

TRACE ELLIOT

SERVICE MANUAL

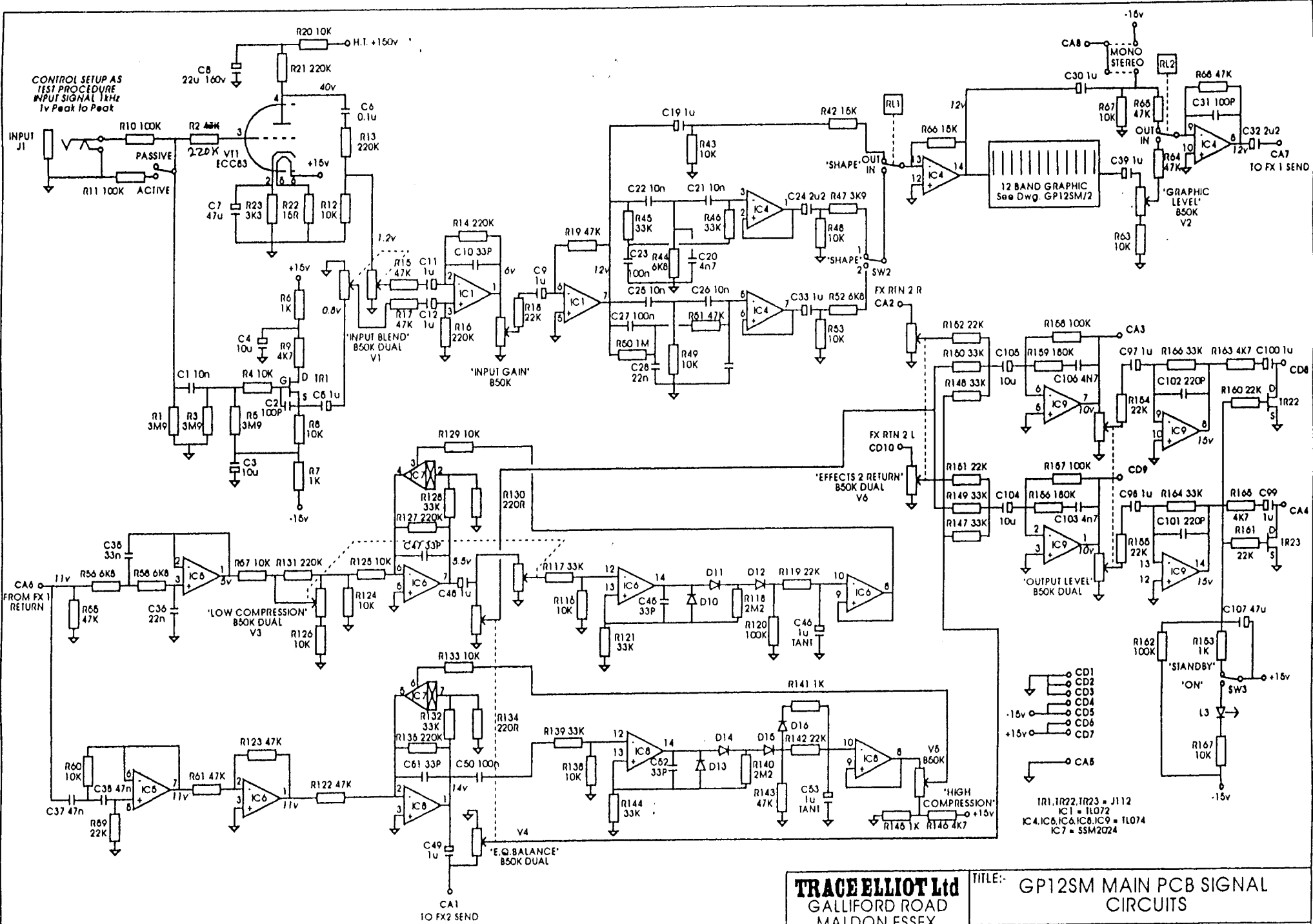
DATE : December 29, 1999
Product Code: N/A
Model Number : GP12 300 WATT SMX SERIES

This unit has used two issues of 300 watt MOSFET power board.
The Bi-polar Bear and the 300 Mosfet Board
Details for both are included in this manual.

You should check which board you have in your unit before
attempting any repair.

The Bi-polar board is marked PC00026
The MOSFET board is marked PC00083

Issued by:
Trace Elliot Limited
Blackwater Trading Estate
The Causeway
Maldon
Essex
England
CM4 4GG

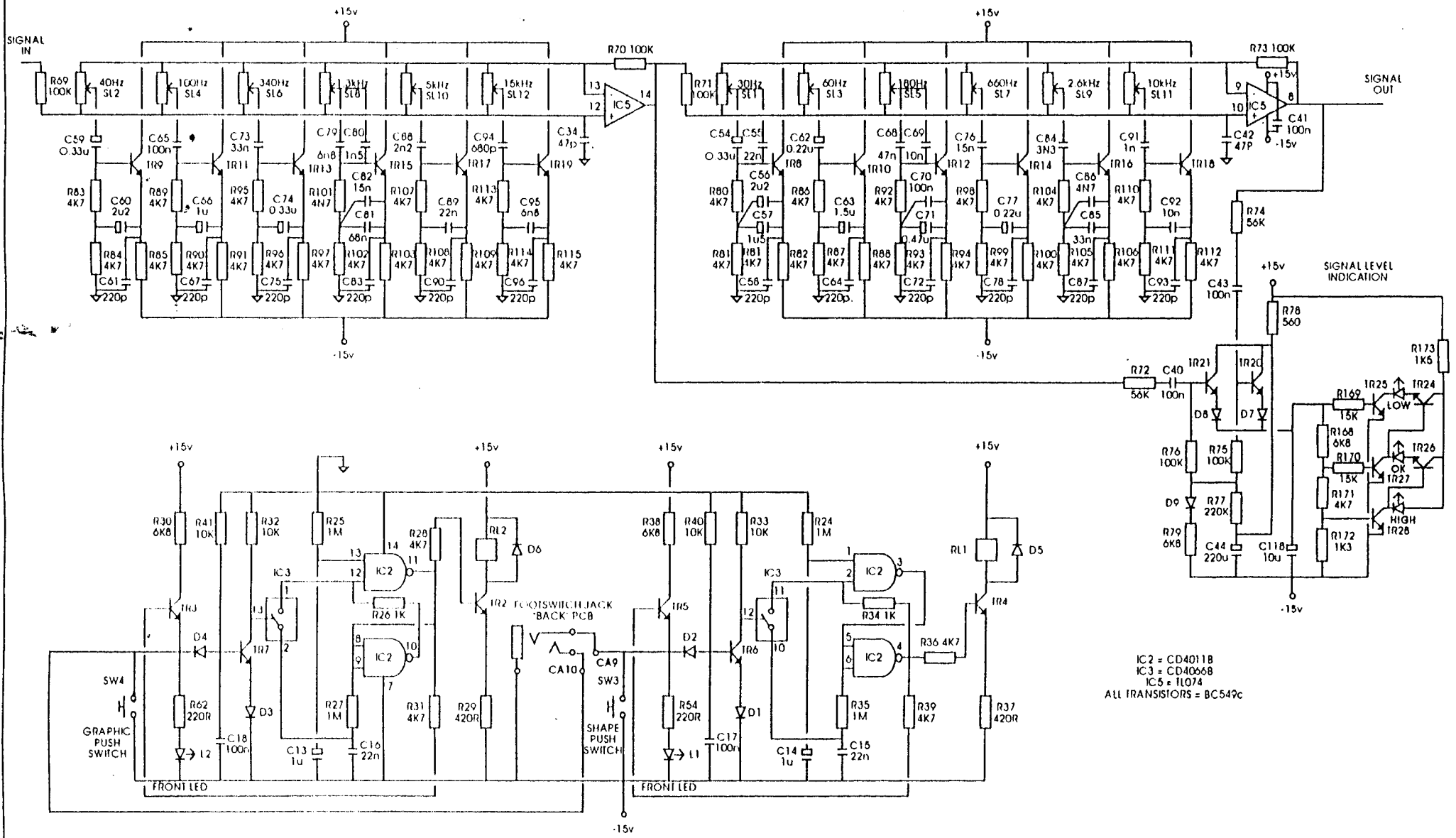


CONTROL SETUP AS TEST PROCEDURE
INPUT SIGNAL 1kHz
1v Peak to Peak

IR1, IR2, IR3 = J112
IC1 = TL072
IC4, IC6, IC8, IC9 = TL074
IC7 = 55M2024

TRACEELLIOT Ltd
GALLIFORD ROAD
MALDON, ESSEX,
CM9 7XD, ENGLAND

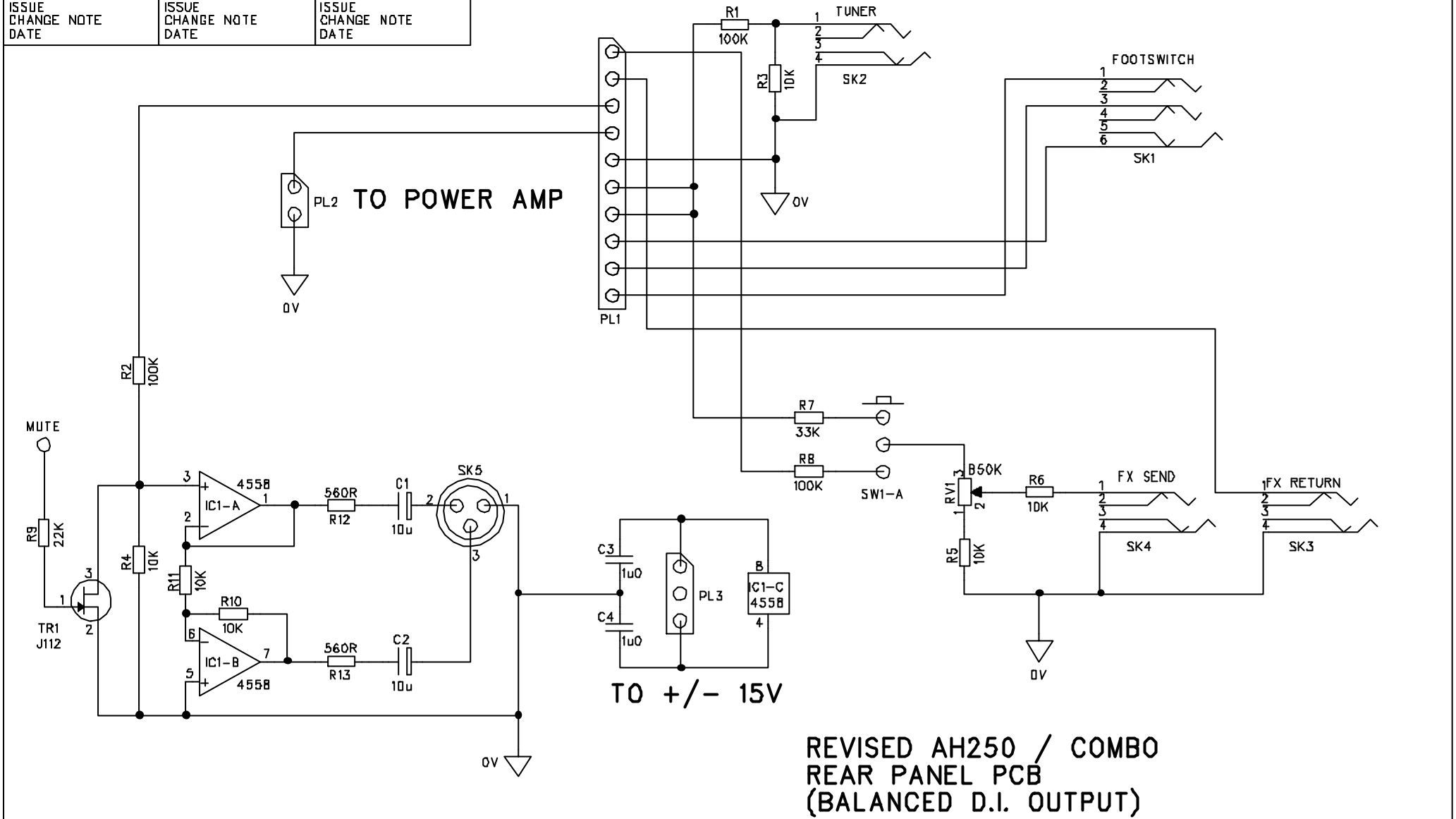
TITLE:- **GP12SM MAIN PCB SIGNAL CIRCUITS**
DRAWN C. BUTTON DATE 21.9.92 ORG No GP12SM/1



IC2 = CD4011B
 IC3 = CD4066B
 IC5 = 1LQ74
 ALL TRANSISTORS = BC549c

TRACE ELLIOT Ltd GALLIFORD ROAD MALDON, ESSEX, CM9 7XD, ENGLAND		TITLE:- GP12SM MAIN, GRAPHIC E.Q. & SWITCHING CIRCUITS	
		DRAWN C. BUITON	DATE 22.9.92

ISSUE CHANGE NOTE DATE	ISSUE CHANGE NOTE DATE	ISSUE CHANGE NOTE DATE
ISSUE CHANGE NOTE DATE	ISSUE CHANGE NOTE DATE	ISSUE CHANGE NOTE DATE



TITLE PROJECT DRAWING No ISSUE DATE DRAWN BY	REAR PANEL OUTPUT BOARD AH250 COMBO CD00017 1 17/11/1995 J B RECKLESS	TRACE ELLIOT TRACE ELLIOT LIMITED MALDON ESSEX CM9 7XD ENGLAND TEL (01621) 851851 FAX (01621) 851932
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GP12 SMX CIRCUIT DESCRIPTION

February 21, 1997

Input

J1 is the instrument input to the pre-amp.

The passive / active switch connects R10 to R11 and acts as a potential divider to effectively half the amplitude of the input signal sent to the valve and FET input stages.

Valve Input Stage

This uses half a twin triode valve (ECC83 / 12AX7) and has a voltage gain of around 40. R12 and R13 form a potential divider to bring the voltage down to about 1.2 volts, which is sent to one half of the 'Input Blend' pot.

FET Input Stage

The FET is configured as a common drain or source follower circuit to provide a low impedance output to feed the 'Input Blend' pot.

Input Blend and Input Gain

This is a dual gang potentiometer which is used as a balance control between the valve and FET input stages. As these two stages are out of phase, IC1, which is configured as a differential amplifier, mixes these two signals as well as amplifying them to around 6 volts.

Mid Pre-Shape

Pre-Shape 1 is determined by the first op-amp stage in IC4 and discrete components C20 to C23 and R44 to R46.

Pre-Shape 2 is determined by the second op-amp stage in IC4 and discrete components C25 to C28 and R49 to R51.

Each pre-shape is selected with SW2.

RL1 is used to switch between 'straight' and 'pre-shape' sounds.

Graphic Section

The graphic equalisation section is configured around IC5.

The graphic is split into two halves with each covering six frequency bands.

After the graphic section the signal is sent to effects loop one, (except on mono versions - AH300SMX / RAH300SMX and all SMX combos) and then into the dual compressor section.

Dual Compressor Section

First of all the signal is split, one half goes through a low pass filter, while the other goes through a high pass filter.

Each signal then goes into separate compression circuits whose ratios are set by V3 and V5 for low and high respectively.

The 'High Compression' signal is then sent to effects loop 2, while the 'EQ Balance' pot sets the balance between the two compression stages to be sent to the output stage of the pre-amp.

IC's 5,6,7 and 8 with their associated components make up the compression section, including filtering.

Output Stage

The signals from the dual gang 'EQ Balance' pot and from the effects return are mixed and amplified by the four op-amp stages in IC9. The output level being set by another dual gang pot.

A FET is connected between the output signals and ground, when this is switched on, by SW3, the drain is effectively at the same voltage as the source thereby shorting the output to ground for 'Standby' mode.

Signal Level Indication

TR21 and TR20 are fed from two points in the graphic section of the pre-amp, these then develop a DC voltage across C118 feeding the potential dividing network R168, R171 and R172.

As the DC voltage rises the corresponding LED's will be switched on.

Graphic and Pre-Shape Switching

This is all performed by IC2 (4011 Quad 2 input nand gate), IC3 (4066 analogue switch) and relays 1 and 2, as well as the associated discrete components.

Pre-Amp Supply Regulation

The mains transformer for each unit in the SMX range, regardless of size, has a low current 18-0-18 volt secondary tapping, as well as the main higher current power board tapping.

The centre of this tapping is connected to the 0 volt rail on the pre-amp, while the other two are fed firstly through F1 and F2 before being connected to a bridge rectifier to give full wave rectification. This is then filtered by C110 and C111 and then regulated by REG 1 (7815) and REG 2 (7915).

This then provides the +15, 0 and -15 volt rails which are used in the majority of the pre-amp.

The 150 volt HT supply for the valve is generated by the circuit consisting of D21 to D24 and C114 to C117.

This is a simple voltage quadruplar circuit that derives 150 volts from the 18-0-18 volt AC supply.

PARTS LIST FOR GP12SM FRONT BOARD

Description	Part Code	Qty	Where Used
RESISTORS			
15K ¼WATT	72-RM15K	2	R169 R170
1K ¼WATT	72-RM1K	2	R174 R176
1K3 ¼WATT	72-RM1K3	1	R172
1K5 ½WATT	72-RM1K5-.5W	1	R173
4K7 ¼WATT	72-RM4K7	1	R171
6K8 ¼WATT	72-RM6K8	1	R168
430R 2.5 WATT	72-RWW430R-2.5W	2	R175 R177
CAPACITORS			
10µF 35V AXIAL	72-C10-35VEA	1	C118
SEMI-CONDUCTORS			
GREEN LED	72-LED-GRN-REC	1	G
RED LED	72-LED-RED-TEG	1	O
YELLOW LED	72-LED-YEL-REC	1	Y
BC549C TRANSISTOR	72-TBC549C	5	TR24-28
OTHERS			
BULB	73-FLUOR-TUBE	2	A
SLIDER	73-SLIDER-B100KC	12	SL1-12
10 WAY LINK	72-LK-10W150TEG	2	2
PLASTIC SPACER	71-SPA-LED-TEG2	3	G,O,Y

Rik Daniels
February 24, 1997

PARTS LIST FOR GP12SM MAIN PCB

Description	Part Code	Qty	Where Used
RESISTORS			
3M9 ¼Watt	72-RM3M9	3	R1 R3 R5
47K ¼Watt	72-RM47K	11	R15 R17 R51 R55 R61 R64 R65 R68 R122 R123 R143
10K ¼Watt	72-RM10K	23	R4 R8 R12 R20 R32 R33 R40 R41 R43 R48 R49 R53 R57 R60 R63 R67 R116 R124 R125 R126 R129 R133 R138
1K ¼Watt	72-RM1K	7	R6 R7 R26 R34 R141 R145 R153
4K7 ¼Watt	72-RM4K7	44	R9 R28 R31 R36 R39 R80-115 R146 R163 R165
100K ¼Watt	72-RM100K	13	R10 R11 R69 R70 R71 R73 R75 R76 R120 R157 R158 R162 R19
220K ¼Watt	72-RM220K	9	R13 R14 R16 R21 R77 R127 R131 R135 R2
22K ¼Watt	72-RM22K	10	R18 R59 R119 R142 R151 R152 R154 R155 R160 R161
3K3 ¼Watt	72-RM3K3	1	R23
3K8 ¼Watt	72-RM3K8	8	R30 R38 R44 R52 R56 R58 R79 R167
1M ¼Watt	72-RM1M	5	R24 R25 R27 R35 R50
15K ¼Watt	72-RM15K	2	R42 R66
33K ¼Watt	72-RM33K	14	R45 R46 R117 R121 R128 R132 R139 R144 R148 R149 R150 R164 R166 R147
56K ¼Watt	72-RM56K	2	R72 R74
2M2 ¼Watt	72-RM2M2	2	R118 R140
180K ¼Watt	72-RM180K	2	R156 R159
15R ¼Watt	72-RM15R	1	R22
470R 1 Watt	72-RM470R-1WATT	2	R29 R37
220R ¼Watt	72-RM220R	6	R54 R62 R130 R134 R136 R137
560R ¼Watt	72-RM560R	1	R78
3K9 ¼Watt	72-RM3K9	1	R47
LINKS	72-RCZERO	56	
CAPACITORS			

PARTS LIST FOR PC00021

AH 250 REAR PCB

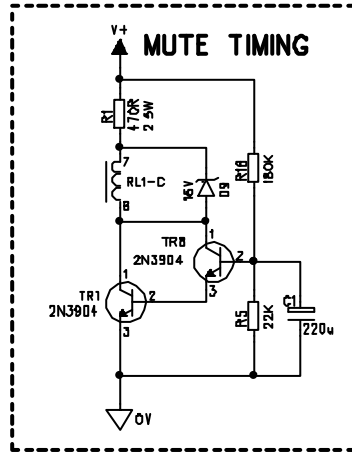
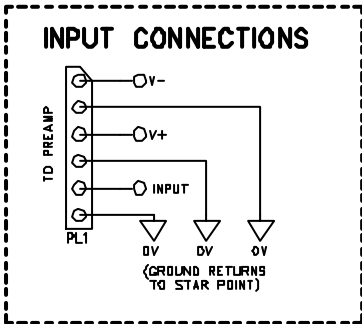
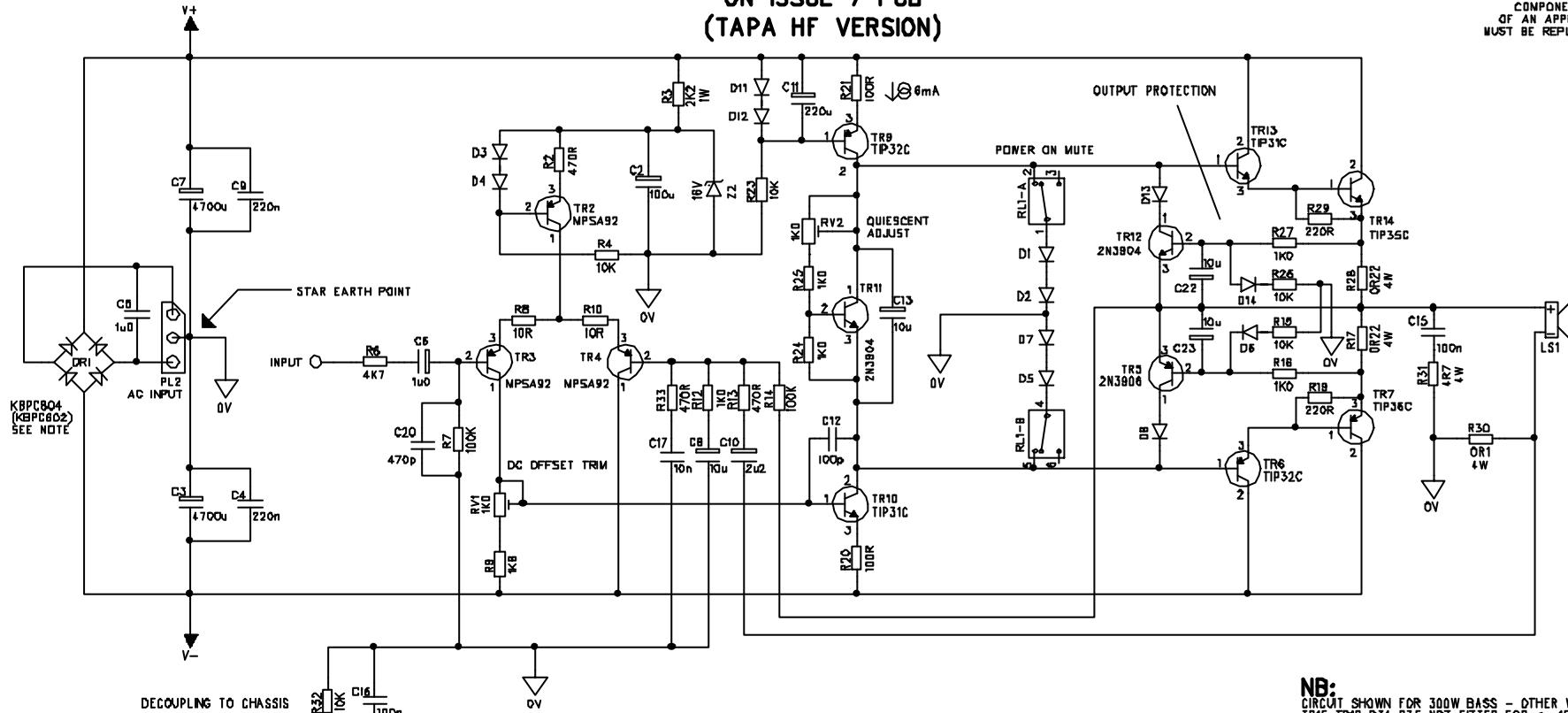
Description	Part Code	Qty	Where Used
RESISTORS			
ZERO OHM LINK	72-RC-ZERO	3	
10K ¼WATT	72-RM10K	6	R3 R4 R5 R6 R10 R11
560R ¼WATT	72-RM560R	2	R12 R13
22K ¼WATT	72-RM22K	1	R9
33K ¼WATT	72-RM33K	1	R7
100K ¼WATT	72-RM100K	3	R1 R2 R8
CAPACITORS			
10µF 63V RADIAL	72-C10-63VER	2	C1 C2
1µF 100V POLY BOX	72-C1-100VP	2	C3 C4
SEMI-CONDUCTORS			
J112 TRANSISTOR	72-FET-J-112	1	TR1
4558 OP-AMP	72-IC-RC4558P	1	IC1
SOCKETS			
MONO JACK SOCKET	73-SKT-JCKBNBG	3	SK2 SK3 SK4
MALE XLR	73-XLR-PCB-M	1	SK5
STEREO JACK SOCKET	73-SKT-JCKBBBG	1	SK1
3 WAY HEADER	72-HEAD-3W-2	1	PL3
10 WAY LINK	72-LK-6W300TEG	1	PL4
3 WAY SOCKET	72-SKT-IDC-3W	1	PL3
2 WAY HEADER	72-HEAD-2W	1	PL2
SWITCHES / POTS			
PUSH SWITCH	72-SW-F2UEE	1	SW1
B50K POT	73-POT-50KB	1	RV1

Rik Daniels
February 21, 1997

ISSUE CHANGE DATE	NOTE	ISSUE CHANGE DATE	NOTE	ISSUE CHANGE DATE	NOTE
ISSUE CHANGE DATE	NOTE	ISSUE CHANGE DATE	NOTE	ISSUE CHANGE DATE	NOTE

THE BIPOLAR BEAR OUTPUT STAGE CIRCUIT DIAGRAM ON ISSUE 7 PCB (TAPA HF VERSION)


 COMPONENTS USED ARE
 OF AN APPROVED TYPE AND
 MUST BE REPLACED ACCORDINGLY



NB:
 CIRCUIT SHOWN FOR 300W BASS - OTHER VARIANTS BELOW.
 TR15 TR16 R34 R35 NOT FITTED FOR <= 150W
 R18 & R26 = 10K FOR <= 150W
 R15 & R26 = 27K FOR 200/300W
 DR1 = KBPC602 FOR <= 150W
 DR1 = KBPC804 FOR 200/300W
 D1 D2 D6 D7 D10 D16 = 1N4007
 ALL OTHER DIODES 1N4148
 OUTPUT DEVICES TIP35C/TIP36C FOR <= 150W
 R37 = 10K 1W FOR 100W

TAPA LF:

R13 = 4.70R
 C10 = 10u
 Z1 = 27V ZENER
 C19 = 4.7u 63V
TEK150:
 R30 = S/C LINK
 R13 C10 NOT FITTED
 R12 = 3K3
 C8 = 2u2
 R15 = 1K0
 C17 = 10n

TAPA HF:

ONE PAIR OF TIP35C/TIP36C FOR OUTPUTS
 FAN DRIVE CIRCUIT NOT FITTED
 R3 = 2K2 1W
 R23 = 10K
 R1 = 4.70R 2.5W
 R16 = 10K
 R13 = 4.70R
 R35 = 4.70R
 C17 = 10n
 C20 = 470p

TITLE	THE BIPOLAR BEAR	TRACE ELLIOT
PROJECT	TAPA HF	TRACE ELLIOT LIMITED
DRAWING No	CD00025	WALDON ESSEX CM9 7X0
ISSUE	1	ENGLAND
DATE	7/10/1998	TEL (01821) 851851
DRAWN BY	J B RECKLESS	FAX (01821) 851832

BIPOLAR BEAR - PC00026

CIRCUIT DESCRIPTION

The Bipolar Bear is a general purpose bipolar junction transistor power amplifier PCB that has been designed for use in bass, lead guitar and acoustic amplifiers. It is fairly straightforward in design, and includes voltage and current feedback so that the frequency response and output damping factor can be adjusted to suit each particular application. The damping factor is a measure of how much the output amplitude varies as the load impedance is changed. A high damping factor means that the output voltage remains constant regardless of load impedance; a low damping factor means that the load impedance plays a major part in the overall output amplitude.

The unit has been designed for use in amplifiers of up to 300 watts rms output. For power output of up to 150 watts, one pair of output transistors is used; for greater power output a second pair of devices is required.

INPUT STAGE

TR3 and TR4 form a 'long tail pair' - their purpose is to compare the input signal with the output voltage and current, and produce a 'difference' signal that is used to drive the following stage. TR2, in conjunction with D3, D4, R2 and R4, provides a 'constant current source' that maintains a current of approximately 6mA into the emitters of TR3 and TR4. The purpose of R3, C2 and Z2 is to 'decouple' the supply voltage ripple, so as to minimise the 100Hz 'hum' into the rest of the amplifier.

The collector load resistor of TR3 and TR4 - R9, can be 'balanced' using preset RV1 so that any differences in gain between the two transistors can be tuned out to give an overall zero DC offset in the output.

Capacitor C20 (across R7) sets the high frequency rolloff of the input stage. C6 (in series with R7) sets the low frequency rolloff of the input stage.

VOLTAGE AMPLIFICATION STAGE

Transistor TR10 is the main voltage amplification stage of the amplifier. It takes the small signal swing from the long tail pair and amplifies it to the full amplitude of the power amplifier output stage. Capacitor C12 is known as the

'compensation capacitor' - its purpose is to prevent the amplifier from becoming unstable at high frequencies.

TR9, in conjunction with R21, D11, D12, R23 and C11, is a 'constant current source' load for the collector of TR10. It ensures that as the collector of TR10 swings from rail to rail, there is always sufficient current to drive the following stages of the amp.

The purpose of TR11 is to control the quiescent or 'bias' current of the output stage. When a bipolar junction transistor becomes hot (i.e. when power is being dissipated) the current through the device increases for a given applied bias voltage. TR11 is mounted on the heatsink and thermally coupled to the output transistors. Its temperature tracks those of the output devices and it therefore keeps the bias current (almost) constant as temperature varies.

Preset RV2 can be used to adjust the bias voltage so that any crossover distortion can be accurately trimmed out. **This is far more important in bipolar power amps than their MOSFET equivalent.**

DRIVER STAGE

The purpose of driver transistors TR13 and TR6 is to increase the current available to drive the base junction of the output transistors - they are emitter followers.

OUTPUT STAGE

Transistors TR14, TR16, TR7 and TR15 are also emitter followers - they pass the voltage from the driver stage through to the output and dissipate most of the heat in the amplifier.

Emitter resistors R17, R28, R34 and R35 are to ensure that each transistor shares an equal part of the current output, and to provide stable biasing in conjunction with TR11.

ZOBEL NETWORK

C15 and R31 ensure that the amplifier 'sees' a suitable load at high frequencies, as many loudspeaker systems act as an 'open circuit' at very high frequencies.

VOLTAGE FEEDBACK

R14, R12 and C8 comprise the voltage feedback of the amplifier. These components set the overall gain and improve consistency from one amp to another.

CURRENT FEEDBACK

R30, R13 and C10 comprise the current feedback of the amplifier. These components determine the overall damping factor of the amplifier.

SHORT CIRCUIT PROTECTION

Transistors TR12 and TR5 play no part during normal amplification. Their purpose is to protect the output transistors from a possible short circuit. A high positive current will produce a voltage across R28 which, when the current reaches a certain amount, will 'turn on' TR12 and short out the base drive to TR13.

Under normal conditions, most of the current that would turn on TR12 is shorted to ground via D14 and R26. However, when the output is shorted out, there is no voltage across D14, so all the current flows into TR12.

This method of short circuit protection is known as 'foldback current limiting' - the maximum current allowed into a normal load is higher than the maximum current allowed into a short circuit.

Transistor TR5 and its associated components provide similar protection for output transistors TR7 and TR15.

POWER ON MUTE

The purpose of relay RL1 and its associated components is to limit the swing of the output stage while the amp is powering up or down, and thus prevent any large 'bangs' being sent into the loudspeaker.

Transistors TR1 and TR8 in conjunction with R18 and C1 set the timing constant for the power on / off muting.

SWING LIMITING

Zener diodes Z3 and Z4 in conjunction with diodes D10 and D15 limit the maximum output swing, to prevent the output transistors from over-volting when the amp is used 'off load'.

FAN DRIVE CIRCUIT

Transistor TR17 passes current to the cooling fan, whilst dropping the voltage from the rails to a more appropriate 12 - 16Vdc. Zener Z1 and resistor R37 set the fan voltage. Transistor TR18 and resistor R36 act to limit the maximum current into the fan - this prevents the destruction of TR17 should the fan become short circuit, or be forced to stop.

Jonny Reckless, 6 December 1995

**PARTS LIST FOR 300W BASS AMP
USING PC00026 ISSUE 7
Please label the pcb '300W BASS'**

Description	Part Code	Qty	Where Used
DIODE 1N4007	72-D-1N4007	14	D1.....D8 D10....D15
ZENER DIODE 16 VOLT	72-D-BZY88C16V	3	Z1 Z2 D9
ZENER DIODE 51 VOLT	72-D-BZY88C51V	2	Z3 Z4
ZERO OHM LINKS	72-RCZERO	14	
RES 1/4W 2R7	72-RM2R7	1	R36
RES 1/4W 10R	72-RM10R	2	R8 R10
RES 1/4W 100R	72-RM100R	4	R2 R9 R20 R21
RES 1/4W 220R	72-RM220R	2	R19 R29
RES 1/4W 1K0	72-RM1K	5	R12 R16 R24 R25 R27
RES 1/4W 4K7	72-RM4K7	2	R6 R13
RES 1 WATT 4K7	72-RM4K7-1WATT	1	R3
RES 1/4W 10K	72-RM10K	2	R4 R32
RES 1 WATT 22K	72-RM22K-1WATT	1	R37
RES 1/4W 22K	72-RM22K	2	R5 R23
RES 1/4W 27K	72-RM27K	2	R15 R26
RES 1/4W 100K	72-RM100K	2	R7 R14
RES 1/4W 470K	72-RM470K	1	R18
CAP RADIAL 1u0 63V	72-C1-63VER	1	C6
CAP RADIAL 2u2 63V	72-C2.2-63VER	1	C10
CAP RADIAL 10u 63V	72-C10-63VER	5	C8 C13 C18 C22 C23
CAP RADIAL 100u 16V	72-C100-16VER	2	C2 C19
CAP RADIAL 220u 25V	72-C220-25VER	2	C1 C11
CAP CERAMIC 100p 100V	72-C100P-100VCD	1	C12
CAP BOX POLY 2n2 100V	72-C2N2-100VP	1	C20
CAP BOX POLY 100n 100V	72-C100N-100VP	2	C15 C16
CAP BOX POLY 220n 250V	72-C220N-250VP	2	C4 C9
CAP BOX POLY 1uF 250V	72-C1-250VP	1	C5
TRANSISTOR MPSA92	72-TMPSA92	3	TR2 TR3 TR4
TRANSISTOR 2N3904	72-T2N3904	5	TR1 TR8 TR11 TR12 TR18
TRANSISTOR 2N3906	72-T2N3906	1	TR5
TRANSISTOR TIP31C	72-TIP31C	2	TR10 TR13
TRANSISTOR TIP32C	72-TIP32C	2	TR6 TR9

PRESET 1K0	72-PRESET-1K	2	RV1 RV2
RELAY 47W/6 12V DPCO	73-RELAY-47W	1	RL1
PCB TERMINAL 2 WAY	73-TERM-PCB-2WAY	1	FAN OUTPUT
HEADER 6 WAY 0.1"	72-HEAD-6W-2	1	PL1
HEADER 3 WAY 0.2"	72-HEAD-3W-3	1	PL2
HEADER 2 WAY 0.2"	72-HEAD-2W-2	1	LS1
RES W/W 0R22 4W	72-RWW0R22-4W	4	R17 R28 R34 R35
RES W/W 4R7 4W	72-RWW4R7-4W	1	R31
RES W/W 0R1 4W	72-RWW0R1-4W	1	R30
RES W/W 1K0 2.5W	72-RWW1K-2.5W	1	R1
CAP 4700u 80V SNAP IN	73-CAP-470080V	2	C3 C7
RECTIFIER KBPC804	73-BRIDGE-3	1	DR1 (fit to heatsink)
HEATSINK FINNED	71-HS-TEG	1	fit to DR1
TRANSISTOR 2SC4468	72-T2SC4468	2	TR14 TR16
TRANSISTOR 2SA1695	72-T2SA1695	2	TR7 TR15
TRANSISTOR BUW11A	72-TBUW11A	1	TR17
HEATSINK KR70	74-HS-KR70-1	2	fit to output devices
TRANSISTOR CLIP	74-HS-KR70-CLIP1	5	fit to output devices
THERMAL TRIP 100C	73-SWT-THERM-2	1	fit to heatsink, wire to TRIP1
FIXINGS:	71-SCR-M3X8PP/TT	10	for heatsinks and trip
	71-SCR-M3X16PP	1	for KBPC602
	71-NUT-M3ZINC	1	for KBPC602
	71-WAS-M3AZINC	1	for KBPC602
	71-WAS-M3SCOIL	1	for KBPC602
	71-WAS-M3NYL	8	for heatsinks under PCB

Important Notice

To make the bi-polar 300 watt bass board reliable the following guidelines must be adhered to.

When a board need to be serviced it is advisable to replace both the Output Transistors and TIP31 and TIP32. Also it is advisable to replace TR11 which is situated under the rear of the heatsink.

The Output device should only be T2SC4468 and T2SA1695's
The Drivers should be of the same manufacturer as each other to ensure stability.

And TR11 is a T2N3904 as listed on the parts list.

TR11 need to be completely covered in Heat Transfer Compound (HTC)
This is to ensure that it keeps the unit biased correctly even when the unit gets hot. If TR11 is not covered then the fan can cool this component down and give the board a fault reading of temperature and provide and inappropriate bias.

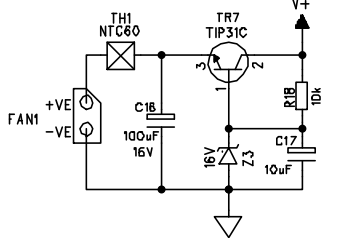
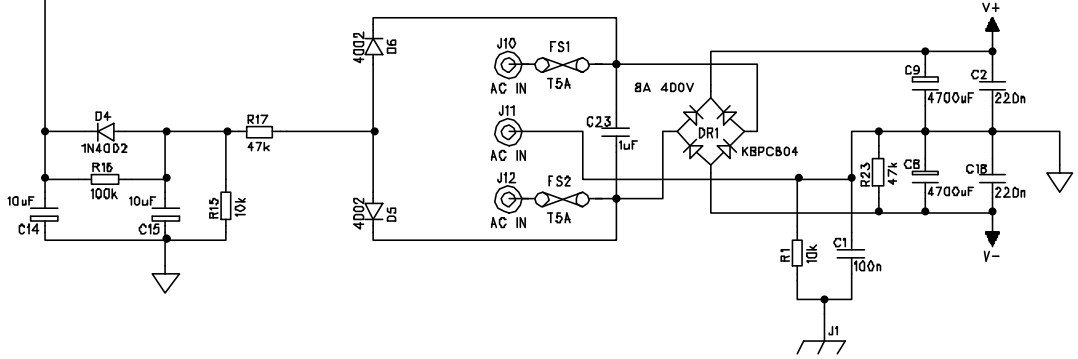
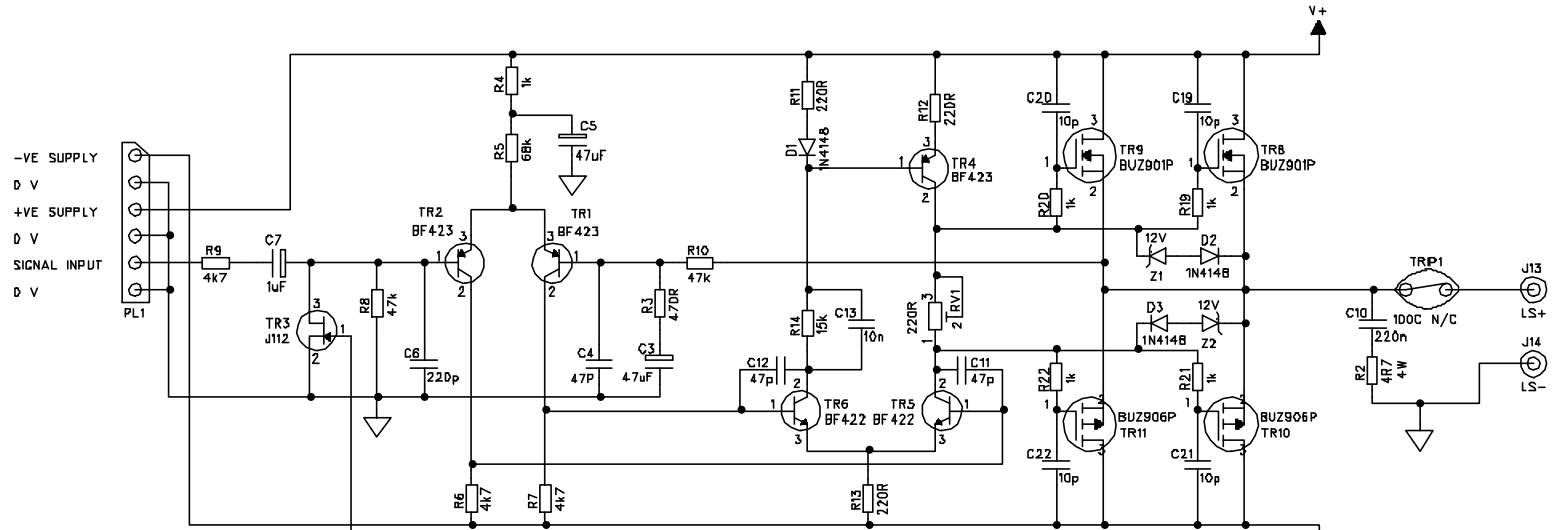
When adjusting the bias on the scope, make sure that the crossover distortion is just not visible. Too far beyond this point will over bias the unit.

Use a Shake-proof washer under the pcb earth point to ensure a permanent connection and prevent crackling noises in the future.

Paul Mathews

Jan 2000-01-25

ISSUE CHANGE NOTE DATE	ISSUE CHANGE NOTE DATE	ISSUE CHANGE NOTE DATE
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 COMPONENTS USED ARE
 OF AN APPROVED TYPE AND
 MUST BE REPLACED ACCORDINGLY

PCB - PC0082

TITLE 300 WATT MOSFET OUTPUT
 PROJECT BIPOLAR BEAR REPLACEMENT
 DRAWING No CD0086
 ISSUE 4
 DATE 6/5/99
 DRAWN BY CLIVE BUTTON

TRACE ELLIOT
 TRACE ELLIOT LIMITED
 WALDON ESSEX CM9 7GG
 ENGLAND
 TEL (01621) 855266
 FAX (01621) 851975

C11-MOD-K300Bx4.

**PARTS LIST FOR 300 WATT MOSFET BASS POWER STAGE
PC00082x3-C BUTTON-21/7/97 UP-ISSUED-8/1/98 A EWEN.
UP-ISSUE 5/2/98 R18 TO 1WATT. ISSUE 4 REFERENCE TO CD0086X4**

Description	Part Code	Qty	Where Used
ZENER1,12V	72-D-BZX55C12V	2	Z1-2
ZENER1,16V	72-D-BZX55C16V	1	Z3
DIODE1,1N4002	72-D-1N4002	3	D4-6
DIODE1,1N4148	72-D-1N4148	3	D1-3
R-1watt 10K	72-RM10K-1WATT	1	R18
R1/4W,100k	72-RM100K	1	R16
R1/4W,10k	72-RM10K	3	R1 R15
R1/4W,15k	72-RM15K	1	R14
R1/4W,1k	72-RM1K	5	R4 R19-22
R1/4W,220R	72-RM220R	3	R11-13
R1/4W,470R	72-RM470R	1	R3
R1/4W,47k	72-RM47K	3	R8 R10 R17
R1/4W,4k7	72-RM4K7	3	R6-7 R9
R1/4W,68k	72-RM68K	1	R5
R4W,4R7	72-RWW4R7-4W	1	R2
	There is no R23 on the PCB		R23
PRESET,220R	72-PRESET-220R	1	RV1
ZERO OHM LINK	72-RCZERO	19	
CAPCER,10p	72-C10P-500VCD	4	C19-22
CAPCER,47p	72-C47P-100VCD2	3	C4 C11-12
CAPCER,220p	72-C220P-100VCD	1	C6
CAPP1,10n	72-C10N-100VP	1	C13
CAPP1,100n	72-C100N-100VP	1	C1
BF422	72-TBF422	2	TR5-6
BF423	72-TBF423	3	TR1-2 TR4
J112	72-FET-J-112	1	TR3
CAPE2,1uF	72-C1-63VER	1	C7
CAPE2,10uF	72-C10-63VER	3	C15 C17 C14
CAPE2,47uF	72-C47-63VER	2	C3 C5
CAPE2,100uF	72-C100-16VER	1	C16
CAPP5,220n	72-C220N-250VP	3	C2 C10 C18
CAPP6,1uF	72-C1-250VP	1	C23
PCB TERMINAL 2 WAY	73-TERM-PCB-2WAY	1	FAN1
HEADER 2 WAY 0.2"	72-HEAD-2W-2	1	LS1

HEADER 3 WAY 0.2"	72-HEAD-3W-3	1	PL2
HEADER 6 WAY 0.1"	72-HEAD-6W-2	1	PL1
PCBFUSECLIP, 20MM FUSE T5A	72-FUS-HLD-PCB-4 72-FUS-5AT	4 1	FS1-2 FS1-2
CAPE6,4700uF 80V	72-CAP-470080V	2	C8-9
SB104	72-BRIDGE-4	1	DR1
BUZ901P	72-MOS-BUZ901P	2	TR8-9
BUZ906P	72-MOS-BUZ906P	2	TR10-11
TRANSISTOR CLIP	71-HS-KR70-CLIP1	4	fit to output devices
THERMISTOR	72-THERMISTER-4 Mount against heatsink with plenty of thermal compound between the thermistor and the heatsink.	1	TH1
TIP31C	72-TIP31C (or 72-TSM2178)	1	TR7
SMALL HEATSINK	71-HS-CLO5-45	1	FIT TO TR7 WITH THERMAL COMPOUND
BRIDGE HEATSINK	71-HS-TEG	1	FOR BRIDGE RECT
LARGE HEATSINK	71-HS-KR180	1	FOR OUTPUT DEVICES
TRIP,100C N/C	73-SWT-THERM-2	1	FIT TO HEATSINK WIRE TO TRIP1
FIXINGS	71-SCR-M3X8PP/TT	7	FOR HEATSINK & TRIP