

LEYSOP LTD

Manufacturers and suppliers of optical and electro-optical components

M2500

High Voltage Differential Amplifier



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THIS MUST BE READ BEFORE USING THE **2500 SERIES AMPLIFIER**

2500 SERIES AMPLIFIER

WARNING

THE MAXIMUM OUTPUT UNDER NORMAL CONDITIONS FROM EITHER A OR B OUTPUT CHANNELS IS 1.5kV. 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 ARE 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 amplifier must not be operated out of its case. Only engineers qualified in high voltage engineering should operate or service this equipment

IMPORTANT

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

SPECIFICATIONS

AC POWER INPUT

90 – 264 volts AC
50 – 60Hz

SIGNAL INPUT

Input voltage swing for linear operation ± 1.25 V

Maximum permissible input voltage ± 15 V

OUTPUT VOLTAGES

Normal voltage range for each channel 100 V to 1450 V

Maximum output voltage swing per channel (overdriven) ~ 1400 V

Maximum differential output voltage swing (overdriven) ~ 2800 V

Maximum differential output voltage swing without clipping ~ 2700 V

Output voltage for zero input signal
and zero differential bias setting 750 V each channel

Output voltages for zero input signal
and maximum differential bias setting one channel 1250 V
other channel 350 V

Output swing for ± 1.0 volt signal input swing ± 500 V each Channel
about bias value

Effective differential output swing
for ± 1.25 volt input swing 2500 V

Gain $\frac{(\text{differential output swing})}{(\text{input swing})}$ 1000 ($\pm 2\%$)

OUTPUT CURRENT

The amplifier is not designed to provide output current into resistive loads.
Capacitive loads will reduce performance.

NOTE

The amplifier has been designed to have a small signal (<500V) frequency response from dc. to 500 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 can be operated continuously up to 120kHz with a square wave signal and 140kHz with a sine wave at normal room temperatures (up to $\sim 30^{\circ}\text{C}$). Operation above these limits is permissible for limited time but the unit will shut down when the thermal limit is reached. The “Limited Run Time” LED will light to indicate that thermal shut down is possible. Operation at high ambient temperature will cause shut down at lower output drive conditions and possibly without the warning indicator showing. Continuous operating conditions are shown in the chart on page 8.

FREQUENCY RESPONSE

Maximum amplitude (2500V differential output) frequency response before significant distortion	dc to 100 kHz
RISE TIME @ Maximum amplitude (2500V differential) @ 2000V differential or less	<600 nS <500 nS
FALL TIME @ Maximum amplitude (2500V differential) @ 2000V differential or less	<600 nS <500 nS
RESPONSE -3dB @ Maximum amplitude (2500V differential)	300kHz

OUTPUT MONITOR

The monitor output is an accurate representation of the differential voltage at the amplifier output terminals and can be connected to an oscilloscope 50 Ω or high impedance input.

Monitor voltage for 2000V differential output voltage	1 V into 50 Ω load 2V into High Z load
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AMPLIFIER 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 $V_B - V_A$
Front Panel differential bias setting	Varies differential output over range $\pm 950V$
External DC Bias Input	+/- 10VDC input varies differential output over range +/- 1000V
Slew rate limit switch. Select as required	Off (fastest response) 1 - Rise Time $\sim 20\mu S$ 2 - Rise Time $\sim 200\mu S$ 3 - Rise Time $\sim 2mS$
Output ON switch	Turns high voltage outputs on
Output ON indicator	Lights when HV outputs are on
Limited Run Time indicator	Lights when thermal shut down Possible
Over temperature indicator	Lights when thermal shut down has occurred

2500 SERIES AMPLIFIER

OPERATING INSTRUCTIONS

SWITCHING ON

ALWAYS ENSURE THAT THE VENTILATION GRILLS ARE CLEAR OF OBSTRUCTIONS

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

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 signal input to the amplifier is connected to the 'SIGNAL 50Ω' BNC connector. This presents a 50Ω load resistance to the signal source which should be suitable to drive this load. The signal input is DC coupled to the amplifier and any offset voltage present will be reflected in the output signals.

A positive transition from zero on the input will cause the A channel output to rise and the B channel output to reduce and conversely for a negative transition. Channel A output, the net differential output voltage and the monitor output are in phase with the input while Channel B output is 180 degrees out of phase with the input.

DIFFERENTIAL BIAS CONTROL

The 'DC BIAS' control adjusts 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 $\sim 750V$.

When the 'DC BIAS' control is set to maximum clockwise rotation the A output bias will be $\sim 1250V$, and the B output bias will be $\sim 350V$. Thus the differential output voltage will be $V_A - V_B = \sim +900V$. When the 'DC BIAS' control is set to maximum anticlockwise rotation the A output bias will be $\sim 350V$, and the B output bias will be $\sim 1250V$. Thus the differential output voltage will be $V_A - V_B = \sim -900V$. The 'DC 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.

Similarly a voltage at the 'EXT DC BIAS' input will alter the output DC bias across the amplifiers dynamic range. An input of +1V produces a bias of +1000V and -1V produces a bias of -1000V. The 'DC BIAS' control and the 'EXT DC BIAS' can be used together and the net bias will be the sum of the two settings.

The digital meter will show the actual DC bias voltage at the outputs. (The meter reading will be affected by low frequency and/or non symmetrical waveforms).

OPERATION OF LIMITS CONTROLS

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 1500V. Similarly the 'negative limit' control precisely limits the voltage $V_B - V_A$ over the range 0 to 1500V. As an example, suppose it is required to limit the differential output swing ($V_A - V_B$) to between + 300V and -900V, the proper settings for the limit controls will be as follows:

$$\text{'Positive limit' control} \quad \frac{(300 \times 100)}{(1500)} = 20\%$$

$$\text{'Negative limit' control} \quad \frac{(900 \times 100)}{(1500)} = 60\%$$

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 V_A and V_B and also the differential output voltage ($V_A - V_B$) when both limit controls are set to 100%.

Fig 1(b) Shows V_A , V_B and ($V_A - V_B$) when the limit controls are set to

$$\text{'POS LIMIT'} = 50\%$$

$$\text{'NEG LIMIT'} = 100\%$$

Fig 1(c) Shows V_A , V_B and ($V_A - V_B$) when the limit controls are set to

$$\text{'POS LIMIT'} = 100\%$$

$$\text{'NEG LIMIT'} = 50\%$$

It can be seen in Fig 1(b) that the setting the 'POS LIMIT' control to 50% limits the positive excursion of V_A to 1075V while at the same time limiting the negative excursion of V_B to 425V.

Similarly in fig. 1(c) the setting of the 'NEG LIMIT' control to 50% limits the negative excursion of V_A to 425V and the positive excursion of V_B to 1075V.

In fig 1(a) the total differential voltage is at the maximum of 2600V while in both Fig 1(b) & 1(c) the total differential voltage is reduced to 1950V.

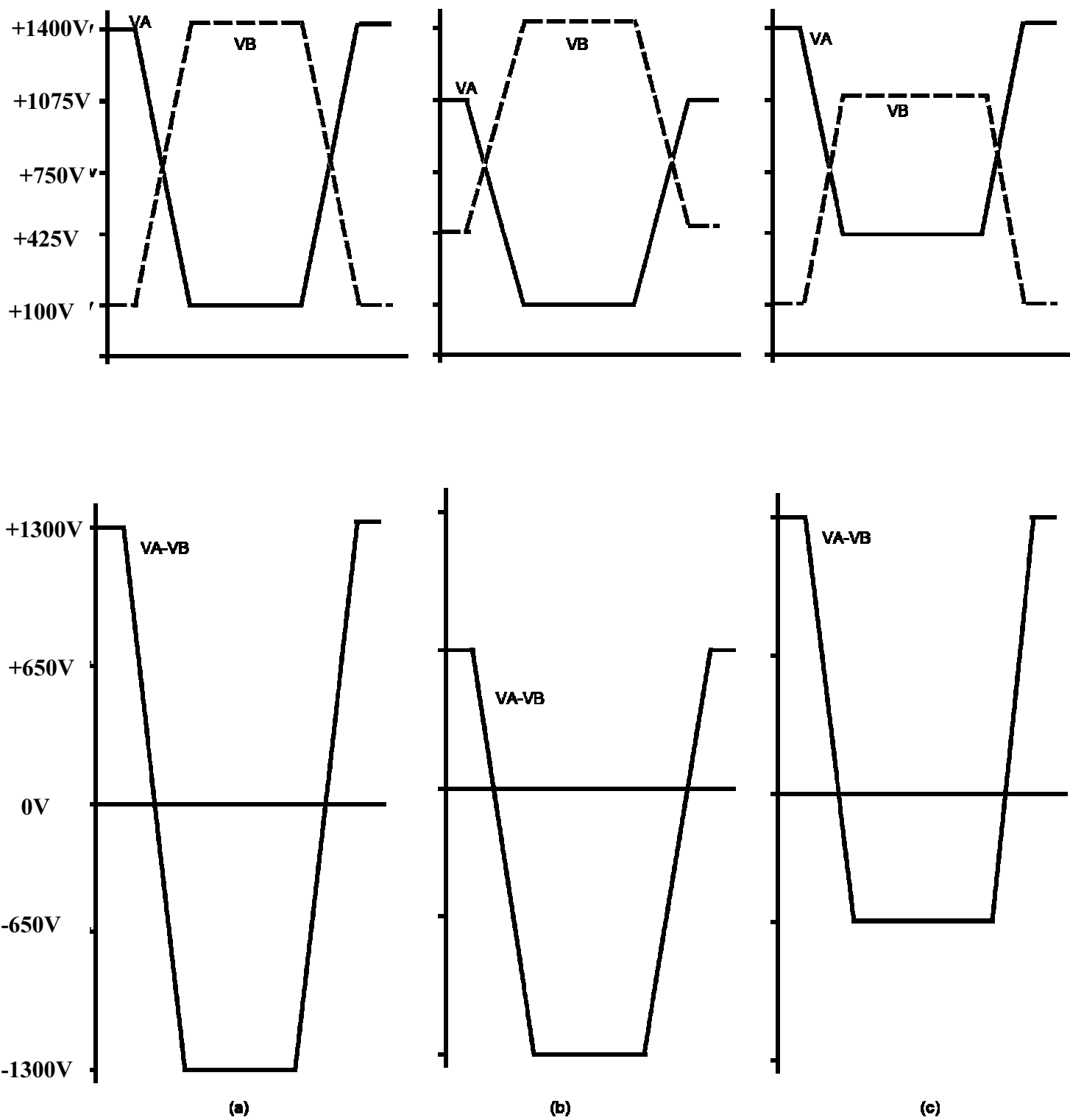


Fig. 1. Showing the effect of limit controls.

SLEW RATE CONTROL

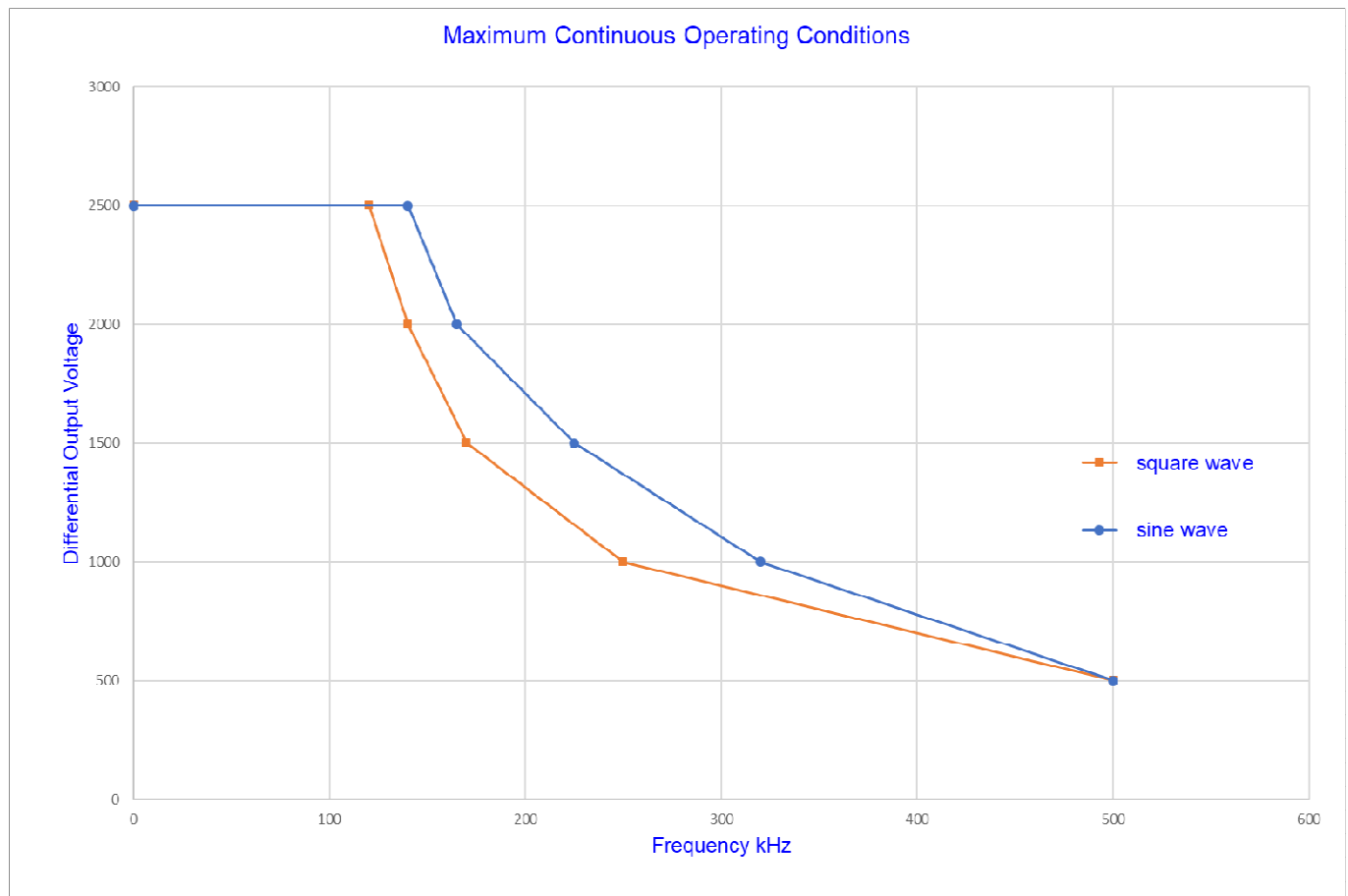
This limits the maximum rate of change of the differential output voltage. The main use of this control will be to limit the rate of change of voltage across a pockel cell when the input is a square wave of fast rise time. If the amplifier is to be used for switching an EM500 modulator the maximum slew rate of 2500V/uS may cause mechanical resonance, through piezo-electric effects, and unwanted optical modulation through the elasto-optic effect.

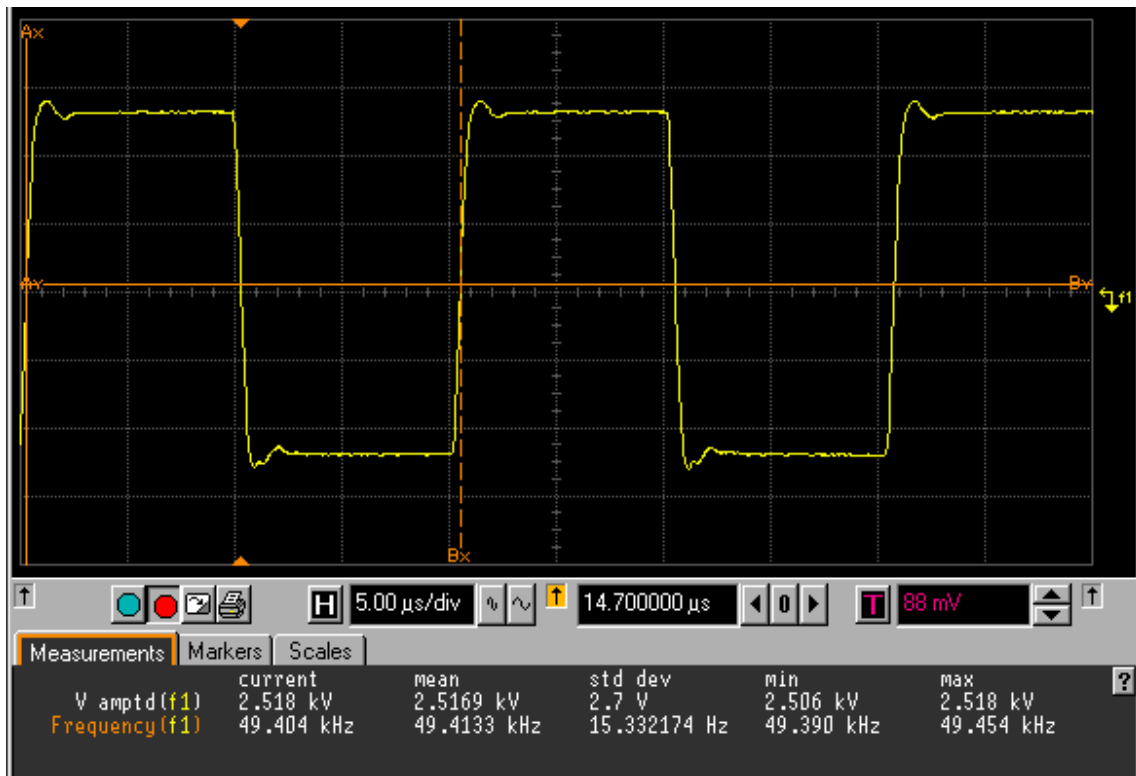
THERMAL OPERATING CONDITIONS

This amplifier can be run continuously up to certain limits that are specified by the thermal stress imposed on internal components. These limits are illustrated by the chart below which shows the safe area of operation for square and sine wave signals up to ambient temperatures of approximately 30°C. The area to the left of the chart lines allows continuous operation where as operating to the right of the line will light the “LIMITED RUN TIME” LED and will result in the unit turning off to prevent damage. After shutdown the amplifier will rapidly cool and operation can be restored by moving the “OUTPUT ON” switch to the off position and switching back ON.

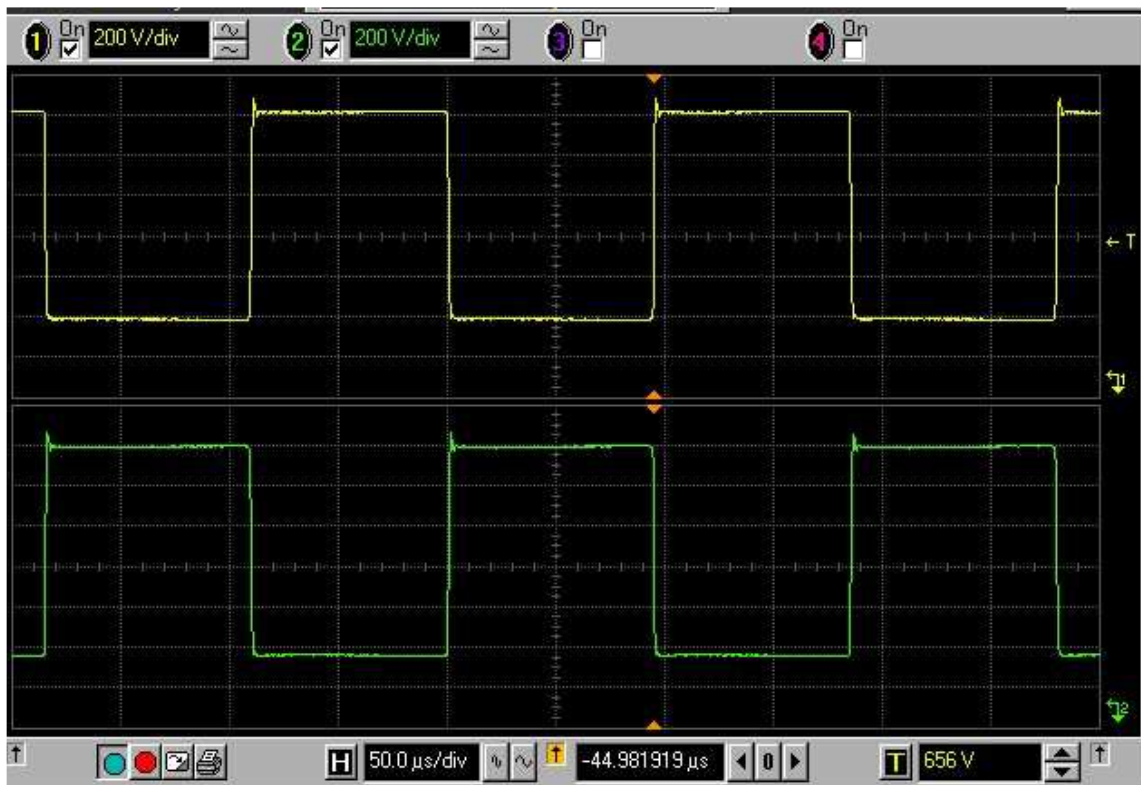
The figures shown on the chart are for guidance only and vary according to ambient temperature, output voltage, operating frequency, DC Offset and waveform. The shutdown system will always protect the unit from extreme operating conditions

Due to the high levels of heat generated in this unit there are two fans helping to cool it, one of these is controlled by the system and when the amplifier is being driven hard this fan will switch to high speed as conditions dictate. The user will notice an increase in the fan noise under these circumstances. This is normal.

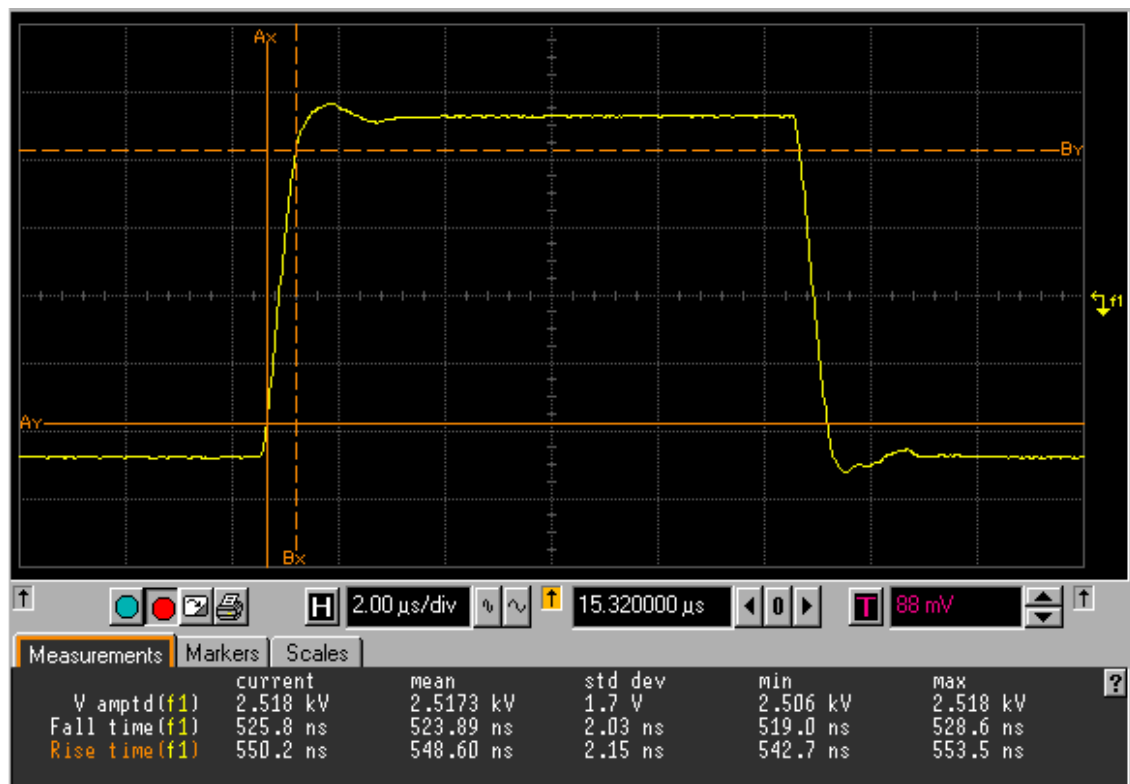




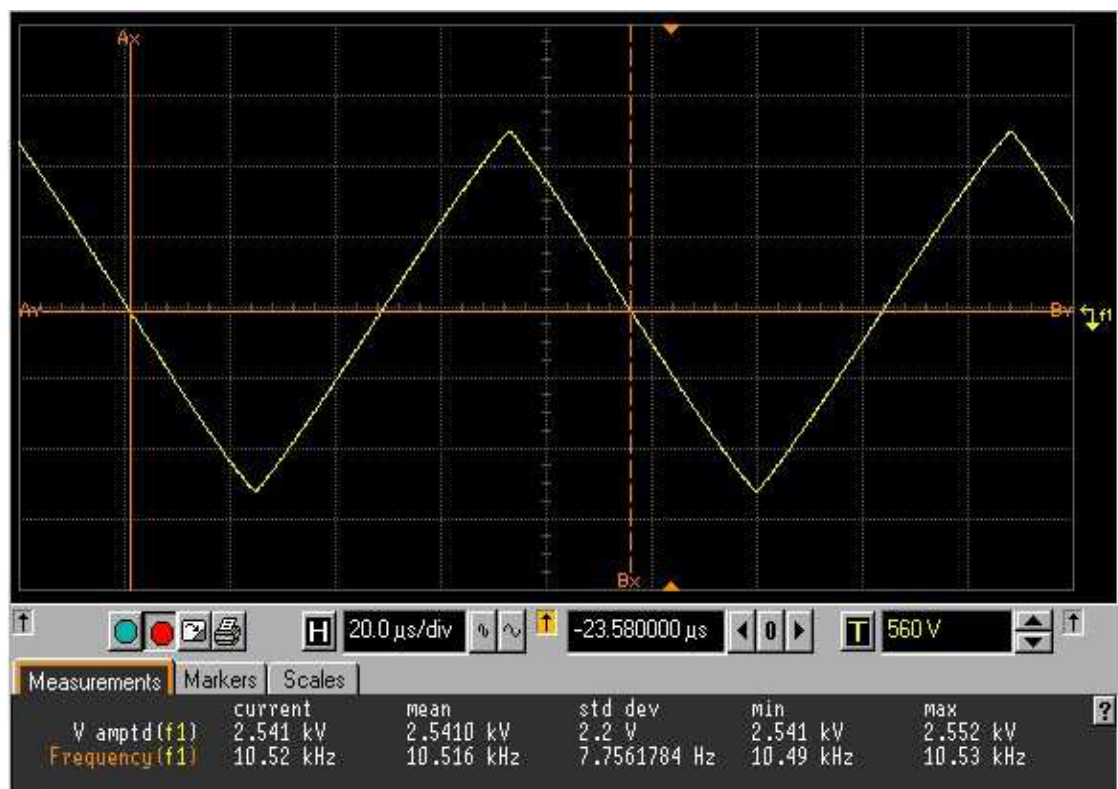
Typical Differential Output Waveform at 50kHz and 2500V



Typical Channel A and Channel B Output Waveforms



Typical rise and fall times at 2500V output

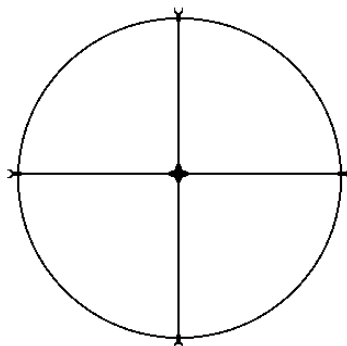


Typical Triangular Wave at 10kHz and 2500V

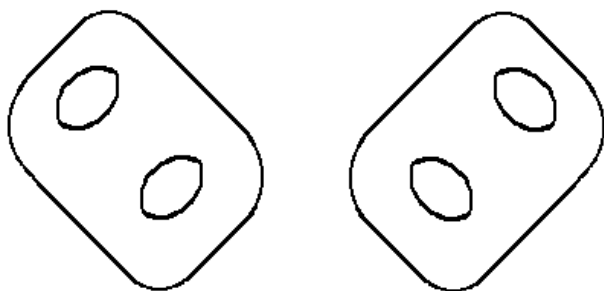
A SIMPLE SETTING UP AND FAMILIARISATION PROCEDURE FOR THE 2500 SERIES AMPLIFIER AND EM500 SERIES MODULATION

Ensure all connections to the amplifier are made correctly and safely.

1. Connect the modulator to the amplifier using the two leads provided.
2. Connect external oscillator to input with 1Hz square wave and amplitude at min.
3. Set Slew rate switch OFF
4. Set positive and negative Output Limits fully clockwise.
5. Switch Output On and increase the input signal amplitude.
6. Check that the amplifier is working by observing the monitor output using an oscilloscope.
7. 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 amplitude 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 & Sense
Voltage -

There is then a phase shift between the ordinary and extraordinary rays leaving the modulator of $\pm 180^\circ$. 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 analyser.

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.