LEYSOP LTD

Manufacturers and suppliers of optical and electro-optical components

M1000

High Voltage Differential Amplifier

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<u>THIS MUST BE READ BEFORE USING THE 1000 SERIES AMPLIFIER</u>

<u>1000 SERIES AMPLIFIER</u>

<u>WARNING</u>

THE MAXIMUM OUTPUT UNDER NORMAL CONDITIONS FROM EITHER A OR B OUTPUT CHANNELS IS 600V. 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

<u>IMPORTANT</u>

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	$\pm$ 1.25 V
Maximum permissible input voltage	$\pm$ 15 V

OUTPUT VOLTAGES

Normal voltage range for each channel	25 V to 590 V
Maximum output voltage swing per channel (overdriven)	~550 V
Maximum differential output voltage swing (overdriven)	~1100 V
Maximum differential output voltage swing without clipping	~1000 V
Output voltage for zero input signal and zero differential bias setting	300 V each channel
Output voltages for zero input signal and maximum differential bias setting	one channel 575 V other channel 125V
Output swing for $\pm$ 1.0 volt signal input swing	$\pm$ 200 V each Channel about bias value
Effective differential output swing for $\pm$ 1.25 volt input swing	1000 V
Gain $\frac{\text{(differential output swing)}}{\text{(input swing)}}$	400 ($\pm$ 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 (<600V) frequency response from dc. To 1 MHz. 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 1 MHz normal room temperatures (up to ~ 30°C). Operation At higher temperatures 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.

FREQUENCY RESPONSE

Maximum amplitude (800V differential output) frequency response before significant distortion	dc to 1000 kHz
RISE TIME @ Maximum amplitude (1000V differential)	<250 nS
@ 800V differential or less	<250 nS
FALL TIME @ Maximum amplitude (1000V differential)	<300 nS
@ 800V differential or less	<300 nS
RESPONSE -3dB @ Differential amplitude (800V differential)	1.5 MHz

OUTPUT MONITOR

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

Monitor voltage for 1000V diffential output voltage	0.5 V into 50Ω load 1V into High Z load

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 ± 950V
External DC Bias Input	+/- 5VDC input varies differential output over range +/- 250V
Slew rate limit switch. Select as required	Off (fastest response) 1 - Rise Time ∼20μS 2 - Rise Time ∼200μS 3 - Rise Time ∼2mS
Output ON switch	Turns high voltage outputs on
Output ON indicator	Lights when HVoutputs are on
Limited Run Time indicator	Lights when thermal shut down Possible
Over temperature indicator	Lights when thermal shut down has occured

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 negatiove transition. Channel A output, the nett 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 ~300V.
When the 'DC BIAS' control is set to maximum clockwise rotation the A output bias will be ~480V, and the B output bias will be ~120V. Thus the differential output voltage will be $V_A - V_B = \sim +360V$.
When the 'DC BIAS' control is set to maximum anticlockwise rotation the A output bias will be ~120V, and the B output bias will be ~480V. Thus the differential output voltage will be $V_A - V_B = \sim -360V$
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 +5V produces a bias of +250V and -5V produces a bias of -250V. 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 600V. Similarly the 'negative limit' control precisely limits the voltage $V_B - V_A$ over the range 0 to 600V. As an example, suppose it is required to limit the differential output swing ($V_A - V_B$) to between + 200V and - 500V, the proper settings for the limit controls will be as follows:

'Positive limit' control $\frac{(200 \times 100)}{(600)} = 33\%$

'Negative limit' control $\frac{(500 \times 100)}{(600)} = 83\%$

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 450 while at the same time limiting the negative excursion of VB to 150V.

Similarly in fig. 1(c) the setting of the 'NEG LIMIT' control to 50% limits the negative excursion of VA to 150V and the positive excursion of VB to 450V.

In fig 1(a) the total differential voltage is at the maximum of 1000V while in both Fig 1(b) & 1(c) the total differential voltage is reduced to 500V.

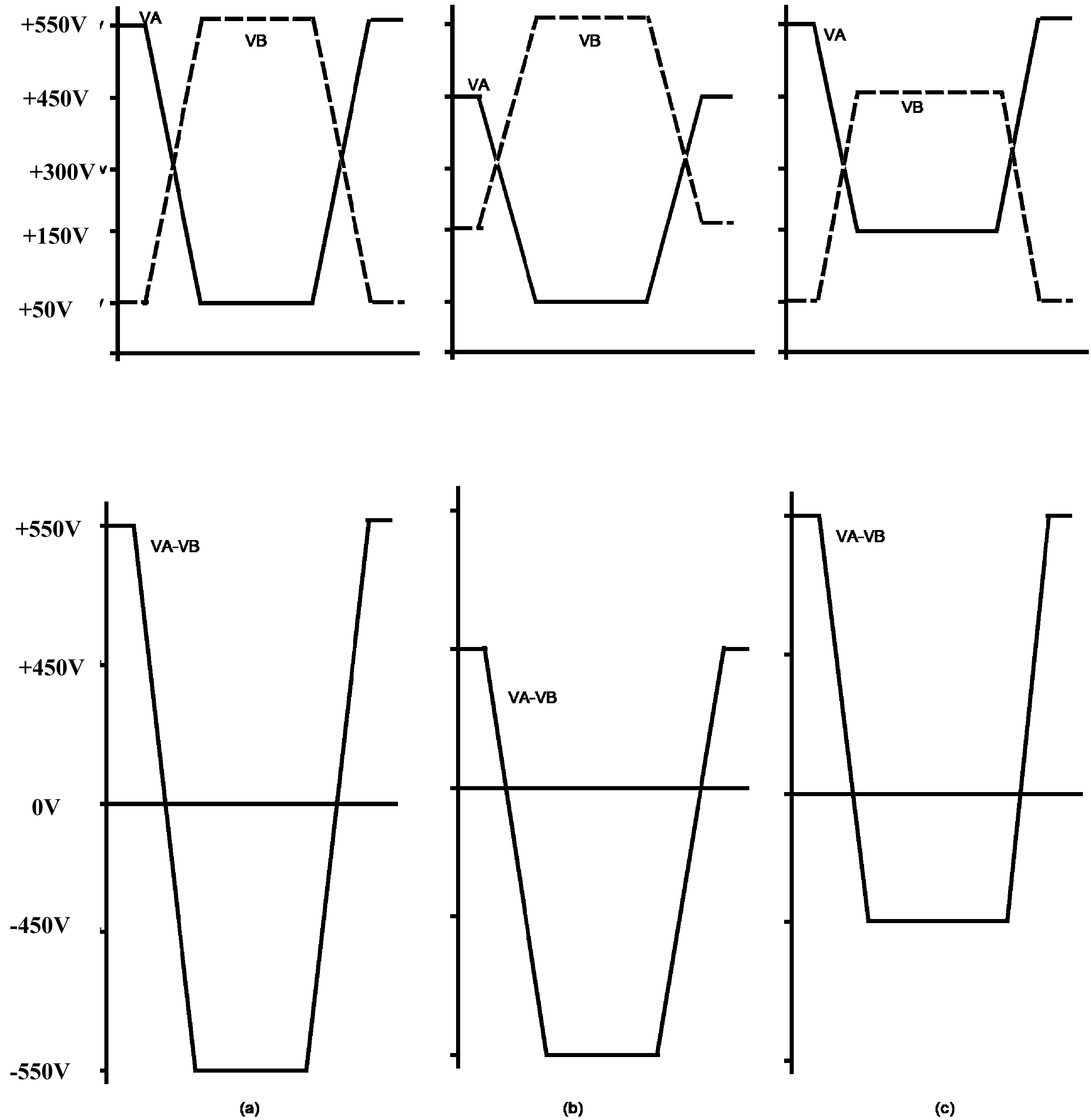
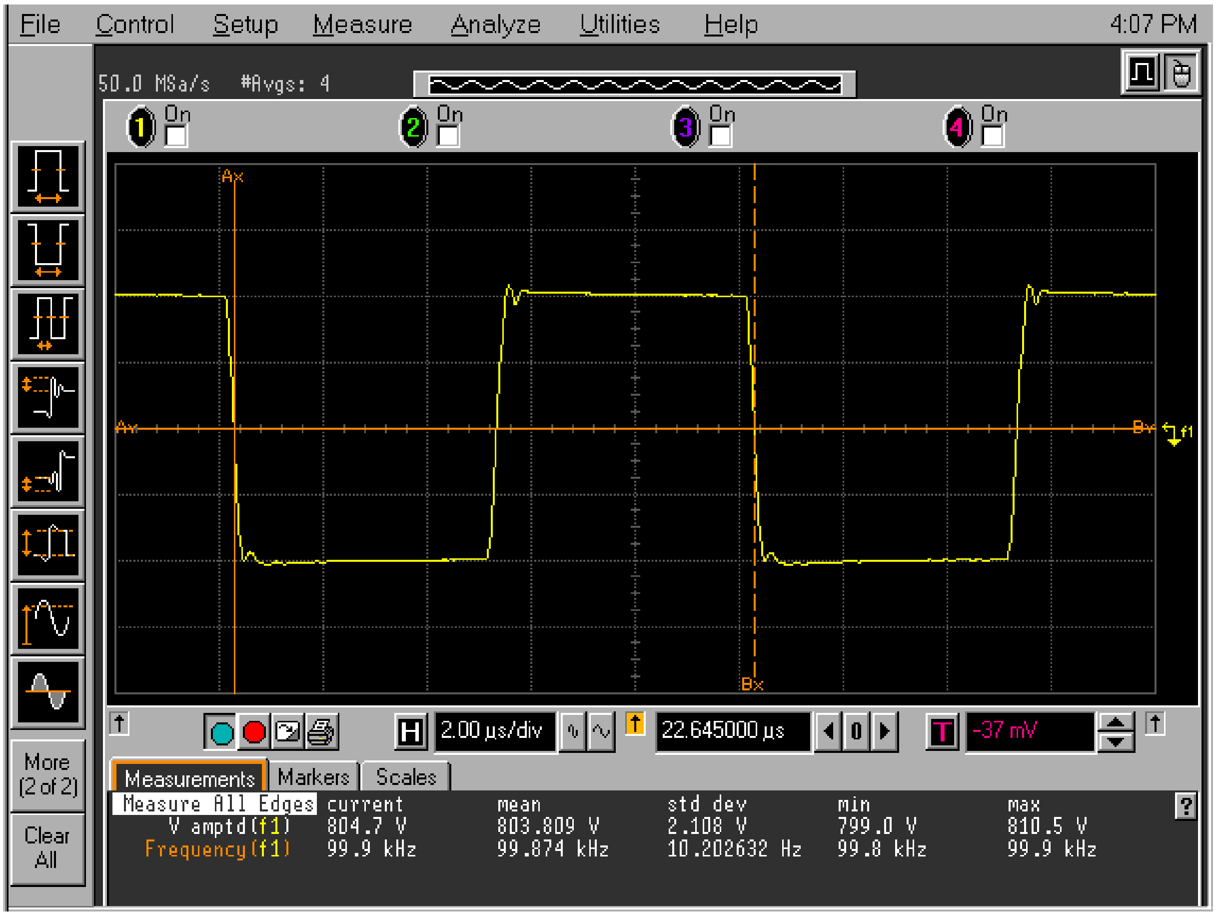


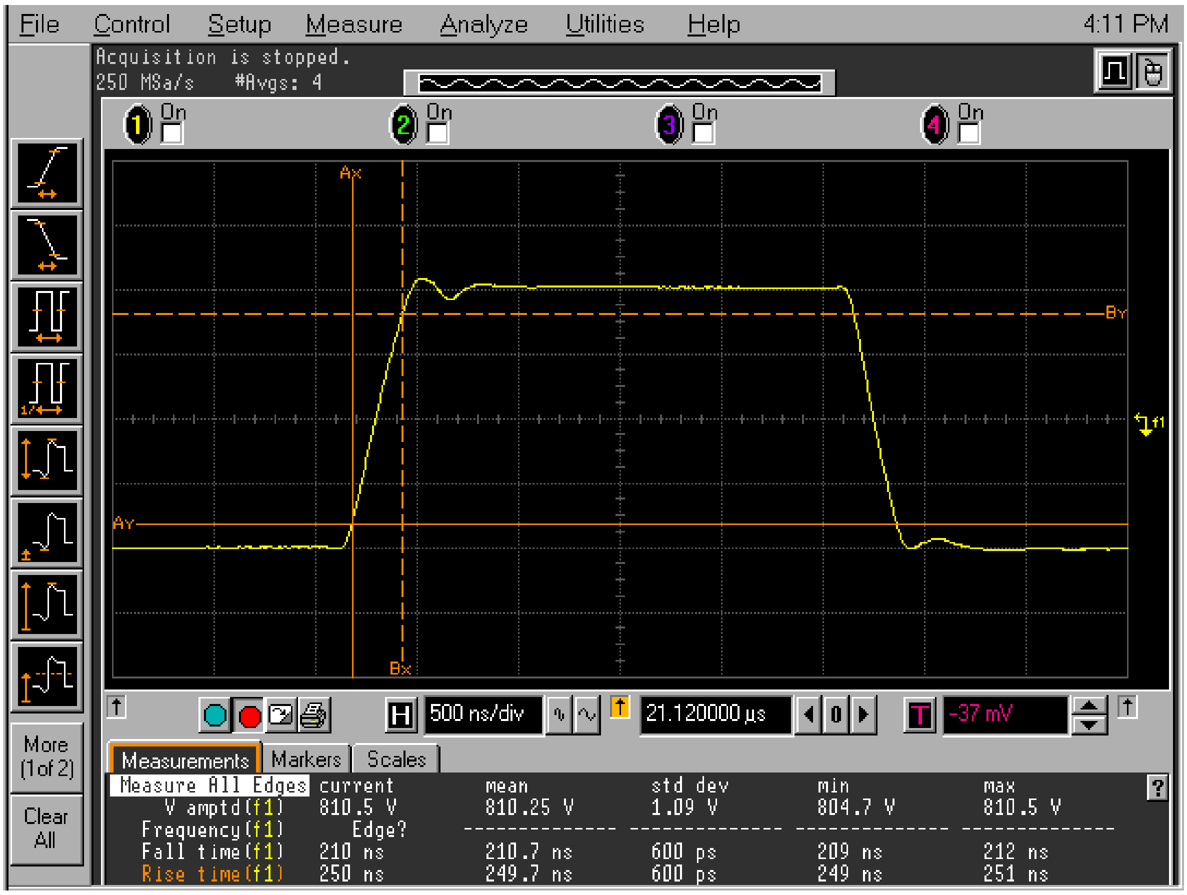
Fig. 1. Showing the effect of limit controls.

SLEW RATE CONTROL

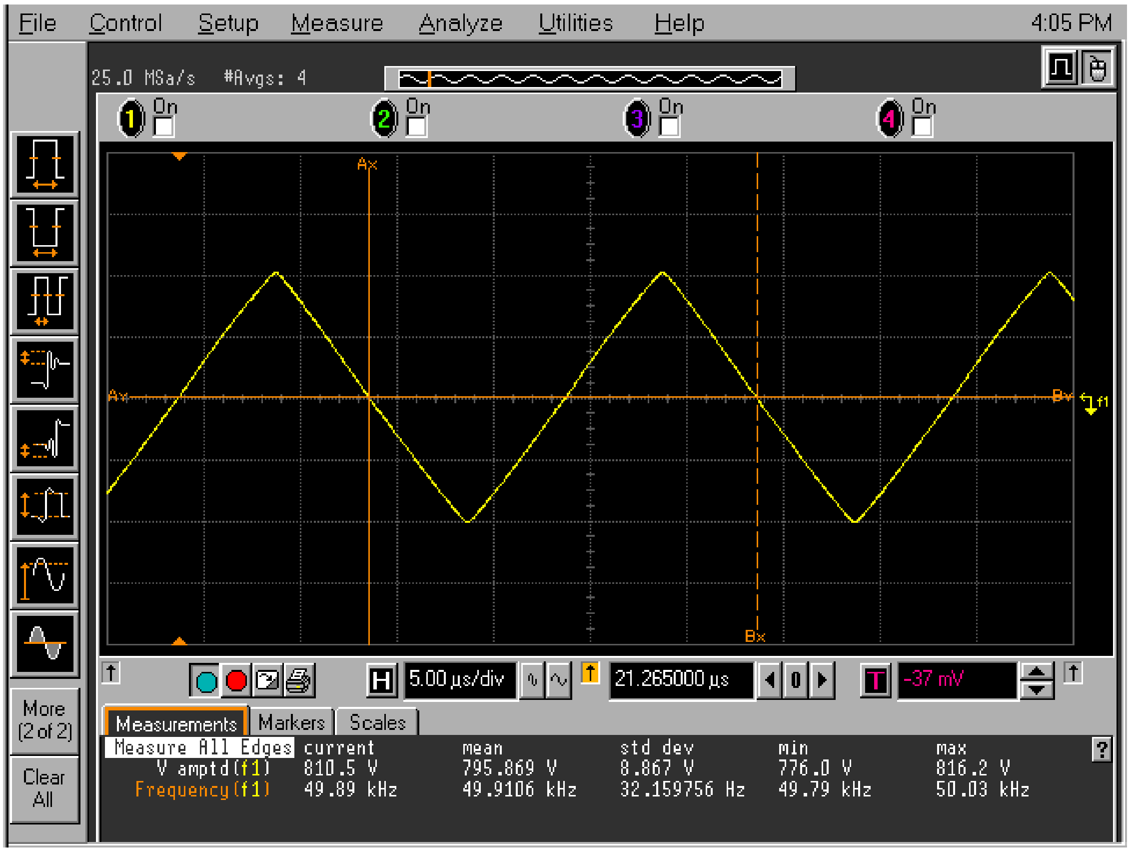
This limits the maximum rate of change of the differential output voltage. The main use of this control will be to limit the rate of change of voltage across a pockel cell when the input is a square wave of fast rise time. If the amplifier is to be used for switching an EM500 modulator the maximum slew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



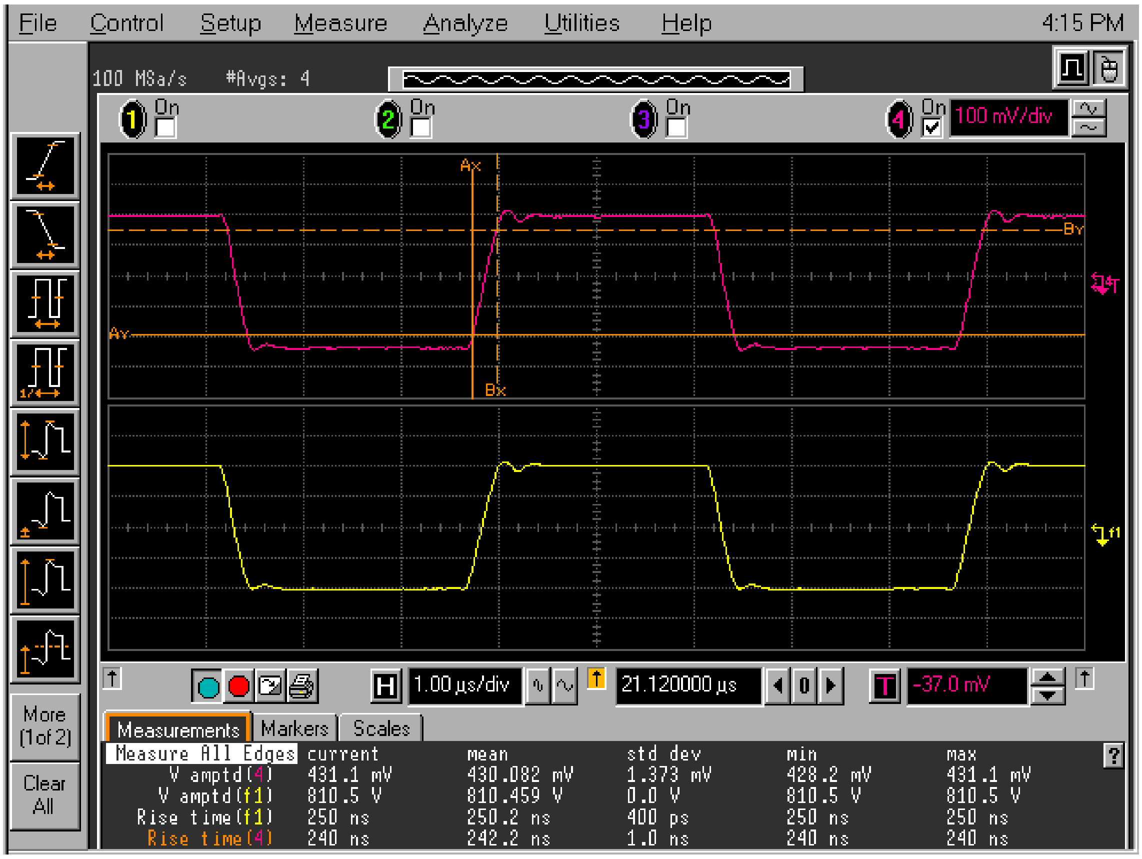
Typical Differential Output Waveform at 100kHz and 800V



Typical rise and fall times at 1000V output



Typical Triangular Wave at 50kHz and 800V

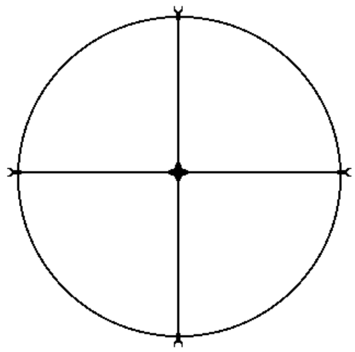


Typical Monitor Output (top) compared withDifferential Output 800 Volts at 200kHz

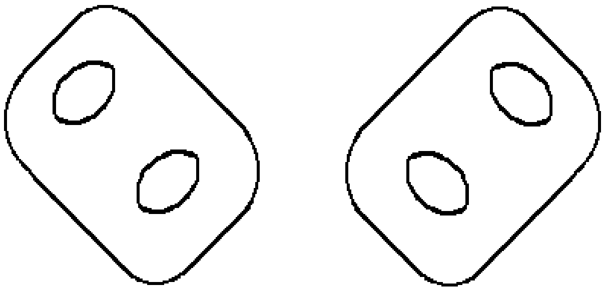
A SIMPLE SETTING UP AND FAMILIARISATION PROCEDURE FOR THE 1000 SERIES AMPLIFIER AND EM500 SERIES MODULATION

<u>Ensure all connections to the amplifier are made correctly and safely</u>.

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°. 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.