5000 SERIES

High Voltage Differential Amplifier

Serial No

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THIS MUST BE READ BEFORE USING THE 5000 SERIES AMPLIFIER

5000 SERIES AMPLIFIER

WARNING

THE MAXIMUM OUTPUT UNDER NORMAL CONDITIONS FROM EITHER A OR B OUTPUT CHANNELS IS 3.2kV. UNDER FAULT CONDITIONS MAXIMUM OUTPUT VOLTAGE COULD RISE TO 4.5kV. THESE OUTPUTS ARE POTENTIALLY LETHAL AND EXTREME CARE MUST BE USED IN BOTH USE AND SERVICING OF THE AMPLIFIER. IT IS ESSENTIAL THAT THE OPERATING INSTRUCTIONS BE EXPLICITLY FOLLOWED IN USE, AND SHOULD THERE BE ANY DOUBT ON THE PART OF THE OPERATOR ABOUT THE USE OF THE AMPLIFIER THE MANUFACTURERS SHOULD BE CONSULTED. THE OUTPUTS ARE FUSED AT 50mA.

The amplifier must not be operated out of its case. Only qualified engineers in high voltage engineering should operate or service this equipment

IMPORTANT

The amplifier is shipped with the four output valves removed and packed separately. These valves are located inside the case. When they have been plugged in position, refit the amplifier into the case before switching on.

The amplifier uses SHV output plugs. REMEMBER THAT THEY ARE LIVE AND POTENTIALLY LETHAL.

IF FOR ANY REASON there is a short on the high voltage leads, the 50mA fuses located inside the amplifier case, in front of the mains transformer will blow.

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SPECIFICATIONS

INPUT

Input voltage swing for linear operation	± 2.5 V
Maximum permissible input voltage	± 50 V

OUTPUT VOLTAGES

Normal voltage range for each channel	0.2 kV to 3.0 kV
Output voltage for zero input signal and zero differential bias setting	1.7 kV each channel
Output voltages for zero input signal and maximum differential bias setting	one channel 1.95 other channel 1.45
Output swing for ± 2.5 volt input swing	± 1.25 kV each Channel about bias value
Effective differential output swing for ± 2.5 volt input swing	5 kV
Gain $\frac{\text{(differential output swing)}}{\text{(input swing)}}$	1000 (± 2%)

INTERNAL OSCILLATOR

Frequency range	1 Kz - 10 kHz in 4 ranges
Amplitude	Continuously adjustable up to approx. ± 2.5 V pk-pk
Functions	Sine, square, triangular

OUTPUT CURRENT

The amplifier is not designed to provide output current into resistive loads.
The output is fused at 50mA.

NOTE

The amplifier has been designed to have a small signal frequency response from dc. to 100 kHz. At large signals the frequency response is limited by (1) the slew rate and (2) the allowable power dissipation. At full amplitude the amplifier has a bandwidth limited to 20kHz due to power dissipation.

DO NOT OPERATE AT FULL AMPLITUDE ABOVE 20KHZ

FREQUENCY RESPONSE

Maximum amplitude (5kV differential) frequency	
response before significant distortion	dc to 20 kHz
Time limitation for maximum output voltage	
swing at frequencies above 10 kHz	30 seconds
RISE TIME	5 - 6 uS
SLEW RATE LIMIT	800 v/uS

PREAMPLIFIER FUNCTIONS

Positive limit		Variable over 0-100% of positive differential output swing $V_A - V_B$
Negative limit		Variable over 0-100% of negative diff. output swing $V_B - V_A$
Input bias/differential bias		Varies differential output over range $\pm$ 0.5kV
Slew rate limit		
	off	800 V/uS (basic H.V. amplifier slew rate
	1	500 V/uS) approx.)
	2	50 V/uS) values)
	3	5 V/uS) only
MAINS INPUT		250, 220, 200 volts, 50 Hz

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OPERATING INSTRUCTIONS

MAINS VOLTAGE SELECTOR AND FUSE

Before switching on the amplifier check the mains voltage selector, situated at the rear of the cabinet, is set correctly and note that the mains fuse 2 Amp, 20mm type is mounted in the voltage selector. Fit the output values by removing the amplifier from its case. Make certain that the amplifier is screwed back into its case before switching on.

SWITCHING ON

Switch on the mains switch and note that the mains lamp comes on.

An internal delay circuit prevents the E.H.T. from switching on for a period of about 30 seconds. After this time, the E.H.T. indicator will come on if the E.H.T. switch is in the ON position. The amplifier is now ready for use, although it is recommended that full output swing at frequencies above 10 kHz should not be demanded for a period of 5 minutes after switch on from cold.

NORMAL OPERATION

For normal operation the controls should be set as follows:-

DIFFERENTIAL	zero
POSITIVE LIMIT	100%
NEGATIVE LIMIT	100%
SLEW RATE LIMIT	off

The input to the amplifier may either be via the EXT input (linear range $\pm$ 2.5 volts) or any of the wave forms, square, sine or triangular from the internal oscillator as selected by the 'source selection' switch. The frequency of the internal oscillator may be varied over the range 1Hz to 10 kHz. In addition, the amplitude of the internal oscillator signal may varied over the range zero up to $\pm$ 2.5 volts (100% setting) by the amplitude control. The auxiliary outputs provide sine, square and triangular wave forms of approximately constant amplitudes of $\pm$ 2.5V pk-pk, irrespective of the wave form selected by the 'Source selector' switch and also independent of the amplitude control.

DIFFERENTIAL BIAS CONTROLS (INPUT BIAS CONTROL)

The 'Differential bias controls' adjust the mean levels of the A and B output channels.

With the bias control set to zero both A and B channel outputs will be biased to 1.7 kV. When the 'Differential bias' controls are set to positive maximum (10%) the A output bias will be 1.95 kV, and the B output bias will be 1.45 kV. Thus $V_A - V_B = 0.5$ kV which is 10% of the maximum differential output. When the 'differential bias' controls are set to negative maximum, A output bias is 1.45 kV and B output bias is 1.95 kV. The Differential bias control/input bias control allows the output levels to be precisely adjusted across the pockels cells for 'zero voltage input conditions', thereby achieving the best extinction ratio or lowest residual phase modulation.

OPERATION OF LIMITS

The maximum positive differential output voltage $V_A - V_B$, may be precisely limited by the 'positive limit' control. This is calibrated 0-100% which corresponds to a $V_A - V_B$ limit of between 0 and 2.5 kV. Similarly the 'negative limit' control precisely limits the voltage $V_B - V_A$ over the range 0 to 2.5 kV. As an example, suppose it is required to limit the differential output swing ($V_A - V_B$) to between + 0.75 kV and -1.25 kv, the proper settings for the limit controls will be as follows:

'Positive limit' control $\frac{(0.75 \times 100)\%}{(2.5)}$ i.e. 25%

'Negative limit' control $\frac{(1.25 \times 100)\%}{(2.5)}$ i.e 50%

Note that the differential bias control acts 'after the limiting process.

The main use of the limit controls is to provide two precise differential output voltages when the input of the amplifier is driven from a square wave. This will allow fast switching between two stable precisely set polarisation states in a pockled cell, or between two levels of optical transmission when the pockled cell is used between crossed polarisers. The 'Differential bias' control allows adjustment of the residual birefringement of the pockel cell, without affecting the limiting polarisation state.

The diagrams of Figs. 1(a), 1(b), 1(c) further illustrate the operation of the limit controls.

Fig 1(a) Shows the A and B output voltage VA and VB and also the differential output voltage (VA-VB) when both limit controls are set to 100%.

Fig 1(b) Shows VA, VB and (VA - VB) when the limit controls are set to

'POS LIMIT' = 50%

'NEG LIMIT' = 100%

Fig 1(c) Shows VA, VB and (VA-VB) when the limit controls are set to

'POS LIMIT' = 100%

'NEG LIMIT' = 50%

It can be seen in Fig 1(b) that the setting the 'POS LIMIT' control to 50% limits the positive excursion of VA to 2.275 kV while at the same time limiting the negative excursion of VB to 1.025 kV. The corresponding value of the differential output voltage (VA - VB) is + 1.25 kV which is 50% of the maximum possible positive output voltage.

Similarly in fig. 1(c) the setting of the 'NEG LIMIT' control to 50% limits the negative excursion of VA to 1.025 kV and the positive excursion of VB to 2.275 kV. The maximum negative differential output voltage (VA - VB) under these circumstances is 1.25 kV which is 50% of the maximum possible negative differential output voltage.

SLEW RATE CONTROL

This limits the maximum rate of charge of differential output voltage. The main use of this control will be to limit the rate of charge of voltage across a pockel cell when the input is a square wave of fast rise time. If the amplifier is to be used for switching an EM500 modulator the maximum slew rate of 800V/uS may cause mechanical resonance, through piezo-electric effects, and unwanted optical modulation through the elasto-optic effect.

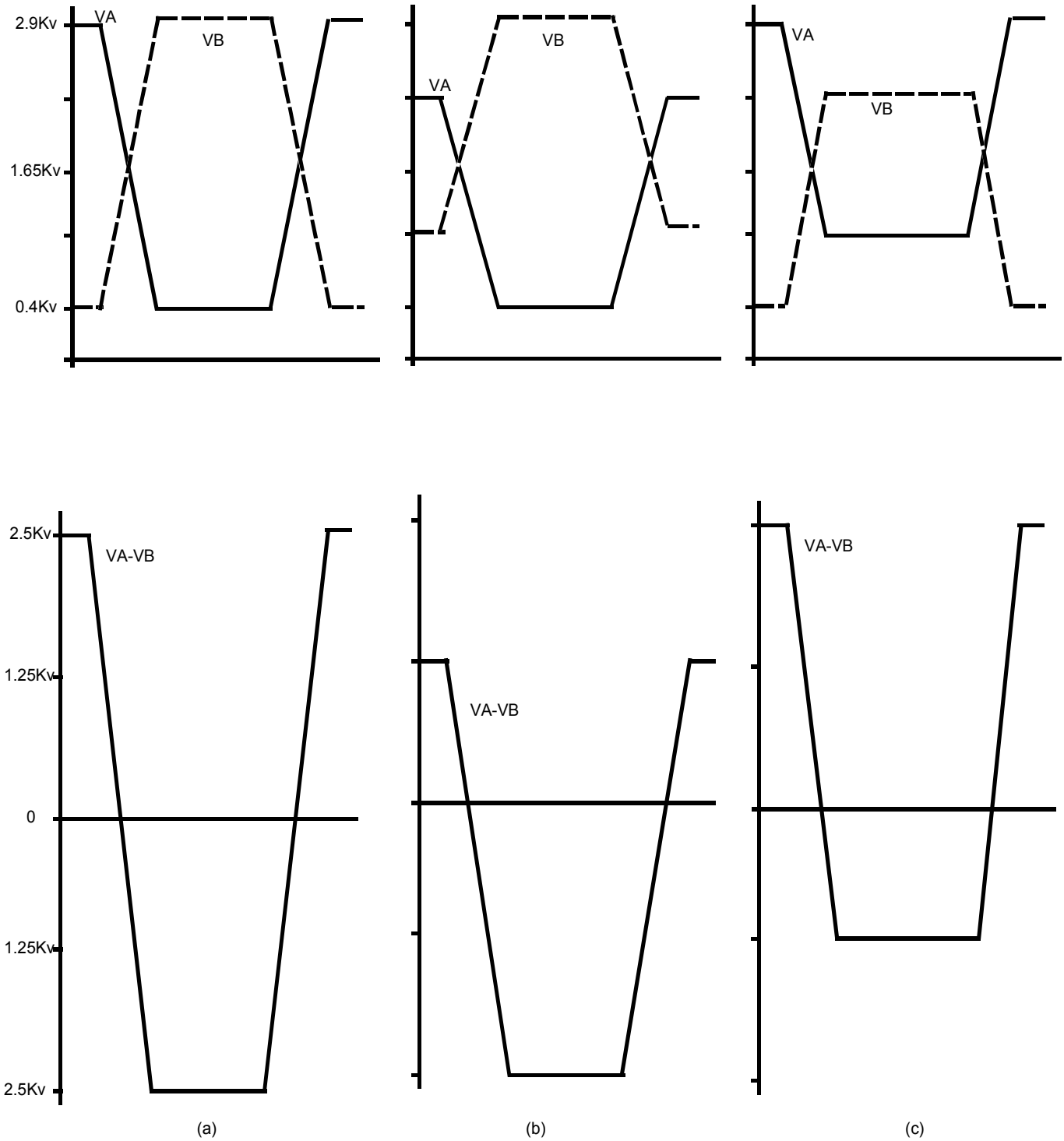


Fig. 1. Showing the effect of limit controls.

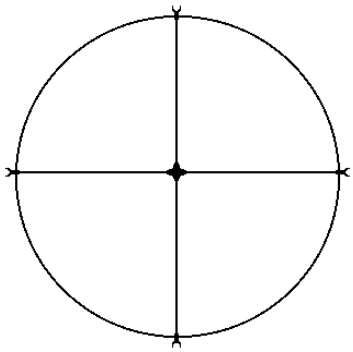
A SIMPLE SETTING UP AND FAMILIARISATION PROCEDURE FOR THE 5000 SERIES AMPLIFIER AND EM500 SERIES MODULATION

BEFORE SWITCHING ON

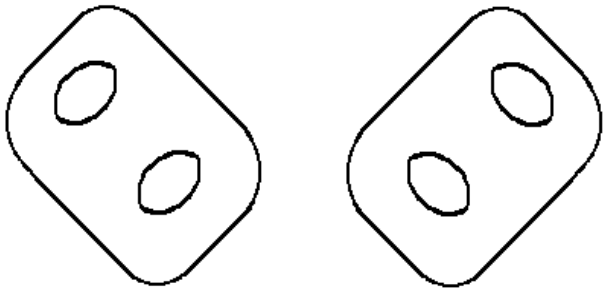
First check that the amplifier input voltage selector is correctly set and that the amplifier output valves have been plugged in.

THEN

1. Connect the modulator to the amplifier using the two leads provided.
2. Set internal oscillator to 1Hz with amplitude at min.
3. Set Input Slew rate switch OFF and Source switch to square wave.
4. Set positive and negative Output Limits fully clockwise.
5. Check that the amplifier is working by observing the monitor output using the oscilloscope.
6. Hold the modulator between two squares of polaroid with the axis of the polaroid film lying along the radial axis of the BNC HV sockets and observe a white light source through this combination. With the polaroids crossed a MALTESE fringe pattern should be seen thus.



As the 1Hz square wave output is increased the Maltese Cross will be changed until at full amplitude the cross will switch between right hand and left hand output polarisation states as shown below.



Full + Output & Voltage - Sense

There is then a phase shift between the ordinary and extraordinary rays leaving the modulator of $\pm$ 180°. Precise square wave $\pm$ phase shifting can be achieved between 0 - 180° by adjustment of the limit potentiometers.

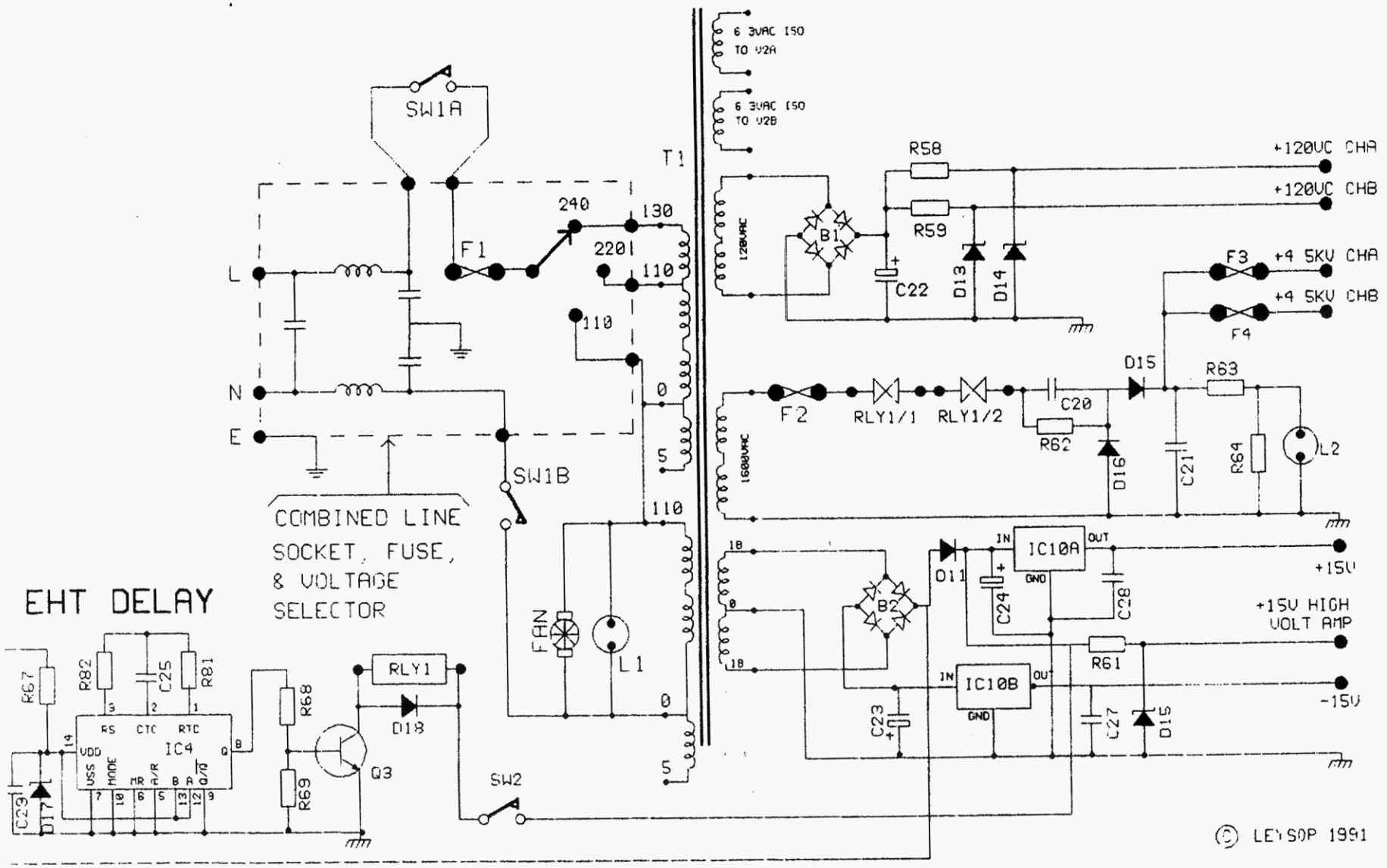
7. If one limit potentiometer is set at zero, only one side of the modulator crystal is driven and the output polarisation state will switch in one direction only. This arrangement can be used for amplitude modulation of a laser beam.

SETTING UP THE MODULATOR WITH A LASER BEAM

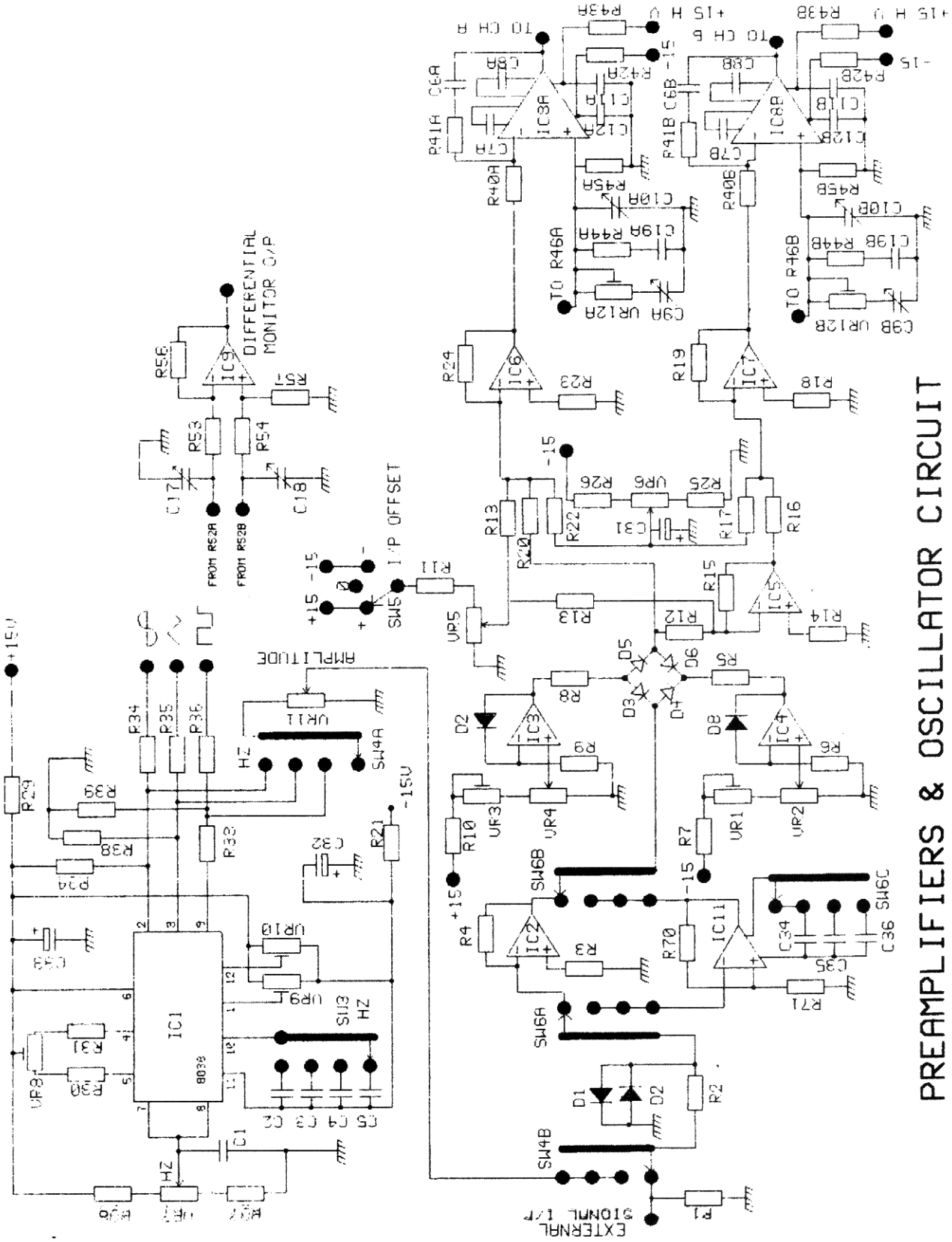
The input polarisation must be along the BNC axis or at 90° to that axis.
A suitable output polariser should be crossed to the input polarisation state.
Initially set up the modulator with back reflections along the beam axis. Place a fine ground glass screen between the input polariser and the modulator and a Maltese cross should be observed after the analiser. Adjust the modulator position until this cross is central to the beam axis. The best extinction ratio is then achieved. This must be performed with the EHT switched OFF.

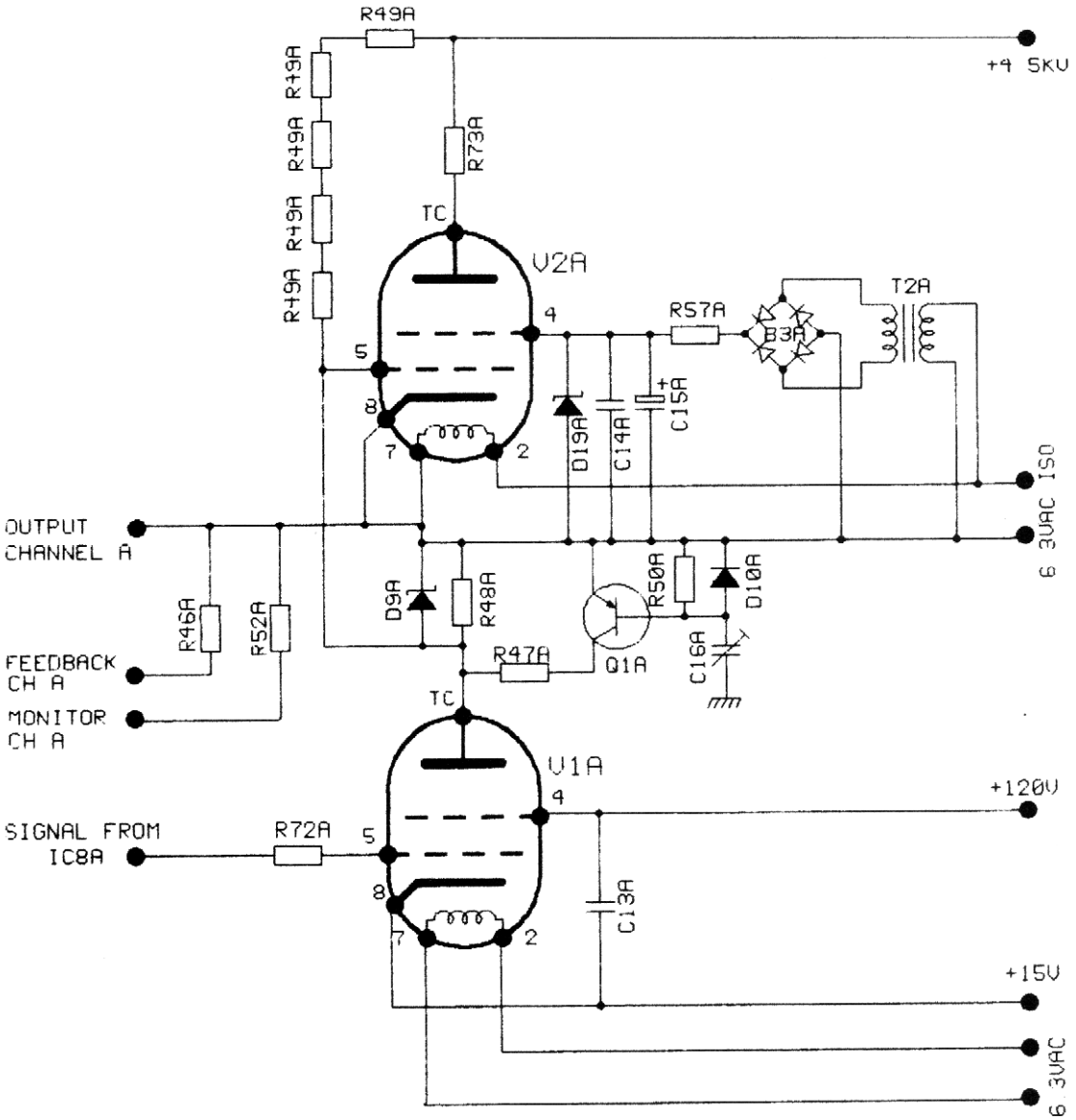
PARTS LIST.

1 off 5000 Series amplifier
2 off HV leads 1 M in length with connectors
1 off Mains lead

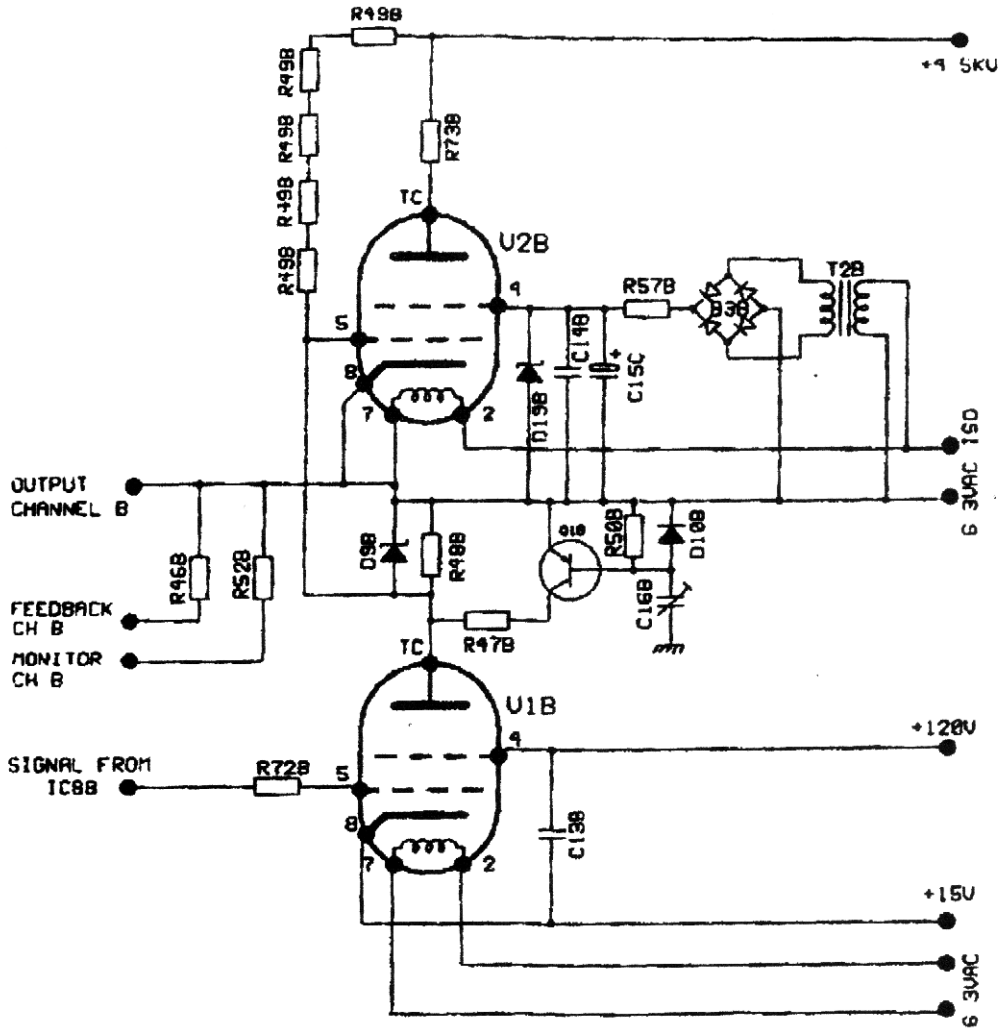


POWER SUPPLIES


PREAMPLIFIERS & OSCILLATOR CIRCUIT
DIFFERENTIAL MONITOR O/P
I/P OFFSET
AMPLITUDE
EXTERNAL SIGNAL I/P
TO CH A
TO CH B
TO R46A
TO R46B
FROM R52A
FROM R52B
+15
-15
+15V
-15V
IC1
8038
SW1
SW2
SW3
SW4A
SW4B
SW5
SW6A
SW6B
SW6C
HZ



HIGH VOLTAGE AMPLIFIER
CHANNEL A



HIGH VOLTAGE AMPLIFIER
CHANNEL B