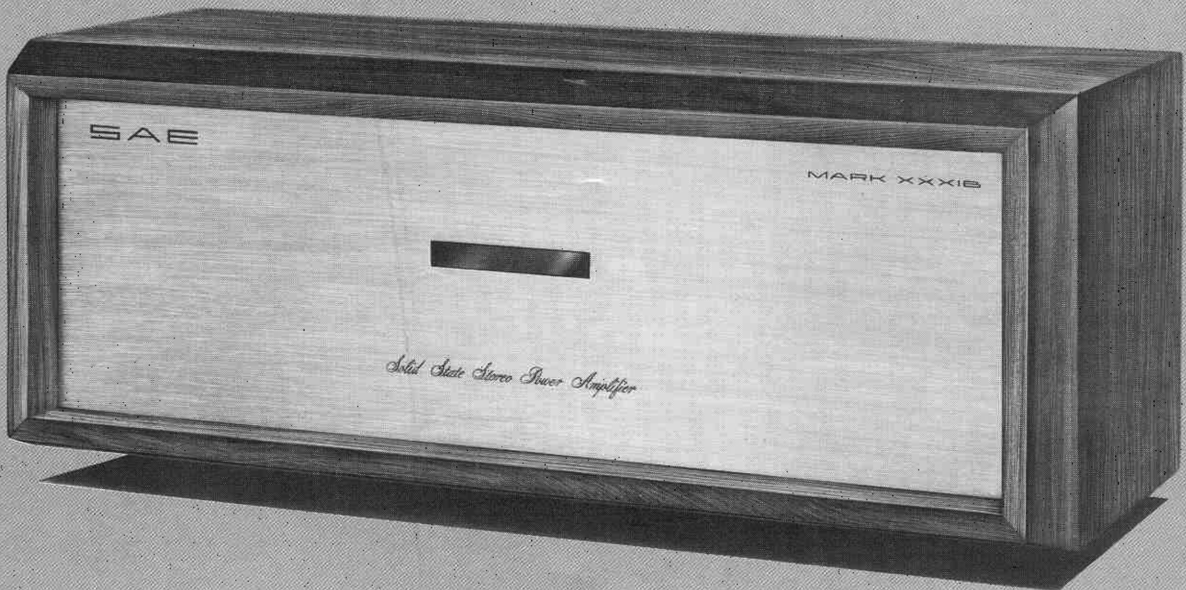
MARK 31B

MARK 31B
SOLID STATE STEREO AMPLIFIER

SERVICE MANUAL



SAE

Components for the Connoisseur

Price $2.00

MARK XXXIB CIRCUIT DESCRIPTION

Each channel of the MARK XXXIB is an **all** complementary amplifier powered with symmetrical +40V and –40V power supplies. Each channel comprises parallel-fed complementary differential inputs pairs, complementary driver stages, and complementary Darlington output stages. A portion of the output signals, determined by R13 (3.9K Ohms) and R14 (200 Ohms), is fed back to the negative inputs of the 2 complementary differential input amplifiers which results in an overall gain of 25.5dB (19 X voltage amplification).

Minimum DC offset voltage at the MARK XXXIB speaker output terminals is provided by balanced (matched) 100KOhm resistors (R2, R3, R11, R12, R52, R53, R61, R62) from base-to-ground, at the inputs of the complementary differential amplifiers.

Excessive input signals are limited at the input to the MARK XXXIB by back-to-back diodes (D1, D2, D51, D52) connected between the 2 differential inputs of the complementary input amplifiers.

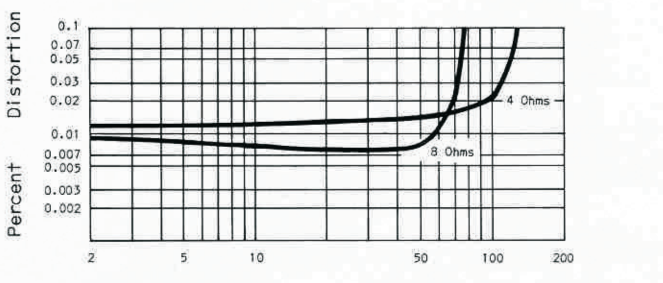
The common emitter resistors in each of the complementary differential input amplifiers are tied to the opposite ends of a 51V zener diode (D7, D57) which provides a regulated current supply for the complementary differential input amplifiers. Because this regulator diode is fed through 2K-Ohm resistors from the +B and –B power supplies, it will float or "ride" in conjunction with a portion of the input audio signal.

The DC-coupled complementary driver transistors (Q5, Q6, Q55, Q56) have 62-Ohm emitter resistors (R15, R16, R55, R56) which also feed overload-protection control transistors (Q7, Q8, Q57, Q58). These overload transistors are, in turn, driven by a portion of the voltage across (R31, R32, R81, R82) which is proportional to the output transistor current. If less than a 4-Ohm load is driven by the MARK XXXIB, high-signal currents will cause the overload-protection transistors to conduct, thus sinking the driver-transistor emitters which will limit the signal to the output transistors. The speaker-load value that will initiate protection is determined by the resistor-diode network in the base circuit of the protection transistors as well as by its V_{BE} characteristics.

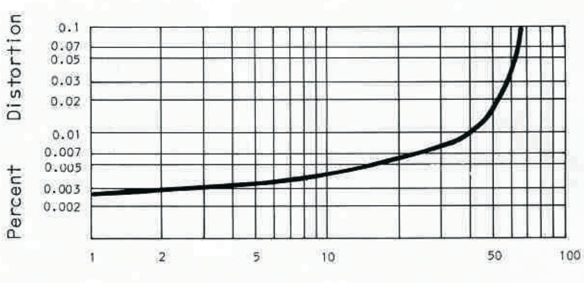
Bias voltage for the complementary Darlington output stages is provided by an integrated-circuit transistor array (Q11, Q61). A bias voltage control (R20, R70) is provided to adjust for minimum distortion. Due to close thermal contact of the bias IC to the output-transistor heat sink, the bias voltage will track accurately with the bias-voltage needs of the output transistors to maintain minimum crossover notch at all operating temperatures. This bias-voltage IC also assures no possibility of output-transistor thermal runaway.

A thermal-sensitive circuit breaker is wired in series with the power transformer primary and will open if the heat sink becomes excessively hot.

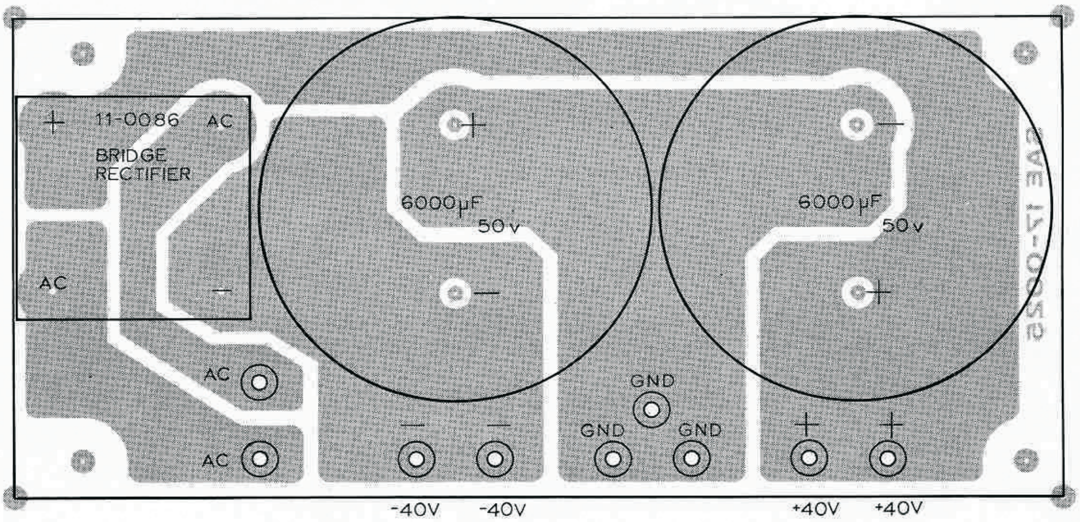
Harmonic Distortion (1KHz) vs. Power (2 Channels Driven)



Intermodulation Distortion vs. Power



SAE 22-0004 MK 31B POWER SUPPLY BD. PARTS LAYOUT
17-0025



POWER SUPPLY P.C. BOARD ASSY. (22-0004)

QTY. OR REF. NO	DESCRIPTION	PART NUMBER
	CAPACITORS	
C22,23	6000µF 50V	09-0047
	SEMICONDUCTORS	
1	Bridge Rectifier 6A	11-0136
	HARDWARE & MISC.	
8	P.C. Board Terminal	18-0082
4	Standoff Swedged #6-32 X ¼"	19-0092

MISCELLANEOUS PARTS

QTY.	DESCRIPTION	PART NUMBER
1	MDL 2½ Amp. Slo-Blo Fuse	12-0007
1	Pilot Lamp 14V	16-0002
1	Front Panel, Gold Metal	17-0013
1	Sub Panel, Blk. Metal	17-0014B
1	Top Cover Blk. Metal	17-0015B
1	Bot. Cover, Blk. Metal	17-0016C
1	Center Sub Panel, Blk. Metal	17-0017E
1	Large Heat Sink, Blk. Metal	17-0018
1	Small Heat Sink, Blk. Metal	17-0019
1	Rear Panel, Blk. Metal	17-0020
1	Tstr. Cover, Blk. Metal	17-0021
1	Lens, Pilot Lamp	17-0023
2	Spacer	17-0106
1	Socket, Pilot Lamp	18-0011
9	Connector, Pin	18-0028
1	Fuse Holder	18-0030
2	Speaker Terminal Post,Blk.	18-0031
2	Speaker Terminal Post, Red	18-0032
2	Lug, Ring	18-0054
2	Input Jack	18-0065
2	Wire Butt Connector	18-0068
1	Line Cord Strain Relief	18-0072
3	Standoff #6-32 X ¼" X ¼" Lg.	19-0081
3	Standoff #6-32 X ¼" X ½" Lg.	19-0082
3	Standoff #6-32 X ¼" X 1" Lg.	19-0085
1	A.C. Line Cord	21-0111

MARK XXXIB AMPLIFIER REPAIR HINTS

DISASSEMBLY:

1. To remove the top cover, unscrew 10 screws (6 on top and 2 on either end).

2. To remove the amp module, unscrew 9 screws: 3 along the bottom rear of the chassis, one in front of each of the two rear feet, one on either rear side, and two on the front top of the circuit board.

3. The transistor cover may be removed by unscrewing 3 screws along the top center of the heat sink.

REPAIRING:

1. If the Mark XXXIB amplifier is not operating properly or blew the power fuse, use an Ohmmeter to measure the resistance from the NPN output-transistor collector case to the output terminal of the appropriate channel. When making this measurement, connect the positive lead of the Ohmmeter to the output terminal. This reading should be **higher** than 500 Ohms. If this resistance reading is **less** than 500 Ohms, it is likely that the transistor is defective and should be replaced. (Refer to paragraph 6).

   Repeat with the PNP output transistors, but this time connect the positive lead of the Ohmmeter to the transistor collector case.

2. To evaluate the condition of the bias IC, short the Mark XXXIB input jacks and monitor the DC voltage across the 0.2-Ohm, 5W resistors (R31, R32, R81, R82) in the output-transistor emitters. This DC voltage should not exceed 0.1V when the amplifier is operated with full-line voltage. However, when a circuit malfunction is suspected, use a Variac to apply only 10% (approximately) of the full supply voltage (12-15V) to check for this condition. If excessive DC voltages are measured across the 0.2 Ohm resistor, replace the bias IC. Also, check the driver transistor condition as described in step 3 below.

3. Check for burned resistors on the drive-circuit board, especially the 62-Ohm (R15, R16, R65, R66) and 10-Ohm resistors (R17, R18, R67, R68). If any resistors appear faulty, then use an Ohmmeter to check the condition of the driver transistors, (Q5, Q6, Q55, Q56) and the protection transistors (Q7, Q8, Q57, Q58) for either collector-to-emitter or base-to-collector shorts. (These resistance readings should each exceed 100 Ohms). If any resistance reading is too low, replace the faulty transistor.

4. With no output load on the amplifier, increase the supply line voltage to rated voltage. Now measure the amplifier-output DC offset voltage. This voltage should not exceed ±0.5V. If the offset voltage approaches +40V or −40V, then check the 1.2 Ohm ground-return resistor (R19, R69) for continuity. If defective, replace this resistor. If excessive offset voltage still persists, check the input differential-amplifier pairs, (Q1, Q2, Q3, Q4, Q51, Q52, Q53, Q54) to verify that none are defective.

5. Adjust the output-transistor bias controls (R20, R60) on the bottom of the drive circuit board for 2.1V DC measured from base-to-base of the output transistors. If possible, the bias should also be readjusted to achieve between .03% to .04% harmonic distortion at 20KHz with an 8-Ohm load at 1 Watt (2.8V RMS) output.

6. When replacing output transistors, care must be taken that silicone heat-transfer compound (#20-0045) is applied to both sides of the plastic Therafilm transistor insulator (#18-0075). Only a thin film is required; however, it is important that the **entire** surface area is covered. It is also important that the area beneath the transistor be kept clean (except for the heat compound) so that there are no foreign objects such as metal filings which might puncture the plastic insulator. Finally, tighten the output transistor securely to the heat sink. To insure that the heat sink performs its heat-transfer function properly, **retighten** the transistor mounting screws after the amplifier has been allowed to become warm after operating under power.

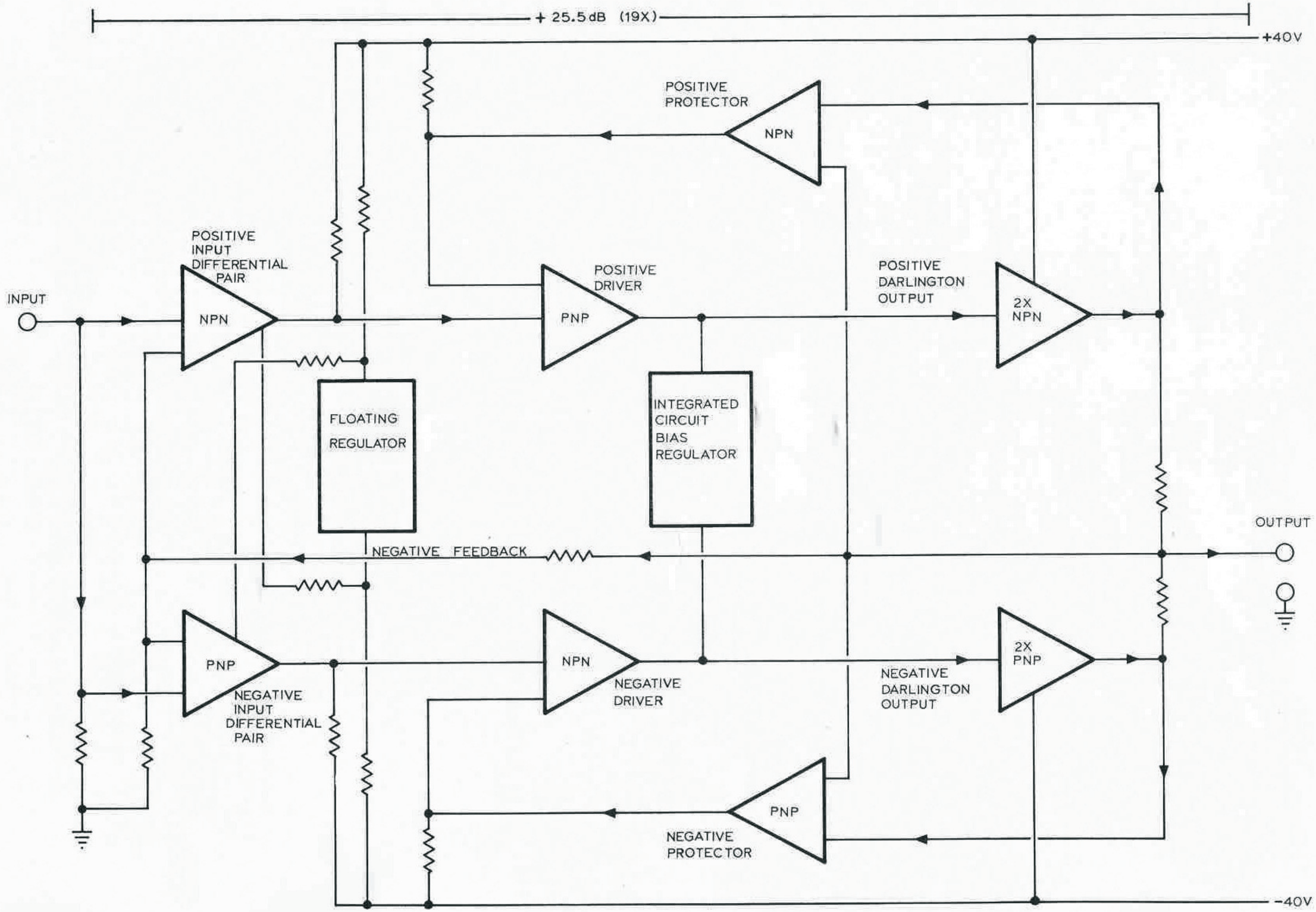
NOTE: **Due to the extremely wide bandwidth of the amplifier, 200KHz R.F. fed directly into the inputs may destroy the output transistors. Therefore, under no circumstances, should the input cable be plugged into the MKXXXIB input** while the amplifier is operating. **Under no circumstances, should the amplifier be checked to ascertain if it is operating by touching the input lead with your finger. Your body acts as an efficient antenna and can transfer an excessive amount of RF to the amplifier.**

Please address all inquiries to:

S A E, INC., CUSTOMER SERVICE DEPARTMENT
P.O. BOX 60271, TERMINAL ANNEX • LOS ANGELES, CALIFORNIA 90060

32-0013 LITHO. IN U.S.A. 1/75

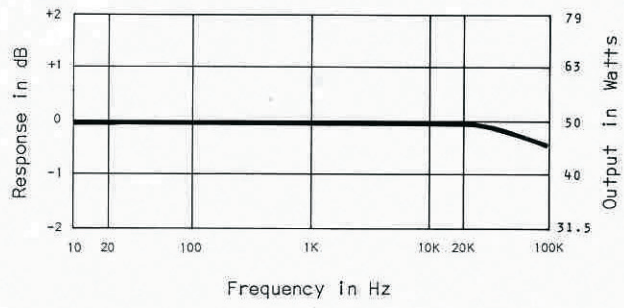
SAE MK31B STEREO AMPLIFIER BLOCK DIAGRAM



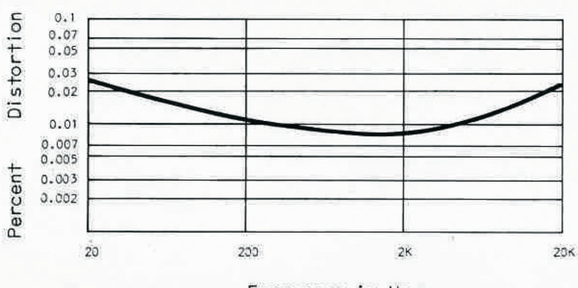
SPECIFICATIONS MARK XXXIB

RMS (MIN) CONTINUOUS POWER OUTPUT PER CHANNEL 10Hz TO 30KHz (BOTH CHANNELS DRIVEN)	4 Ohms: 75 Watts @ 0.2% Harm. Dist. 8 Ohms: 50 Watts @ 0.1% Harm. Dist. 16 Ohms: 35 Watts @ 0.1% Harm. Dist.
T.H.D. (HARMONIC DISTORTION) FROM 20Hz TO 20KHz AT 1/4W TO RATED POWER.	4 Ohms: 0.2% Max. 8 Ohms: 0.1% Max. 16 Ohms: 0.1% Max.
IM (INTERMODULATION DISTORTION) FROM 1/4W WITH ANY 2 MIXED FREQUENCIES BETWEEN 20Hz AND 20KHz AT 4/1 VOLTAGE RATIO.	4 Ohms: 0.1% Max. 8 Ohms: .05% Max. 16 Ohms: .05% Max.
FREQUENCY RESPONSE AT 1 WATT	±1dB 1Hz to 100KHz.
NOISE	100dB below rated power
TRANSIENT RESPONSE OF ANY SQUARE WAVE.	2.5 Microseconds rise and fall time.
STABILITY	Unconditionally stable with any type of load or no load including full-range electrostatic loudspeakers.
DAMPING FACTOR	150 Min (100Hz)
INPUT SENSITIVITY	1.0V RMS for rated power output (8 Ohms)
INPUT IMPEDANCE	50K Ohms
SLEW RATE	40 Volts-per-µsec
SEMICONDUCTOR COMPLEMENT	20 transistors (4 Darlington), 12 diodes
OVERLOAD PROTECTION	1) Low-impedance electronic-sensing circuit limits with load impedance below 2 Ohms without limiting loads of 4 Ohms or higher (or reactive loads such as electrostatic speakers.) 2) Thermal sensing of abnormal heat-sink temperature.
INTERNAL ADJUSTMENTS	Output-bias adj.
POWER REQUIREMENTS	110-125V, 50Hz/60Hz: 25 Watts @ idling to 300 Watts @ rated out.
SHIPPING WEIGHT	18 pounds (8.2Kg)
DIMENSIONS	Front Panel: 15in. (38.1cm)W. X 4.75in (12.1cm)H. Chassis: 8in. (20.3cm)D.
WALNUT CABINET	WC-31B (not included)

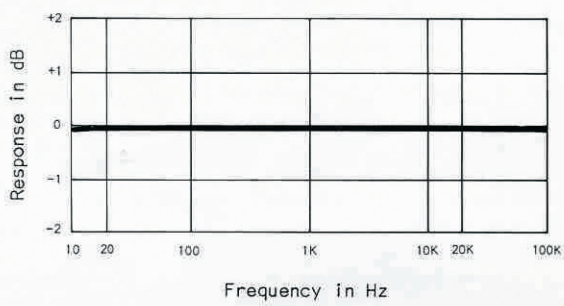
Power Bandwidth



Harmonic Distortion vs. Frequency



Frequency Response
1 Watt Output



SPECIFICATIONS MARK XXXIB

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T.H.D. (HARMONIC DISTORTION) FROM 20Hz TO 20KHz AT 1/4W TO RATED POWER.	4 Ohms: 0.2% Max. 8 Ohms: 0.1% Max. 16 Ohms: 0.1% Max.
IM (INTERMODULATION DISTORTION) FROM 1/4W WITH ANY 2 MIXED FREQUENCIES BETWEEN 20Hz AND 20KHz AT 4/1 VOLTAGE RATIO.	4 Ohms: 0.1% Max. 8 Ohms: .05% Max. 16 Ohms: .05% Max.
FREQUENCY RESPONSE AT 1 WATT	±1dB 1Hz to 100KHz.
NOISE	100dB below rated power
TRANSIENT RESPONSE OF ANY SQUARE WAVE.	2.5 Microseconds rise and fall time.
STABILITY	Unconditionally stable with any type of load or no load including full-range electrostatic loudspeakers.
DAMPING FACTOR	150 Min (100Hz)
INPUT SENSITIVITY	1.0V RMS for rated power output (8 Ohms)
INPUT IMPEDANCE	50K Ohms
SLEW RATE	40 Volts-per-μsec
SEMICONDUCTOR COMPLEMENT	20 transistors (4 Darlington), 12 diodes
OVERLOAD PROTECTION	1) Low-impedance electronic-sensing circuit limits with load impedance below 2 Ohms without limiting loads of 4 Ohms or higher (or reactive loads such as electrostatic speakers.) 2) Thermal sensing of abnormal heat-sink temperature.
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POWER REQUIREMENTS	110-125V, 50Hz/60Hz: 25 Watts @ idling to 300 Watts @ rated out.
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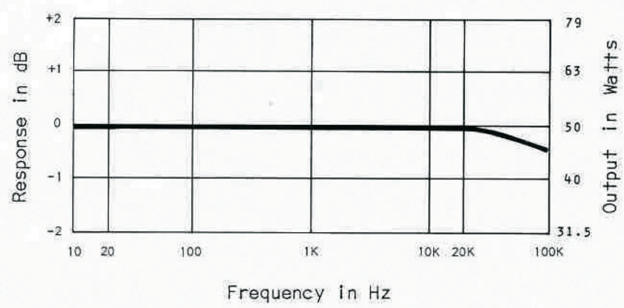
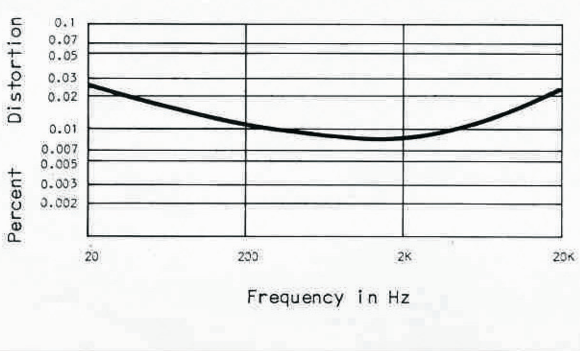
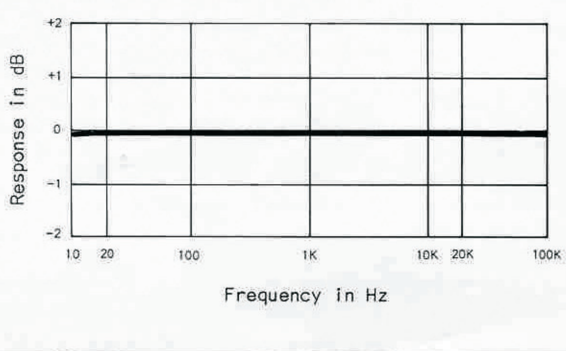
Power Bandwidth

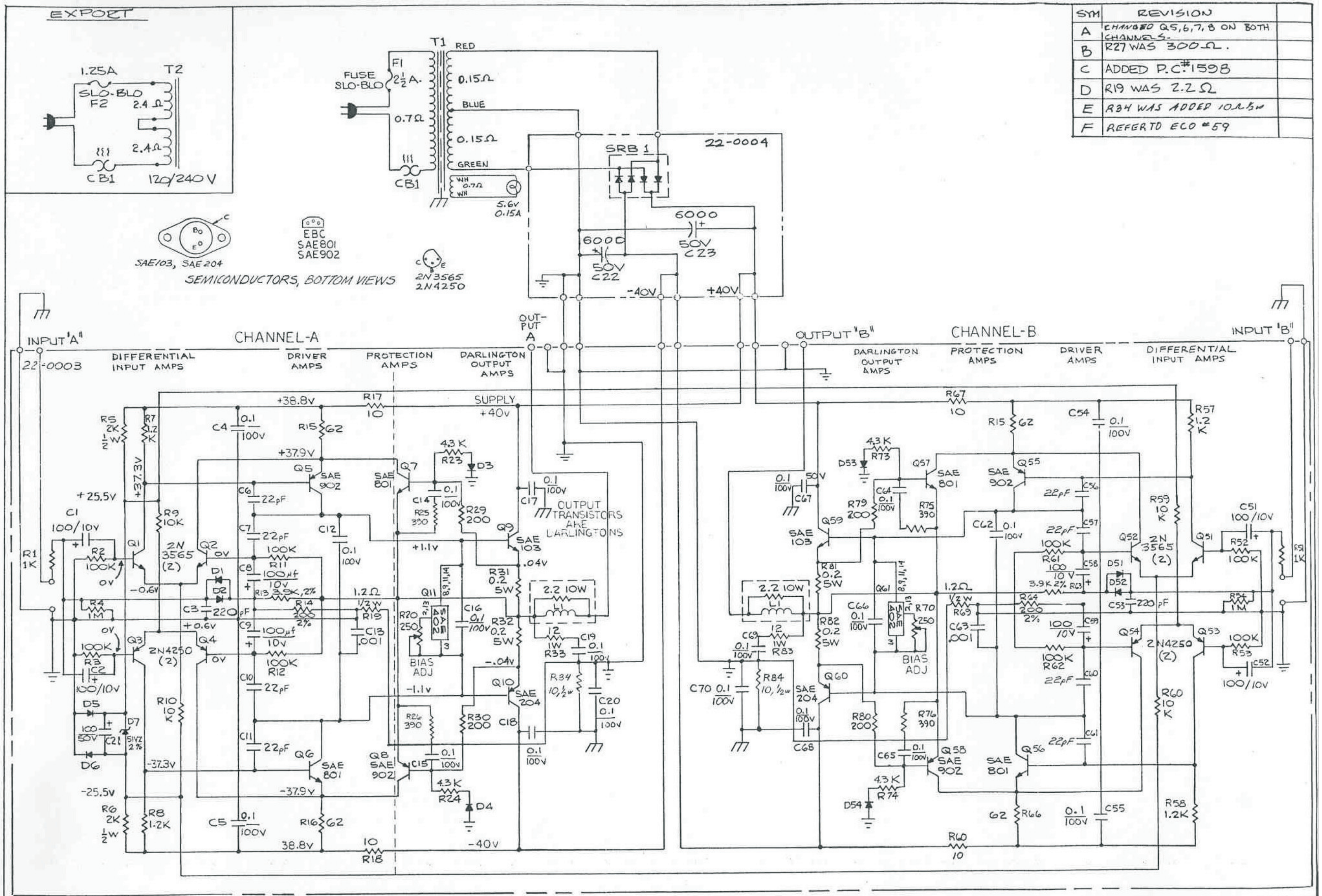


Harmonic Distortion vs. Frequency



Frequency Response
1 Watt Output





SYM	REVISION
A	CHANGED Q5,6,7,8 ON BOTH CHANNELS.
B	R27 WAS 300 Ω.
C	ADDED P.C.# 1598
D	R19 WAS 2.2 Ω
E	R34 WAS ADDED 10Ω ½W
F	REFER TO ECO #59

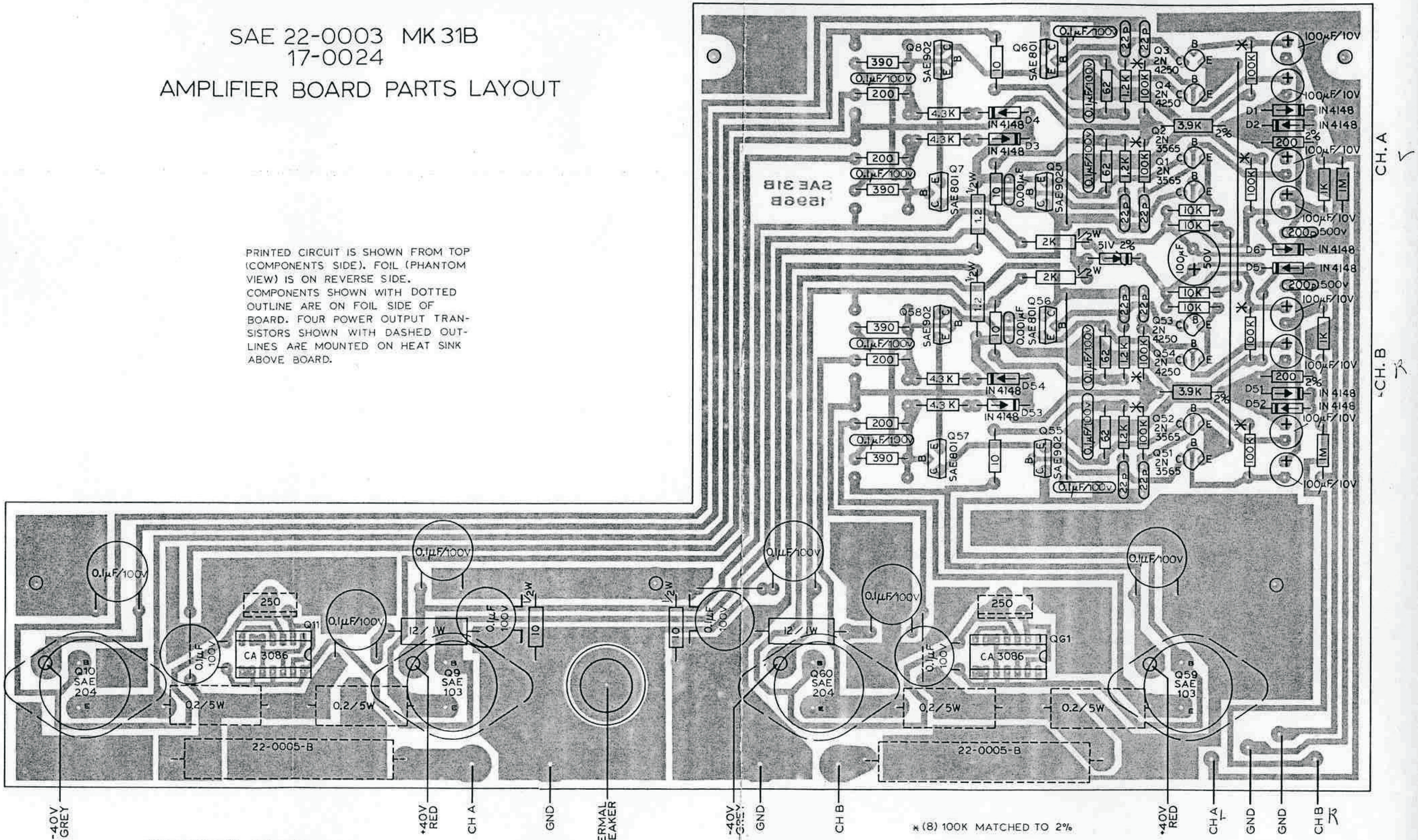
NOTES:

1. ALL DIODES SIMILAR TO IN4148/IN914.
2. D5, D6, D7 & C22 & R5, R6 COMMON TO BOTH CHANNELS.
3. C21 MAY BE OMITTED FROM CERTAIN UNITS.
4. VOLTAGE VALUES GIVEN ARE AT 15mA QUIESCENT CURRENT.

PART NO.	1800	PART NAME	SCHEMATIC-AMPL.
SAE	SCIENTIFIC AUDIO ELECTRONICS, INC. P.O. BOX 60271 TERMINAL ANNEX 601 E. MACY ST. LOS ANGELES, CALIF. 90060		
MATERIAL	—	FINISH	—
SCALE	DRAWN BY	APPROVED	USED ON
—	R. Clark	[signature]	XXXI B

SAE 22-0003 MK 31B
17-0024
AMPLIFIER BOARD PARTS LAYOUT

PRINTED CIRCUIT IS SHOWN FROM TOP (COMPONENTS SIDE). FOIL (PHANTOM VIEW) IS ON REVERSE SIDE. COMPONENTS SHOWN WITH DOTTED OUTLINE ARE ON FOIL SIDE OF BOARD. FOUR POWER OUTPUT TRANSISTORS SHOWN WITH DASHED OUTLINES ARE MOUNTED ON HEAT SINK ABOVE BOARD.



*(8) 100K MATCHED TO 2%

MAIN BOARD ASSY. (22-0003)

REF. NO	DESCRIPTION	PART NUMBER
	RESISTORS (Carbon Film unless otherwise specified)	
R17,18,60,67	10 Ohm 5% 1/3W	02-0001
R15,16,65,66	62 Ohm 5% 1/3W	02-0005
R14,64	200 Ohm 2% 1/3W	02-0011S
R29,30,79,80	200 Ohm 5% 1/3W	02-0011
R25,26,75,76	390 Ohm 5% 1/3W	02-0016
R1,51	1.0K Ohm 5% 1/3W	02-0024
R7,8,57,58	1.2 Ohm 5% 1/3W	02-0025
R13,63	3.9K Ohm 2% 1/3W	02-0035S
R23,24,73,74	4.3K Ohm 5% 1/3W	02-0040
R9,10,59,60	10K Ohm 5% 1/3W	02-0071
R2,3,11,12 52,53,61,62	100K Ohm 5% 1/3W Matched to 2%	02-0056M
R4,54	1M Ohm 5% 1/3W	02-0071
R19,69	1.2 Ohm 5% 1/2W	03-0010
R34,84	10 Ohm 5% 1/2W	03-0015
R5,6	2.0K Ohm 5% 1/2W	03-0048
R33,83	12 Ohm 10% 1W	04-0003
R31,32,81,82	0.2 Ohm 10% 5W-PW	04-0047
R20,70	Pot: 250 Ohm PC(Grn)	06-0002
	CAPACITORS	
C6,7,10,11,56,57,60,61	Cer. Disc. 22pF ±10% 100V	07-0007
C3,53	Cer. Disc. 220/200pF ±10% 500V	07-0014
C13,63	Cer. Disc. .001µF +80%, -20% 100V	07-0019
C4,5,12,14,15,16,17,18 19,20,54,55,62,64,65, 66,67,68,69,70	Cer. Disc. 0.1µF +80%, -20% 100V	07-0034
C1,2,8,9,51,52,58,59	Electrolytic 100µF 10V	09-0027
C21	Electrolytic 100µF 50V	09-0028
	SEMICONDUCTORS	
D1,2,3,4,5,6,51,52,53,54	Diode, Silicon IN4148	11-0096
Q11,61	I.C. CA-3086/SAE 40.	11-0030

QTY. OR REF. NO	DESCRIPTION	PART NUMBER
Q1,2,51,52	Tstr Si NPN 2N3565/BC237B/SE4010	11-0044M
Q9,59	Tstr Darlington SAE 103	11-0064
Q10,60	Tstr Darlington SAE 204	11-0070
Q6,7,56,57	Tstr Si NPN MPS-U06/SAE 801	11-0080
Q5,8,55,58	Tstr Si PNP MPS-U56/SAE 902	11-0086
Q3,4,53,54	Tstr Si PNP 2N4250/BC307B (Matched for β)	11-0017M
D7	Diode, Zener IN5878C 51V 2%	11-0135
	HARDWARE & MISC.	
1	Thermal Breaker	12-0042
4	Insulator, Tstr. Socket	17-0022
2	Socket, I.C. 14 Pin	18-0005
4	Socket, Tstr.	18-0016
4	Insulator, Therafilm Tstr.	18-0075
As Reqd.	Thermal Compound	20-0045
2	Coil/Resistor Assy.	22-0005 B