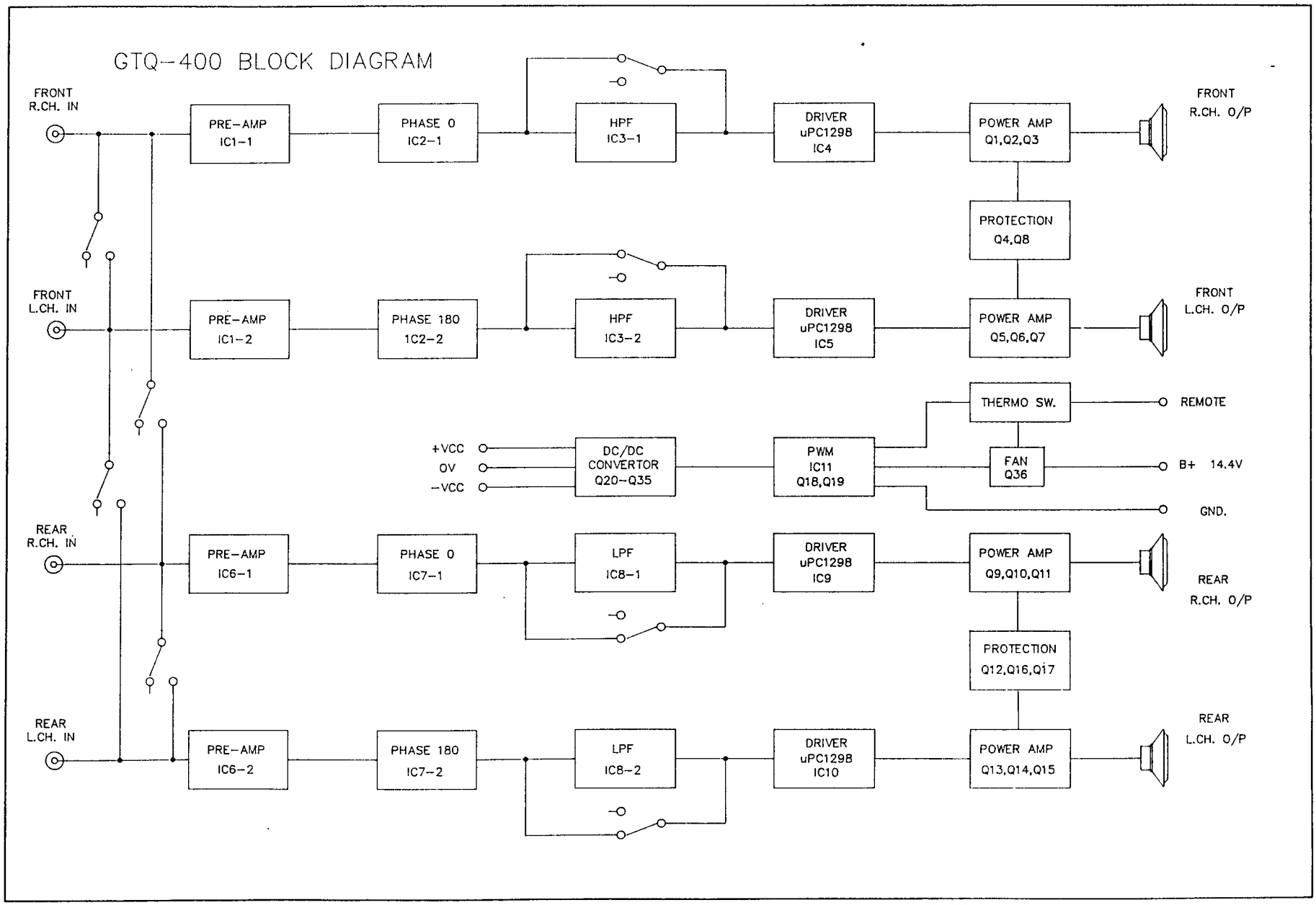
REV: 0 MODEL: GTQ400 REVISE DATE : SEPT. 21, 1992

PART NO.	REFERENCE NO.	CODE	DESCRIPTIONS	QTY
3-61-004	1	PANEL	2018B-4 HEAT SINK L=381mm	1
3-61-001	2		2018B-1 FRONT PANEL	1
3-61-002	3		2018B-2 REAR PANEL	1
3-61-003	4		2018B-3 BOTTOM COVER	1
3-61-008	5		2018B-8 SW. KNOB	2
3-61-009	6		2018B-9 BADGE	1
3-61-005A	7	T'NAL	SPEAKER TERMINAL ASSEMBLY	2
3-61-007A	7A		POWER TERMINAL ASSEMBLY	1
3-42-010	8	BKT.	1841-5 TRA.BKT. 3 HOLES	4
3-42-011	9		1841-5B TRA.BKT. 1 HOLE	6
3-57-001B	10	PCB	2018 MAIN BD. 380x116x1.6FR4	1
1-27-150	11	P.SW	EX13EQ13	2
1-27-016	12	SL.SW	2P2T SK-22D03G6	1
1-27-017	13		4P2T SK-42D01G6	1
1-43-012	14	JACK	B217 2RCA JACK BD.GOLD-PLATE	2
1-26-016	15	F.VR	RK1241210 20KAx2 L=15mm NEW	2
1-37-130	16	S&W	M3 FLAT WASHER ZNC	16
1-37-230	17		M3 SPRING WASHER ZNC	16
1-35-314	18		3x14 TTB-PH ZNC	12
1-35-307	19		TORX T10 TTB-BTN 3x10 TIN	8
1-35-308	20		TTB-PH 3x10 TIN	2
1-35-305	21		MSB 3x6 TIN	8
1-35-381	22		MSP 3x20 TIN	3
3-20-009	23		1730-9 THERMO SW. HOLDER	1

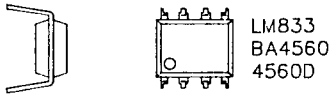
PARTS LIST FOR PACKAGE

REV: 0 MODEL: GTQ400 REVISE DATE : SEPT. 21, 1992

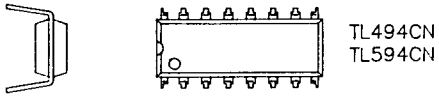
PART NO.	REFERENCE NO.	CODE	DESCRIPTIONS	QTY
GTQ400-1	1		GTQ400 SET	1
GTQ400-2	2		GIFT BOX	1
2018-P1	3		INNER BOX 2018 P1	1
2018-P2	4, 5		INNER PAD 2018 P2	2
1-29-108	5A		FUSE LAMP 30A	2
1-36-120	5B		10x5/8 PA BZ	4
1-37-150	5C		M5 FLAT WASHER BZ	4
1-37-250	5D		M5 SPRING WASHER BZ	4
GTQ400-3	6		OWNER'S MANUAL	1
GTC-001	6A		WARRANTY CARD	1
1-50-034A	7		GTQ200/400 FUSE WIRE SET + 30A FUSE SET	2
1-50-022	7A		WIRE, BLACK 915mm (15+15)	1


GTQ-400 BLOCK DIAGRAM
FRONT R.CH. IN
PRE-AMP IC1-1
PHASE 0 IC2-1
HPF IC3-1
DRIVER uPC1298 IC4
POWER AMP Q1,Q2,Q3
FRONT R.CH. O/P
PROTECTION Q4,Q8
FRONT L.CH. IN
PRE-AMP IC1-2
PHASE 180 1C2-2
HPF IC3-2
DRIVER uPC1298 IC5
POWER AMP Q5,Q6,Q7
FRONT L.CH. O/P
THERMO SW.
REMOTE
+VCC
0V
-VCC
DC/DC CONVERTOR Q20-Q35
PWM IC11 Q18,Q19
FAN Q36
B+ 14.4V
GND.
REAR R.CH. IN
PRE-AMP IC6-1
PHASE 0 IC7-1
LPF IC8-1
DRIVER uPC1298 IC9
POWER AMP Q9,Q10,Q11
REAR R.CH. O/P
PROTECTION Q12,Q16,Q17
REAR L.CH. IN
PRE-AMP IC6-2
PHASE 180 IC7-2
LPF IC8-2
DRIVER uPC1298 IC10
POWER AMP Q13,Q14,Q15
REAR L.CH. O/P

DETAIL OF IC'S

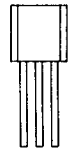


LM833
BA4560
4560D

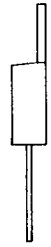


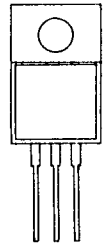
TL494CN
TL594CN

DETAIL OF TRANSISTORS

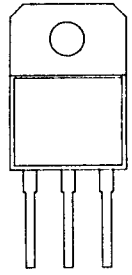


2N3904
MPS-A06
MPS-A56
9014C
9015C





CTU-21S
CTU-21R
IRF540



TIP141
TIP146

GTQ400
TYPICAL AT IC PINS

MEASUREMENT REQUIRED
MEASUREMENT METER: DIGITAL MULTI METER
POWER SOURCE: DC +14.4V
INPUT: NO SIGNAL INPUT

PIN NO. / IC NO.	1	2	3	4	5	6	7	8
IC1,IC6	0V	0V	0V	−15V	0V	0V	0V	+15V
IC2,IC7	0V	0V	0V	−15V	0V	0V	0V	+15V
IC3,IC8	0V	0V	0V	−15V	0V	0V	0V	+15V

PIN NO. / IC NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
IC4,IC5 IC9,IC10	40V	40V	21.5V	0V	0V	−26.8V	−1.6V	1.1V	−40V	−40V	−0.8V	0.8V	N.C.	N.C.

PIN NO. / IC NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
IC11	0V	2.5V	0.05V	0V	1.5V	3.5V	0V	11.2V	4.8V	4.8V	11.2V	13.5V	5V	5V	3.7V	2.5V

TYPICAL AT TRANSISTOR PINS

TRANSISTORS (UNIT: VOLTS)

PIN NO. / TRA.NO.	E	B	C
Q1,Q5 Q9,Q13	1.1V	−1V	−1.6V
Q2,Q6 Q10,Q14	30V	0.8V	0V
Q3,Q7 Q11,Q15	30V	−0.8V	− 0V
Q4,Q8 Q12,Q16	28V	0V	0V

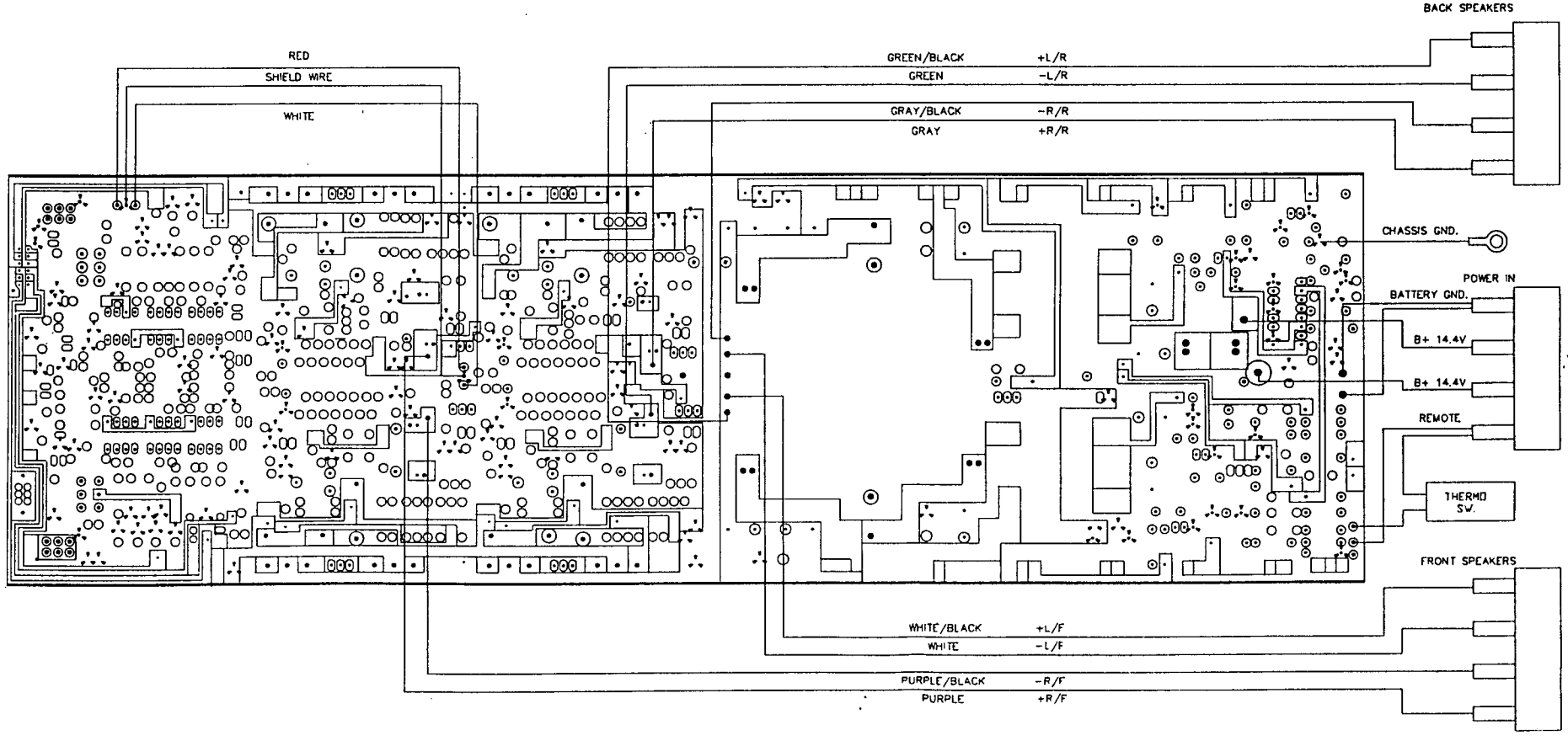
TRANSISTORS (UNIT: VOLTS)

PIN NO. / TRA.NO.	E	B	C
Q17	30V	30V	0.05V
Q18	13.6V	13.6V	0.06V
Q19	0V	0.06V	13.6V
Q20,Q24	4.5V	4.8V	0V

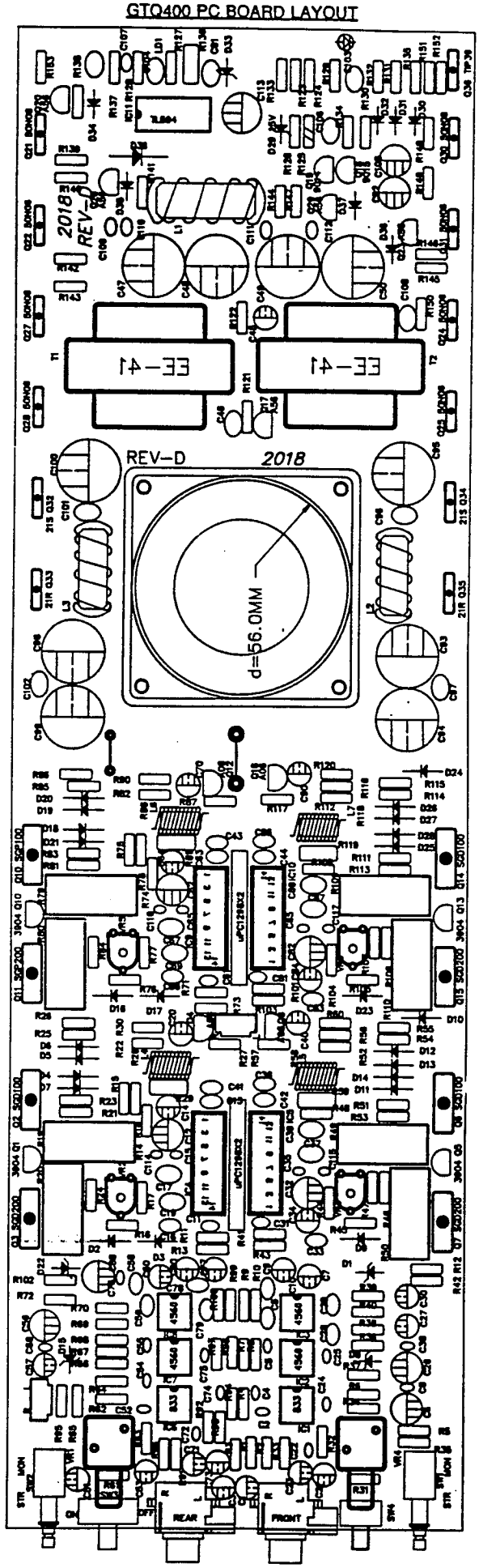
TRANSISTORS (UNIT: VOLTS)

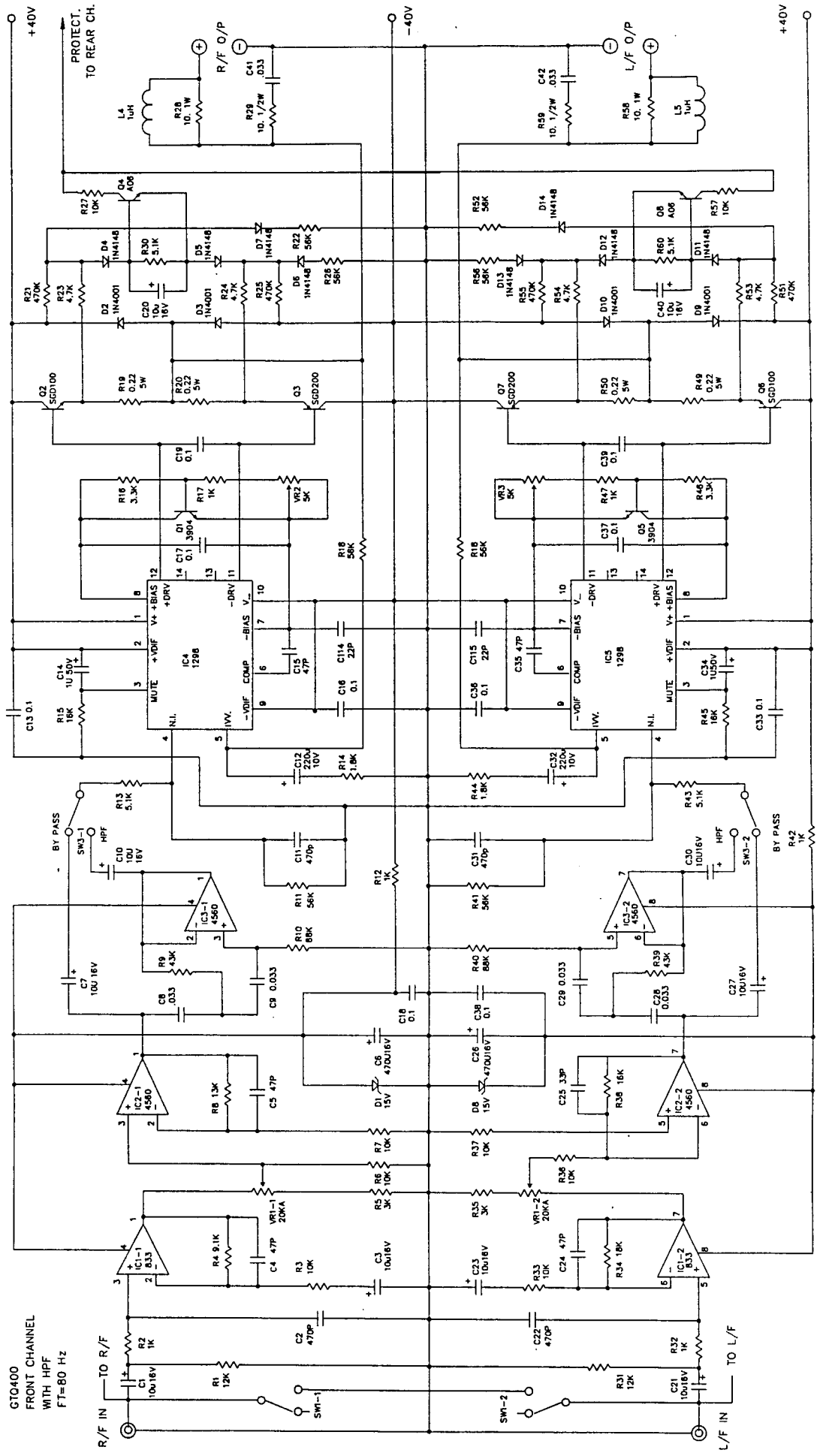
PIN NO. / TRA.NO.	E	B	C
Q21,Q22 Q23	0V	4.5V	14.4V
Q25,Q26 Q27	0V	4.5V	14.4V

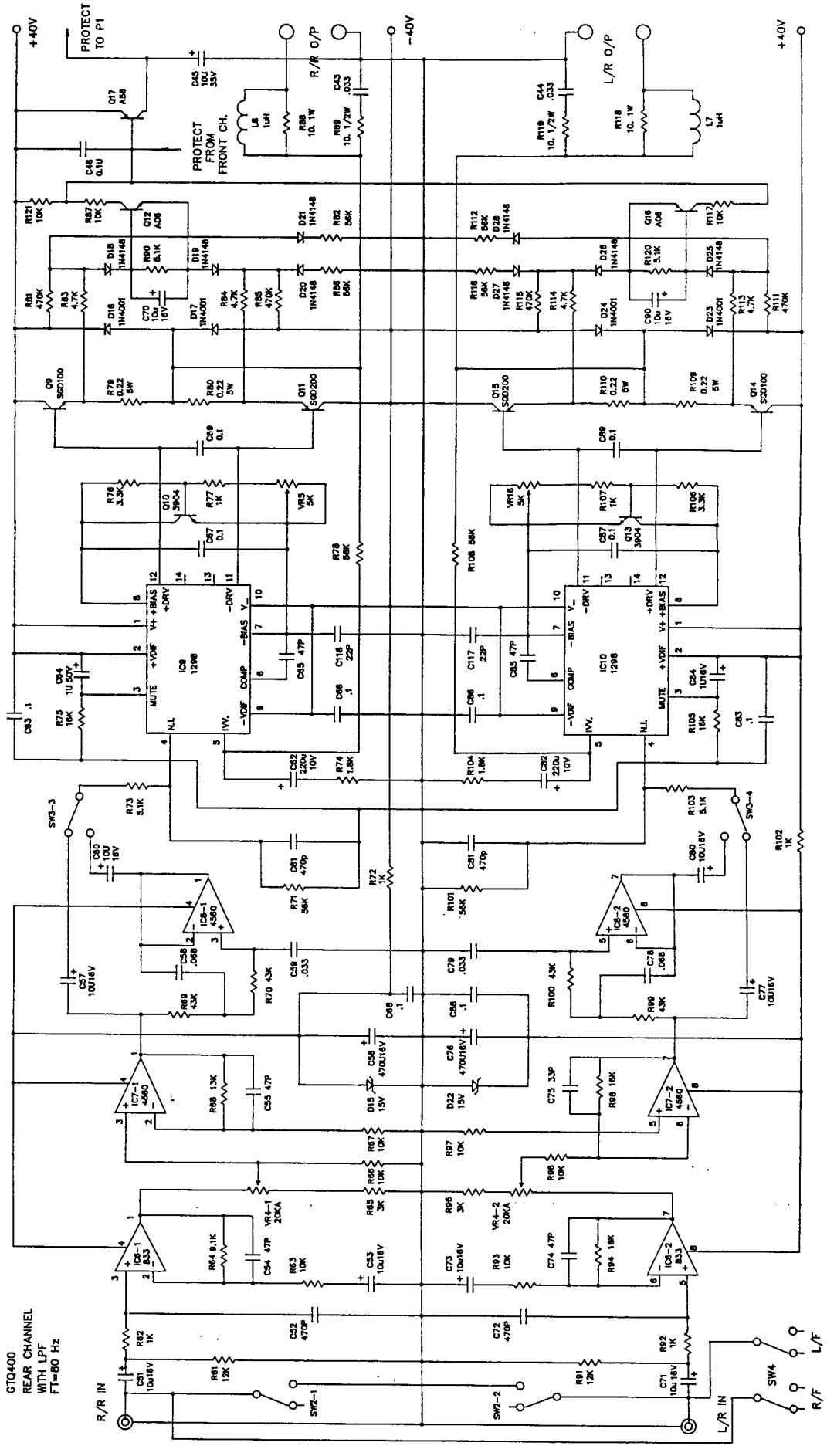
GTQ400 WIRING DIAGRAM

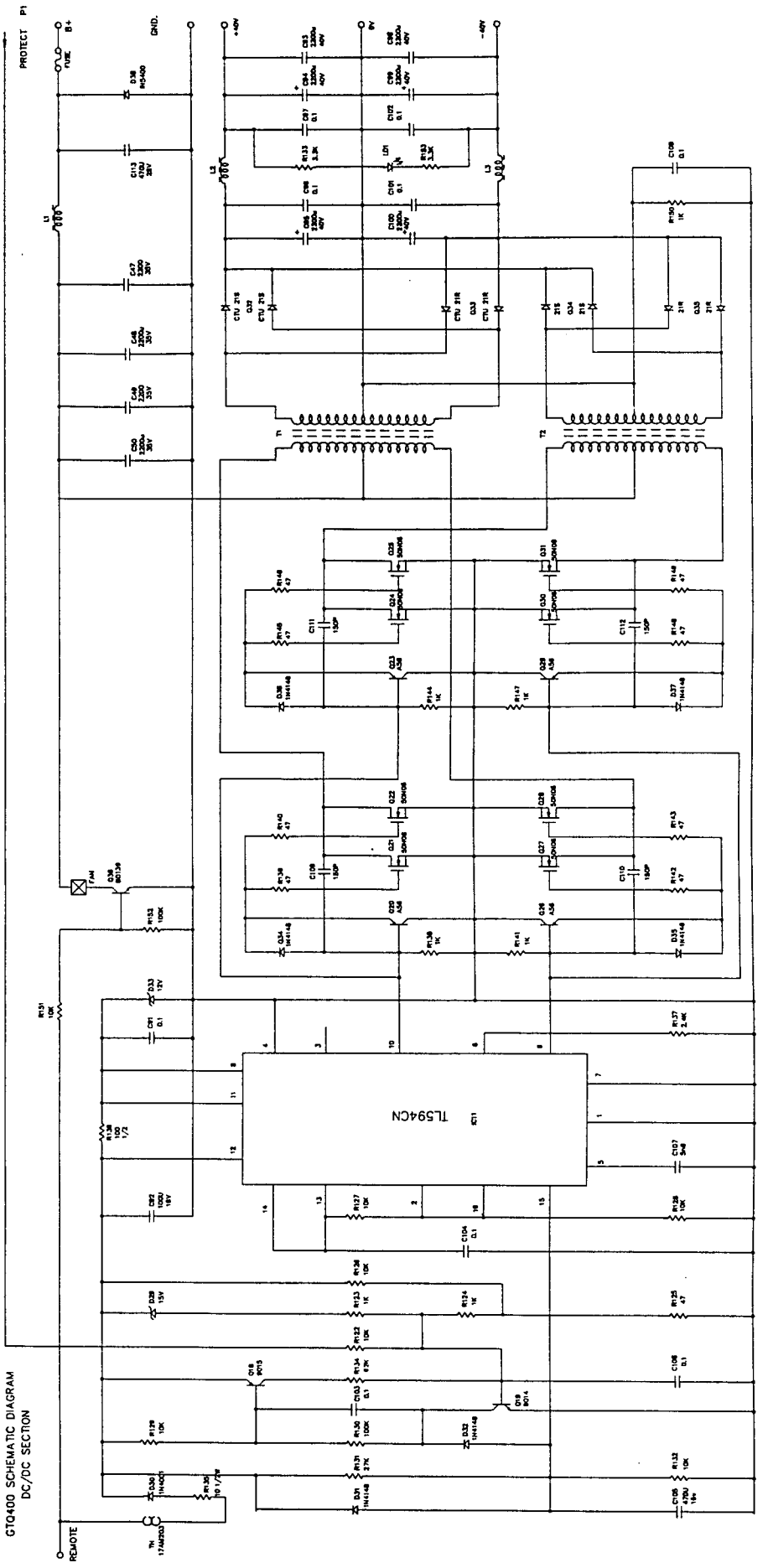


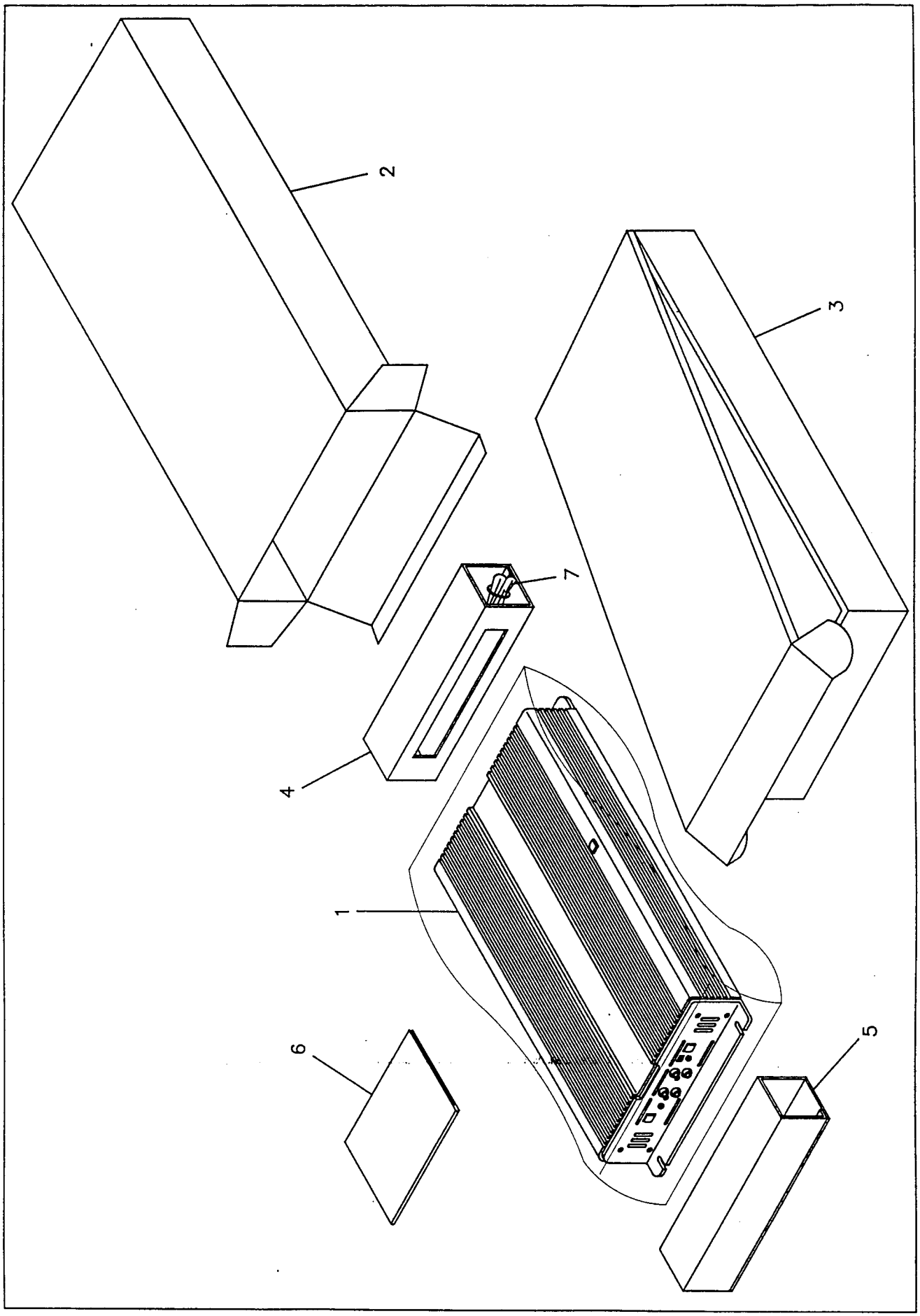
GTQ400 PC BOARD LAYOUT




GTQ400
FRONT CHANNEL
WITH HPF
FT=80 Hz
+40V
-40V
PROTECT.
TO REAR CH.
R/F O/P
L/F O/P
TO R/F
TO L/F
R/F IN
L/F IN
BY PASS
HPF
IC4 1298
IC5 1298
IC1-1 833
IC1-2 833
IC2-1 4580
IC2-2 4580
IC3-1 4560
IC3-2 4560
SW1-1
SW1-2
SW3-1
SW3-2


GTQ400
REAR CHANNEL
WITH LPF
Fl=80 Hz
R/R IN
L/R IN
R/R O/P
L/R O/P
+40V
-40V
PROTECT
TO P1
PROTECT
FROM
FRONT CH.
SW1-1
SW1-2
SW2-1
SW2-2
SW3-3
SW3-4
SW4
L/F
R/F
IC9
1298
IC10
1298
IC5-1
4560
IC5-2
4560
IC6-1
4560
IC6-2
4560
IC7-1
4560
IC7-2
4560
IC8-1
833
IC8-2
833


GTQ400 SCHEMATIC DIAGRAM
DC/DC SECTION
PROTECT P1
FUSE
B+
GND.
+40V
0V
-40V
REMOTE
T1
T2
TL594CN


2
3
7
4
1
6
5

GTQ 400 WIRING DIAGRAM