Kentech Instruments Ltd.

High Rate Pockels Cell Driver

Serial Number J04*****

6th. July 2005

PLEASE READ THIS MANUAL CAREFULLY BEFORE USING THE

CAMERA.

DISCLAIMER

This equipment contains high voltage power supplies. Although the current supply capacity is small, careless use could result in electric shock. It is assumed that this highly specialised equipment will only be used by qualified personnel.

Kentech Instruments Ltd. accept no responsibility for any electric shock or injury arising from use or misuse of this equipment. It is the responsibility of the user to exercise care and common sense with this highly versatile equipment.

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NOTES ON THE SETTING UP AND ALIGNMENT OF POCKELS CELLS. BASED UPON A FAST PULSE TECHNOLOGY USER MANUAL OF 1991.

POCKELS CELL SETUP AND ALIGNMENT

This procedure is applicable to all modulators and Q-switches both transverse and longitudinal mode, fabricated with KDP, KD*P, ADP, AD*P and similar single axis crystals.

FastPulse Technology type Q-switches are supplied with a marker on one of the stainless steel aperture plates or the outer housing to indicate the polarisation plane of the incoming beam. In some models, the connector or terminals serve as the marker . The input plane of polarisation must be aligned with the marker (or rotated 90° from it) for correct operation. If the marker is missing, then the appropriate directions must be determined by viewing the side of the crystal inside of the device through the clear aperture in a bright light.All crystals have a straight line marked on the barrel of crystal (the crystal is cylindrical) The input plane of polarisation must be parallel to or perpendicular to the line on the crystal.

CAUTION: Protective laser goggles should be worn during the following alignment procedures.

It is strongly recommended that initial alignment of all pockels cells be done with a low power (0.5 to 2 mW) HeNe laser (or similar) to assist in visualizing beam position. We do not recommend attempting this alignment procedure with an IR laser unless the power can be throttled to 1 or 2 mW and an IR viewer is available. Great care must be taken to insure that the laser beam does not impinge on the external aperture stops or the crystal electrodes. At higher, operating power levels, it is possible to damage the device if the beam strikes the internal electrodes thereby causing thermal damage.

Unless there are strict restraints on space and positioning devices, the device should be mounted in a gimbal that provides accurate and stable pitch and azimuth adjustments. Some means for obtaining horizontal and vertical translation is usually necessary to centre the device on the input laser beam.

If the Pockels cell is being used in a laser cavity, it is recommended that the alignment be done with a HeNe laser having its beam coaxial with the laser rod. This coaxial condition should be confirmed by operating the laser with the HeNe to insure that the beams are indeed coaxial and the HeNe beam centred. If this cannot be done conveniently , then the HeNe beam should be retro-reflected off the nearest laser rod surface back onto itself. The Q- switch can then be placed in the optical train.

It is essential that the laser beam pass through the Pockels cell entrance and exit apertures without vignetting. The beam should be centred in both apertures with at least 0.5 mm clearance all around.

The following procedure has been shown to be most reliable for obtaining optimum alignment. The object is to centre the laser beam in the device apertures and then generate an optical pattern which accurately locates the optical axis of the crystal with respect to the laser beam.

The procedure will probably require several adjustments of pitch, azimuth and translation to optimise the alignment but it will provide positive and visual confirmation of the alignment. The basic alignment configuration is shown in Figure 1.

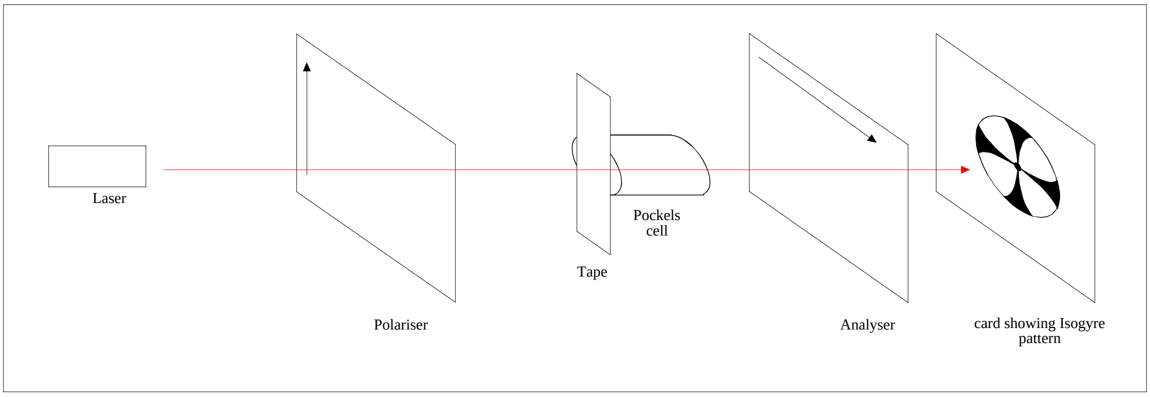

Figure 1 Modulator Between Crossed Polarisers

1. Remove any polarisers used to polarise the beam entering the device. If the laser is already polarised it does not effect this procedure, however, the plane of polarisation must be aligned (eyeball accuracy is usually good enough) with the marks or terminals on the Pockels cell. Position the device in the HeNe laser beam so that the beam is centred and passes through the apertures without touching the aperture edges.

2 Place a light coloured matt finish card in the path of the beam at a distance of between 1 to 2 feet from the exit aperture of the Pockels cell. If the device is located within a laser cavity, the card should be placed against the laser rod holder and a small hole made in the card to locate the centre of the rod aperture. Mark the beam location on the card with a circle or dot and leave the card in place.

3 Place the input polariser in the beam with its polarising axis aligned to the mark on the Pockels cell aperture plate. If the laser rod produces a polarized beam (as with a ruby rod) the polariser must be aligned to the rod polarisation direction. It is assumed that the polariser does not deviate the beam angularly.

Place the output polariser (analyser) at the output side of the device and insure that its polarising axis is rotated 90° from that of the input polariser.

4. Place a strip of frosted adhesive tape (Scotch Magic Mending Tape No. 810 or similar material) over the device entrance aperture. Gently press the tape in place but do not allow it to touch the window surface. A lightly frosted glass plate will provide the same scattering but must be nearly in contact with the entrance aperture.

The actual measurement is usually made in a darkened room after basic alignment and adjustments are completed. In most instances, the pattern to be viewed will be difficult to see in normal room lighting.

When the HeNe beam propagates through the optical train, a pattern, or some part of it, will be projected on the card. This is called an isogyre pattern and is illustrated in Figure 2a and 2b below

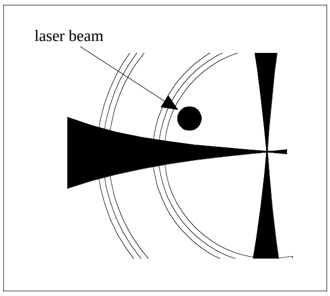

Figure 2a. Isogyre Pattern Off Centre

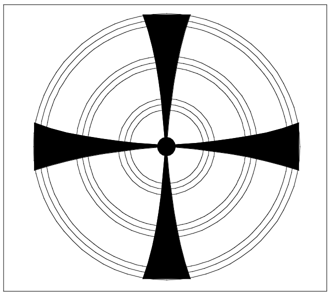

Figure 2b. Isogyre Pattern Centred

If the optic axis of the crystal is not parallel to the path of the laser beam, the isogyre pattern will be off-centre and the device must be moved in pitch and azimuth. When the isogyre is centred over the circle or dot or hole in the card this indicates that the device is well aligned.

After making any positional adjustments, the beam position relative to the device aperture stops must be confirmed. The beam must still pass through both apertures without vignetting and with adequate clearance. If it does not, employ horizontal and vertical translation until clearance is confirmed. If the figure is not in the form of a cross, then the polarisers are not rotationally aligned to the faceplate mark or at 90° to each other.

Once the cross of the isogyre is centred, the polarisers can be rotated slightly to maximize the darkness of the centre of the cross. After this is done, the device is not only aligned with the laser beam, it is also nulled with respect to the crossed polarisers for best contrast ratio and it is ready for operation.

The extra polariser, if one was used, may be removed.

3.0 OPERATION

3.1 Cautionary Note:

Application of DC voltage to some Pockels cell Q-switches and light modulators for long periods of time may result in permanent damage to the electro-optic crystal(s).

Devices fabricated from KDP, KD*P, ADP and AD*P, in the presence of continuous (DC) high electric fields, are subject to an effect that is not well understood but is apparently electrolytic in nature. With long term application of high voltage, the polished optical surfaces become fogged and etched. All crystal surfaces, including those under the conductive electrodes can be similarly effected. This may result in discontinuities between the crystal and electrode conductors. Application of AC electric fields, even those with a net DC value, appear to minimize the effect and extend lifetimes dramatically.

The effect is independent of the electrode materials used and has been documented for gold, indium, silver and transparent conductive oxide electrode materials. One manufacturer reports that a sustained voltage of 50 volts will eventually have an effect on the crystal. Use of inert index matching fluids does not mitigate the damage. The effect appears with or without the use of fluid.

We recommend that DC voltage not be applied to a Pockels cell when the laser system in which it is employed is not actively in use. When the system is in a stand-by condition, care must be taken to turn off the DC voltage to the Pockels cell. When this procedure is followed, operational lifetimes of more than 5 years is not unusual and where this voltage off safeguard has been observed, many Fastpulse/Lasermetrics Q-switches have been in active use for more than 15 years

REFERENCE

R. Goldstein, Electro-Optic Devices in Review, Lasers & Applications, April, 1986

Contents

Figure Captions

ABBREVIATIONS

LCD	Liquid Crystal Display
UCS	Users Control System (to be provided by the user)
EPROM	Electrically programmable read only memory, non volatile
EEPROM	Electrically programmable and erasable Read only memory, non volatile
ADC	Analogue to Digital Convertor
RAM	Random access memory, volatile.
EPLD	Electrically programmable logic device
dv	desired value
mv	measured value
wo	write only
ro	read only
rw	read and write
sw	software
hw	hardware
W/E	Write Enable
RTP	Rubidium Titanyl Phosphate or $RTiOPO_4$

1 INTRODUCTION

This manual describes the operation and use of the High Rate Pockels Cell Driver. This package is designed for manual control via the front panel. Although it can be controlled via an RS232 link no user interface has been designed and the details of such control are not included here. The package will switch a voltage at either terminal of a pockels at independent times. In addition there is a facility to apply a bias voltage to the pockels cell.

1.0 SPECIFICATIONS OF THE PACKAGE

Number of channels	1
Maximum switched voltage	4kV x 2*
Output optical pulse duration	will achieve 2µs but specification is only guaranteed for 1µs
Trigger delay ON switch	18ns.
Trigger delay OFF switch	7ns.
Power requirements	typically 80 to 240 volts AC at less than 3 amps. ~120 watts
Bias voltage	0 - 4kV [supplied disabled]
Maximum repetition rate	>100kHz*
Electrical trigger requirements	5 volts into 50Ω rising in < 5ns for both the gate ON and gate OFF triggers.

Connectors:-

Power	IEC lead	
Interlocks etc.	15 way DIN female pins,	

Power supply interlock on pin 5, EEPROM write enable on pin 8, both ground to enable.

RS232	9 way DIN female pins	
Low voltage control to head unit		Fischer
High voltage to head unit		Fischer
Trigger ON	Lemo	FFA.00S.250. CTA C22
Trigger OFF	Lemo	FFA.00S.250. CTA C22

Note tat the maximum switched voltage is not the voltage applied to the pockels cell. In practice for the cell supplied the DC bias voltage required is ~1200 volts but the optimum switched voltage is ~1900 volts. This is in part due to the switching technique which is incapable of putting the whole switched voltage across the cell.

* The maximum repetition rate is normally limited by the current available, 12mA. At low voltages and or narrow gate widths less current is drawn and the maximum repetition rate is higher The head is inhibited for 3µs after the OFF edge is triggered, this is the only hard limit.

Figure 1   Overall picture of unit

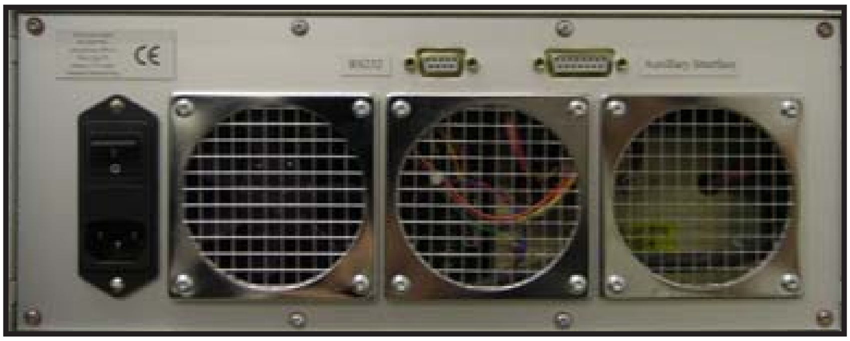

Figure 2   Rear Panel of unit

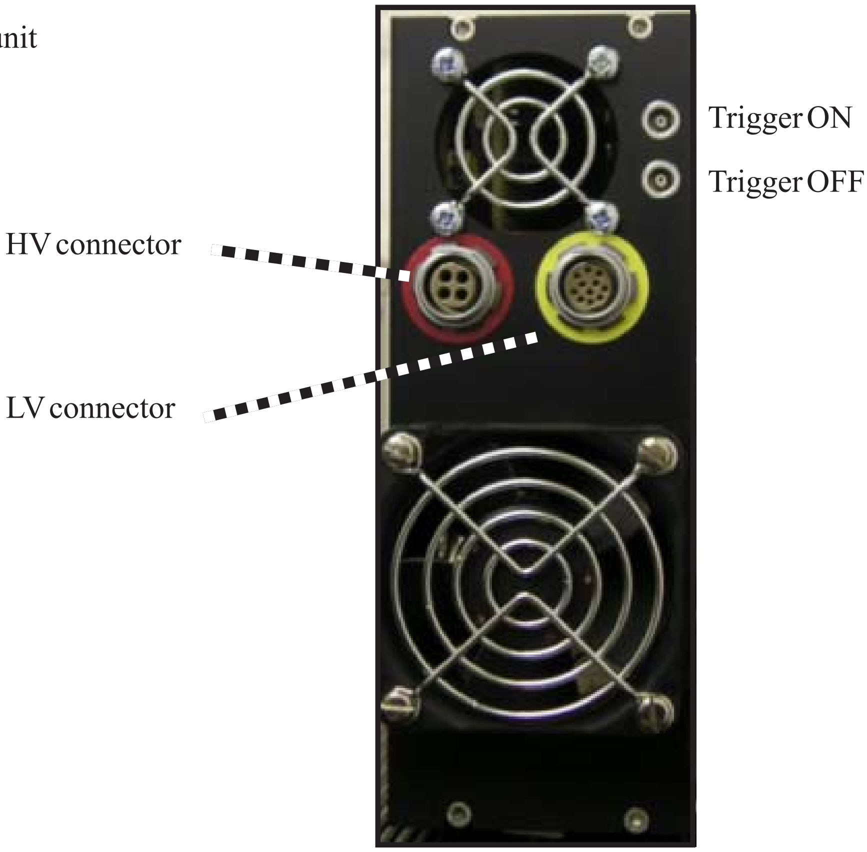

Figure 3   Connection Interface of Head.

2 OVERALL DESCRIPTION

2.0 MECHANICS

The system consists of 2 modules, a control unit and an optical head. The control unit contains the high voltage power supplies and delivers power to the head for the main high voltage switches, a bias supply to set the operating point of the pockels cell and also power for the fan logic and drive circuits. The head contains two high voltage switches and various biasing and charging components. All the trigger logic is also housed in the head. Trigger signals are taken directly to the head unit, so keeping the pre trigger requirement low.

The pockels cell fitted to the head unit can be of various types but the software in the control unit is configured for a particular cell. This prevents inadvertent application of too high a voltage to the cell.

2.1 ELECTRICAL CONNECTIONS

2.1.1 ELECTRICAL CONNECTIONS BETWEEN THE MODULES

The system is supplied with two leads that connect the head to the control unit. One carries the two high voltage supplies, a high current one (up to 12mA) to drive the two high voltage switches and a low current bias supply. There is an interlock lead in the high voltage cable that prevents operation of the high voltage supplies unless both leads are connected to the head (and other interlocks are set).

2.1.2 CONNECTING THE CAMERA HEAD

The following needs to be connected to the head:

1. two 2 metre cables carrying the high voltage, low voltage and control signals.
2. A trigger lead to switch the ON switch.
3. A trigger lead to switch the OFF switch.

2.1.3 CONNECTIONS TO THE CONTROL UNIT

1. two 2 metre cables carrying the high voltage, low voltage and control signals.
2. Interlock lead to the 15 way DIN connector on the rear panel. Note that there are other pins on this connector that may be used for other applications, see appendix 1.
3. RS232 to the 9 way DIN connector on the rear panel, this is not needed for normal operation.
4. Power lead.

2.3 RUNNING THE ELECTRONICS

The electronics can run in air at normal atmospheric pressure. The unit has not been tested at elevated altitudes although, at sea level, the head fan does not need to run at full speed to cope with maximum power dissipation, so there is some scope for running in air with poorer thermal transfer properties.

2.4 POWERING UP

On power up the control unit fan will start up and the power LED will illuminate. A copyright message will appear briefly in the LCD display. The unit will power up with the power supplies disabled but the voltages set to those saved in Setup 0 .

2.5 LEDS

There are three LEDS, power, triggered and enabled. The enabled LED will also flash if a fault condition is met that causes the unit to shut down.

3 GENERAL DESCRIPTION OF SYSTEM

3.1 THE HEAD

The system will switch the voltage on the pockels cell for between 0 and 1µs. In practice it will run out to 2µs but may be out of specification on repetition rate and possibly droop.

3.1.1 THE SWITCHES

The circuit is shown in figure1 and 2 In the quiescent state the voltage across the cell is set by the bias supply. On receipt of an ON trigger the voltage on one side of the cell will be reduced by a fraction of the charge voltage, the fraction is typically 80% of the charge voltage (Vswitch). The exact figure will depend upon the cell used.

When the head receives a trigger pulse to the OFF trigger input the second switch will fire causing the voltage on the other side of the cell to drop by the same fraction of the charge voltage, so returning the voltage across the cell to its initial value. Some 100ns after the receipt of the OFF trigger, both switches are synchronously turned off and the recharge cycle begins. As both sides of the cell recharge synchronously there is no net voltage across the cell during this period and so of the cell bifringence.

In the absence of an OFF trigger the OFF switch will be triggered at 2µs after the ON switch, the recharge will then start 100ns later and the OFF input will be inhibited for a further 3µs.

If the OFF trigger arrives before the ON trigger the voltage on the cell is switched in the opposite direction and then the inhibit and recharge circuits are activated as above. However, as the voltage on the cell is reversed it will add to the bias voltage rather than subtract from it. The total voltage on the cell can be higher than may be desirable. Although the cell should be able to withstand this voltage *the condition should be avoided*. Always trigger the ON switch first, (the top trigger input).

3.1.2 THE BIAS VOLTAGE

The use of the bias voltage is somewhat complex and discussed in detail in section 4.

The bias voltage is adjustable from 0 to 4kV. As with the main switch voltage it is only active if the relevant interlocks are set. In addition the head must be configured to apply the bias. It is normally shipped in a disabled state for the reasons discussed in section 4. There is no monitor of the bias voltage.

3.1.4 THERMISTORS AND HEAD FAN

Thermistors are fitted to several components in each module. Those in the control unit are not monitored by the software although they can be accessed through the RS232 port (no details are given in this manual). There are two positive temperature coefficient thermistors in the head. These are wired in parallel so that if either heats up there is a signal detected at the control unit. The unit will shut down if a temperature in excess of about 40°C is detected.

Note that this unit is capable of delivering up to 60 watts to the head and this poses a considerable fire hazard, especially with a fan running. It is essential that the temperature monitoring system is able to shut down the system. The user should also not inhibit the head fan from running. If the airflow

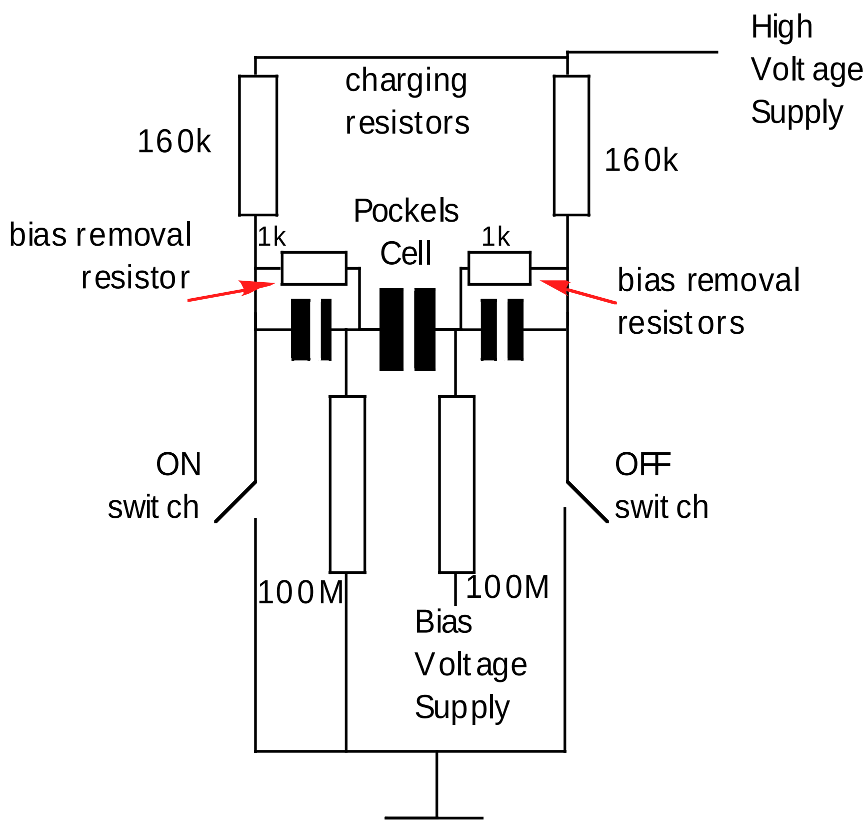

Figure 4 The Circuit in the Head, NO BIAS

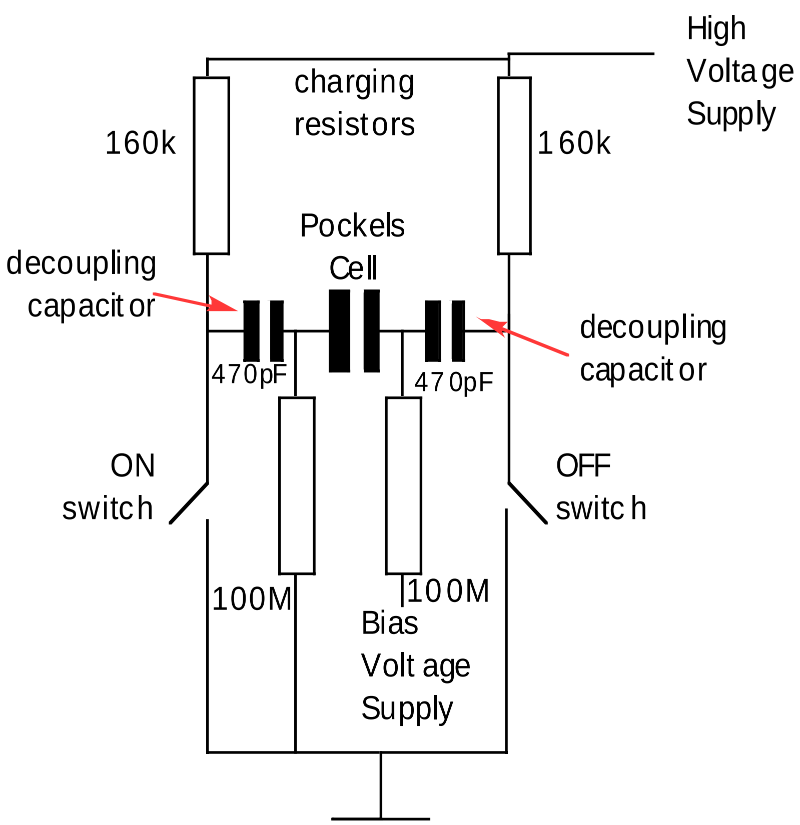

Figure 5 The Circuit in the Head, WITH BIAS

through the head is a serious issue to laser stability then the user should consider ducting it. We would appreciate being told if this is done as it may be that we will design a suitable duct system if it is routinely required. The head fan speed is adjustable, if it is set too low the head will heat up and the system will shut down. The required fan speed is a function of the average power being consumed by the head. For continuous operation at sea level at 40kHz at 3.8kV on the switch the fan should be set to at least a setting of 45 (in the range 15 to 63).

3.2 CONTROL UNIT

The control unit houses 2 high voltage power supplies, a low voltage power supply, an embedded microcontroller and various ancillary electronics.

The two high voltage power supplies are for the switch and the bias. The main switch supply is capable of delivering 60watts at 5kV although it is limited to 4kV in this application (~48 watts).

The voltages to each unit may be set via the front panel or the RS232 connection. The voltage of the high power supply can also be read.

Similarly the current for each can be set and the current for the main supply can also be read.

Each supply has a low voltage control to enable it but these are not safety critical, consequently a second enable control is used that turns the power to the supplies on or off. This is interlocked in hardware to both a rear panel enable and to an interlock that runs to the head through both connecting leads. I.e. both leads to the head and the rear panel interlock have to be made before the supplies can be enabled.

The rear panel interlock requires pin 5 of the 15 way D type connector to be grounded. A dongle (number 1) is available to do this or for connection to other equipment a lead is supplied (number 1a).

The control unit allows the user to adjust both the switch and bias voltages from the front panel and also set the fan speed.

The actual voltages and the main supply current can be read at the front panel. The head temperature may also be read at the front panel.

Note that the requested voltages can be set with the unit disabled.

The unit can be enabled via the front panel only if the interlocks are all set, the temperature is below the trip level and the current drawn by the main supply bellow its trip level.

Once enabled the system monitors the head temperature, total current and the anticipated power dissipation based upon the voltage, current and repetition rate. Should any exceed the set thresholds the unit will trip and become disabled. Similarly if the interlock is broken the unit will become disabled. The disabled state will remain even if the cause is removed. The parameter causing the trip (disabling) can be seen in the LCD window by pushing the Disable button. A 0 indicates the parameter is within bounds, a 1 indicates the parameter caused a trip. This data is latched and will not go away until both the condition has been rectified and the enable button is pressed to re-enable the system.

Although this unit can operate with a switch voltage of up to about 4kV, the user will most likely find that it has been limited to a lower value commensurate with the particular pockels cell fitted to the head.

3.2.1 LOCAL CONTROL

For normal use all the necessary commands are available through the front panel. This will allow the user to set up the operating voltages, measure the switch voltage, check that the unit is triggered, measure the total current drawn by the main supply, check head temperature etc.

The local control is by way of six buttons on the front panel, two LEDs and a LCD display with several pages. The cluster of four buttons is used to navigate and edit the LCD pages. The two other buttons are to enable and disable the unit, in addition the disable button will display the status page on the LCD after the unit has tripped. There are LEDs to indicate, power, enabled state and trigger detect.

3.2.2 REMOTE CONTROL RS232

All controls available on the front panel can be accessed through the RS232 interface. Type help at the RS232 to get a list of available commands.

There are also a few others, in particular the trigger rate in kHz is available.

Note that whilst commands entered via the RS232 connector can do all the functions that are available from the front panel, other commands should not be used without prior communication with the factory. It is possible that spurious commands entered via the RS232 interface could set the unit into an undesirable and possibly hazardous or unprotected mode. Only use the commands available in the HELP file. (Type help at the RS232 port).

If it is necessary to change the maximum voltage on either the main or the bias supply then this can be done through the RS232 interface with a text command. However, a write enable connection is also required by grounding pin 8 on the 15 way D type connector. Only do this if you are certain that this is what you need to do.

Full details of the Remote interface are in section 5.

3.2.3 REPETITION RATE

The maximum repetition rate at low voltages is set by the recovery time of the switches and up to 150kHz is certainly available, higher might also be. The unit specification is only up to 100kHz, we give not guaranty beyond this. The ON switch is disabled for about 3 µs after the receipt of a trigger. As the switch voltage is increased the maximum repetition rate becomes limited by the current available from the main supply, 12mA. Should this limit be reached the unit will trip and indicate an over current condition.

The current drawn is dependent upon the switch voltage, the trigger repetition rate and also the gate width. The unit is only rated at up to 1µs however, it will exceed this and also if the OFF trigger is not received within 2µs of the ON trigger then the OFF switch is activated.

The unit monitors the voltage, current and repetition rate and assumes that the gate length is at maximum. If the measured current exceeds that measured empirically at the factory the unit will trip giving an over current indication.

3.2.4 FAN SPEED

The head unit is fitted with a variable speed fan. It will be necessary to run the fan for sustained operation at all but the lowest voltages. However, the speed required will be low at low voltages and repetition rates. With the unit running at maximum voltage and current the fan should be set to near the maximum speed for all but burst operation.

Should the head temperature exceed a threshold the unit will trip indicating over temperature. At sea level in an ambient temperature of around 20°C we have found that the fan can cope with the full 48 watts available running a little below maximum speed.

4 THE BIAS VOLTAGE

Please read the following carefully.

4.1 INTRINSIC BIFRINGENCE

Some electro-optic materials, especially those used in transverse modulators can have some intrinsic bifringence. The level will usually be temperature sensitive and so may depend upon the incident optical power. Many cells are made from two crystals in which this effect will cancel. However, differences in the thermal properties of the two crystals or their temperatures can cause there to be net bifringence in the cell.

In some applications it is desirable to have a quarter wave of bifringence in the cell. The bias voltage can be used to set the operating point of the cell, either for zero or for quarter wave bifringence. In some systems the quarter wave bifringence is obtained either by the insertion of a quarter wave plate or by operating the cell at a small angle to its inherent optical axis, i.e. off the centre of the isogyre pattern. Whilst this is still possible with this system one may also use the bias with similar effect. It may be that using a bias offers greater optical bandwidth to the system.

There are complications with using a bias voltage. Once the circuit is configured so that the bias can be applied then a bias will certainly be necessary at high repetition rates. For this reason the system is shipped with the bias disabled in the head. With the bias disabled it does not become necessary at high repetition rates.

The bias should therefore only be configured if it is necessary for some other reason. In particular to operate the cell away from the intrinsic bifringence point. Cells sometimes exhibit intrinsic bifringence and this may well be undesirable.

Configuring the circuit for the application of a bias voltage actually removes the DC component of the pulse drive signal. This is because the configuration places a capacitor either side of the cell so blocking the DC component of the drive wave form.

The DC component of the drive waveform is only significant at high repetition rates. A fourier analysis of the drive waveform shows that there is a DC component = V switch x Tp x f where V switch is the switch voltage, Tp is the pulse length and f the repetition rate. The DC component is blocked when the bias circuitry is added and so has to be put back along with any required voltage to move the operating point.

The bias voltage required at high repetition rate will always be in the same direction as the pulse as it is compensating for that removed from the pulse waveform. However, if there is any intrinsic bifringence to be removed it could be in any direction. In one direction there may not be enough adjustment to achieve zero bifringence. If this is the case it will be necessary to reverse the direction of the electric field in the crystal, this can be accomplished by either turning the crystal round in the housing or swapping the leads to the bias boards in the housing. However, if the leads are swapped then it may be that at a different repetition rate the correct voltage is again not accessible. Ideally turning the crystal round is the better option.

4.2 CONSIDERATIONS FOR DC VOLTAGES IN RTP

RTP (Rubidium Titanyl Phosphate or $RTiOPO_4$) is known to exhibit electrochromic damage. This is a process by which electrode material can diffuse into the crystal due to an electric field. AC fields are not a problem as the effect averages to zero, but DC fields are a problem. Note that even a high repetition rate system with long pulses has a significant DC component. Linos indicate that up to 10% duty cycle at the quarter wave voltage will not be a problem.

The system is supplied with the bias system disabled and so the damage will only be an issue at high repetition rates and long pulses. If it is necessary to overcome this problem then the bias system can be reinstated but the bias kept at zero. This will remove the DC component of the drive. However, this will result in an effective intrinsic DC component as the DC component of the drive will be missing. Angle tuning can be used to overcome this. As a result the degree of angle tuning necessary will depend upon the repetition rate and pulse length as these determine the level of the DC component that is being lost.

5 USE

5.1 INTRODUCTION

It is assumed here that the user is familiar with setting up a pockels cell in a laser system. Obviously there are many possible configurations. Some notes in section 8 may help the uninitiated.

5.2 CONNECTIONS TO THE HEAD

Before using the system the pockels cell should be set up optically and the head connected to the control unit via the two cables provided. One cable delivers high voltages for the switches and the bias, the other low voltage power, fan power, and trigger detect signals. In addition the hard wired interlock runs through each cable and the head.

5.2.1 TRIGGERS

The head requires two trigger signals. 5 volts in to 50Ω is suitable. They should be fast rising for low jitter, under 5ns rise time is good.

The two trigger signals are for trigger ON and trigger OFF. The ON trigger places a voltage across the pockels cell equal to a fraction of the set switch voltage. The OFF trigger removes it. If a bias is also applied, see section 4, then this is superimposed upon the switch voltages.

The trigger delays for the ON and OFF triggers are different, see section 1. Note that if the OFF switch fires first the applied voltage across the cell is reversed. This only works for short gate widths and is not a recommended mode of operation.

Approximately 100ns after the OFF switch is fired the switch goes into its recharge mode. In this mode both the ON and OFF switches recover together resulting in not net voltage across the cell other than the bias voltage, should one be applied.

Should the OFF switch not receive a trigger within 2µs of the ON trigger then the OFF switch is triggered any way. This means the longest gate available is currently 2µs. In addition the OFF trigger input is inhibited for a further 3 µs from it s trigger time. As a result there is a maximum repetition rate of 1/(gate width +3µs) Hz. Up to this rate the logic will behave correctly, however, there may not be sufficient power available for the switch to operate at this speed. This is limited by the 12mAs available from the high voltage power supply.

Note that the trigger detect circuitry works at the logic level and is operational even when the unit is disabled. The enable/disable control works only on the high voltages.

Note also that the ON trigger is the upper connection of the two.

5.2 INTERLOCKS

In addition to the interlock lead running to the head and back via the two connection leads to the head, a further interlock needs to be set via the rear panel 15 way D type connector, see section 1. A dongle is available for this as well as an interlock cable. Note that there are two dongles, one is for the high voltage interlock and the other is to enable writing to the EEPROM.

5.3 CONTROLLING THE UNIT

The switch and bias voltages are set from the front panel using the four button keyboard. The various pages of the LCD display are shown in figures 7 through 13.

On power up the settings stored in memory 0 are restored to the unit. Other settings may be restored through the save and restore pages.

Be careful not to save a zero fan speed in memory 0 unless that is really desired. With a zero fan speed the unit will heat up significantly and eventually cut out unless very low voltages or repetition rates are used.

The fan speed should be set to maximum (level 5) unless there is a good reason not to. In any case it should be set to a level that does not allow the head to heat past its trip temperature of ~32°C.

The voltage across and the current drawn by the switch circuit can also be monitored through the LCD panel. The bias voltage and bias current is not available.

The head is enabled by pressing the Enable button after having ensuring that all the interlocks are set. Should an interlock become un-set and then reset the enable button will need to be used again.

The head is disabled with the Disable button or by breaking the interlock.

Should the head trip the condition that caused the trip can be found by pressing the Disable button. This will display the trip status page on the LCD, see figure 13. The unit cannot be re-enabled until the condition is corrected.

Possible conditions are:

1 broken interlock
2 excessive temperature
3 excessive current.

The maximum current available to the switch is 12mA. If the combination of trigger rate, voltage and gate width is such that more than 12mA is drawn then the unit will trip.

In addition the trigger rate, voltage and current are monitored to ensure that the unit is working reasonably, i.e. the current is around what is expected for the voltage and repetition rate being used.

The unit will trip if the current exceeds the expected value. This will be a fault condition, whilst a normal current trip is just a protection to stop the unit being driven off regulation.

5.4 MAXIMUM VOLTAGE

The maximum voltage for both the switch and the bias can be re-set using the RS232 connection. This is discussed in section 6.

6 REMOTE CONTROL

6.1 INTRODUCTION

All the functions available from the front panel are also available through the RS232 interface on the rear panel. In addition the user can change the maximum switch and bias voltages through the RS232 interface.

Note that the RS232 interface has not been designed for general use and if commands other than those in the help file are used then conditions can be set up that could cause damage to the pockels cell, or the head electronics. In particular the maximum voltage settings and the thermal trip can both be circumvented. We strongly recommend that the user only use those commands in the HELP file as listed here and no others.

6.2 REMOTE MODE

The RS232 port should be connected to a terminal or a computer running a terminal emulator program. Kentech can supply suitable programmes for both MAC and PC environments.

The RS232 port is configured for 9600 baud.

The unit powers up in Local Mode in which the settings can be modified with the front panel controls. (If these controls do not work then the unit may have been forced to remote mode via an RS232 link.) In remote mode the LCD screen will indicate Remote . If the unit states that it is in Remote Mode this means that it is under computer control. The unit will switch to remote mode as soon as any character is received at the serial interface.The unit will revert to local mode either by the remote command local or by cycling the power. The unit switches to remote mode as soon as a character is received, the mode is transparent to a remote host. No characters are lost when switching from local to remote mode.To use remote mode simply connect an RS232 link and issue commands.

6.3 HELP FILE

For the following commands n is a numeric value that will be clipped to an acceptable range

n SetVsw	- set vswitch to n volts,"
n SetVbias	- set vbias to n volts,"
n SetFanSpeed	- set fanspeed to n"
n SaveSettings	- save user settings to n"
n RestoreSettings	- restore user settings from n"
?Vpsu	- return the Vpsu adc reading in volts"
?Ipsu	- return the Ipsu adc reading in uA"
?Thead	- return the head temp adc reading"
?Ttrip	- return the head temp trip level"
?TrigRate	- return trigger rate in kHz"
?TripStatus	- return trip status"
Enable	- enable unit "
Disable	- disable unit"
Safe	- trigger and voltages off"

For the following commands x is a numeric value that will not be clipped, inappropiate values will give unchecked errors. These commands work only if the bootprom is write enabled"

x SetVmaxBias - set maximum allowable bias voltage"
x SetVmaxSwitch - set maximum allowable switch voltage"

Local - Set unit to local mode

Note: all commands are insensitive to the case.

6.4 REMOTE CONTROL LANGUAGE

The high rate pockels cell driver uses FORTH as its internal language and will understand FORTH commands via the RS232 port. Consequently the commands listed above may be configured as part of FORTH commands. In particular they can be strung together or put into loops for testing etc. The user should obtain third party information on the FORTH language to use this facility.

7 ENABLING THE BIAS CIRCUIT

7.1 THE CIRCUIT

A simplified circuit diagram of the switch system is shown in figures 1 and 2. The unit is supplied with the bias disabled. In order to enable the bias two resistors must be removed from the head. Currently these resistors are connected across the isolation capacitors and the potential either side of the cell is determined by the switch charging resistors not the bias injection supply voltage.

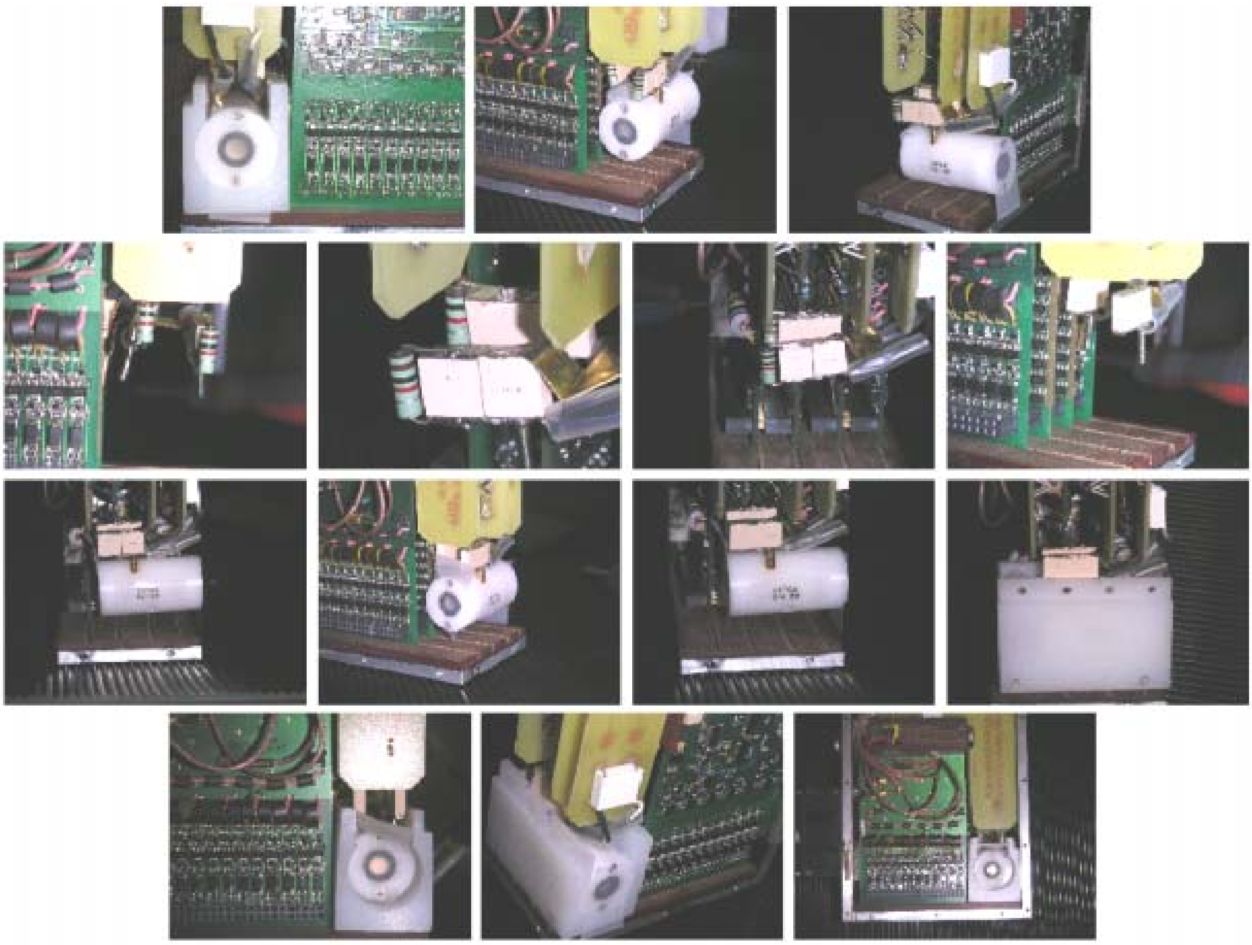

Figure 6 Enabling the bias circuit.

7 HELP FILE LISTING

```
FINISHED EXECUTE

FINISHED EESTART

MPE H8S ANS ROM PowerForth
99586 bytes free

 ok
help
For the following commands n is a numeric value
that will be clipped to an acceptable range

n SetVsw          - set vswitch to n volts,
n SetVbias        - set vbias to n volts,
n SetFanSpeed     - set fanspeed to n
n SaveSettings    - save user settings to n
n RestoreSettings - restore user settings from n

?Vpsu       - return the Vpsu adc reading in volts
?Ipsu       - return the Ipsu adc reading in uA
?Thead      - return the head temp adc reading
?Ttrip      - return the head temp trip level
?TrigRate   - return trigger rate in kHz
?TripStatus - return trip status

Enable      - enable unit
Disable     - disable unit
Safe        - trigger and voltages off

For the following commands x is a numeric value
that will not be clipped, inappropiate values will give
unchecked errors. These commands work only if the
bootprom is enabled

x SetVmaxBias   - set maximum allowable bias voltage
x SetVmaxSwitch - set maximum allowable switch voltage

Local  - put into local mode controlled from front panel ok
```

Figure 7 Save and restore settings.
On power up settings in set 0 are used.

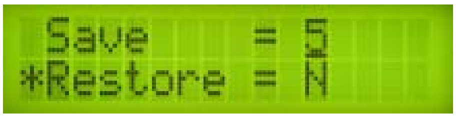

Figure 8 Set switch voltage and bias voltage (if connected)

Figure 9 Set fan speed; the most recent version of the software has levels 0 through 5.

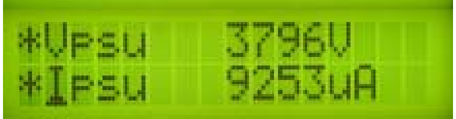

Figure 10 Measure the Switch voltage and current, note that these are only valid if the high voltage is enabled. The maximum current is ~12000µA

Figure 11 Head temperature and trip level, Note that the trip level cannot be changed.

Figure 12 When the system is enabled the enabled light is ON.

Figure 13 If the system trips, push the Disable button to interrogate the software for the cause.

8 TEST DATA

All tests were made at 1064nm with a 8mW laser diode. The cell was double passed with the mirror at around 63mm from the cell centre.

The bias circuit was connected but set to zero except where stated otherwise.

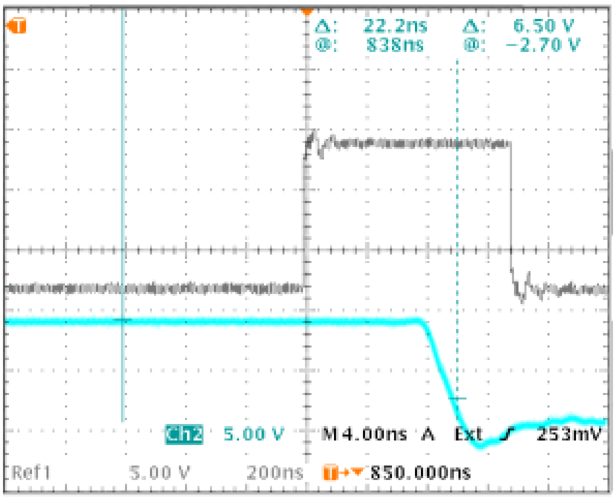

Figure 14 OFF trigger delay ~ 12ns

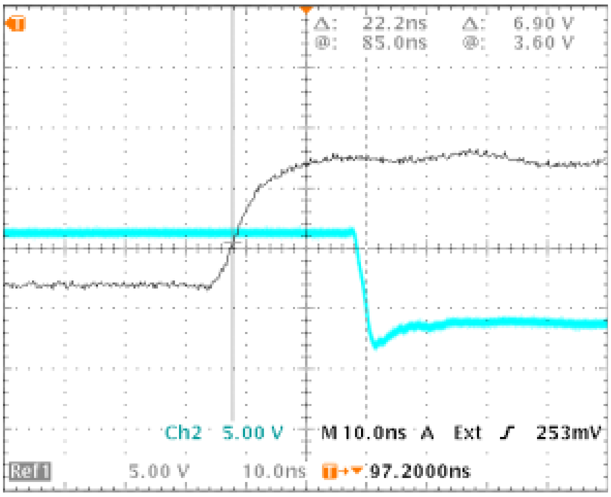

Figure 15 ON trigger delay ~ 22ns

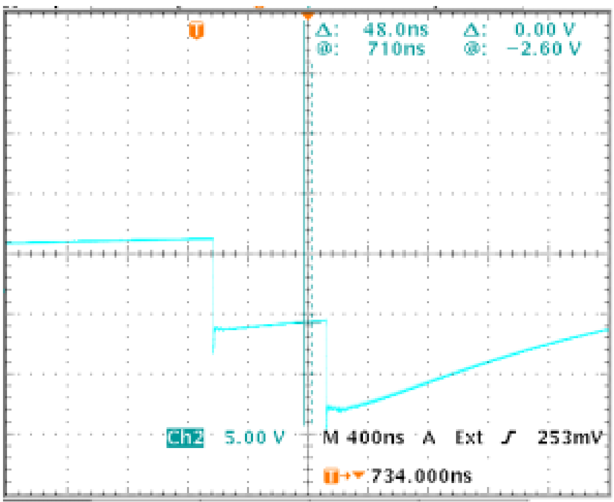

Figure 16 Signal from high voltage probe placed in optical aperture. The slope is due to the AC coupling of the probe to the switches, the two edges are the ON and OFF drives to the pockels cell.

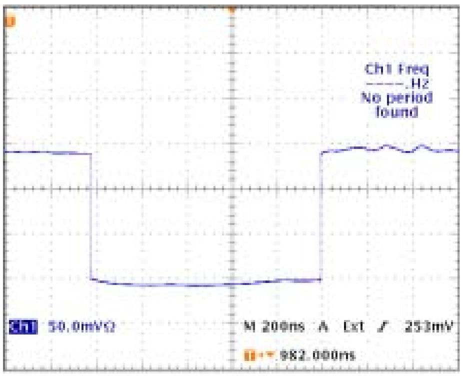

Figure 17 1µs Gate OFF @ 200ns/div

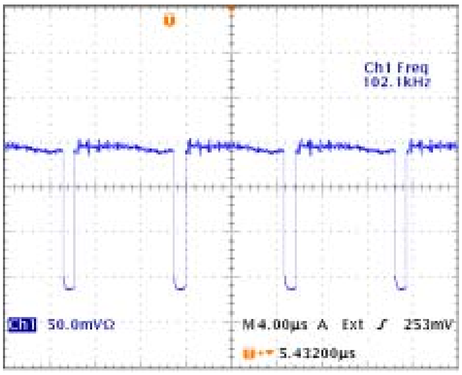

Figure 18 1µs Gate OFF @ 102kHz

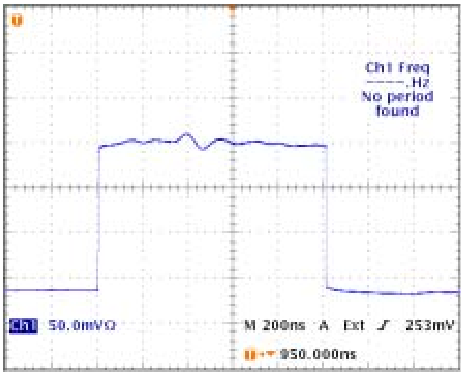

Figure 19 1µs Gate ON @ 200ns/div, ripples thought to be due to laser modulation.

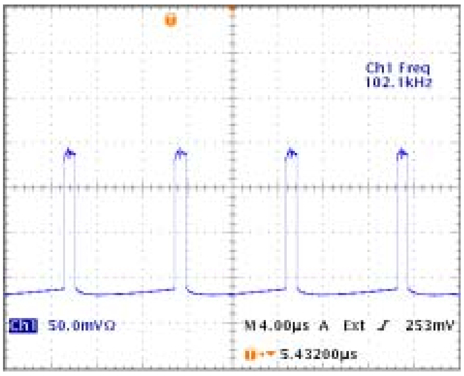

Figure 20 1µs Gate ON @ 102kHz.

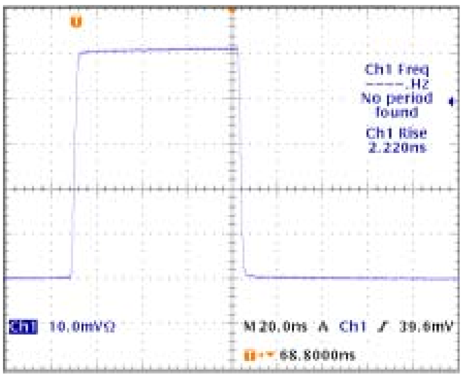

Figure 21 80ns Gate ON @ 20ns/div

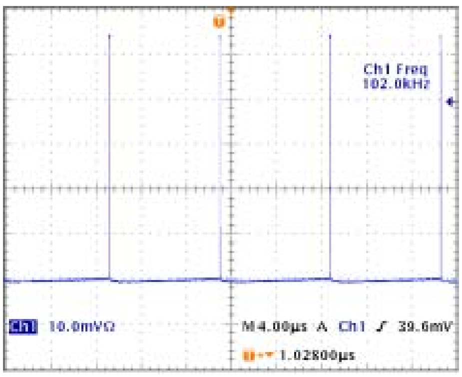

Figure 22 80ns Gate ON @ 1023kHz

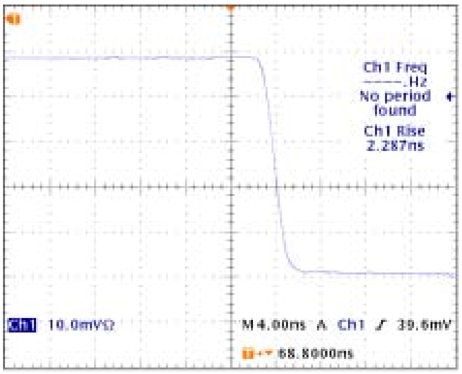

Figure 23 Fall time @ 4ns/div

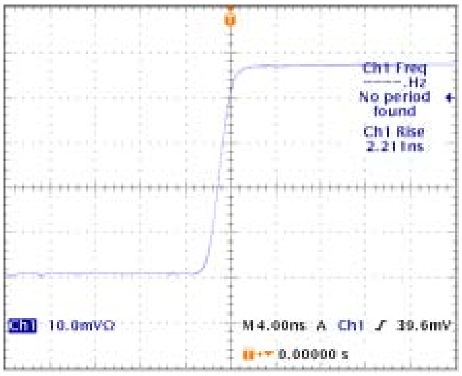

Figure 24 Rise time @ 4ns/div

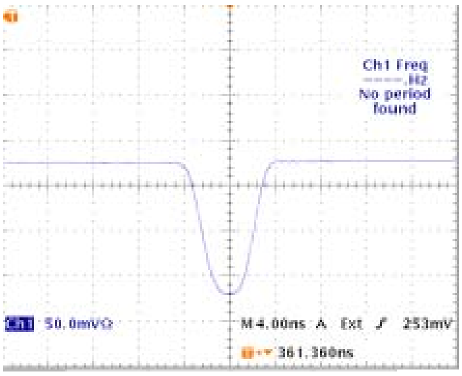

Figure 25 Short OFF gate @ 4ns/div

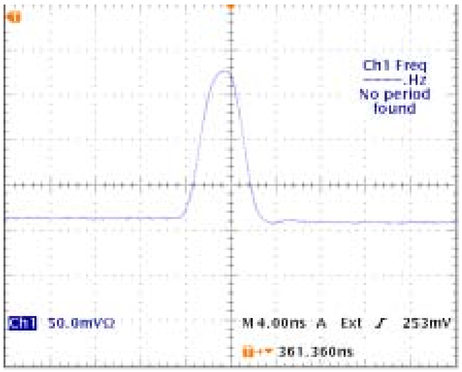

Figure 26 Short ON gate @ 4ns/div

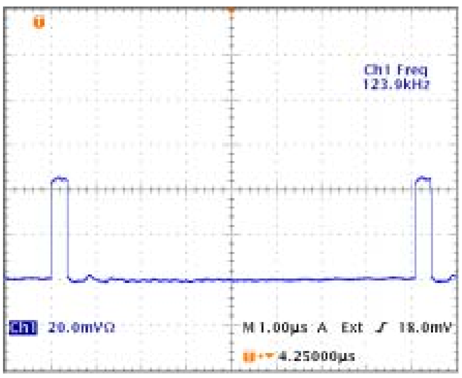

Figure 27 400ns gate ON @123.9kHz, bias disconnected.

Notes:

[1] Rise time, fall time and short gates are longer than inherent in the system as the measurement was made by double passing the cell, the round trip time to the mirror was around 300ps.

[2] Ripples in the laser pulse are thought to be caused by reflections from the collection system getting back into the laser diode module. Although the module has feedback control of its light output there is a time constant for this which is slower than the transitions being generated by this system.

SMS TEST DATA SHEET

MODEL: SMS5P60/10002 DATE: ______ SERIAL NO.: ______ W/O NO.: 679722-DC

39 SN 1.2-A0100)

PARAMETER MEASURED	SPECIFICATION	MEASUREMENT
Short Circuit	Go/No Go	✓
Enable(Low<1.0V)(Hi>3.4V)	Hi Low	✓
OutputVoltage (Prog=5.0V)	2.500KV	2.500KV
Voltage Test Point(0-5V= 0-Rated vo ±1%)	4.90V-5.10V	500V
Output Voltage (Prog = 10.00V)	5.000 KV	4.995 KV
Voltage Test Point (0-10V= 0-Rated vo±2%)	9.80-10.20VDC	1000V
Output current Maximum	12 mA	12 mA
Current Test Point (0-10V= Rated I out ±2%)	9.80-10.20VDC	10.00V
I offset at 50% of Vmax	≤25mV	6.76 mV
OVP Setting	KV Max +7%, -12%	5.410 KV
10V Reference	10.2-10.4VDC	104 V
Droput @ Full Load (<-10% of Vin)	<21.6 VDC	20.8V
Iin at Nominal Vin		3.04 A
Line Regulation (.01% of V out for 10% line change)	±.5 V	0V
Load Regulation (.01% of V out NL to FL)	±.5 V	100 mV
Ripple (.1% p-p of V out)	5 V p-p	1.12 Vpp
Frequency		42.21 KHz

Comments: ______

Tester: JM Date: 4/28/05

FINAL

APR 29 2005

INSPECTION

Test Sheet for Customers

Type: RTPC6

Serial number	66	
Wavelength:	1064 nm	
Aperture:	ø 5.6 mm	fitted.

			specifications	
Insertion loss	98.3 %	@ 1064 nm	> 98%	ok x
Extinction ratio	> 1:250	@ 1064 nm	> 1:250	ok x
$U_{\lambda/4}$	1208 V	@ 1064 nm		ok x

Specs: **ok** x

Date 27.06.05

Signature