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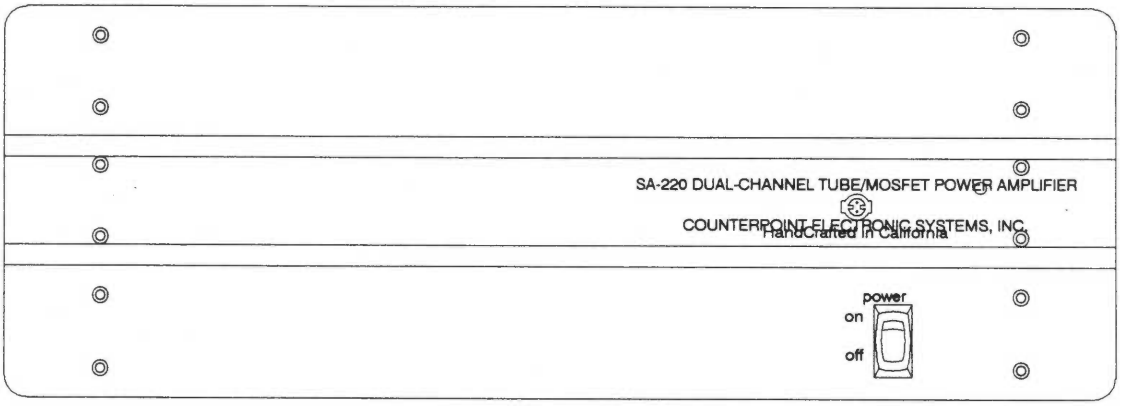
COUNTERPOINT
POWER AMPLIFIER
MODEL SA20 & SA220
SERVICE
MANUAL



SA-20 FRONT PANEL

This document applies to all SA-20 with serial numbers starting 52000 and above.

COUNTERPOINT ELECTRONIC SYSTEMS, INC. 2610 Commerce Drive, Vista, CA. 92083

GENERAL DESCRIPTION

GENERAL

The SA-20 is a stereo high fidelity power amplifier intended for music reproduction in a home environment. It is not intended for professional use where abusive handling can damage the delicate electronics, nor is it intended for continuous high-power output where overheating of the output stage can cause failure of the output devices. Ventilation is essential for reliable operation.

The SA-20 may be used with normal home-type high fidelity loudspeakers with typical impedances as low as 1 ohm. There is no current-limiting ciruitry in the SA-20, so proper speaker wiring is essential. Shorted speaker wires can destroy the output stage. Typical output voltage swing can approach +/- 70 volts; speakers withinput protection circuits that short the amplifier output must be carefully evaluated before reliable full-power operation can be assured.

Either amplifier channel may be used separately as in normal stereo operation. Monophonic 'bridge' operation with the speaker connected the two amplifier channels is also possible by using channel B's internal signal inverter. Bi-wire and biamplified operation may also be used with the SA-20.

SPECIFICATIONS

Tube Complement

4-6DJ8, Audio Amplification. V1, V101, V2 & V102.
1-6DJ8. Phase Tube. V5.
1-6CA4, Rectifier. V6.

Typical Electrical Specifications

Gain. (voltage)
SA-20 Stereo: 29dB.
SA-20/20 Bridge Mono: 35dB.

R.M.S. Power Output. (120 VAC Line)

Configuration	8 ohm load	4 ohm load	2 ohm load	1 ohm load
SA-20 Stereo:	220W	420W	640W	730W
SA-20/20 Bridged Mono:	600W	700W	N.R.	N.R.
			N.R. = Not Recommended	

Peak Power Output. (120 VAC Line)

Configuration	8 ohm load	4 ohm load	2 ohm load	1 ohm load
SA-20 Stereo:	310W	590W	900W	1000W
SA-20/20 Bridged Mono:	840W	980W	N.R.	N.R.
			N.R. = Not Recommended	

Peak Output Current.
(0.1 ohm load, 1kHz switched ON for 20mSec, OFF for 480mSec)
50 Amperes.

Frequency Response.
8 ohm load: <1.2Hz to 200kHz.
8 ohm/8u resistive/capacitive load: <1.2Hz to 32kHz.

RiseTime.
8 ohm load : 0.6uSec.
8 ohm/8uf resistive/capacitive load: 5.0uSec.

Distortion. (THD)
SA-20 Stereo:
200W r.m.s.: <0.5%.
10 Wr.m.s.:<0.1%.
1W r.m.s.:<0.05%.
SA-20/20 Bridged Mono:
600W r.m.s.: <0.5%.
10W r.m.s.:<0.10%.
1W r.m.s.:<0.08%.

Intermodulation Distortion.
1W, 8 ohms
CCIF: 0.025%, DIM100: 0.02%, SMPTE: 0.018%
100W, 8 ohms
CCIF: 0.2%, DIM100: 0.4%, SMPTE: 1.5%

Signal-To-Noise.
(input shorted 400-80kHz unweighted, stereo configuration 8 ohm load, 1W ref.)
-84dB.

Output Impedance.
0.12 ohm, typ.

Damping Factor.
6 (ref 8 ohm).

Input Impedance.
100K ohm, 100pF.

Signal Polarity.
("Absolute Phase")
Non-inverting.

Power Requirements.
U.S. Domestic 120VAC operation, scale other A.C. Mains voltages accordingly:
260W, idle.

Replacement Fuse Value.
A.C. Mains Fuse (U.S., 120VAC): 10A "Slow Blow,"
Speaker Fuses and Rail Fuses: 6A AGC.

Dimensions.
Front Panel: 19 inches (480 cm) wide, 4.46 inches (11.3 cm) tall.
Front-to-rear dimension: 19 inches (480 cm).

Weight.
69 pounds (unit weight).
72 pounds (shipping weight).

TECHNICAL DESCRIPTION

Technical Description

The output stage of the SA-20 consists of four complementary pairs of 125-Watt MOSFETs per channel, wired in parallel. Each MOSFET has its own gate ballast resistor to eliminate parasitic oscillations, and there are small 6-10 volt zener diodes connected between the gate line and sources to prevent the gate-to-source voltage from exceeding the 20 volt maximum recommended by the manufacturer of the devices during tube warmup. The output stage is biased for Class AB operation using a standard Vbe multiplier consisting of Q1, R16, R17, R15 and VR1, which is used to adjust the bias current. Q1 is thermally coupled to the heatsink so that a hotter heatsink results in less gate bias, thus controlling the bias current flowing through the MOSFETs. The voltage for the bias network is regulated by D1, D2, D22, and D23. Offset control is set by R19, R20, VR2, R21 and R29. There are fuses in the drain supply lines and at the speaker output line.

The output stage is driven by a cathode-follower, the upper half of V2. The load for the cathode follower is the other half of V2, configured as a constant-current source. Bias for the CCS is set by R12, R11 and R3. C4 decouples the grid from any variations in the B+ (Ebb) supply line. This stage is capacitor coupled to the output stage through C5 and C6.

Voltage gain in the SA-20 is accomplished by two cascaded gain stages, both contained in V1. All three tube stages have their own power supply decoupling. In the case of the input half of V1, it consists of R24, C12 and C11.

Overall gain is established by connecting the cathode of the CCS to the cathode of the input stage. The output stage is not included in the feedback loop.

During bridge operation, the input signal is connected to channel A, which is driven normally, and to the input of V5, an anode follower phase inverter. The gain of this stage is set by R80, R82 and R84. R83, C82 and C81 decouple this stage's B+ from the supply lines. The output of this stage is connected to the input of channel B. Thus, the two channels are driven equally, but out of phase. A speaker is connected between the two amplifier red speaker terminals.

High voltage (B+) is derived from V6, a full wave rectifier. The unfiltered dc output of this tube is applied to the filament supply for the rectifier through a 1k ohm resistor in order to prevent exceeding the manufacturer's recommended cathode-to-filament voltage. The dc voltage from V6 is filtered by C30, R30 and C31 before being sent to the individual stage decoupling networks as described above.

Units with Option 100783 use a "capacitance multiplier" to further filter the B+ voltage. This assembly is mounted on a small board, and consists of Q4, VR5, R40, C40, R41, C41 and C43. The input voltage, approximately 370Vdc, is reduced to about 330Vdc by this circuit.

Caution

Voltages which are dangerous to life are present within the SA-20. Disconnect the power cable from the AC Mains before removing the cover plate. Before attempting any work on the output stages, be certain to discharge the main filter capacitors at the front of the amplifier with a 10-50 ohm high wattage resistor. Do not remove or install any "rail fuses" until you are certain that these capacitors have been completely discharged. Failure to do so will result in damaged output devices.

Cover Removal

To remove the cover, unscrew the screws which fasten the cover to the chassis, and lift the cover off the the top of the SA-20.

General

All the components in the SA-20 are of the highest quality and should have a long trouble-free life since they are operated well below their manufacturer's rating. The following procedure may facilitate locating the source of trouble if the SA-20 does not function properly.

The likeliest source of failure are the solid-state components since they are inherently more fragile and susceptable to failure in the high-voltage/high temperature environment of the SA-20. Check for shorted or opened diodes in the power supplies.

Another common problem is a failure of an electron tube since these devices have a shorter life than the passive parts (resistors, capacitors). Check first to see if all the tubes are inserted securely in the sockets. Check also to see if the tubes are located in the proper sockets, and that they are the correct RETMA type as specified in the parts list.

Note if each tube's filament is lit. If the unit then fails to operate properly and the correct plate and heater supply voltages are present, check the possibility of a faulty tube. Obtain new tubes and then one at a time, substitute the new tubes in each position in the SA-20 where it is used. The location of each electron tube is clearly marked on the circuit board adjacent to each tube socket. In most cases, one of these substitutions will affect a cure. If, however, this approach does not help, a detailed analysis of 1. the dc voltages, and 2. point to point signal tracing should be made.

Test points in the SA-20 with their correct dc voltages with reference to chassis ground are listed below, in Figures 3.3.1 and 3.3.2, which should be used as a rough guide only due to the variations in different brands of electron tubes. If the test point voltage differs significantly from the correct voltage, all of the components, wiring and voltage and resistance readings to ground associated with the tube (preceding) (associated with) the test point should be made.

Remember that the SA-20 is a stereo device, so you do have another channel with which to compare against since the liklihood of the tubes in both channels failing at the same time is slight.

All dc voltages are measured after the SA-20's front panel lamp has changed to green (unmuted condition).

Figure 3.3.1 —D.C. test point voltages.
This chart is for SA-20s without Option 100783 Electronic Voltage Regulator.

TUBE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
V1	75	0	2	0	-6	106	0	4	0
V101	106	0	4	-6	0	75	0	2	0
V2	77	1.6	4	-6	0	370	75	77	0
V102	370	75	77	0	-6	77	1.6	4	0
V5	0	0	0	0	-6	61	0	1.7	0

Rear Gate Line: +3 to +5 VDC
Front Gate Line: -3 to -5 VDC

Figure 3.3.2 - dc test point voltages.
This chart is for SA-20s with Option 100783 Electronic Voltage Regulator.

TUBE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
V1	65	0	2	0	-6	92	0	3.5	0
V101	92	0	3.5	-6	0	65	0	2	0
V2	67	1.4	3.5	-6	0	330	65	67	0
V102	330	65	67	0	-6	67	1.4	3.5	0
V5	0	0	0	0	-6	61	0	1.7	0

Rear Gate Line: +3 to +5 VDC
Front Gate Line: -3 to -5 VDC

Test points in the SA-20 with their correct ac voltages with reference to chassis ground are listed below, in Figure 3.3.3. This measurement is based upon the following:

1. Inject a 100mV rms 1kHz sine wave into the input.

If the test point voltage differs appreciably from the correct voltage, all of the components, wiring and voltage and resistance readings to ground associated with the tube preceding the test point should be made.

Figure 3.3.3 - AC test point voltages.
All voltages are peak-to-peak as read on an oscilloscope.

TUBE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
V1	8	0.5	0.06	—	—	0.45	0.3	0.25	0
V101	0.45	0.3	0.25	—	—	8	0.5	0.06	0
V2	7.8	0	0.25	—	—	0	8	7.8	0
V102	0	8	7.8	—	—	7.8	0	0.25	0

Rear Gate Line: 7.8
Front Gate Line: 7.8

Totally Dead Amplifier

A cartridge fuse, located behind the front panel, on the right, is used in the primary circuit of the power transformer to protect the power supply components from short circuits. The rating of this fuse was selected for proper protection of the SA-20 and should be replaced with the same type and rating.

If a failure is detected the following procedure is recommended before replacing the fuse.

(a) Check for faulty rectifier tube, 6CA4.

(b) Check for faulty output stage rectifier bridges, located near the power transformer.

(c) Check for faulty filament rectifier bridge located at the front of the PCB (Printed Circuit Board).

(d) Short circuits in 27,000uF output stage filter capacitors, can best be detected by connecting an ohmmeter across the terminals directly.

(e) Short circuits in 100uF filter capacitors, C30 and C31 used in the unregulated portion of the B+ (Ebb) high voltage power supply, can best be detected by connecting an ohmmeter from either end of R30 to ground.

(f) Short circuits in C50 and C51 used to filter the filament voltage can best be read by connecting an ohmmeter from either end of R50 to ground. Please note that the dc resistance of the 6 volt filament supply will read about 0.5 ohms, due to the resistance of the tube filaments.

(g) The dc resistance of the power transformer primary should be at least 0.8 ohms. A much lower resistance probably indicates a shorted primary.

Failed Output Stage

An output stage that has failed is indicated by a large dc offset at the speaker terminals, and fused gate resistors on the MOSFET sockets. The muting relay may also be fused, causing gate drive lines to be shorted to ground.

Replacement of all eight MOSFETs (per affected channel), gate resistors, protection diodes and possibly the muting relay is indicated. Use only replacement MOSFETs from Counterpoint. Device matching is critical, since the SA-20 does not use any ballast resistors in the source circuits to force the MOSFETs to share current (such resistors degrade the sound dramatically). MOSFETs obtained from Counterpoint have been selected to have equal currents at elevated temperatures (80C). After replacement, the repaired output stage will need to have its bias current and offset voltage adjusted.

ALWAYS DISCHARGE THE OUTPUT STAGE MAIN FILTER CAPACITORS THROUGH A 10 TO 50 OHM HIGH POWER RESISTOR BEFORE ATTEMPTING ANY REPAIR OR PARTS REPLACEMENT ON THE OUTPUT STAGES.

Procedure For Adjusting A Repaired Output Stage

After discharging the main filter capacitors, remove both of the "rail" fuses from their clips on the circuit board. The original MOSFETs can now be removed after first prying off the plastic covers. They are held in place with a silicone rubber cement.

Install the new MOSFETs. Use a small amount of thermally conductive silicone heatsink compound between the device and the heatsink Check to be certain that the replacement MOSFET mounting screws are firmly tightened.. They should be tightened almost to the point of damaging the mounting sockets. A poorly tightened MOSFET will overheat and fail (at idle, each device dissipates about 14 Watts). Replace the gate resistors and protection diodes. Do not overheat the diodes during soldering. Check them with a ohmmeter after installation to be certain that they still show normal cathode/anode resistance.

Check the grounding of the MOSFET main gate lines by using an ohmmeter from the gate lines to ground. The reading should indicate less than 1 ohm, which shows that the muting relay is connecting the gates to ground, preventing any gate bias from being applied during tube warm-up.

Using an ohmmeter, check the dc resistance from the cases of the MOSFETs to ground. The reading should be well over 1,000 ohms. If the reading is less than this, one or more of the MOSFET cases is shorted to the heatsink. Remove the MOSFETs, one at a time, until the problem is eliminated. Examine the base of the MOSFET and the insulating pad for damage. Correct the problem and re-check the case-to-ground resistance again.

Set the Offset trimpot to the center position. Turn on the SA-20 and apply nominal AC Mains voltage. After a moment, the front panel LED should light RED. Use a small wire jumper to short across R70 on the circuit board near the 555 Timer IC. This will force the amplifier into the unmuted state. The front panel lamp will change to GREEN. If the lamp does not change color, the 555 timer IC (U1) should be replaced. Measure the dc voltage from the front (P-channel) gate line to ground. The gate line is the bare wire that all four of the gate resistors are connected to. This voltage should be about -3 to -5 volts. Measure the dc voltage from the rear (N-channel) gate line to ground. This voltage should be about +3 to +5 volts. If no voltages can be measured, the most likely cause is a fused muting relay. Measure the dc resistance from the gate lines to ground. If you have a short, either the relay needs to be replaced, or Q1's case (collector) is shorted to the heatsink. Q1 is located on the output stage heatsink, and is a small 2N2222 NPN type. The relay is located on the circuit board near the output stage, and is a 5-6VDC DPDT relay. If no short is indicated, it is possible that the bias transistor, Q1, is shorted. If the voltages are greater than indicated, it is likely that the bias transistor, Q1, is open. Again, be certain to discharge the main filter capacitors before replacing any of the above components.

After ascertaining that the gate voltages are correct, turn off the SA-20 and discharge the output stage main filter capacitors as described above.

Install a 1 AMP FAST-BLO fuse into one of the "rail fuse" holders. Install a 1-ohm 2 watt resistor into the other "rail fuse" clips next to the 1 amp fuse. You can solder this resistor across an open fuse for easy installation.

If there is no output fuse (or this fuse is bad), install a good one into the output fuse clips located at the rear of the circuit board.

Connect a digital voltmeter (20 dc volt range) across the speaker output terminals, from red to black. This meter will be used to monitor the dc offset.

Connect a second DVM across the 1-ohm resistor installed in the "rail fuse" position. Set this meter to the 2 dc volt range. This meter will be used to monitor the bias current.

Set your AC Mains voltage to zero and turn on the SA-20. Slowly increase the Mains voltage to 1/3 nominal and observe the bias current meter. The reading should remain less than 10mV. If there is a reading higher than this, either the MOSFETs have been

installed incorrectly, one or more gate resistor has not been connected or is open, or there is a faulty MOSFET.

Slowly increase the AC voltage to full nominal mains value. If the dc offset reading begins to exceed 5 volts, it is possible that one of the MOSFETs is faulty.

Set the amplifier into the unmuted condition by connecting a wire jumper across R70, as described above. If the bias current exceeds 0.7 volts, attempt to reduce this voltage with VR1, the bias trimpot. If the trimpot has no effect, it is likely that Q1 is faulty. If the trimpot does control the bias current reading, but you cannot reduce the voltage to 0.7 volts or below, the value of R16 needs to be reduced. Try placing a 100k ohm resistor in parallel with R16. This should bring the bias reading into a controllable range.

Adjust the AC mains voltage to within 2% of nominal and adjust VR1 to set the bias current reading to between 0.48 and 0.52 volts. This voltage will initially climb to a somewhat higher reading and then begin to drop as Q1 controls the temperature of the heatsink by modifying the gate bias voltage.

Adjust VR 2 to reduce OFFSET VOLTAGE to less than .01V.

Allow the SA-20 to heat up. Occasionally readjust both readings until the amplifier has settled. We recommend a minimum of 24 hours of observation and adjustment.

After burn-in, turn off the SA-20, discharge the output stage filter capacitors and install 20 amp fast blow fuses into both "rail fuse" positions. NOTE: the 20 amp value was selected for reliable performance into low-impedance loudspeakers of 1 ohm. If more protection is desired, and the customer is not using low impedance speakers, fuses of smaller rating may be used here.

Adjustments

The SA-20 has no internal adjustments other than the offset and bias control described above.

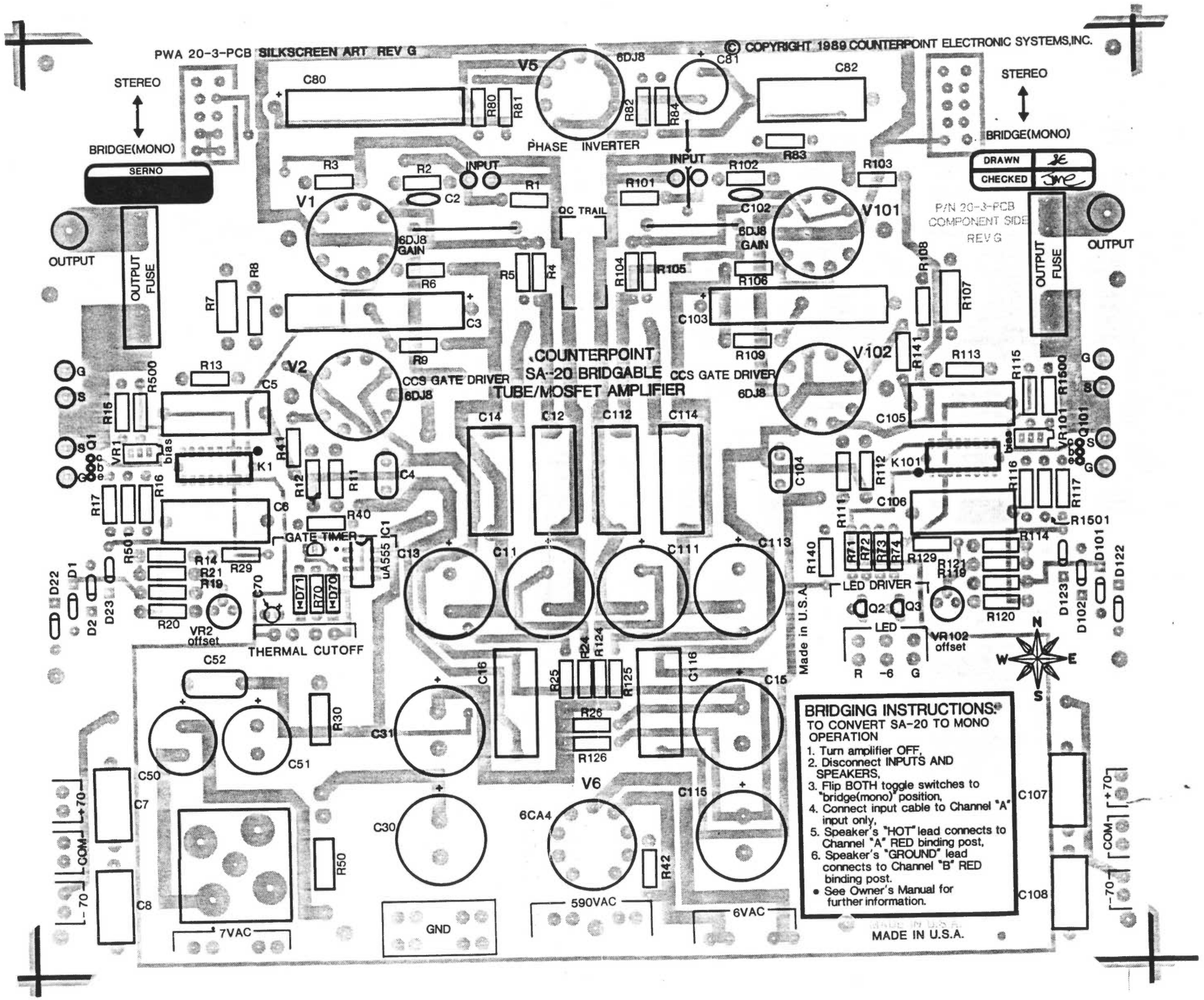
TABLE OF REPLACEMENT PARTS

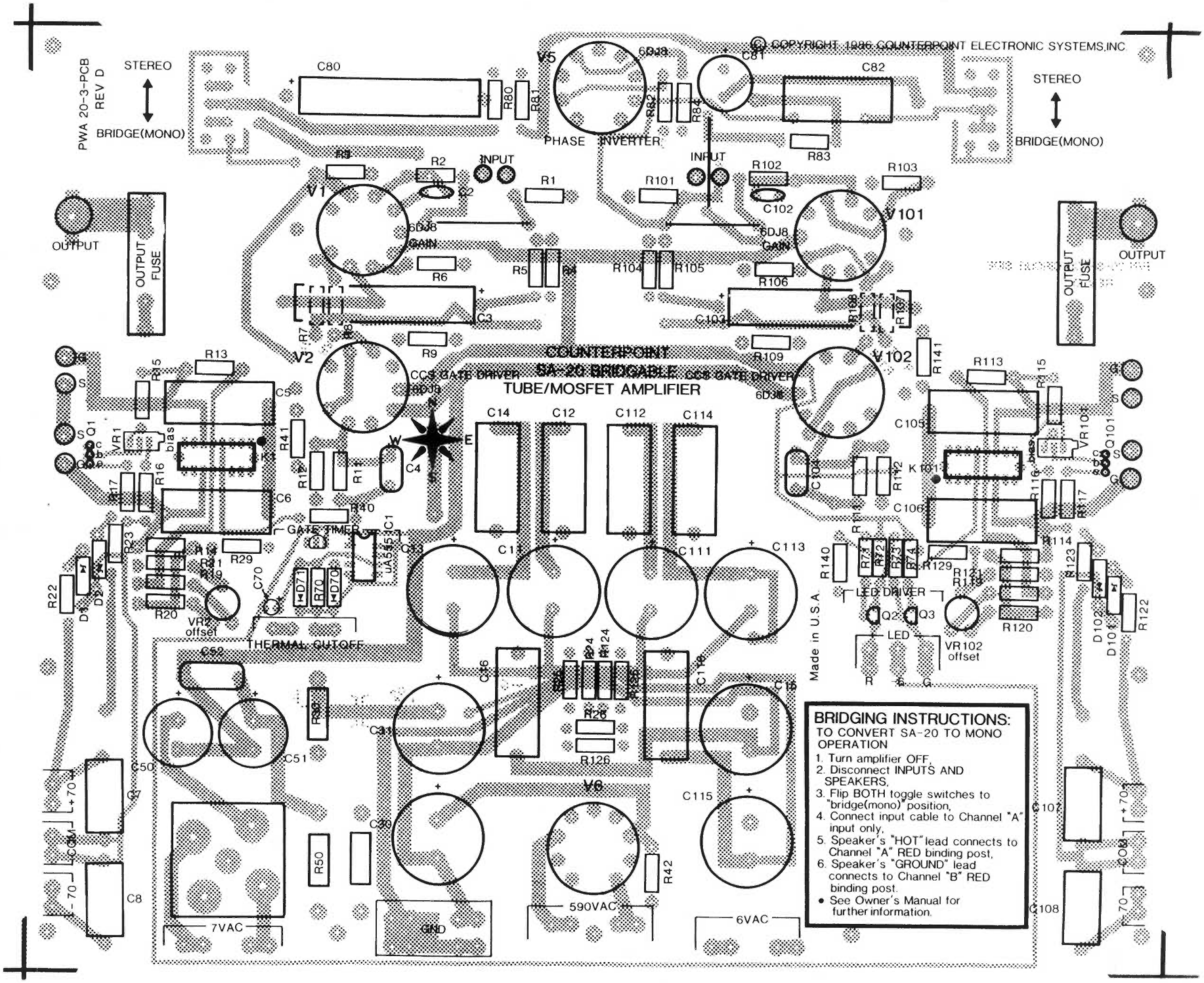
CIRCUIT BOARD ASSEMBLY

R50	1 OHM 5W
R41,141	51.1R
R40, 140, 500, 501, 1500,1501	100R
R74	332R
R72	475R
R24, 25, 26, 124, 125, 126	499R
R30	5005 WW5W
R3, 5, 6 ,8 ,82, 103, 105, 106, 108	681R
R42	1.00K
R71, 73	1.00K
R2, 102	2.21K
R11, 111	10.0K
R17, 83, 117	22.1K
R80	40.2K
R16, 81, 116	47.5K
R1, 4, 21, 29, 84, 101, 104, 121, 129	100K
R7, 107	100K 1W
R9, 13, 14, 15, 19, 20, 109, 113, 114, 115, 119, 120	1.00M
R12, 112	2.21M
R70	4.02M
C2, 102	3PF MICA
C82	.1/425 PP
C3, 103	.68/425 PP
C4, 104	1/63 PP
C52	1/100 PE
C7, 8, 107, 108	1/160 PP
C5. 6. 106. 106	1/25 PP
C12, 14, 16, 112, 114, 116	1/400 PP
C80	8/210 PP
C70, 81	22/350 LYTIC
C11, 13, 15, 30, 31, 111, 113, 115	100/400 LYTIC
C50, 51	6800/10 LYTIC
D22, 23, 122, 123	1N5303
D70, 71	1N4007
D1, 2, 101, 102	1N5371B
Q1, 101	2N2222
Q2, 3	PN2222
	2N4403
V1, 2, 5, 6, 101, 102	
VR1, 101	100K TRIMPOT
VR20, 120	250K 10 TURN TRIMPOT
	RELAY 5V DPDT DIP
I.C.C.	LM555

HEATSINK ASSEMBLY

20.0 OHMS P-CHANNEL GATE RESISTORS
R51.1 OHMS N-CHANNEL GATE RESISTORS
1N4740A DIODE
MOSFET IRF9241
MOSFET RFM10N15
UF4003 ULTRA FAS BACK-EMF DIODE


PWA 20-3-PCB SILKSCREEN ART REV G
© COPYRIGHT 1989 COUNTERPOINT ELECTRONIC SYSTEMS,INC.
STEREO
BRIDGE(MONO)
SERNO
OUTPUT
OUTPUT FUSE
INPUT
V1
6DJ8 GAIN
QC TRAIL
V5
6DJ8
PHASE INVERTER
V101
V2
CCS GATE DRIVER
6DJ8
COUNTERPOINT
SA-20 BRIDGABLE
TUBE/MOSFET AMPLIFIER
V102
GATE TIMER
uA555 IC1
VR2 offset
THERMAL CUTOFF
LED DRIVER
LED
VR102 offset
R -6 G
V6
6CA4
7VAC
GND
590VAC
6VAC
Made in U.S.A.
P/N 20-3-PCB
COMPONENT SIDE
REV G
DRAWN
CHECKED
BRIDGING INSTRUCTIONS:
TO CONVERT SA-20 TO MONO OPERATION
1. Turn amplifier OFF,
2. Disconnect INPUTS AND SPEAKERS,
3. Flip BOTH toggle switches to "bridge(mono)" position,
4. Connect input cable to Channel "A" input only,
5. Speaker's "HOT" lead connects to Channel "A" RED binding post,
6. Speaker's "GROUND" lead connects to Channel "B" RED binding post.
• See Owner's Manual for further information.
MADE IN U.S.A.


© COPYRIGHT 1986 COUNTERPOINT ELECTRONIC SYSTEMS,INC
PWA 20-3-PCB REV D
STEREO
BRIDGE(MONO)
COUNTERPOINT
SA-20 BRIDGABLE
TUBE/MOSFET AMPLIFIER
CCS GATE DRIVER
PHASE INVERTER
INPUT
OUTPUT
OUTPUT FUSE
GAIN
bias
GATE TIMER
THERMAL CUTOFF
VR2 offset
VR102 offset
LED DRIVER
LED
Made in U.S.A.
7VAC
GND
590VAC
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BRIDGING INSTRUCTIONS:
TO CONVERT SA-20 TO MONO OPERATION
1. Turn amplifier OFF,
2. Disconnect INPUTS AND SPEAKERS,
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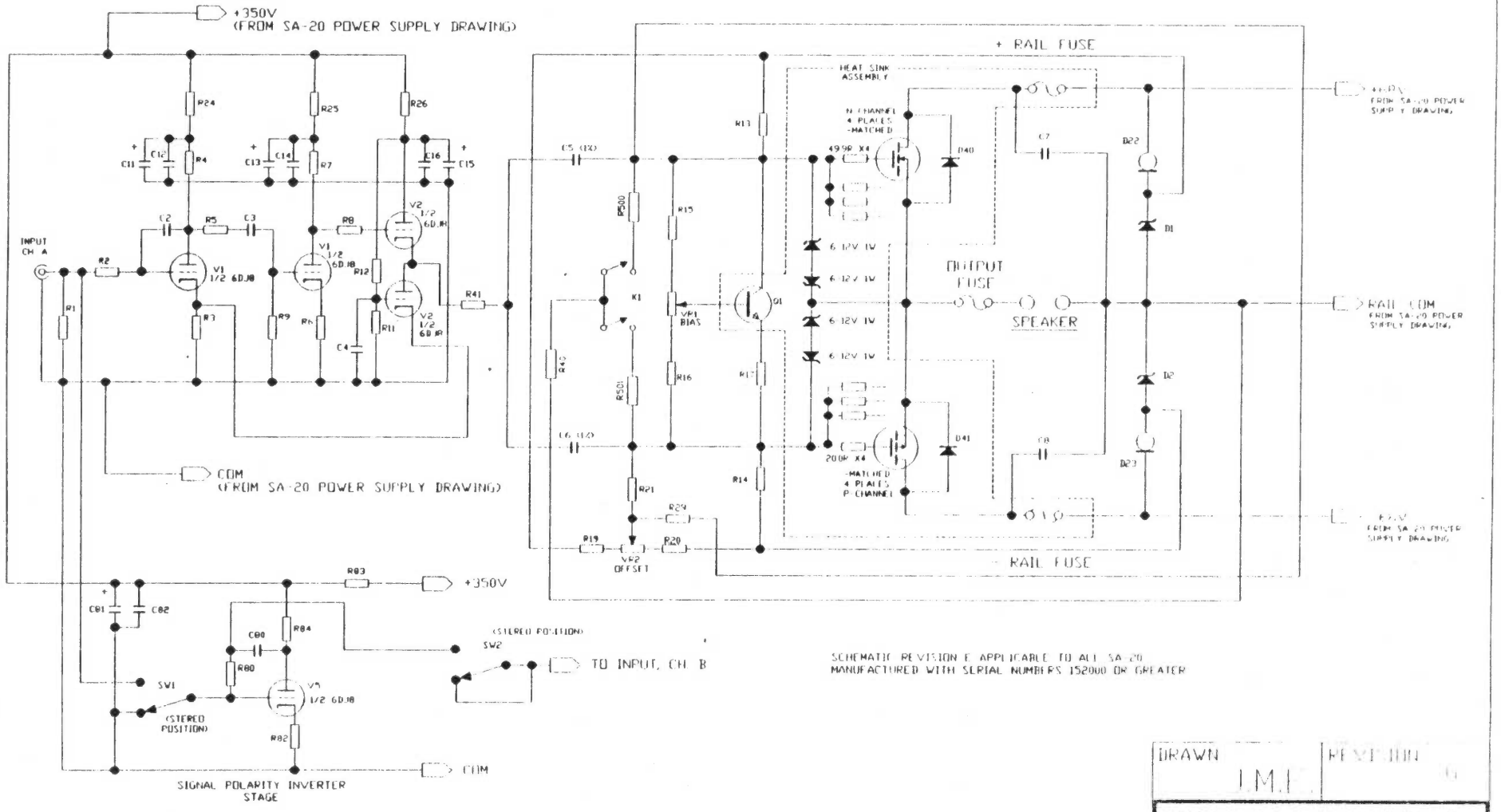
4. Connect input cable to Channel "A" input only,
5. Speaker's "HOT" lead connects to Channel "A" RED binding post,
6. Speaker's "GROUND" lead connects to Channel "B" RED binding post.
• See Owner's Manual for further information.

REV	DESCRIPTION	DATE
D	DRAWING UPDATED ACCORDING TO PRODUCTION	3/09/88
E	RELIABILITY ENHANCEMENTS ADDED 1. R22/R23 REPLACED WITH D22/23 2. R500/501 ADDED 3. R41 ADDED - REFER TO SERVICE BULLETIN # 20-1088 FOR UPDATE DETAILS	9/11/88
F	R40 ADDED TO SCHEMATIC TO REFLECT ACTUAL AMPLIFIER CIRCUITRY	2/17/89
G	D40/D41 ADDED FOR BACK E.M.F. PROTECTION PER ECO 154	3/15/89



SCHEMATIC REVISION E APPLICABLE TO ALL SA-20 MANUFACTURED WITH SERIAL NUMBERS 152000 OR GREATER

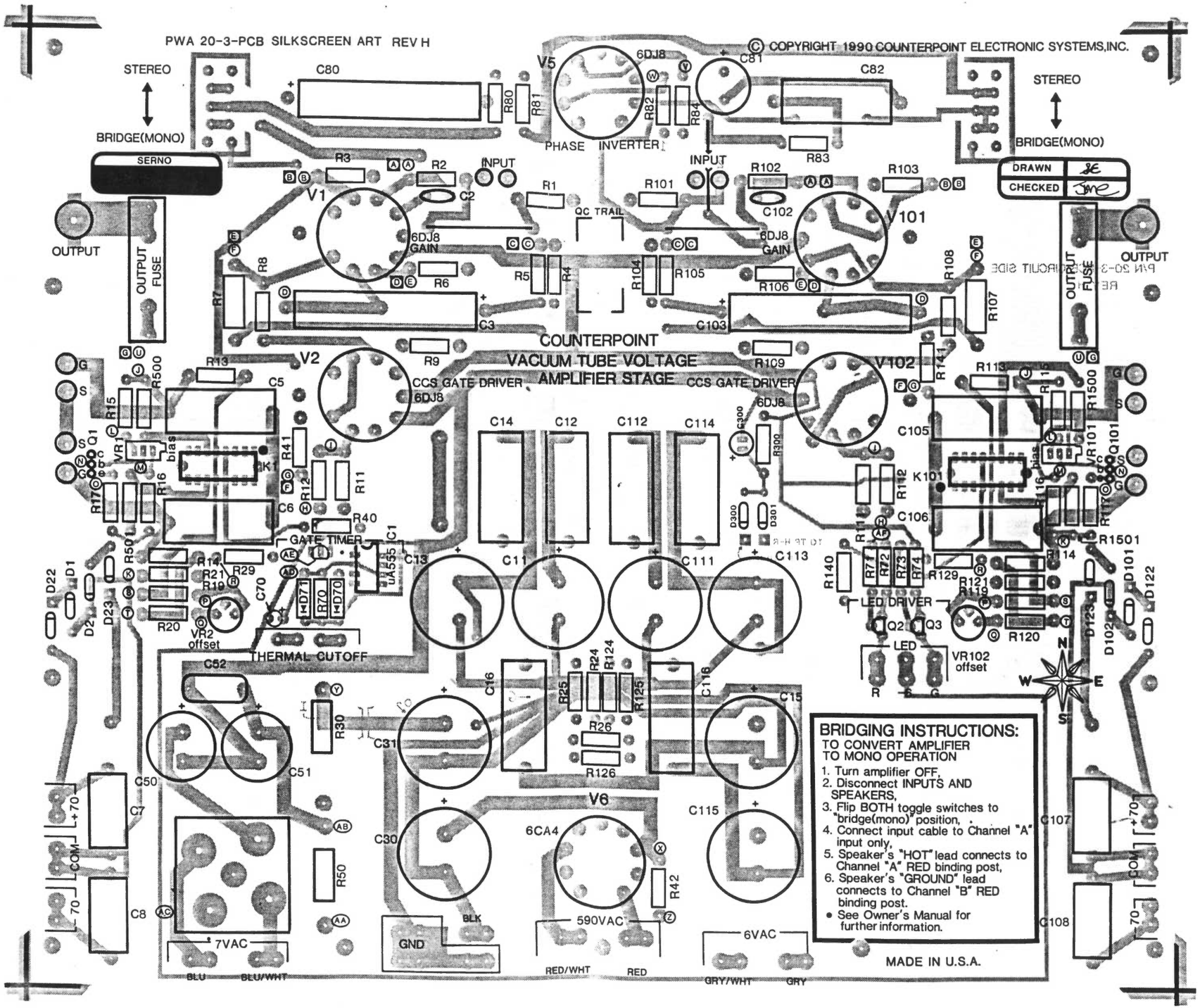
NOTES:
1. CHANNEL "A" (LEFT CHANNEL) SHOWN ONLY. CHANNEL "B" COMPONENTS USE "100" PREFIX.

DRAWN	REVISION
I.M.F.	G

COUNTERPOINT

SA-20 AUDIO SCHEMATIC

CAD FILE: SA20SCH1 DWG SIZE: D


PWA 20-3-PCB SILKSCREEN ART REV H
© COPYRIGHT 1990 COUNTERPOINT ELECTRONIC SYSTEMS,INC.
STEREO
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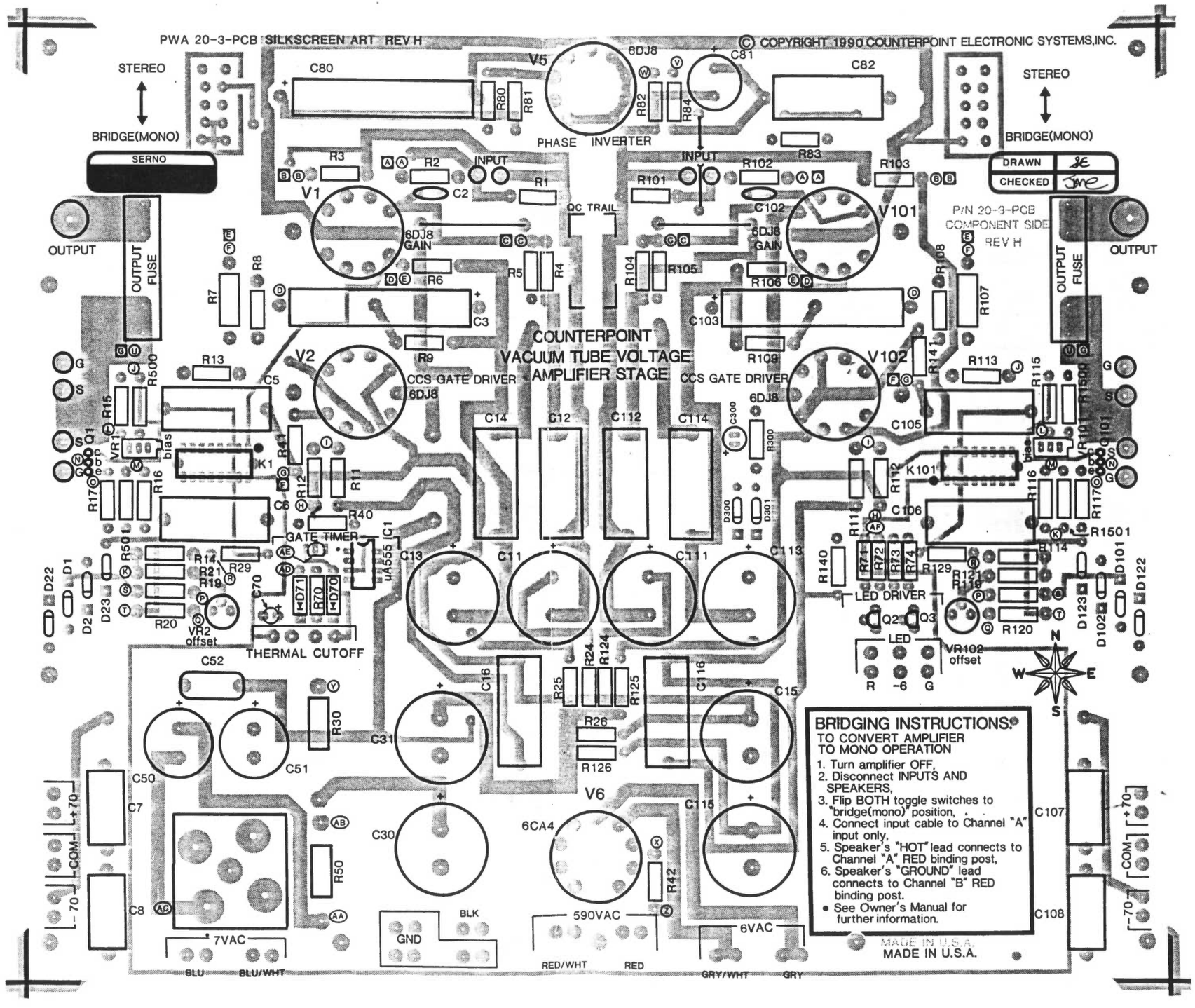
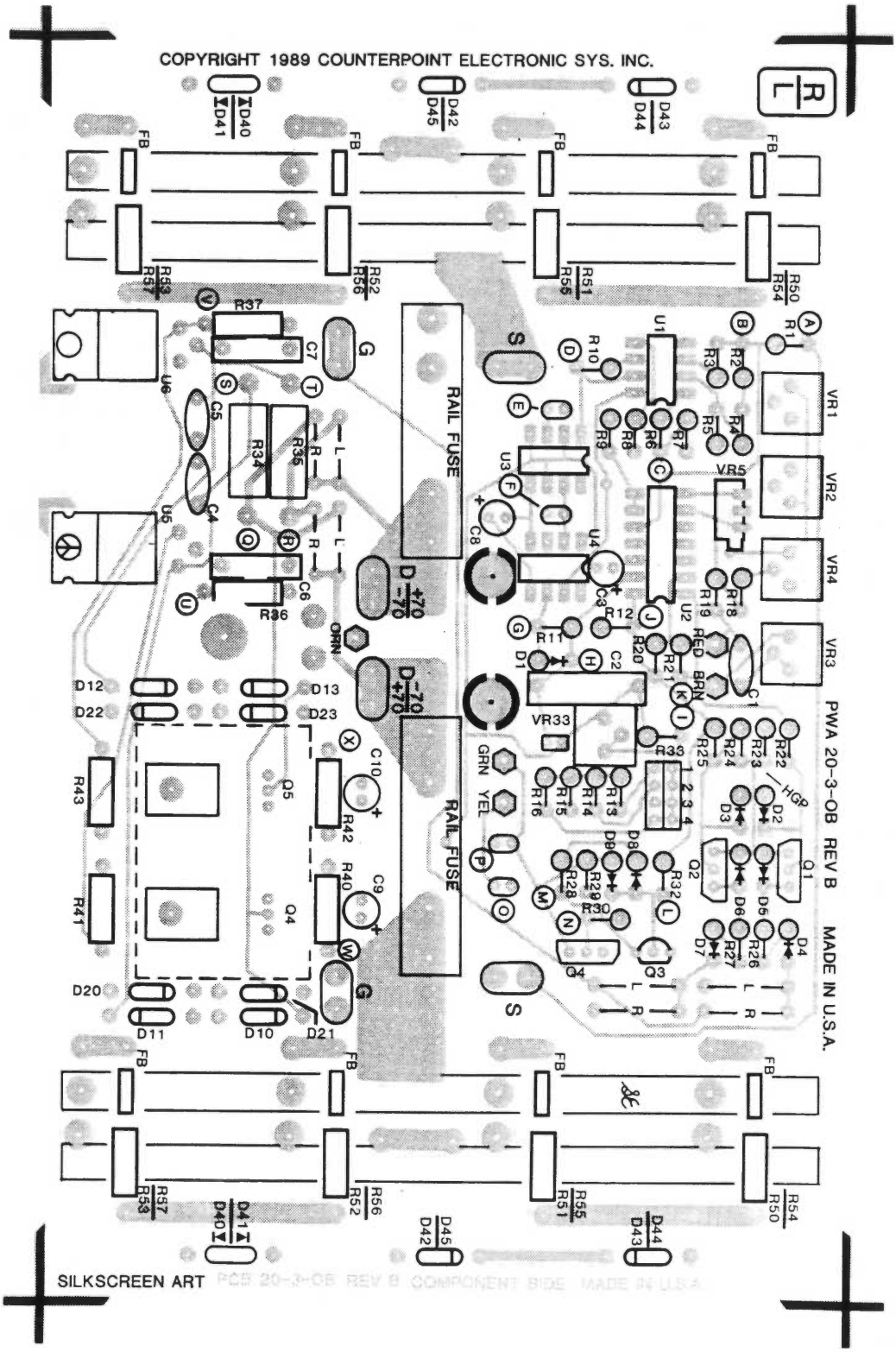
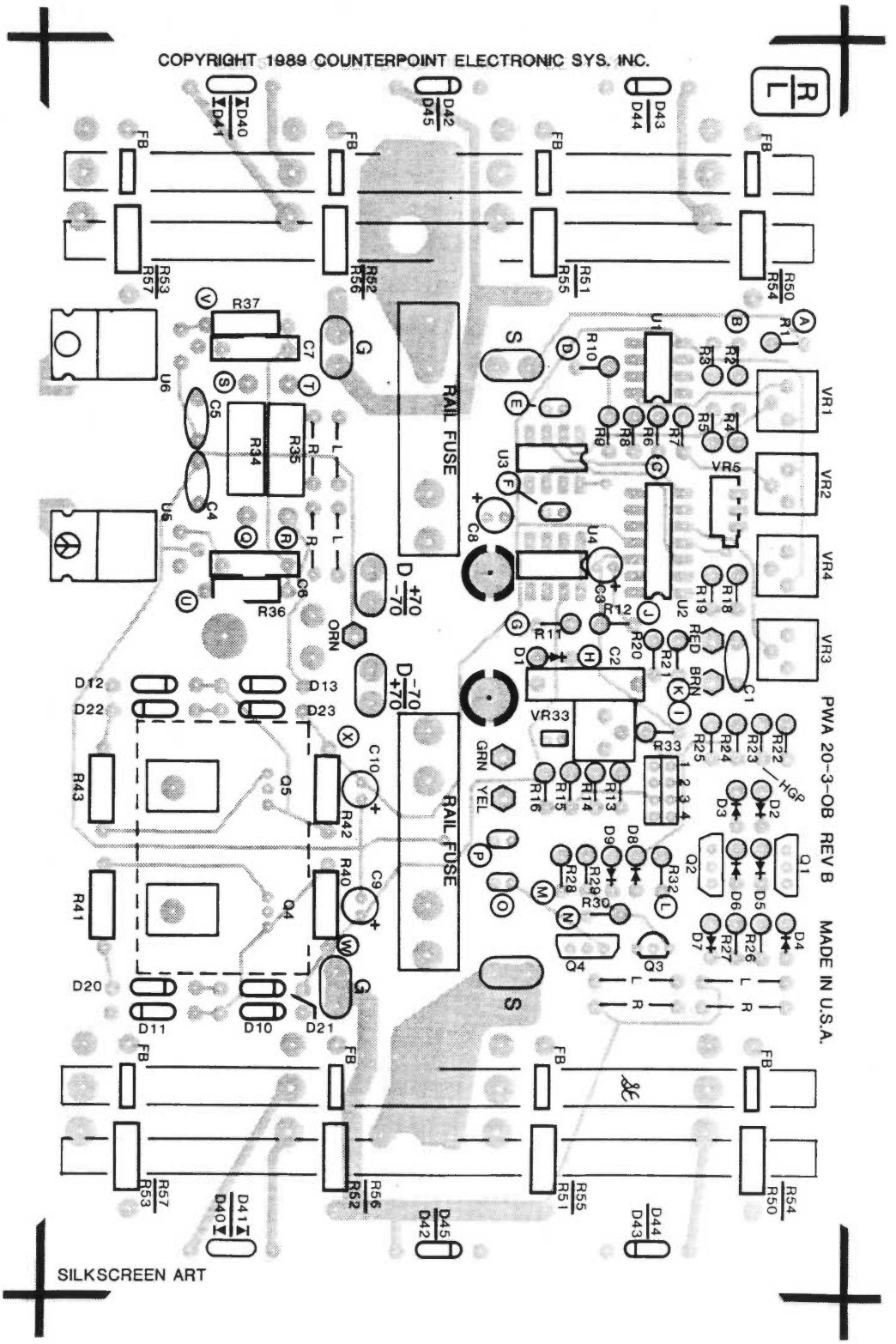
INPUT
OUTPUT
OUTPUT FUSE
6DJ8
GAIN
PHASE INVERTER
CCS GATE DRIVER
COUNTERPOINT
VACUUM TUBE VOLTAGE
AMPLIFIER STAGE
GATE TIMER
LED DRIVER
LED
VR2 offset
VR102 offset
THERMAL CUTOFF
6CA4
7VAC
590VAC
6VAC
GND
BLK
BLU
BLU/WHT
RED/WHT
RED
GRY/WHT
GRY
BRIDGING INSTRUCTIONS:
TO CONVERT AMPLIFIER TO MONO OPERATION
1. Turn amplifier OFF,
2. Disconnect INPUTS AND SPEAKERS,
3. Flip BOTH toggle switches to "bridge(mono)" position,
4. Connect input cable to Channel "A" input only,
5. Speaker's "HOT" lead connects to Channel "A" RED binding post,
6. Speaker's "GROUND" lead connects to Channel "B" RED binding post.
• See Owner's Manual for further information.
MADE IN U.S.A.


PWA 20-3-PCB SILKSCREEN ART REV H
© COPYRIGHT 1990 COUNTERPOINT ELECTRONIC SYSTEMS,INC.
STEREO
BRIDGE(MONO)
SERNO
OUTPUT
OUTPUT FUSE
INPUT
PHASE INVERTER
6DJ8
V5
C80
C81
C82
R80
R81
R82
R84
R83
V1
V101
6DJ8 GAIN
QC TRAIL
R1
R2
R3
C2
R101
R102
R103
C102
R4
R5
R6
R7
R8
R104
R105
R106
C3
C103
R108
R107
P/N 20-3-PCB
COMPONENT SIDE
REV H
DRAWN
CHECKED
COUNTERPOINT
VACUUM TUBE VOLTAGE
AMPLIFIER STAGE
V2
V102
CCS GATE DRIVER
R9
R109
R141
R113
R115
R500
R13
C5
C105
R15
Q1
VR1
bias
K1
K101
R41
R11
R12
R16
R17
C6
R40
GATE TIMER
IC1
uA555
C13
C11
C111
C113
C14
C12
C112
C114
C300
R300
D300
D301
R50
R14
R21
R29
R19
C70
D71
R70
D70
D22
D1
D2
D23
R20
VR2
offset
THERMAL CUTOFF
C106
R1501
R140
R111
R114
R121
R119
R129
R120
LED DRIVER
Q2
Q3
LED
VR102
offset
R
-6
G
N
W
E
S
C52
C51
C50
C7
C8
R30
C31
C16
R24
R124
R25
R125
R26
R126
C116
C15
V6
6CA4
C30
C115
R42
R50
C107
C108
BRIDGING INSTRUCTIONS:
TO CONVERT AMPLIFIER
TO MONO OPERATION
1. Turn amplifier OFF,
2. Disconnect INPUTS AND SPEAKERS,
3. Flip BOTH toggle switches to "bridge(mono)" position,
4. Connect input cable to Channel "A" input only,
5. Speaker's "HOT" lead connects to Channel "A" RED binding post,
6. Speaker's "GROUND" lead connects to Channel "B" RED binding post.
• See Owner's Manual for further information.
MADE IN U.S.A.
MADE IN U.S.A.
+70
COM
-70
7VAC
BLU
BLU/WHT
GND
BLK
590VAC
RED/WHT
RED
6VAC
GRY/WHT
GRY


COPYRIGHT 1989 COUNTERPOINT ELECTRONIC SYS. INC.
R
L
RAIL FUSE
RAIL FUSE
PWA 20-3-OB REV B MADE IN U.S.A.
SILKSCREEN ART
PCB 20-3-OB REV B COMPONENT SIDE MADE IN U.S.A.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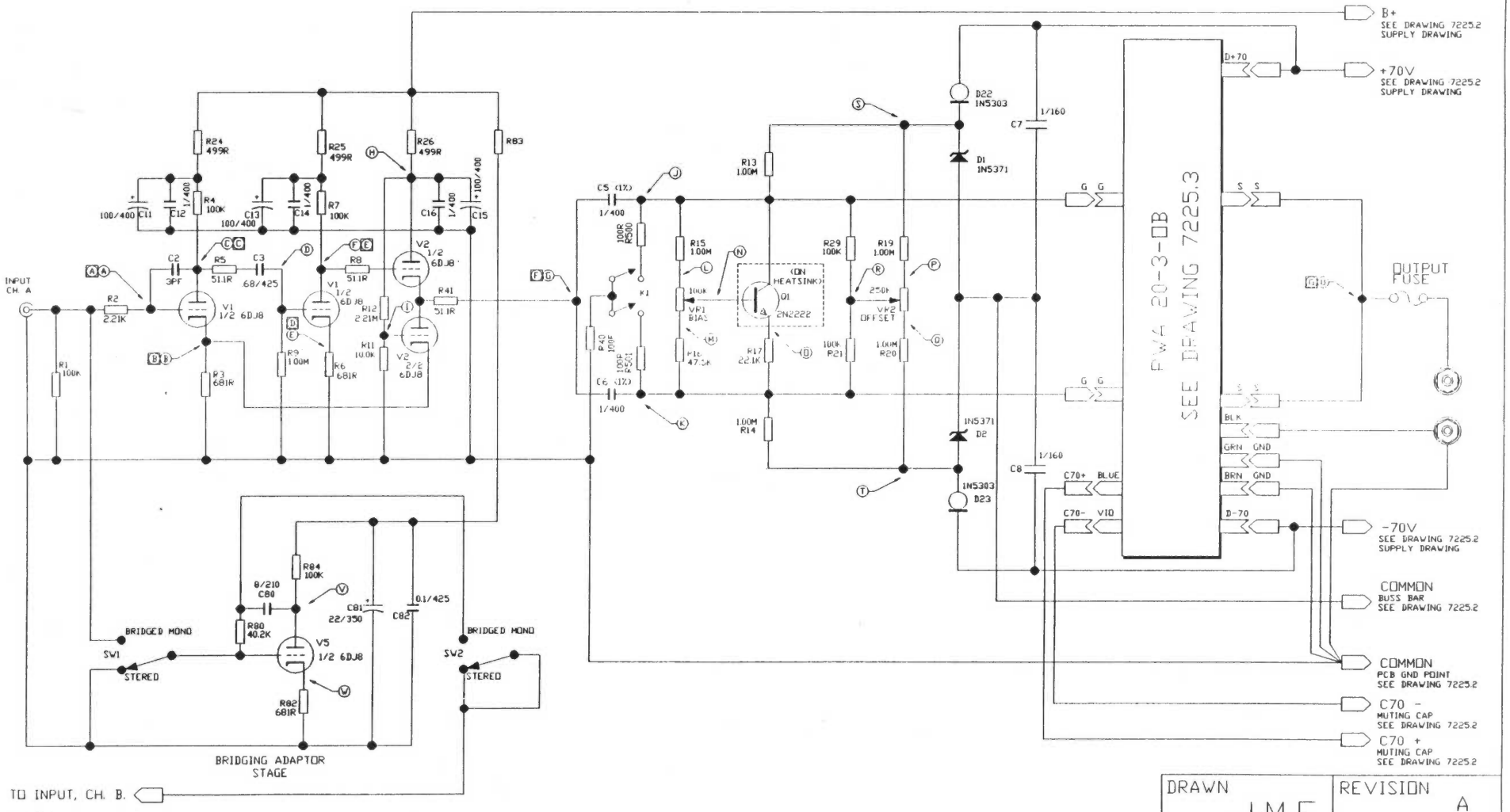
R
L
PWA 20-3-OB REV B MADE IN U.S.A.
RAIL FUSE
RAIL FUSE
SILKSCREEN ART

REV	DESCRIPTION	DATE
A	DRAWING UPDATED PER PROTO	



NOTES:
1. CHANNEL "A" (LEFT CHANNEL) SHOWN ONLY. CHANNEL "B" COMPONENTS USE "100-" PREFIX. BRIDGING ADAPTOR STAGE IS SHARED BY BOTH CHANNELS.
2. REFERENCED VOLTAGES (A) THROUGH (V) REFER TO NORMAL DC OPERATING VOLTAGES AS SHOWN ON DRAWING NUMBER 7221.1 "DC OPERATING VOLTAGES, PWA 22-3-AB."
3. REFERENCED VOLTAGES (A) THROUGH (J) REFER TO NORMAL AC SIGNAL LEVELS AS SHOWN ON DRAWING NUMBER 7224.1 "SIGNAL LEVELS, PWA 22-3-AB."
4. FOR CIRCUIT DIAGRAM OF POWER SUPPLY SECTION OF PWA 22-3-AB, REFER TO DRAWING 7225.2 "SA-220 POWER SUPPLY CIRCUIT."
5. FOR CIRCUIT DIAGRAM OF PWA 20-3-DB, REFER TO DRAWING 7225.3 "CIRCUIT DIAGRAM, PWA 20-3-DB."
6. FOR DESCRIPTION OF CIRCUIT, REFER TO DRAWING 7223.1 "CIRCUIT DESCRIPTION, PWA 22-3-AB."
7. FOR LISTING OF FIELD-REPLACEABLE PARTS, REFER TO DRAWINGS 7223.1 "LIST OF MATERIALS, PWA 22-3-AB."

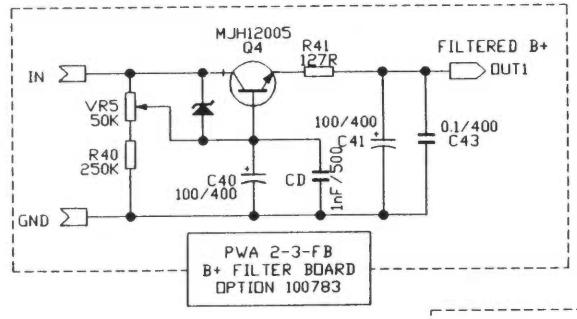
DRAWN	REVISION
J.M.E.	A

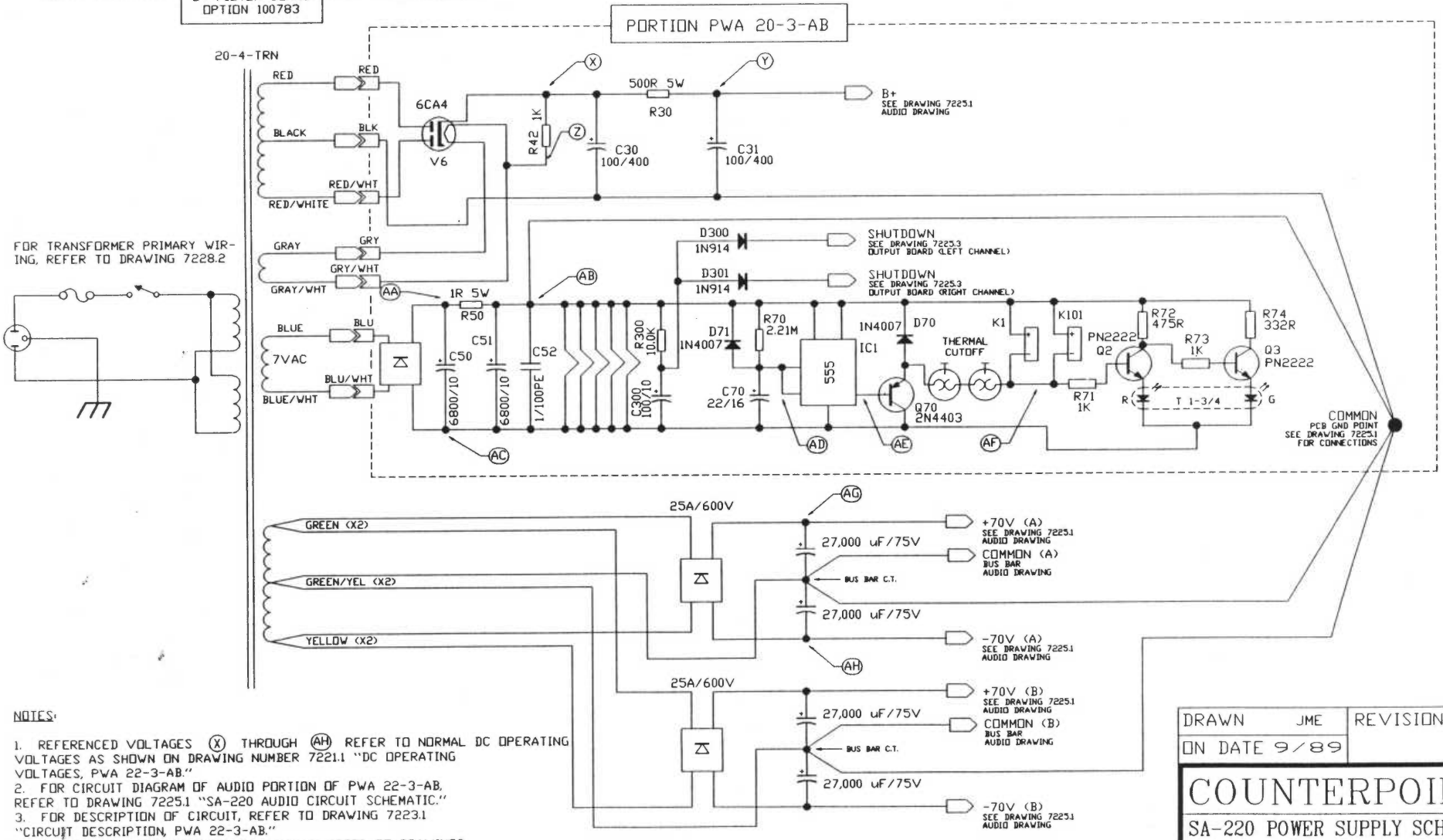
COUNTERPOINT

SA-220 AUDIO CIRCUIT SCHEMATIC

CAD FILE:	DWG:
22AUDIO	7225.1

REV	DESCRIPTION	DATE
A	REVISED PER PROTO	9/89
B	REVISED PER ECO 199; C300, R300, D300 AND D301 ADDED TO ELIMINATE RELAY BOUNCE EFFECTS ON SHUTDOWN.	1/90





NOTES:

1. REFERENCED VOLTAGES (X) THROUGH (AH) REFER TO NORMAL DC OPERATING VOLTAGES AS SHOWN ON DRAWING NUMBER 7221.1 "DC OPERATING VOLTAGES, PWA 22-3-AB."
2. FOR CIRCUIT DIAGRAM OF AUDIO PORTION OF PWA 22-3-AB, REFER TO DRAWING 7225.1 "SA-220 AUDIO CIRCUIT SCHEMATIC."
3. FOR DESCRIPTION OF CIRCUIT, REFER TO DRAWING 7223.1 "CIRCUIT DESCRIPTION, PWA 22-3-AB."
4. FOR LIST OF FIELD-REPLACEABLE PARTS, REFER TO DRAWINGS 7223.1 "LIST OF MATERIALS, PWA 22-3-AB."

DRAWN JME	REVISION
ON DATE 9/89	B

COUNTERPOINT

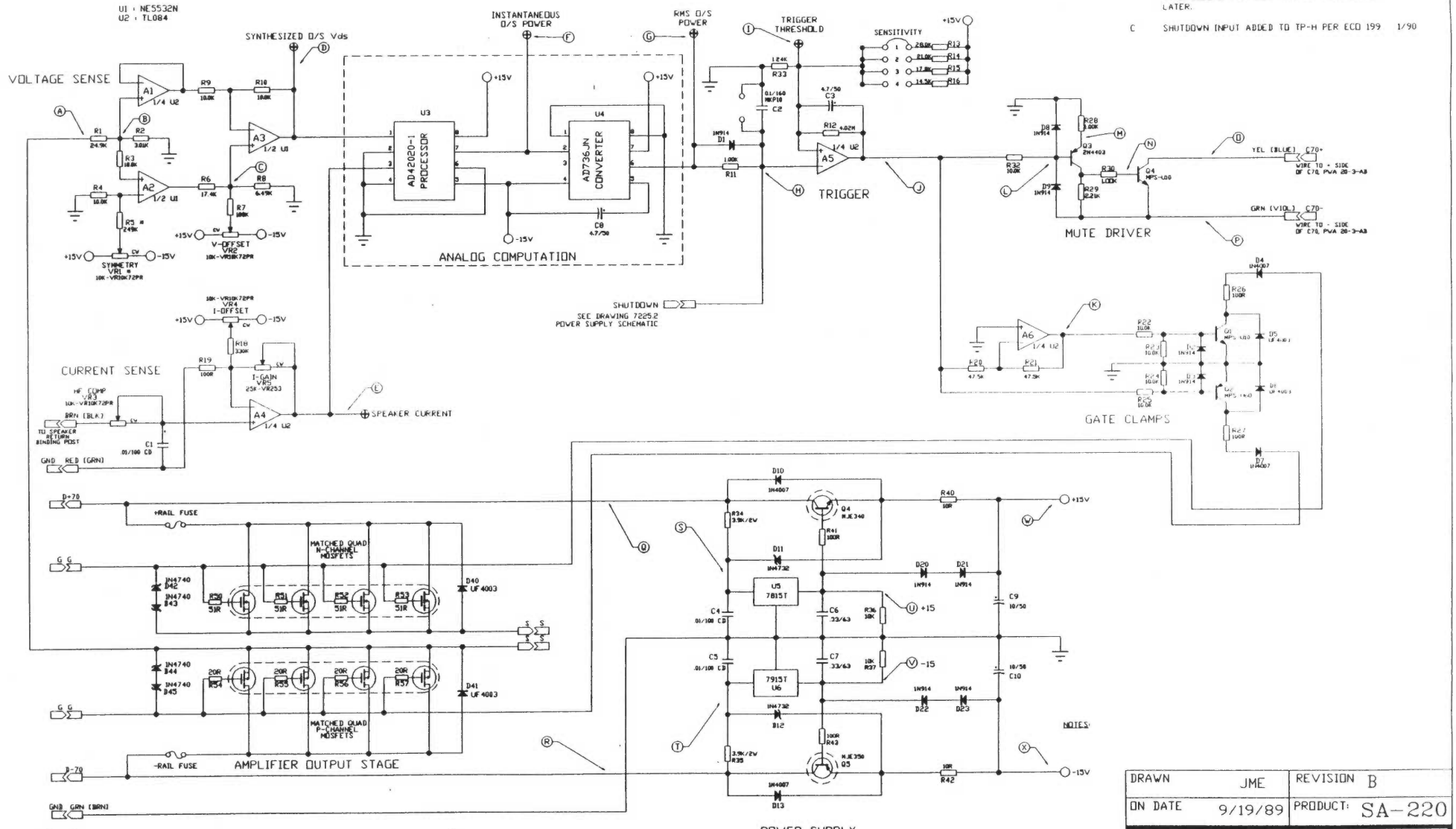
SA-220 POWER SUPPLY SCHEMATIC

CAD FILE: 22POWER	DWG 7225.2

REV	DESCRIPTION	DATE
-NONE-	FIRST ITERATION DRAWING FOR PROTOTYPING PURPOSES ONLY. DO NOT USE FOR PRODUCTION WITHOUT CONFIRMING CURRENT REV LEVEL.	9/89
A	C9, C10, ADDED TO SCHEMATIC. DAMPING RESISTORS R41 AND R43 ADDED. APPLIES TO ALL REVISIONS OF PCB.	10/15/89
B	SHORT CIRCUIT PROTECTION PARTS R40, R42, D20, D21, D22, D23 ADDED. DRAWING UPDATED TO SHOW CORRECTED PAD LABELS TO MATCH WIRE COLORS. APPLIES TO REV B PCB'S AND LATER.	10/31/89
C	SHUTDOWN INPUT ADDED TO TP-H PER ECO 199	1/90

POWER SENSITIVITY

SENSITIVITY SETTING	TP I APPROXIMATE TRIGGER VOLTAGE	MAX POWER/1 OHM BEFORE MUTE
1	0.610	100 WATTS
2	0.805	200 WATTS
3	0.930	400 WATTS
4	1.200	>800 WATTS



NOTES

1. DIAGRAM IS SCHEMATIC OF SA-220 OUTPUT STAGE AND PROTECTION CIRCUIT, LOCATED ON PVA 20-3-0B.
2. CIRCUIT SHOWN IS FOR ONE CHANNEL ONLY. OTHER CHANNEL CIRCUITRY IDENTICAL.
3. REFER TO DRAWING 7204.1 "AC AND DC OPERATING VOLTAGES, PWA 20-3-0B" FOR TYPICAL VOLTAGES AND WAVEFORMS AT TESTPOINTS (A) THROUGH (V).
4. FOR INSTALLATION AND CALIBRATION, REFER TO SERVICE BULLETIN # 20-0789. DO NOT ATTEMPT INSTALLATION WITHOUT CALIBRATION.
5. FOR DESCRIPTION OF PROTECTION CIRCUIT, REFER TO DRAWING NUMBER 7202.1 "CIRCUIT DESCRIPTION, PWA 20-3-0B."
6. FOR LIST OF REPLACEABLE PARTS, REFER TO DRAWING NUMBER 7203.1 "LIST OF MATERIALS, PWA 20-3-0B."

⊃Σ INDICATES CONNECTION TO SAME-NAMED CONNECTIONS ON PWA 20-3-AB. REFER TO DRAWING 7225.1 "SA-220 AUDIO CIRCUIT SCHEMATIC" FOR FURTHER DETAILS. INDICATED COLOR REFERS TO WIRE COLOR USED FOR CONNECTION. COLOR IN (BRACKETS) INDICATED COLOR MARKED ON REV A CIRCUIT BOARDS. REV B AND LATER ARE LABELLED WITH CORRECT COLOR AS SHOWN NOT IN BRACKETS.

DRAWN	JME	REVISION	B
ON DATE	9/19/89	PRODUCT:	SA-220

COUNTERPOINT

DETAIL CIRCUIT DIAGRAM
PWA 20-3-0B OUTPUT BOARD

CAD FILE: 220S | DWG 7225.3

REV	DESCRIPTION	DATE
-NONE-	FIRST ITERATION DRAWING FOR PROTOTYPING PURPOSES ONLY. DO NOT USE FOR PRODUCTION WITHOUT CONFIRMING CURRENT REV LEVEL.	11/10/89

CIRCUIT DESCRIPTION, PWA 20-3-0B OUTPUT BOARD

GENERAL

The SA-220 has three circuit boards: the main audio board located in the center of the SA-220 contains power supplies, audio amplification and driver stages; and two circuit boards, PWA 20-3-0B, located on the side heatsinks which contain the amplifier output stage and protection circuitry. This document describes the circuitry on PWA 20-3-0B.

For further information, refer to the following documents:

For schematic of the audio circuitry on the main audio board, use drawing number 7225.1 "SA-220 AUDIO CIRCUIT SCHEMATIC"

Power supply and power supply portion of the main audio board are diagrammed on drawing 7225.2 "SA-220 POWER SUPPLY SCHEMATIC."

For schematic of the audio output stage, use drawing 7225.3 "DETAIL CIRCUIT DIAGRAM PWA 20-3-0B OUTPUT BOARD."

For schematic of the Advanced Protection Circuit, use Drawing 7225.3 "DETAIL CIRCUIT DIAGRAM PWA 20-3-0B OUTPUT BOARD."

For List of Materials, refer to Drawings 7203.1 "LIST OF MATERIALS, PWA 20-3-0B".

AMPLIFIER OUTPUT STAGE portion PWA 20-3-0B

As shown on "SA-220 AUDIO SCHEMATIC," the amplifier output stage is standard complementary circuit consisting of four paralleled N-channel MOSFETs for the top half signal cycle, and four P-channel MOSFETs for the bottom half. Device matching at operating temperature and shared gate bias voltage is critical as there are no source resistors to force current-sharing. The output stage is biased class-AB by bias network Q1, located on the Audio Board.

Zener diodes, D42, D43, D44 and D45 assure that the maximum gate-to-source voltage as specified by the MOSFET manufacturer is never exceeded. Ultra-fast recovery diodes D40 and D41 are used to clamp speaker-generated back EMF and eliminate excessive reverse-biasing conditions to the MOSFETs.

PROTECTION CIRCUIT portion PWA 20-3-0B

The Advanced Protection Circuit ("APC"), located on the side Printed Wiring Assemblies, may be broken down into seven parts: Voltage Sense circuitry, Current Sense circuity, Analog Computation, Trigger circuit, Gate Clamp circuitry, Mute Driver circuitry and Power Supply.

Voltage Sense circuity

Audio amplifier output signal is divided by R1 and R2. Amplifier A1 is a voltage follower and buffers the divided signal. Amplifier A2 is a comparator, whose output is a square wave. This square wave may be considered a severely clipped representation of the audio amplifier's output, with zero-crossings corresponding to the zero-crossings of the audio waveform. This square wave is divided by R6 and R8 to + and - 7VDC. Differential amplifier A3 subtracts the two waveforms. The resultant signal is a very close 1:10 simulation of the drain-to-source voltage across the audio amplifier's output

Current Sense circuity

Amplifier A4 is operated as a differential amplifier, and senses the speaker current voltage drop in the internal wire connected between the speaker return binding post on the rear of the audio amplifier and the PCB star ground point. VR5 is adjusted to scale the amplified voltage to one-tenth its actual value. RC network VR3 and C1 allow compensation for wiring inductances at high frequencies.

Analog Computation

Signals from the voltage sense circuit and the current sense circuit are processed by proprietary IC's U3 and U4. The product of the simulated Vds and speaker current is converted to an rms voltage. The final processed signal, at test point G, is an accurate representation of the rms power dissipated in the audio amplifier's output devices. This voltage is a DC voltage and may be monitored on an oscilloscope for a moment-by-moment visual indication of amplifier output stage operation.

Trigger circuitry

Comparator A5 is used to compare the processed output of the analog computation circuit against the "sensitivity" setting as established by a jumper link. If audio amplifier output stage dissipation exceeds the trigger threshold, the output of A5, normally high, goes low, to -14V. Trigger threshold voltages and the approximate maximum power the audio amplifier may dissipate into a 1 ohm load are shown on the schematic detail drawing. Capacitor C3 applies positive feedback and forces A5 to remain low for tens of milliseconds, preventing early unmuting of the amplifier before the amplifier's muting relay has had an opportunity to operate.

Gate Clamps

If the output of A5 goes low, transistors Q1 and Q2, connected between the gates of the output stage MOSFETs and ground conduct, eliminating gate bias and clamping the gates to ground preventing any audio amplifier output voltage swings.

Mute Driver

When the output of A5 goes low, transistors Q3 and Q4 are used to discharge the audio amplifier's mute circuit capacitor C70, (located on the main audio circuit board) causing the amplifier's muting relay to do a final clamping of the output stage's MOSFETs to ground. The moment the output stage's gates are clamped to ground, the fault is eliminated and the output of A5 returns to the high condition (once C3 permits it). However, the audio amplifier will not unmute until power-on mute timer capacitor C70 has charged up again, a process requiring 60 seconds or more. This is intended to be a "mute" reminder to the customer to be more cautious with his speaker cables.

Summary

If a fault is detected, as indicated by the output of the Analog Computation exceeding the "sensitivity" trigger threshold the following sequence of events occurs: the output of A5 goes low with positive feedback through C3 forcing A5 to stay low; the Gate Clamping circuit immediately clamps audio amplifier MOSFETs to ground for the duration of A5's remaining in saturation; the Mute Driver circuit shorts out power-on Mute Timer C70 placing the amplifier into its warm-up timeout period; after some tens of milliseconds the muting relays release, holding the amplifier muted until warm-up timeout has occured.

Board Power Supplies

The + and - regulators derive operating voltages for the APC from +_and - 70 VDC "rail" voltages. Three-terminal 15V voltage regulators U5 and U6 drive high-voltage pass device transistors Q4, Q5. Diodes D11 and D12 establish the input-to-output voltages for U5 and U6 at approximately 4 VDC, reducing dissipation from these devices.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.X = ±.1
.XX = ±.03
.XXX = ±.010

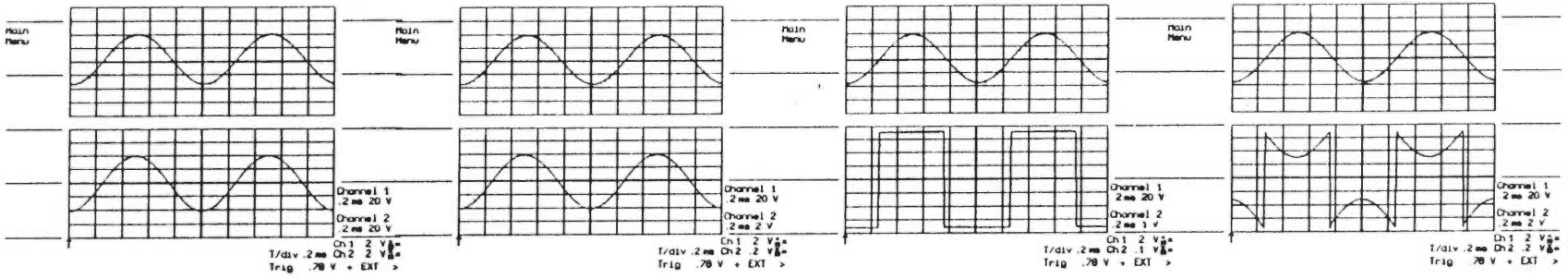
DRAWN JME | CHECKED
ON DATE 11/10/89

BLOCK T-1
REV

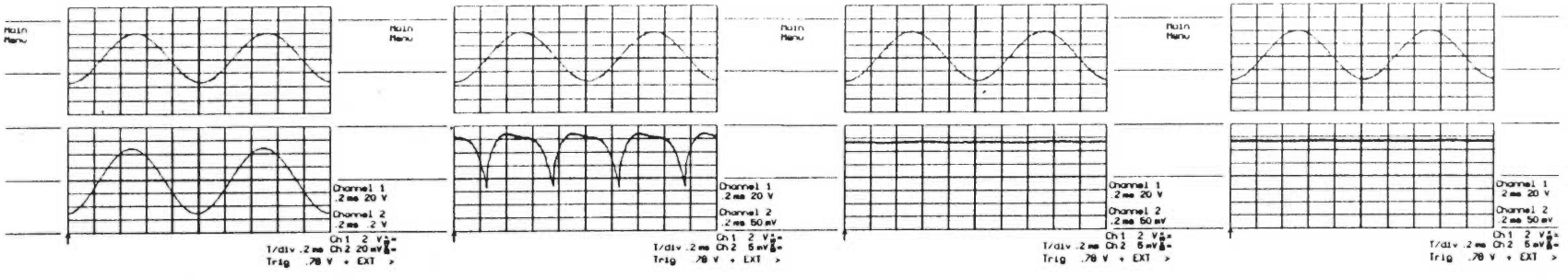
COUNTERPOINT PART NUMBER
NONE
DO NOT SCALE DRAWING

COUNTERPOINT
CIRCUIT DESCRIPTION
PWA 20-3-0B
CAD FILE: 72021.DWG | DWG: 7202.1

REV	DESCRIPTION	DATE
-NONE-	FIRST ITERATION DRAWING FOR PROTOTYPING PURPOSES ONLY. DO NOT USE FOR PRODUCTION WITHOUT CONFIRMING CURRENT REV LEVEL.	9/11/89



TP A TP B TP C TP D



TP E TP F TP G TP H

NOTES:
1. REFER TO DRAWING 7204.1 'AC AND DC OPERATING VOLTAGES, PWA 20-3-0B' FOR TEST CONDITIONS AND MEASUREMENT TECHNIQUE.

DRAWN	JME	REVISION	
ON DATE	9/11/89	PRODUCT:	SA-220

COUNTERPOINT

TYPICAL WAVEFORM SIGNALS
DETAIL FROM DWG 7204.1

CAD FILE: 72042.DWG DWG: 7204.2

REV	DESCRIPTION	DATE
-NONE-	FIRST ITERATION DRAWING FOR PROTOTYPING PURPOSES ONLY. DO NOT USE FOR PRODUCTION WITHOUT CONFIRMING CURRENT REV LEVEL.	9/11/89

TYPICAL OPERATING VOLTAGES

TEST POINT	NO SIGNAL DC VOLTAGE See Note 2	NOTES	100W/8 OHM AC/DC VOLTAGE See Note 3	WAVEFORM DRAWING See Note 4
A	<±100mV	5	28Vrms AC	TP A
B	<±10mV	5	2.8Vrms AC	TP B
C	+ (OR -) 3.5V		3.55Vrms AC	TP C
D	+ (OR -) 7.0V		4.69Vrms AC	TP D
E	<±3mV	6	0.348Vrms AC	TP E
F	<±3mV		49mVrms AC	TP F
G	<±5mV		138mVrms DC	TP G
H	<±5mV		138mVrms DC	TP H
I	VARIES	7		
J	+13.7V	8		
K	-13.7V			
L	+0.6V			
M	0V.			
N	-6.4V	9		
O	-1.6V	9		
P	-6.4V	9		
Q	+70			
R	-70			
S	+19.2V			
T	-19.2V			
U	+15.1V			
V	-15.1V			
W	+14.5			
X	-14.5			

NOTES

1. ALL VOLTAGES AND SIGNAL LEVELS MEASURED WITH SA-220 FULLY WARMED UP, AC MAINS AT NOMINAL.

2. NO SIGNAL DC VOLTAGES MEASURED WITH NO LOAD CONNECTED TO SPEAKER TERMINALS, INPUTS SHORTED.

3. INDICATED 100W/8 OHM VOLTAGES MEASURED USING TRUE RMS MULTIMETER, AMPLIFIER ADJUSTED TO DELIVER 100 WATTS INTO 8 OHMS AT 1kHZ.

4. ALL WAVEFORM VOLTAGES MEASURED USING DIVIDE-BY-TEN OSCILLOSCOPE PROBE, AMPLIFIER ADJUSTED AS DESCRIBED IN NOTE 3. REFER TO DRAWING 7204.2 FOR WAVEFORMS.

5. MEASURED VOLTAGES INDICATE SA-220 OFFSET AND LOW FREQUENCY NOISE VOLTAGES.

6. TRIGGER THRESHOLD VOLTAGE VARIES WITH SETTING OF "SENSITIVITY" JUMPER. REFER TO DRAWING 7205.1, "APC O/S PROTECTION CIRCUIT, DETAIL DRAWING" FOR TEST POINT I SETTINGS.

7. PLUS VOLTAGE INDICATES UNTRIGGERED CONDITION.

8. THESE VOLTAGES DERIVED FROM UNREGULATED TUBE FILAMENT VOLTAGES. VOLTAGES ARE NOT CRITICAL AND WILL VARY WITH AC MAINS AND WARMED-UP CONDITION OF AMPLIFIER.

DRAWN	JME	REVISION
ON DATE	9/11/89	PRODUCT: SA-220

COUNTERPOINT

AC AND DC OPERATING VOLTAGES

PWA 20-[illegible]-0B

CAD FILE: 72041.DWG | DWG: [illegible]04.1

REV	DESCRIPTION	DATE
NONE	FIRST ITERATION DRAWING BASED UPON FIRST PRODUCTION RUN, SERIAL NUMBERS STARTING WITH 12200 AND UPWARD.	9/89

AC SIGNAL VOLTAGES AND GAINS

REF	DRAWING	SIGNAL VOLTAGE	dBR	NOTES SEE NOTE 2
A	703506	860mV	0	
B	703506	780mV	-0.8	
C	703506	1.3V	+3.5	
D	703506	210mV	-12.3	
E	703506	30V	+30.9	
F	703507	28.9V	+30.5	
G	703508	28.4V	+30.3	

NOTES:

1. CAUTION: VOLTAGES AT SOME TEST POINTS MAY EXCEED MAXIMUM DC VOLTAGE RATINGS OF SOME AUDIO TEST EQUIPMENT. REFER TO DRAWING 7221.1 FOR TYPICAL DC VOLTAGES. IF IN DOUBT, CONTACT THE MANUFACTURER OF YOUR TEST EQUIPMENT.

2. TEST CONDITIONS:
   GENERAL.
   ALL VOLTAGES WITH AC MAINS AT NOMINAL VOLTAGE, ALL TUBES INSTALLED. AMPLIFIER CONNECTED TO 8-OHM LOAD RESISTOR.

   INPUT LEVELS.
   APPLY A 1kHz SINE WAVE TO AMPLIFIER INPUT. ADJUST GENERATOR AMPLITUDE TO DRIVE AMPLIFIER TO 100-W LEVEL INTO 8-OHM LOAD.

   TEST POINT VOLTAGE.
   VALUE SHOWN IS RMS, dBR REFERENCED TO INPUT SIGNAL LEVEL.

3. INPUT Z OF AUDIO VOLTMETER ASSUMED TO BE 100K OHMS.

4. SOME VARIATION IN INPUT DRIVE VOLTAGE MAY BE EXPECTED HERE DUE TO NORMAL TOLERANCES IN AMPLIFIER GAIN. TUBE V1 (V101) MAY BE RE-PLACED AS A MEANS OF ADJUSTING OVERALL GAIN.

DRAWN JME	REVISION
ON DATE 9/20/89	PRODUCT: SA-220

COUNTERPOINT

SIGNAL LEVELS
PWA 22-[illegible]-AB

CAD FILE: 72241.DWG	DWG: [illegible]224.1

REV	DESCRIPTION	DATE
-NONE-	FIRST ITERATION DRAWING FOR PROTOTYPING PURPOSES ONLY. DO NOT USE FOR PRODUCTION WITHOUT CONFIRMING CURRENT REV LEVEL.	9/19/89

TYPICAL OPERATING VOLTAGES

TEST POINT	REFER TO DRAWING	NO SIGNAL DC VOLTAGE See Note 2	AC RIPPLE VOLTAGE See Note 3	AC NOISE VOLTAGE See Note 3	NOTES
A	7225.1	0V		<2uV	
B	7225.1	4.0 ±0.2V		2uV	4
C	7225.1	115 ±20V		6uV	4
D	7225.1	30mV MAX		6uV	
E	7225.1	1.9 ±0.1V		3uV	4
F	7225.1	70 ±10V		100uV	4
G	7225.1	79 ±10V		100uV	4
H	7225.1	350 ±2V	250uV	100uV	7
I	7225.1	1.58 ±0.02V		3uV	
J	7225.1	4.0 ±0.8V		100uV	5
K	7225.1	3.8 ±0.8V		100uV	5
L	7225.1	-1.6 TO -2.1V			5
M	7225.1	-3.0 TO -4.0V			5
N	7225.1	-2.0 TO -3.0V			5
O	7225.1	-2.6 TO -3.6V			5
P	7225.1	1.0 TO 5.0V			5
Q	7225.1	-1.0 TO -6.0V			5
R	7225.1	-1.0 TO +1.0			5
S	7225.1	59 ±2V	2.5mV	2.5mV	
T	7225.1	-59 ±2V	2.5mV	2.5mV	
U	7225.1	0V		100uV	6
V	7225.1	55 ±5V			4
W	7225.1	1.6 ±0.2V			4
X	7225.2	360 ±2V	375mV		
Y	7225.2	350 ±2V	10mV		
Z	7225.2	360 ±2V	375mV		
AA	7225.2	2.12 ±0.1V	470mV		
AB	7225.2	0.02 ±0.01V	1.8mV		
AC	7225.2	-6.45 ±0.1V	82mV		
AD	7225.2	-1.6 V 20%	82mV		
AE	7225.2	-6.45 ±0.1V	82mV		
AF	7225.2	-5.7 ±0.1V	82mV		
AG	7225.2	+70 ±2V	35mV		
AH	7225.2	-70 ±2V	35mV		

NOTES

1. ALL VOLTAGES MEASURED WITH SA-220 FULLY WARMED UP FOR AT LEAST 20 MINUTES, AC MAINS AT NOMINAL, ALL TUBES INSTALLED, OPTION 100783 NOT INSTALLED, AMPLIFIER INPUTS SHORTED.

2. DC VOLTAGES MEASURED WITH DC MULTIMETER.

3. MEASUREMENT CONDITIONS FOR RIPPLE AND NOISE:

RIPPLE: 10 TO 20kHz, 18dB/OCTAVE BANDPASS, RMS.

NOISE: 400 TO 20kHz, 18dB/OCTAVE BANDPASS, RMS.

INDICATED POWER SUPPLY RIPPLE VOLTAGES TYPICAL FOR 60-Hz OPERATION. INCREASE BY ROUGHLY 20% FOR 50-Hz OPERATION. PCB STAR 'GND' POINT USED AS GROUND REFERENCE IN ALL CASES.

4. DC VOLTAGES AT THESE POINTS WILL VARY WITH TUBES. ASSUME ±20% VARIATION IN INDICATED VOLTAGE.

5. DC VOLTAGES AT THESE POINTS VARY WITH OUTPUT STAGE MOSFETS. FOLLOW CORRECT BIASING AND OFFSET ADJUSTMENT PROCEDURE AS DESCRIBED IN SERVICE MANUAL.

6. ADJUST WITH OFFSET TRIMPOT VR2.

7. INDICATED RIPPLE VOLTAGE HERE IS TYPICAL FOR ALL AUDIO STAGE B+ R-C DECOUPLING NETWORKS.

DRAWN	JME	REVISION
ON DATE	9/19/89	PRODUCT: SA-220

COUNTERPOINT

DC AND AC OPERATING VOLTAGES

PWA 22-3-AB

CAD FILE: 72211.DWG	DWG: 7[illegible]21.1