Kentech Instruments Ltd.

Two Channel Gated Optical Intensifier

Serial Number J14080131

Last Modified 5-2-15

PLEASE READ THIS MANUAL CAREFULLY BEFORE USING THE UNIT

Print in colour not in Black and White.

Hazard information is coloured RED

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Declaration of Conformity

We:- **Kentech Instruments Ltd**
The Isis Building
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Certify that this apparatus:

Kentech Instruments Ltd.
Serial no: J1408131

Conforms with the requirements of European Community Directives:

2006/95/EC	**Low Voltage Directive**
2004/108/EC	**EMC Directive**
768/2008/EC	**CE Marking Directive**

The following harmonized standards have been applied:

BS EN55011:2009 +A1:2010 Radio-Frequency disturbance characteristics. Industrial, Scientific, Medical equipment

96/211711 DC Electromagnetic compatibility. Generic Immunity Standard.
Part 2 Industrial environment (EN 50082-2)

BS EN 61010-1:2010 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

The following documents contain additional relevant information:-

Kentech file reference J1408131

Name:
A.K.L. Dymoke-Bradshaw

Signature:

On behalf of Kentech Instruments Ltd

Position:
Director

Issued:
5th. February 2015

2 DISCLAIMER

There are high voltage power supplies (6kV) present in this instrument when the unit is operating. Do not remove any covers from the GOI or expose any part of its circuitry. In the event of malfunction, the GOI must be returned to Kentech Instruments Ltd. or its appointed agent for repair.

The accessible terminals of this instrument are protected from hazardous voltages by basic insulation and protective grounding via the IEC power input connector. It is essential that the ground terminal of this connector is earthed via the power lead to maintain this protection.

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

Image intensifier tubes are very delicate and very expensive and must be handled with great care both in use and in storage. Read this manual before unpacking and using the instrument. Kentech Instruments Ltd. accepts no responsibility for any damage to the intensifier arising from misuse, we offer the manufacturer's warranty only on this component.

If cleaning is necessary this should be performed with a soft dry cloth or tissue only.

3 EMC CAUTION

This equipment includes circuits intentionally designed to generate short high energy electromagnetic pulses and the EM emissions will be sensitive to the details of the experimental set up, particularly in proximity to the cathode.

The emissions from this equipment should not exceed the limits specified in EN55011 "Emissions Specification for Industrial, Scientific and Medical equipment" with the cathode and phosphor windows covered with a conductive screen.

In practice with the user's equipment in place and the conductive screens removed from cathode and phosphor windows emissions may exceed E55011 and the unit may cause interference with other equipment in its immediate environment. It is therefore suitable for use only in a laboratory or a sealed electromagnetic environment, unless it is used in a system that has been verified by the system builder to comply with EC directive 89/336/EEC. Use of this apparatus outside the laboratory or sealed electromagnetic environment invalidates conformity with the EMC Directive and could lead to prosecution.

4 MAGNETIC HAZARD

Each intensifier head contains two strong neodymium large magnets. All normal care when working with strong magnets should be employed. In particular:

1. If wearing a pacemaker keep the head at least 1 foot from your chest. Ideally get someone else to do the work.
2. Be aware that the head will attract magnetic items. Be particularly careful of normal tools and screws. Stainless steel screws are normally only slightly magnetic. "Non-sparking" tools are also nearly non-magnetic. Non magnetic allen keys and screwdrivers are readily available.
3. Do not place the head in a dusty environment that may contain magnetic particles.
4. If shipping the head be aware of various shipping regulations, particularly if it is necessary to use air freight.

5. If operating the head on a magnetic optical table be very careful moving it around and always clamp it firmly.

5 ABBREVIATIONS

ASCII	American Standard Code for Information Interchange
ADC or adc	Analogue to Digital Convertor
AF	Across Flats
CCD	Charge Coupled Device (camera)
cr	carriage return
EEPROM	Electrically programmable and erasable Read only memory, non-volatile
EHT or eht	Extra High Tension (high voltage)
EMC	Electromagentic Compatibility
FO	Fibre Optic
GXD	Gated X-ray Detector
IEC	International Electrotechnical Commission
JSON	JavaScript Object Notation
lf	Line Feed
MCP	Micro Channel Plate
ND	Neutral Density
PC	Photo Cathode
PRF	Pulse Repetition Frequency
PSU or psu	power supply unit
SD	Standard Deviation
sw	software
URL	Uniform Resource Locator
w.r.t.	With Respect To
XML	Extensible Markup Language

6 INTRODUCTION

This manual describes the operation and use of a dual channel gated optical intensifier system. The intensifiers can be gated over the range ~80ps to DC, over an 18mm diameter cathode aperture.

The image intensifiers used in this system is very sensitive to light when active and easily damaged. Before turning the unit on always check that the light levels to be used are appropriate.

The unit has four modes of operation: DC on, slow gate (10ns - 10μs), medium gate (300ps to 5ns) and fast gate (<100ps to 250ps) and may thus be used as a fast camera or as an ungated image intensifier. The wafer type design gives a large number of pixels across the full 18mm diameter cathodes. The resolution is typically 10 1pmm^{-1}. The system has a maximum PRF of 100Hz so sampling/scanning operation is possible.

The cathode responds to 840nm light which allows easy setup with a laser diode (not supplied).

7 SPECIFICATIONS OF THE SYSTEM

7.1 TRIGGER MODULE

Number of channels	4
Output	~500 volts into 50 Ω on each of 4 channels. Jitter SD <20ps , typical figures <4ps
Trigger requirements	5V into 50Ω with <5ns rise.
Power requirements	110/240 VAC <100W.
PRF	100Hz.
Dimensions	1U, 19inch x 400mm

7.2 DRIVER AND HEADS

Number of channels	2	
Intensifier type	Photonis XK2050JE 18mm micro channel plate intensified wafer genII S20 cathode on quartz input window P43 phosphor on fibre optic output.	
MCP (gain)	260 through 925 volts mapped linearly to gain settings of 0 through 1000 in steps of 1.	
Phosphor voltage	6kV w.r.t. MCP output, i.e. the absolute value wrt ground = 6kV + MCP out.	
Gating times	≤100ps to 1ms but see gate profiles in section 15 on page 39	
Spatial resolution	10 1pmm^{-1} typical	
Power requirements	110/240 VAC <100W.	
PRF	100Hz.	
Trigger delay (typical)		
Fast mode	speed 0	54ns
Medium mode	speed 3	65ns
Slow mode		104ns
	Jitter SD	<20ps , typical figures <4ps
Trigger requirements	500V into 50Ω with <1ns rise.	
Length of umbilical	nominally 3m	
Dimensions	3U, 19inch x 500mm	

8 PRINCIPALS OF OPERATION

The camera is very simple in operation. It consists of a micro channel plate intensifier tube configured for the fast application of high voltage gate pulses to the cathode with a high voltage supply for the tube bias voltages.

The tube is biased off by means of a small positive potential applied to the cathode with respect to the channel plate input. A short duration negative pulse is applied to the cathode in order to gate the camera on. There are two different mechanisms to apply this pulse, which is used depends on the selected gating mode.

8.1 FAST AND MEDIUM MODES

The gating pulse is applied to the relatively high capacitance load presented by the cathode via a ring electrode which is capacitively coupled to the cathode. The cathode forms the centre plate in a capacitive divider. The capacitive load seen by the pulser is reduced at the expense of pulse amplitude. The high voltage available from our fast pulse generators allows the voltage division ratio to be >10:1 with a 1/10 reduction in the load seen by the driver. This allows the very fast gating which is available with the GOI. The gate time is adjustable from <100ps to 5ns.

8.2 SLOW MODES

The gating pulse is conventionally driven by a suitable pulse applied directly to the cathode. The gate time is adjustable from 100ns to 1ms.

8.3 COHERENT LIGHT ILLUMINATION

The high resolution and large cathode area result in a very large number of pixels in the gated image. The input aperture to the intensifier tube is clear and coherent light may be imaged onto the cathode without the production of interference fringes. Some units use a gating mesh and are not suitable for coherent light. This unit has no mesh.

9 POWER SUPPLY

The electronic package which drives the intensifiers in the GOI is housed in one box. The box contains four sections.

These are:

1. Low voltage power supply
2. Micro processor
3. High voltage pulse generators and delaying circuits.
4. High voltage tube bias supply

The system can be controlled remotely using RS232 connection on the rear panel or via the front panel Ethernet connection. In this case it is more suitable to use a Labview driver. Without the Labview driver the Ethernet can be used with “POST” and “GET” functions.

The following is relevant to each channel separately. Apart from a few commands the two channels are completely independent. There is a trigger indicator light which shows when a trigger has been received. There is an adjustable delay circuit which provides a total of ~50ns timing adjustment in the trigger circuit. There is a second adjustable delay generator that controls the timing of the “OFF” edge of the gate pulse in medium mode. In fast mode the gate width is only controlled by the reverse bias applied to the cathode.

The high voltage tube bias supply provides the static potentials required for the intensifier tube.

The channel plate voltage is variable to adjust the intensifier gain.

In DC mode the cathode is biased at approximately -50 volts with respect to the channel plate input. The DC mode is only maintained for 5 seconds. After this it will switch off to protect the tube. The intensifier must not be left for a long time with a bright and damaging image on the phosphor. In the slow gate mode the cathode is normally biased at approximately +50Volts with respect to the channel plate input. The intensifier is off in this state. At the application of a trigger signal to the supply the cathode is pulsed to -50Volts, with respect to the channel plate input, for 100ns to 1ms, turning the intensifier on for this period.

In fast mode a variable positive bias is applied to the cathode with respect to the channel plate input. This bias is overcome when the fast gate signal from the pulser is applied to the imager. The bias is varied automatically by the microprocessor to give the correct gate time. Gate duration can be selected from ~100ps to~ 5ns with one of 10 durations, see section 15 on page 39. The trigger delay is different between fast mode and medium/slow mode, but note that different pulse generator circuits are used for these modes and there can be some variation in the respective delays of the order of 10ps as the unit warms up after switching modes. Note speeds 0,1,2 use a different set of electronics from speeds 3 through 9. If changing from one set to another allow a little while for temperature stabilisation if timing is critical.

The electrical delay in the GOI between the arrival of a trigger pulse at the front panel and the arrival of the gate pulse at the cathode is shown in the specification see section 7 on page 8.

10 CONNECTIONS AND MECHANICS

The unit is supplied with the detection heads disconnected from the control unit.

These need to be connected before use.

The driver should not be switched on without the heads connected and the rear plastic cover secured in place.

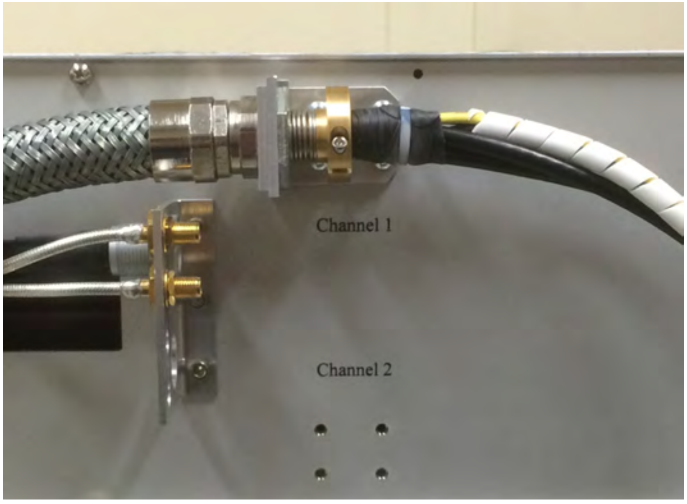
10.1 ATTACHING A HEAD TO THE CONTROL UNIT

1. Make sure there is no power connected to the control unit.
2. Remove the rear white plastic cover of the control unit
   This needs the removal of five M2.5 allen head screws. Tool 2mm AF.

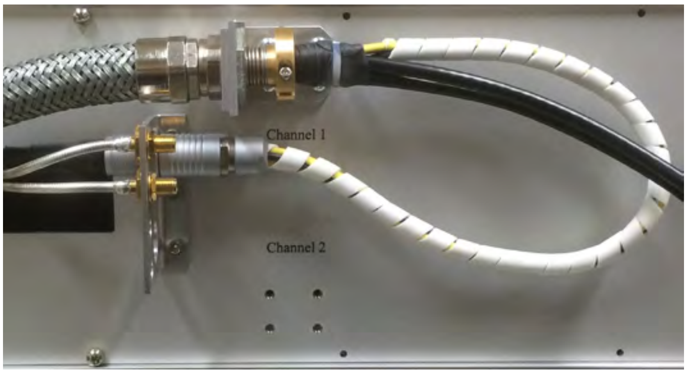
3. The head labelled as Channel 1 must be connected to the channel one connections on the rear of the control unit and Channel 2 to the channel 2 connections. Although the heads may well work fine if switched, the software knows the maximum voltage ratings of each tube and is set up not to exceed this for each tube. Similarly if more than one system is available the heads should not be mixed up. The tube serial numbers as well as the channel numbers are labelled both on the heads and on the rear panel of the driver.

4. If it is necessary to mix and match heads and control units please contact us and we will arrange to have the control unit suitably programmed for a specific head.

5. Attach the bracket of the umbilical from the head to the upper square array of holes shown. The screws needed should be stored in the holes. This may require the anti-rotation collar on the umbilical to be moved to access the mount screws. If necessary move it out the way and fix it back afterwards. There is a clamp screw in the brass piece.



6. Attach the 4 pin Fischer connector. Be careful to mate it with the correct orientation. There are "half moon" pieces inside the connector that stop it being mated wrongly but it is important not to damage these by trying the wrong orientation. There is also a red dot on each piece; these should be aligned when mated.



7. Attach the two SMA connectors. They can fit either jack on the bracket but should be connected to the indicated (upper or lower) socket for each channel. If they are switch around between upper and lower the gate pulse width, particularly on the shortest gate may be different. Tighten the SMA connectors with a spanner 8mm or 5/16 inches, to a torque of 0.3 to 0.6 Nm. This is a little more than finger tight. Ideally use a torque wrench. The jacks are fitted to the bracket through an anti-rotation slot. It is also advisable to inspect and clean out loose debris from the internal surfaces with compressed air or a gas duster can before mating.

8. Refit the plastic cover.

10.2 THE HEADS

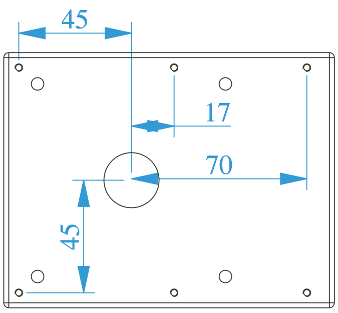
The heads contain the intensifiers which are fragile, mechanically, electrically and optically. Appropriate care must be taken. In addition the head contains a pair of strong magnets. These can cause the head to become attracted to the environment. Do not allow the head to slam into a magnetic object. Do not allow magnetic objects to get accelerated towards the head. See section 4 on page 6 **for safety considerations.**

Make sure the head is well clamped in position before use.

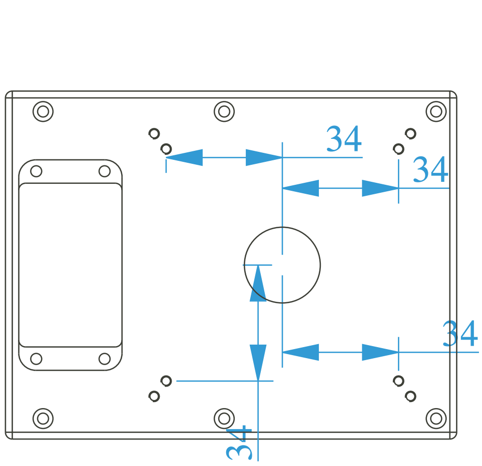
10.3 ATTACHING EQUIPMENT TO A HEAD

If it is necessary to attach equipment to a head, several screw holes can be used. We recommend using stainless steel screws as these have low magnetic susceptibility. If a normal magnetic screwdriver is used, support the shaft as well as holding the handle to stop it being dragged towards the magnet.

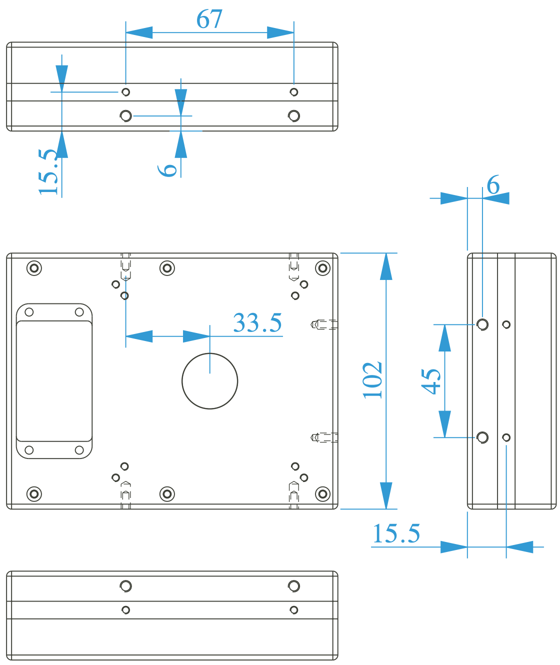
On the front face are 6 M3 tapped holes at positions shown above. Screws may only protrude into the head by 9 mm into these holes.



On the rear face are four holes on a 68 mm square. They are tapped M3 and screws can protrude into them by 12mm but only 7mm is tapped.



Holes on the sides are also tapped M3 and are available to a depth of 5mm.



10.4 CONNECTING THE TRIGGER UNIT

This 2 channel unit has a separate 4 channel trigger unit. This supplies 4 synchronous high voltage trigger pulses, one to each of up to 4 channels. By using high voltage trigger signals the channel to channel jitter can be kept very low. Typical SD between channel down to <2ps can be achieved.

The trigger unit should be connected to the driver unit with suitable BNC cables, (four 1m cables are supplied). The cables should not degrade the fast (sub ns rise time) trigger pulse that the trigger unit delivers. If long cable runs are needed then the cable quality may need to be upgraded.

10.5 POWERING UP THE SYSTEM

Do not apply power unless both heads and the rear plastic cover are in place.

Applying power and switching on the control unit will not turn on an intensifier. An intensifier can only be turned on under software control via either the RS232 connection at the rear panel or the Ethernet connection at the front panel.

Read section 13 on page 18 about how to control the system.

Before an intensifier is powered up, the photocathode input should be shielded from any ambient light. A large signal on an imager output phosphor will reduce the life of the imager and could even result in permanent damage.

Set the gain control set to minimum before turning on an intensifier. If a DC image is required for setting up then it should be kept as dim as possible and the duration should be as short as possible. The image should only be sufficiently bright to see in a dimly lit room. The DC mode can only be enabled for 5 seconds. After this it will be necessary to re-enable the mode. Start at minimum gain and work up to a reasonable level. A safer alternative to using the DC mode is to use the slow gate mode. The user may set a gate duration of 100ns to 1ms and apply gate pulses to the trigger input at the rate of 100 Hz. Starting with the gain at minimum set the gate mode control to slow gate and look for a pulsed image on the phosphor. In this mode the imager is much safer in the presence of excessive illumination.

Ensure that no excessive force is applied to the phosphor fibreoptic as this may damage the tube.

If using a fibre optic coupled device on the rear of the intensifier, make sure it is lightly sprung onto the output face. Do not clamp a FO device hard onto the output face. The output face may be slightly at an angle to the tube axis, this is a tube manufacturing issue and sometimes cannot be avoided.

The imager is most conveniently characterised by the use of a laser diode pulser. The cathode will respond to 840nm or shorter wavelength light, see figure Figure 37 on page 52. The user will require a pulse generator, a delay unit and a short pulse laser diode pulser in addition to the standard components supplied with the imager.

The imager may be triggered at up to 100Hz. The image may be seen by eye on the phosphor if a sufficiently powerful laser diode is used. As a guide a diode producing 100mW with a pulse width of 80ps and a wavelength of <840nm is adequate to illuminate the whole of a cathode at a level which can be observed on the phosphor in a dimly lit room. In normal operation the camera will only be triggered once per image. The user will be able to see a single exposure in a darkened room and this exposure level will be captured easily by a well coupled scientific CCD camera.

11 OPERATIONAL NOTES

11.1 TIMING

Timing the imager is particularly critical when a single shot exposure is required such as in a laser produced plasma experiment. The first requirement is a trigger signal of stable timing (to within less than the gate window) and stable amplitude. Since the trigger circuits integrate the trigger signal for the first nanosecond or two a varying amplitude will cause a timing change.

A second requirement may be a stable delay generator, ideally a passive switched cable network, to set the timing. The unit has a built in 50 ns system of this type. A further highly desirable aid is an optical fiducial signal of suitable wavelength.

The delay between initial trigger at the front panel and the gate pulse getting to the intensifier is shown in the specifications, see section 7 on page 8. The camera could be triggered from the signal it is detecting if a suitable optical delay can be introduced after the trigger signal generator (which is probably a photodiode). This could be accomplished by means of fibre optics or by relaying the image via several lenses over a suitable distance. Ensure that the cables take the most direct path to the camera so that they do not contribute to the trigger delay.

This scheme would be most suitable if there is no reliable pre-trigger available (for example in an electrical discharge machine).

There is no timing monitor output on this unit. A simple way to derive an accurate timing signal is to place a scope probe near the input to the intensifier. This will pick up the gate signal and is a very accurate indicator of the gate timing.

11.2 DELAY ADJUSTMENT.

The delay adjustment gives approximately 50ns of adjustment in approximately 25ps steps.

THIS IS NOT A PRECISION DELAY AND SHOULD NOT BE USED AS A CALIBRATED TIME REFERENCE

but it is a very stable delay as it is based on passive delay lines switched with relays. If a longer inter-fame time is required then the cable between the trigger unit and the driver input can be lengthened but make sure the pulse is not significantly degraded.

12 TESTS

12.1 STATIC TESTS.

The gated imager should be set up with a target resolution grid imaged onto the cathode. A controlled and uniform light source should be used to backlight the target. This may be a variable output microscope lamp with a diffuser and ND filters over the front. All other light sources should be excluded from the input by using a black tube.

A microscope should be set up to view the output. This can be an objective lens mounted close to the output. Take care not to scratch the fibre optic window. Fibre optic face windows are made of soft glass and the surface is in the image plane so any surface defects will appear on the image. Only use lens tissues or other lens cleaning materials to clean the input and output faces.

In a dimly lit room (i.e. just enough light to manoeuvre after ones eyes have adjusted to the low light level) turn on the imager and set the gain set to 350V. Activate the DC mode and gradually turn up the lamp until a dim image is seen. Then turn up the gain in steps of 10 until a relatively bright image of the resolution mask is present on the output. Note that the DC mode only remains active for 5 seconds from receipt of a DC mode command but it can be repeatedly enabled and can be enabled before the previous 5 seconds has elapsed to maintain the DC mode. Be very careful if doing this. The whole point of the 5 second limit is to protect the tube from accidental over illumination.

Ensure that the imager is able to resolve lines separated by at most 100μm. Turn the gated imager off and remove the microscope. Set the imager to SLOW GATE mode with the slow gate duration set to 10μs. While triggering the power supply at a ~ 100Hz turn up the gain until a pulsed image is seen on the phosphor.

12.2 DYNAMIC TEST.

For this test a short pulse light source is required. A laser diode is most convenient although a single pulse mode locked laser can be used. The source should have a wavelength >200nm to ≤ 840nm and should produce ~ 10^8 photons per pulse. A >100mW peak power laser diode with a ≤ 60ps pulse duration is suitable. In both cases a pre-trigger signal is required with a lead time ~50ns. It should satisfy the trigger requirements in the specification. A switched cable delay generator and a fine delay will also be required. For fine delays one can move the light source w.r.t. the detector (if the bean is collimated) or use a variable length transmission line on the trigger signal or some other system such a sampling system. In some sampling systems the delay is measured after the event and the position of the sample moved accordingly.

Be sure to use the appropriate laser safety goggles.

Connect up the pulser, trigger source and delay lines as shown.

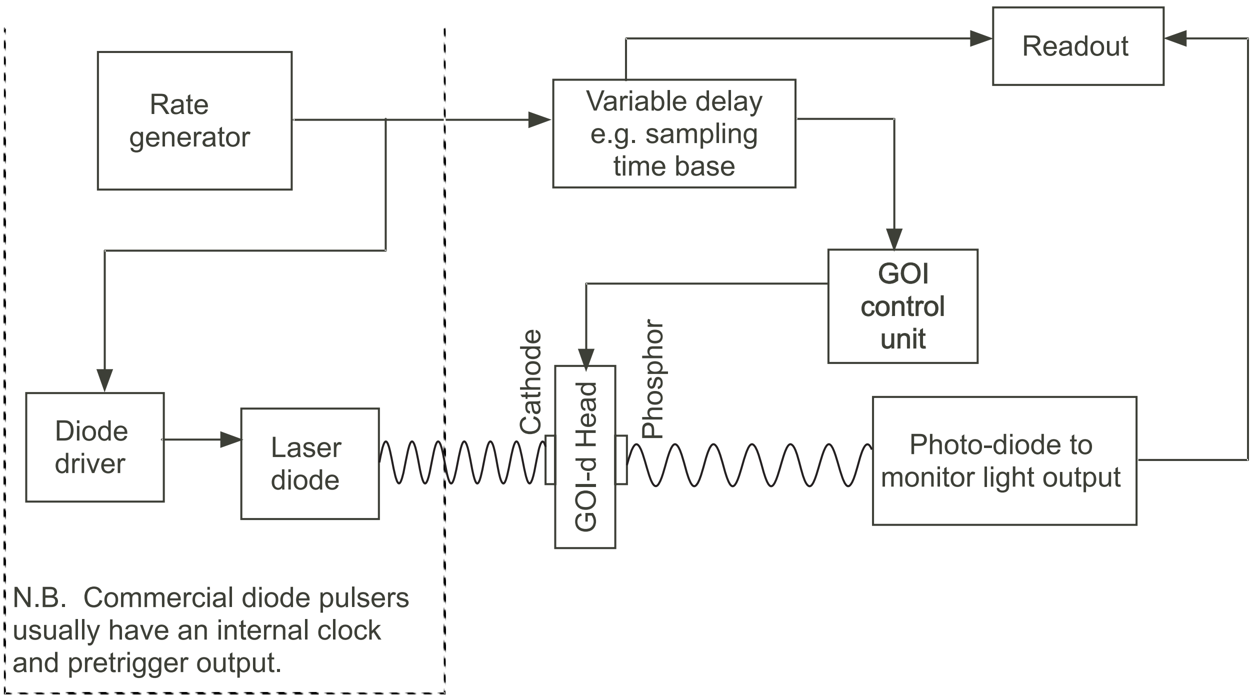


Figure 1 Set up for testing the gating.

The camera should be removed from the imager. The light source ideally will run at a repetition rate from single shot to 100Hz. Set up the source to run at 100Hz with the power level on the cathode at a minimum.

The laser should be set up to illuminate uniformly the input with a resolution mask in place as in the previous test. Take care that the power level is not so great as to burn the cathode. This is not a danger when using a laser diode. All other light sources should be excluded from the input.

In a dimly lit room turn on the imager in DC mode with the MCP set to about 350V. Activate the DC mode and turn up the source brightness until a dim image is seen. Increase the MCP voltage in steps of 10 until a relatively bright image of the resolution mask should be present on the output. This establishes a reasonable exposure level for the test.

Initially the longest gate pulse duration should be used. Set up the imager as shown. Check that the pulser is being triggered. In a dimly lit room turn on the imager and pulser and with the source intensity and gain setting as in the previous section and scan the delay until an image is present. Observe the effect of increasing and decreasing the delay and find a delay setting that positions the light pulse at the start of the cathode gate profile. Once this setting has been established, the gate width can be progressively reduced, but note the changes in trigger delay for the different modes.

The gate window may now be measured either by monitoring the output intensity with a CCD or a photodiode. The most convenient way to obtain the gate time is with a photodiode monitoring the output signal and plotting the output intensity while stepping the delay. The source and camera must be triggered at a sufficient rate that a quasi DC signal can be obtained by integrating the diode output. This rate is typically 1kHz so some kind of averaging may be needed to do this at 100Hz. A sampling time base may be used as a delay generator and the photodiode output displayed directly on the scope. By this means a rapid record of the gate profile can be obtained.

It should be established that the imager is being reliably triggered. This is most readily achieved by triggering the imager at a few hertz and looking to see if the image is stable. If there is jitter then the brightness of the image will vary from shot to shot. This test is most sensitive if the timing is set such that the image is approximately 50% of peak brightness, i.e. the source is changing most rapidly.

Figure 2 Input window

Figure 3 Output window

13 GOI SOFTWARE INTERFACE

13.1 REVISIONS

0.0 21 Jan 2015

13.2 INTRODUCTION

This document describes the GOI software interface supplied.

The GOI has both an Ethernet and an RS232 interface. The instrument cab be controlled from either of these interfaces. To prevent conflict between them only one should be used for control, i.e. to change the various parameters. It is possible to use the non control port to monitor the instrument.

13.3 DUAL CHANNEL SYSTEM

The following describes control of channel 2 (also called channel b). The commands all start with the letter "b". Commands for channel 1 (also called channel a) are identical except that the leading "b" should be replaced with an "a".

13.4 SYSTEM VARIABLES

The GOI is controlled and monitored by reading from and writing values to a set of system variables. These variables are:-

Channel 1(a) variables:
a_fast_width
a_ovld_flag
a_trig_flag
a_slow_width
a_mcp_gain
a_fast_mode
a_goi_mode
a_trig_delay
a_dc_on
a_status

Channel 2(b) variables:
b_fast_width
b_ovld_flag
b_trig_flag
b_slow_width
b_mcp_gain
b_fast_mode
b_goi_mode
b_trig_delay
b_dc_on
b_status

13.5 1.1 GOI MODES

The GOI has 4 primary operating modes, INHIBIT, FAST, SLOW and DC. Note that the "medium" mode is not distinguished in software.

The primary operating mode is determined by the value in the variable b_goi_mode.

0 = Inhibit

1 = Fast
2 = Slow
3= DC

[Internally the unit splits the fast mode into fast and medium and this is displayed on the front panel.]

The current operating mode can be determined by reading [for channel 1(a)] **a_goi_mode**.

The operating mode can be changed by writing 0 through 3 to **a_goi_mode**.

The mode is also indicated by the front panel LEDs.

13.5.1 INHIBIT MODE

In INHIBIT mode the tube is not gated and there should be no image as the fast and slow pulsers are disabled and the photocathode is reverse biased.

13.5.2 FAST MODE

In FAST mode the fast pulser is enabled and a high voltage pulse is capacitively coupled onto the photocathode to give an optical gate in the range 80 ps to 5 ns. The slow pulser is disabled.

The length of the optical gate is determined by the value in [for channel 2(b)] **b_fast_mode.**

0 = 80 ps
1 = 100 ps
2 = 120 ps
3 = 250 ps
4 = 500 ps
5 =1000 ps
6 = 2000 ps
7 = 3000 ps
8 = 4000 ps
9 = 5000 ps

The current fast mode gate width can be read from **b_fast_mode**.

The fast mode gate width can be changed by writing 0 though 9 to **b_fast_mode**.

The nominal fast mode gate width in ps can be read from the variable **b_fast_width**.

Writing values to **b_fast_width** has no effect.

There are in fact two different pulsers used for fast mode. Fast mode settings 0 though 2 uses the fastest pulser and the FAST led will be illuminated. Fast mode settings 3 though 9 use the longer gate pulser and the MEDIUM led will be illuminated.

13.5.3 SLOW MODE

In SLOW mode the fast pulser is disabled and the slow pulser is enabled, driving the cathode directly and producing gate widths in the range 100 ns to 1 ms.

The current slow gate width in ns can be read from [for channel 2(b)] **b_slow_width**.

The slow gate width can be changed by writing the desired gate width in ns to **b_slow_width**.

In SLOW mode the slow LED is illuminated.

13.5.4 DC MODE

In DC mode, the GOI can be made to switch the intensifier tube on to produce a DC image for approximately 5 seconds. This is done by writing 1 or -1 to [for channel 1(a)] **a_dc_on**.

This has no effect if the GOI is not in DC mode.

Whether or not the intensifier is on DC can be determined by reading **a_dc_on**.

1 = dc on
0 = off

The 5 seconds can be extended by re-writing to b_dc_on before the initial 5 seconds has expired. This will cause the DC mode to be maintained by 5 seconds from the last write time.

13.6 TRIGGER

The trigger delay can be varied by up to 55 ns in 25 ps steps.

The current trigger delay in ps can be read from [for channel 2(b)] **b_trig_delay**.

The trigger delay can be changed by writing the desired delay in ps to **b_trig_delay**.

An incoming trigger edge will flash the triggered light on the front panel. It will also set the trigger latch.

The state of the trigger latch can be read from **b_trig_flag**.

1 = triggered
0 = not triggered

The trigger latch can be reset by writing 0 to **b_trig_flag**.

13.7 OVERLOAD

A high level of phosphor current due to an overbright image or hardware fault will trip the overload latch. This is indicated by the overload LED on the front panel. If the overload latch is tripped, the MCP power supply is disabled and there will be no image.

The state of the overload latch can be read from [for channel 2(b)] **b_ovld_flag**

1 = overload
0 = normal

The overload latch can be reset by writing 0 to **b_ovld_flag**.

When the overload latch is reset the unit will restore the previous settings and be enabled. If the fault has not been corrected the latch will be set again.

13.8 SELF TEST

On power up or reset the GOI performs a self test of the high voltage switching circuits. If this test fails, the high voltage power supply will not be enabled and there will be no image. It is not possible to clear the self test fail condition other than by rerunning the test by cycling the power.

The results of the self test can be read from [for channel 2(b)] **b_status**

0 = normal
non zero = self test fail

13.9 DEFAULT SETTINGS

At power up or rest the GOI will use the following default settings.

a_fast_width	= 80	80 ps fast gate setting
a_ovld_flag	= 0	overload flag reset
a_trig_flag	= 0	triggered flag reset
a_slow_width	= 100	100ns slow gate width
a_mcp_gain	= 0	minimum gain
a_fast_mode	= 0	fastest fast gate setting
a_goi_mode	= 0	inhibit mode
a_trig_delay	= 0	minimum trigger delay setting
a_dc_on	= 0	dc on flag reset
a_status	= 0	status flag set to normal by self test routine

b_fast_width	= 80	80 ps fast gate setting
b_ovld_flag	= 0	overload flag reset
b_trig_flag	= 0	triggered flag reset
b_slow_width	= 100	100ns slow gate width
b_mcp_gain	= 0	minimum gain
b_fast_mode	= 0	fastest fast gate setting
b_goi_mode	= 0	inhibit mode
b_trig_delay	= 0	minimum trigger delay setting
b_dc_on	= 0	dc on flag reset
b_status	= 0	status flag set to normal by self test routine

13.10 ETHERNET INTERFACE

The Ethernet interface is configured to get an IP address from a DHCP server at power up. The MAC address of the unit is marked on the rear panel. The IP address can be read by a command on the RS232 interface if necessary.

Control of the GOI is by manipulation of the system variables, see section 12.3 on page 18 and has been set up to be used with a Labview Driver. Currently, however, our Labview driver cannot control the trigger delay.

The variables can be written and read by POST and GET operations to various web page addresses. The example responses here, were obtained using the POSTER plugin with FIREFOX, this is available at https://addons.mozilla.org/en-US/firefox/addon/poster/

The URL for communicating with the instrument depends on the IP address. The examples here assume the IP address is 192.168.2.215. The URL can return either XML or JSON.

The values of all the system variables, together with data type and limits can be obtained by a GET operation to http://192.168.2.215/i.xml or http://192.168.2.215/i.json.

Here is an example of responses using POSTER

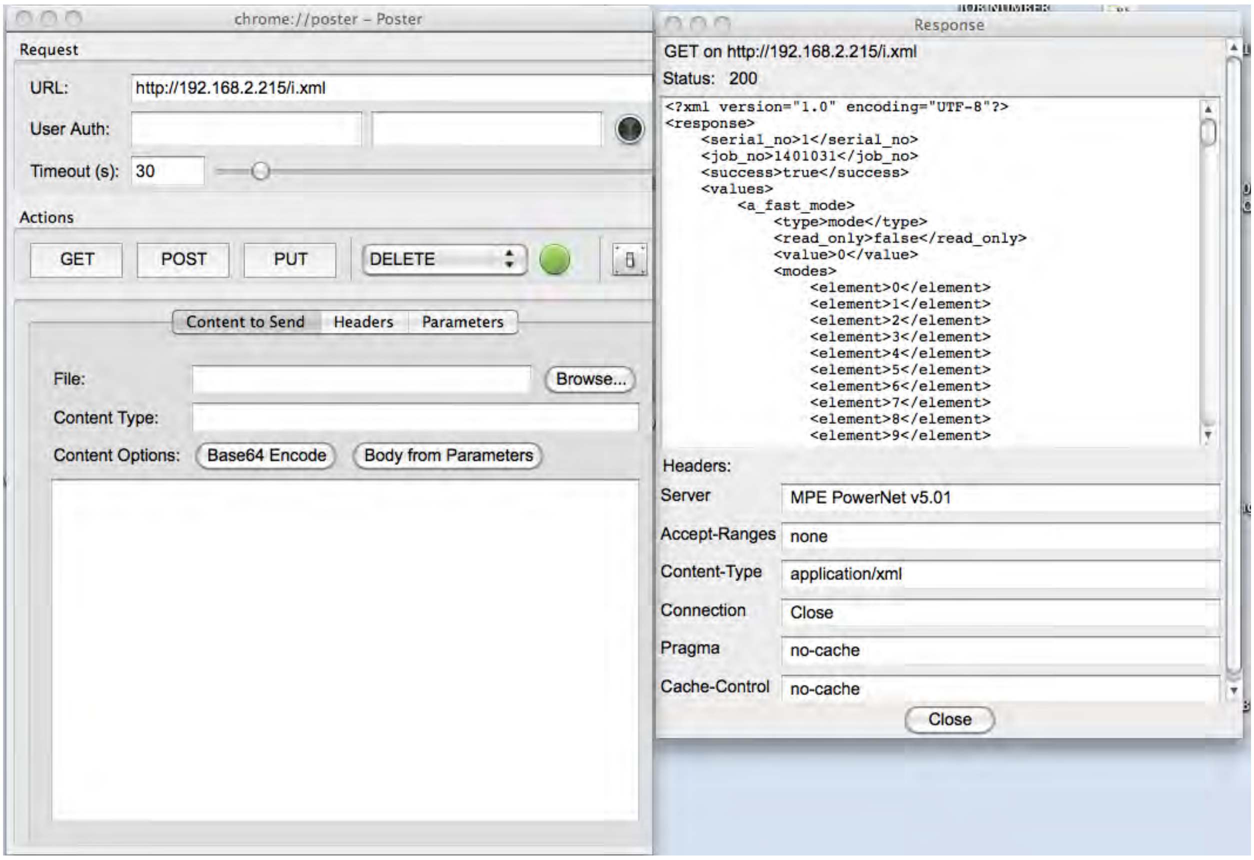


Figure 4 Example responses using POSTER with xml response

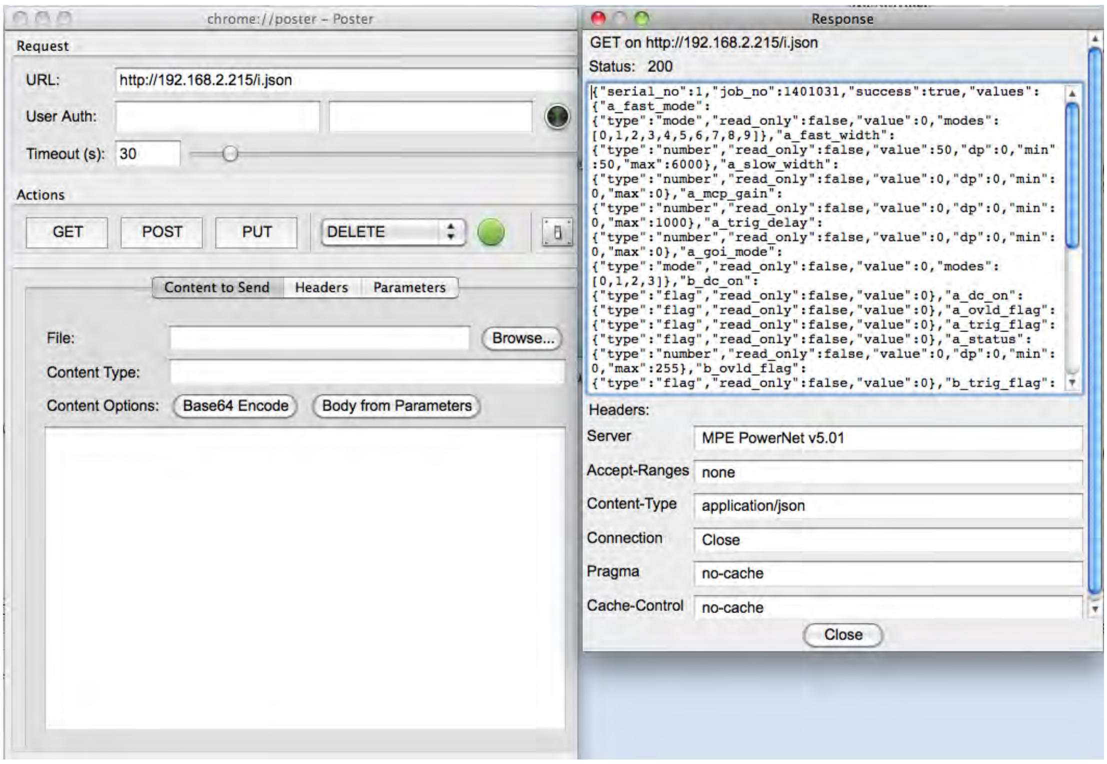


Figure 5 Example responses using POSTER with json response

The complete response text is shown in Appendix 2 on page 57 for XML and Appendix 3 on page 61

These pages always contain the values of all the system variables.

The values of variables than have been changed since the previous GET operation can be read by a GET to http://192.168.2.215/g.xml or http://192.168.2.215/g.json. Example responses using POSTER are

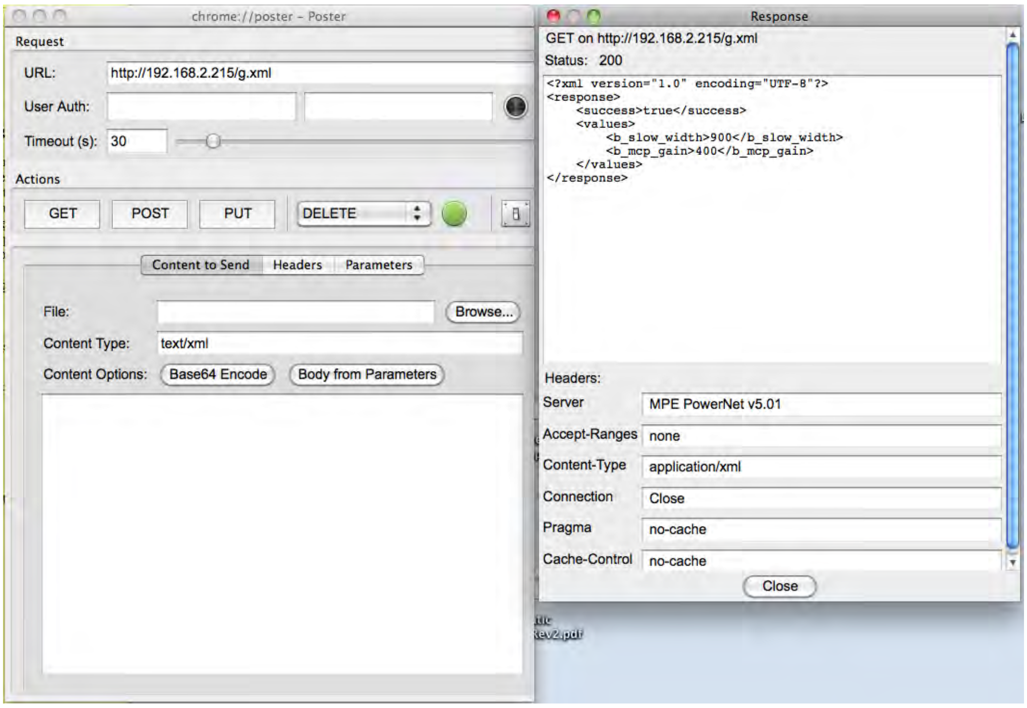


Figure 6 Changed variables XML

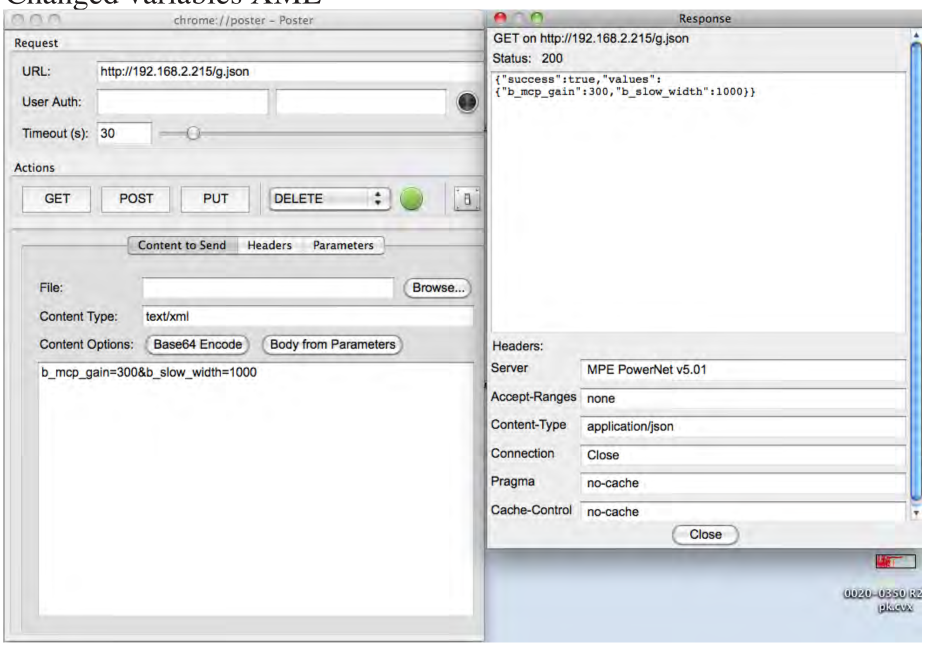


Figure 7 Changed Variables JSON

If no variables have changed, the GOI will pause for 2 seconds or so before responding. This is done to limit web traffic if it is continually polled.

The values of the variables can be written by a POST operation to http://192.168.2.215/s.xml or http://192.168.2.215/s.json. Example responses using POSTER are shown in Figure 8 on page 24

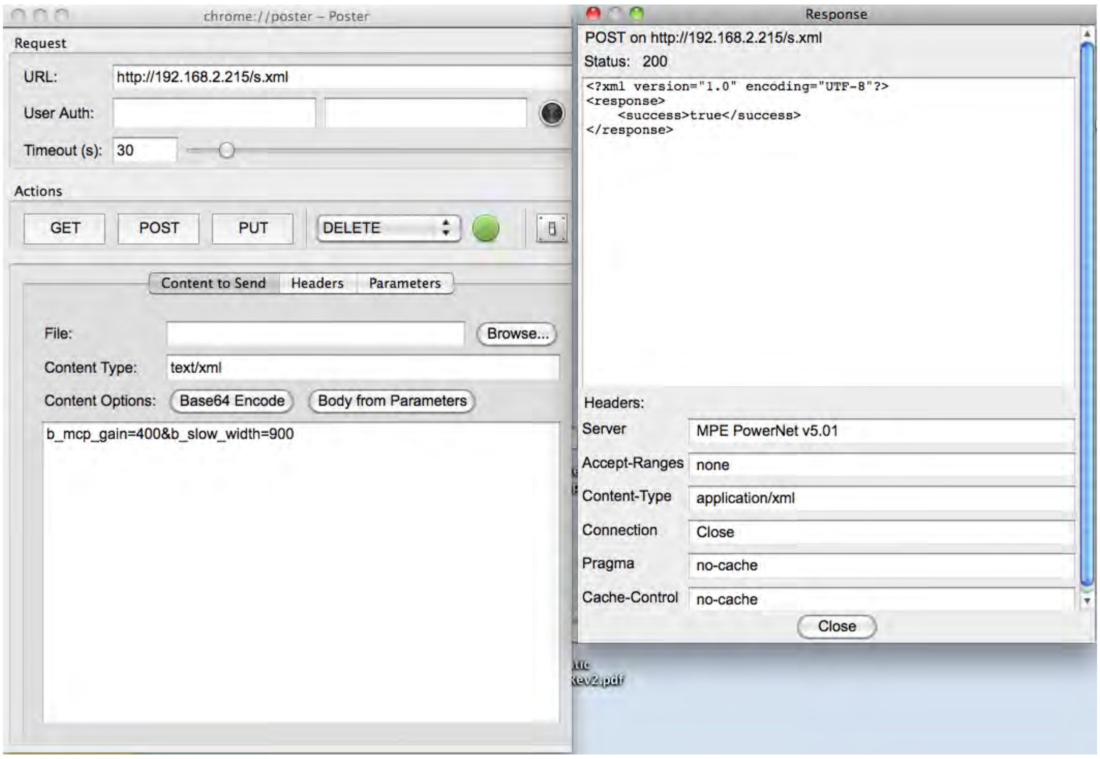


Figure 8 Write to variables XML

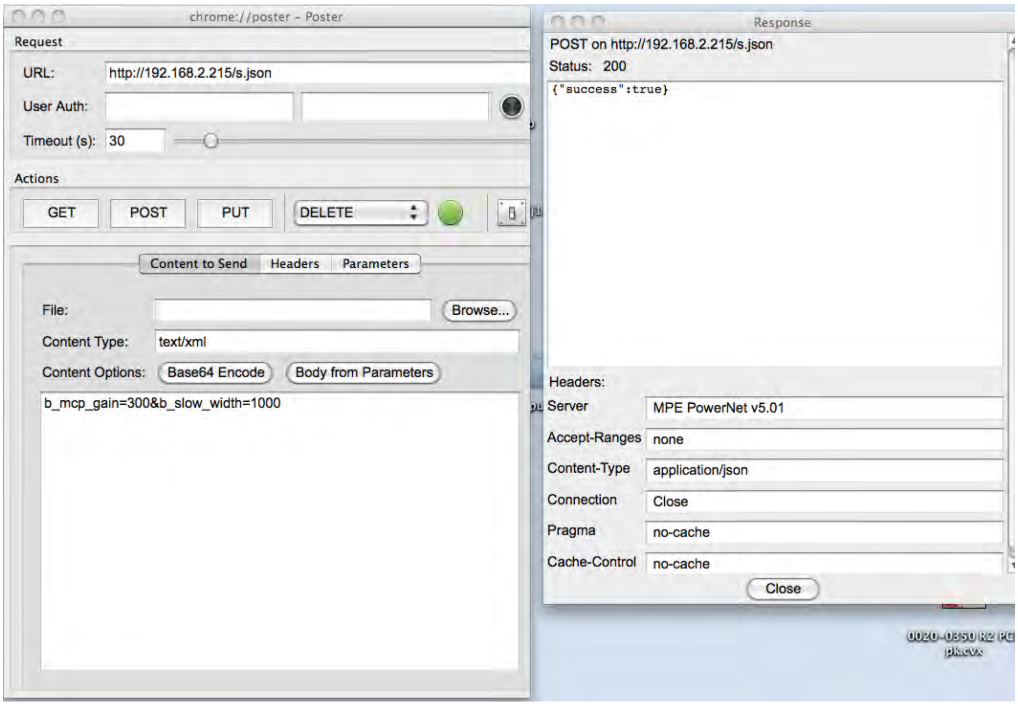


Figure 9 Write to variables JSON

13.11 RS232 INTERFACE

The RS232 interface is set to 115.2 kBaud, 8 data bits, 1 stop bit, no parity, no handshake.

13.11.1 THE PROTOCOL

The GOI uses a protocol that is very similar to other Kentech products such as: GXD/HGXD/DISC/SPIDER. The GOI generates responses to valid commands and does not generate any unsolicited output. Invalid commands will be ignored. All commands and response will be in ASCII characters. Commands are case sensitive.

For simplicity commands are parsed by the GOI using the Forth interpreter, parameters need to be delimited by spaces and the command line should be terminated by carriage return and linefeed characters. The Forth interpreter will not recognise any commands other than those defined in the command set.

The GOI will not echo command characters as they are received, no output will be generated until a valid command is recognised. This has proved to be a very robust protocol.

When a valid command is recognised, the GOI will output a response. Responses are preceded with a cr and lf, then an ascii { character and end with an ascii }. The response will be delimited into fields by an ascii ; character. The first field in the response will be a repeat of the command. If the command cannot be completed the GOI will return an error code in the second field. The possible error codes are:-

?stack the command interpreter has detected a wrong stack depth error, i.e. the wrong number of parameters has been received.

?param the command interpreter has detected an out of range parameter

After any error, the command is not executed, the stack is cleared and no values are returned other than the error code. Following a stack error, the stack is cleared then dummy parameters (generally -1 or 65536) are added for the purpose of formatting the response only.

All commands expect and deliver data as decimal numbers and all numeric data should be decimal, no decimal points or other punctuation to be used.

For example

1) to change to fast goimode channel 2(b):-

1 b!gm

and the response if the command can be completed would be:-

{1 b!gm}

2) as above but with a missing parameter

b!gm

and the response would be:-

{-1 b!gm;?stack}

The command interpreter detects the wrong stack depth, corrects this by clearing the stack and adding a dummy parameter then flags the error. No execution will result.

3) as above with invalid parameter

5000 b!gm

and the response would be:-

{5000 b!gm;?param}

Again no execution will result.

13.12 COMMANDS FOR CHANNEL 1 (A)

Name **a!gmode**

Explanation set goimode, i.e. write to a_goi_mode

Format **p1 a!gm**

Parameters p1 = {0, 3} goi mode no.

Returned values none

Name **a@gmode**

Explanation read goimode no., i.e. read a_goi_mode

Format **a@gm**

Parameters none

Returned values r1 = {0, 3} goi mode no.

Name **a!fmode**

Explanation set fastmode no., i.e. write to a_fast_mode

Format **p1 a!fm**

Parameters p1 = {0, 9} fast mode no.

Returned values none

Name **a@fmode**

Explanation read fast mode no., i.e. read a_fast_mode

Format **a@fm**

Returned values r1 = {0, 9} goi mode no.

Name **a@fwidth**

Explanation read fast gate width, i.e. read a_fast_width

Format **a@fw**

Parameters none

Returned values r1 = {80, 500, x 1ps} fast gate width

Name **a!swidth**

Explanation set slow gate width, i.e. write to a_slow_width

Format **p1 a!sw**

Parameters p1 = {100, 1000000, x 1ns} slow gate width

Returned values none

Name **a@swidth**

Explanation read slow gate width, i.e. read a_slow_width

Format **a@sw**

Parameters none

Returned values r1 = {100, 1000000, x1ns} slow gate width

Name **a!gain**

Explanation set gain, i.e. write to a_mcp_gain

Format **p1 a!ga**

Parameters p1 = {0, 1000} gain setting

Returned values none

Name **a@gain**

Explanation read gain, i.e. read a_mcp_gain

Format **a@ga**

Parameters none

Returned values r1 = {0, 1000} gain setting

Name **a!tdel**

Explanation set trigger delay, i.e. write to a_trig_delay

Format **p1 a!td**

Parameters p1 = {0, 55000, x1ps} trigger delay

Returned values none

Name **a@tdel**

Explanation read trigger delay, i.e. read a_trig_delay

Format **a@td**

Parameters none

Returned values r1 = {0, 55000, x1ps} trigger delay

Name **a!ovld**

Explanation write overload flag, i.e. write to a_ovld_flag

Format **p1 a!ov**

Parameters p1 = {0, 1} overload flag

Returned values none

Name **a@ovld**

Explanation read overload flag, i.e. read a_ovld_flag

Format **a@ov**

Parameters none

Returned values r1 = {0, 1} overload flag state

Name **a!trigf**

Explanation write triggered flag, i.e. write to a_trig_flag

Format **p1 a!tr**

Parameters p1 = {0, 1} triggered flag
Returned values none

Name a@trigf

Explanation read triggered flag, i.e. read a_trig_flag

Format a@tr

Parameters none
Returned values r1 = {0, 1} triggered flag state

Name a!dconf

Explanation write dcon flag, i.e. write to a_dc_on

Format p1 a!dc

Parameters p1 = {0, 1} dc on flag
Returned values none

Name a@dconf

Explanation read dconf flag, i.e. read a_dc_on

Format a@dc

Parameters none
Returned values r1 = {0, 1} dc on flag state

Name a@status

Explanation read status flag, i.e. read a_status

Format a@st

Parameters none
Returned values r1 = {0, 3} status flag

Name a@all

Explanation read status flag, i.e. read a_status

Format a@al

Parameters none
Returned values r1 = {80, 5000, x1ps} fast gate width, i.e. value of a_fast_width
r2 = {0, 1} overload flag, i.e. value of a_ovld_flag
r3 = {0, 1} triggered flag, i.e. value of a_trig_flag
r4 = {100, 1000000, x1ns} slow gate width, i.e. value of a_slow_width
r5 = {0, 1000} gain, i.e. value of a_mcp_gain
r6 = {0, 9} fast mode no., i.e. value of a_fast_mode
r7 = {0, 3} goimode no., i.e. value of a_goi_mode
r8 = {0, 55000, x1ps} trigger delay, i.e. value of a_trig_delay
r9 = {0, 1} dconf flag, i.e. value of a_dc_on
r10 = {0, 1} status flag, i.e. value of a_status

13.13 COMMANDS FOR CHANNEL 2 (b)

Name **b!gmode**
Explanation set goimode, i.e. write to b_goi_mode
Format **p1 b!gm**
Parameters p1 = {0, 3} goi mode no.
Returned values none

Name **b@gmode**
Explanation read goimode no., i.e. read b_goi_mode
Format **b@gm**
Parameters none
Returned values r1 = {0, 3} goi mode no.

Name **b!fmode**
Explanation set fastmode no., i.e. write to b_fast_mode
Format **p1 b!fm**
Parameters p1 = {0, 9} fast mode no.
Returned values none

Name **b@fmode**
Explanation read fast mode no., i.e. read b_fast_mode
Format **b@fm**
Returned values r1 = {0, 9} goi mode no.

Name **b@fwidth**
Explanation read fast gate width, i.e. read b_fast_width
Format **b@fw**
Parameters none
Returned values r1 = {80, 500, x 1ps} fast gate width

Name **b!swidth**
Explanation set slow gate width, i.e. write to b_slow_width
Format **p1 b!sw**
Parameters p1 = {100, 1000000, x 1ns} slow gate width
Returned values none

Name **b@swidth**
Explanation read slow gate width, i.e. read b_slow_width
Format **b@sw**
Parameters none
Returned values r1 = {100, 1000000, x1ns} slow gate width

Name **b!gain**

Explanation set gain, i.e. write to b_mcp_gain

Format **p1 b!ga**

Parameters p1 = {0, 1000} gain setting

Returned values none

Name **b@gain**

Explanation read gain, i.e. read b_mcp_gain

Format **b@ga**

Parameters none

Returned values r1 = {0, 1000} gain setting

Name **b!tdel**

Explanation set trigger delay, i.e. write to b_trig_delay

Format **p1 b!td**

Parameters p1 = {0, 55000, x1ps} trigger delay

Returned values none

Name **b@tdel**

Explanation read trigger delay, i.e. read b_trig_delay

Format **b@td**

Parameters none

Returned values r1 = {0, 55000, x1ps} trigger delay

Name **b!ovld**

Explanation write overload flag, i.e. write to b_ovld_flag

Format **p1 b!ov**

Parameters p1 = {0, 1} overload flag

Returned values none

Name **b@ovld**

Explanation read overload flag, i.e. read b_ovld_flag

Format **b@ov**

Parameters none

Returned values r1 = {0, 1} overload flag state

Name	**b!trigf**
Explanation	write triggered flag, i.e. write to b_trig_flag
Format	**p1 b!tr**
Parameters	p1 = {0, 1} triggered flag
Returned values	none

Name	**b@trigf**
Explanation	read triggered flag, i.e. read b_trig_flag
Format	**b@tr**
Parameters	none
Returned values	r1 = {0, 1} triggered flag state

Name	**b!dconf**
Explanation	write dcon flag, i.e. write to b_dc_on
Format	**p1 b!dc**
Parameters	p1 = {0, 1} dc on flag
Returned values	none

Name	**b@dconf**
Explanation	read dconf flag, i.e. read b_dc_on
Format	**b@dc**
Parameters	none
Returned values	r1 = {0, 1} dc on flag state

Name	**b@status**
Explanation	read status flag, i.e. read b_status
Format	**b@st**
Parameters	none
Returned values	r1 = {0, 3} status flag

Name	**b@all**
Explanation	read status flag, i.e. read b_status
Format	**b@al**
Parameters	none
Returned values	r1 = {80, 5000, x1ps} fast gate width, i.e. value of b_fast_width r2 = {0, 1} overload flag, i.e. value of b_ovld_flag r3 = {0, 1} triggered flag, i.e. value of b_trig_flag r4 = {100, 1000000, x1ns} slow gate width, i.e. value of b_slow_width r5 = {0, 1000} gain, i.e. value of b_mcp_gain r6 = {0, 9} fast mode no., i.e. value of b_fast_mode r7 = {0, 3} goimode no., i.e. value of b_goi_mode r8 = {0, 55000, x1ps} trigger delay, i.e. value of b_trig_delay r9 = {0, 1} dconf flag, i.e. value of b_dc_on r10 = {0, 1} status flag, i.e. value of b_status

13.14 COMMANDS WHICH ARE CHANNEL INDEPENDENT

Name **@ipabytes**

Explanation read bytes of ip address

Format **@ipa**

Parameters none

Returned values r1 = {0, 255} ip address byte 3 (msb)
r2 = {0, 255} ip address byte 2
r3 = {0, 255} ip address byte 1
r4 = {0, 255} ip address byte 0 (lsb)

Notes *The ip address bytes will read zero until an address is allocate by the DHCP server*

Name **@macbytes**

Explanation read bytes of mac address

Format **@mac**

Parameters none

Returned values r1 = {0, 255} ip address byte 5 (msb)
r2 = {0, 255} ip address byte 4
r3 = {0, 255} ip address byte 3
r4 = {0, 255} ip address byte 2
r5 = {0, 255} ip address byte 1
r6 = {0, 255} ip address byte 0 (lsb)

Name **@version**

Explanation read software version no.

Format **@ver**

Parameters none

Returned values r1 = {0, 255} version no.

Name **@job_no**

Explanation read job no.

Format **@job**

Parameters none

Returned values r1 = {0, 9999999} read job no.

Name **@serial_no**

Explanation read serial no.

Format **@ser**

Parameters none

Returned values r1 = {0, 255} read serial no.

Name **safe**

Explanation put both channels of the GOI into inhibit mode

Format **safe**

Parameters none

Returned values none

13.15 EXAMPLE COMMS

13.15.1 RANDOM EXAMPLES TO TRY FIRST

Characters sent in red, response in blue. Comments in black.

Power up, wait a few seconds.....

Send a safe command to check comms working, the GOI should already be in inhibit mode by default. Sent commands must be followed by a cr.

safe

{safe}

Read GOI mode, should be mode0 = inhibit...

b@gm

{b@gm;0 }

Read fast gate width, should be default value of 80ps...

b@fw

{b@fw;80 }

Read overload flag, should be default value of zero...

b@ov

{b@ov;0 }

Read triggered flag, should be default value of zero...

b@tr

{b@tr;0 }

Read slow width, should be default value of100ns...

b@sw

{b@sw;100 }

Read gain, should be default value of zero...

b@ga

{b@ga;0 }

Read fast mode, should be default value of zero...

b@fm

{b@fm;0 }

Read trigger delay, should be default value of 0ns...

b@td

{b@td;0 }

Read status, should be normal value of zero...

b@tst

{b@st;0 }

Read software version no....

@ver

{@ver;0 }

Read ip address bytes, note the bytes will be all zero until DHCP server allocates an address....

@ipa

{@ipa;192 ;168 ;2 ;215 }

Read mac address bytes. Note this looks odd as it is normal convention to write the mac address bytes as hexadecimal numbers, these numbers are decimal but will correspond if converted to hex....

@mac

{@mac;112 ;179 ;213 ;234 ;192 ;1 }

Read all the system variables....

b@al

{b@al;80 ;0 ;0 ;100 ;0 ;0 ;0 ;0 ;0 ;0 }

Set to goi mode 1 = fast mode....

1 b!gm

{1 b!gm}

Reset overload flag....

0 b!ov

{0 b!ov}

Reset triggered flag....

0 b!tr

{0 b!tr}

Reset dc mode flag....

1 b!dc

{1 b!dc}

Set gain to 200....

200 b!ga

{200 b!ga}

Set trigger delay to 25ns....

25000 b!td

{25000 b!td}

Set fast mode 3....

3 b!fm

{3 b!fm}

Set slow width to 1000 ns

1000 b!sw

{1000 b!sw}

Read job no.......

@job

{@job;1401031 }

Read serial no.......

@job

{@ser;1 }

13.15.2 SETTING THE GOI UP IN DC MODE FROM A COLD START

Power up, wait a few seconds.....

Send a safe command to check comms are working, the GOI should already be in inhibit mode by default...

safe

{safe}

Check the GOI passed the self test.....

b@st

{b@st;0 }

Set GOI mode 3 = DC mode

3 b!gm

{3 b!gm}

Switch cathode on DC for 5 seconds by setting DC on flag

1 b!dc

{1 b!dc}

Look for image, can't see it because it is too dim, so increase the gain

100 b!ga

{100 b!ga}

Switch cathode on again DC for 5 seconds by setting DC on flag

1 b!dc

{1 b!dc}

Etc.

13.15.3 SETTING THE GOI UP IN FAST MODE FROM A COLD START

Power up, with trigger disconnected wait a few seconds. Send a safe command to check comms working, the GOI should already be in inhibit mode by default

safe

{safe}

Checked the GOI passed the self test.....
b@tst

{b@st;0 }

Set GOI mode 1 = FAST mode
1 b!gm

{1 b!gm}

Select a speed, say 120ps = fast mode 3
3 b!fm

{3 b!fm}

Set the gain, say 800 (max setting 1000)
800 b!ga

{800 b!ga}

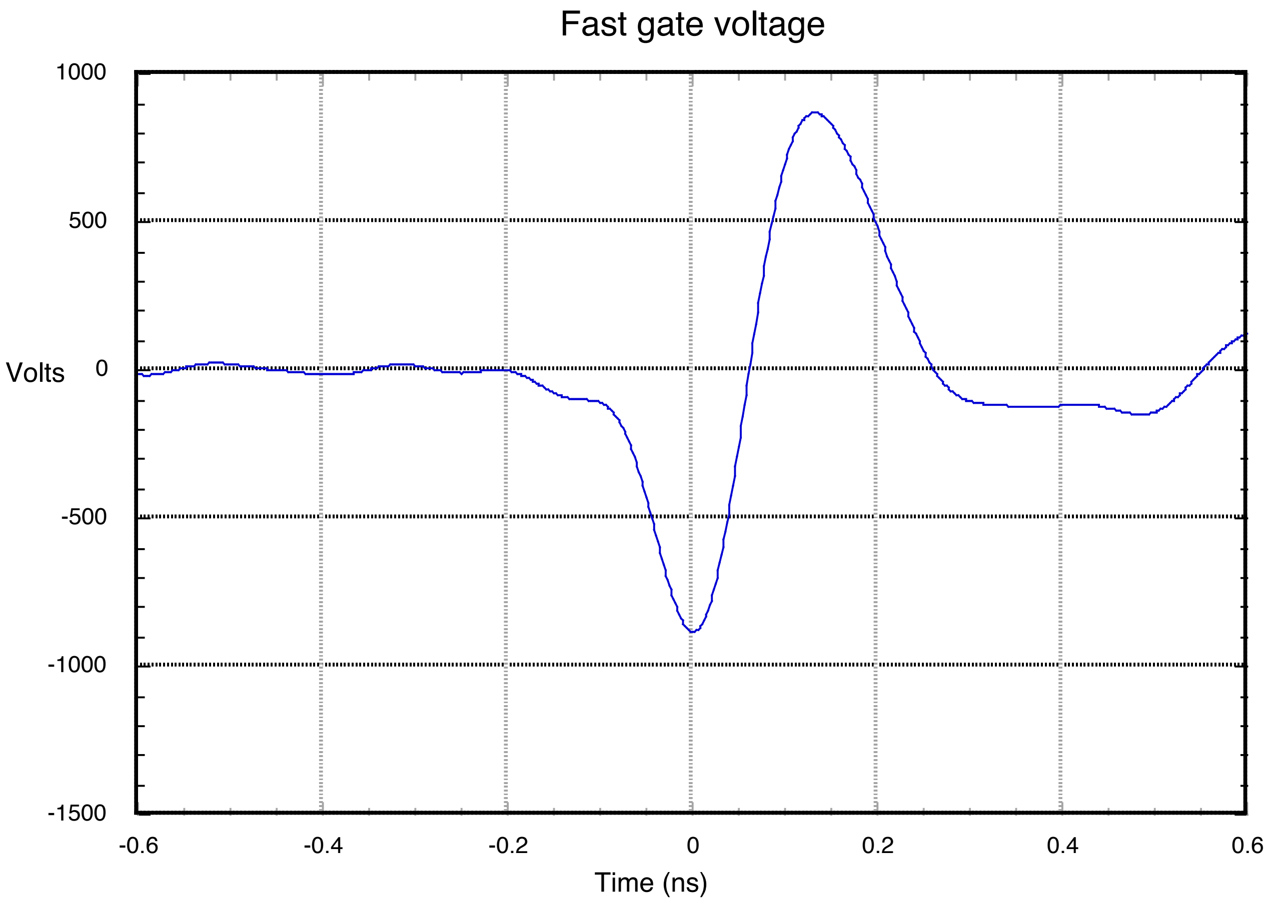
Check triggered flag is zero
b@tr

{b@tr;0 }

Now apply a trigger signal, and check triggered flag again...
b@tr

{b@tr;1}

Success



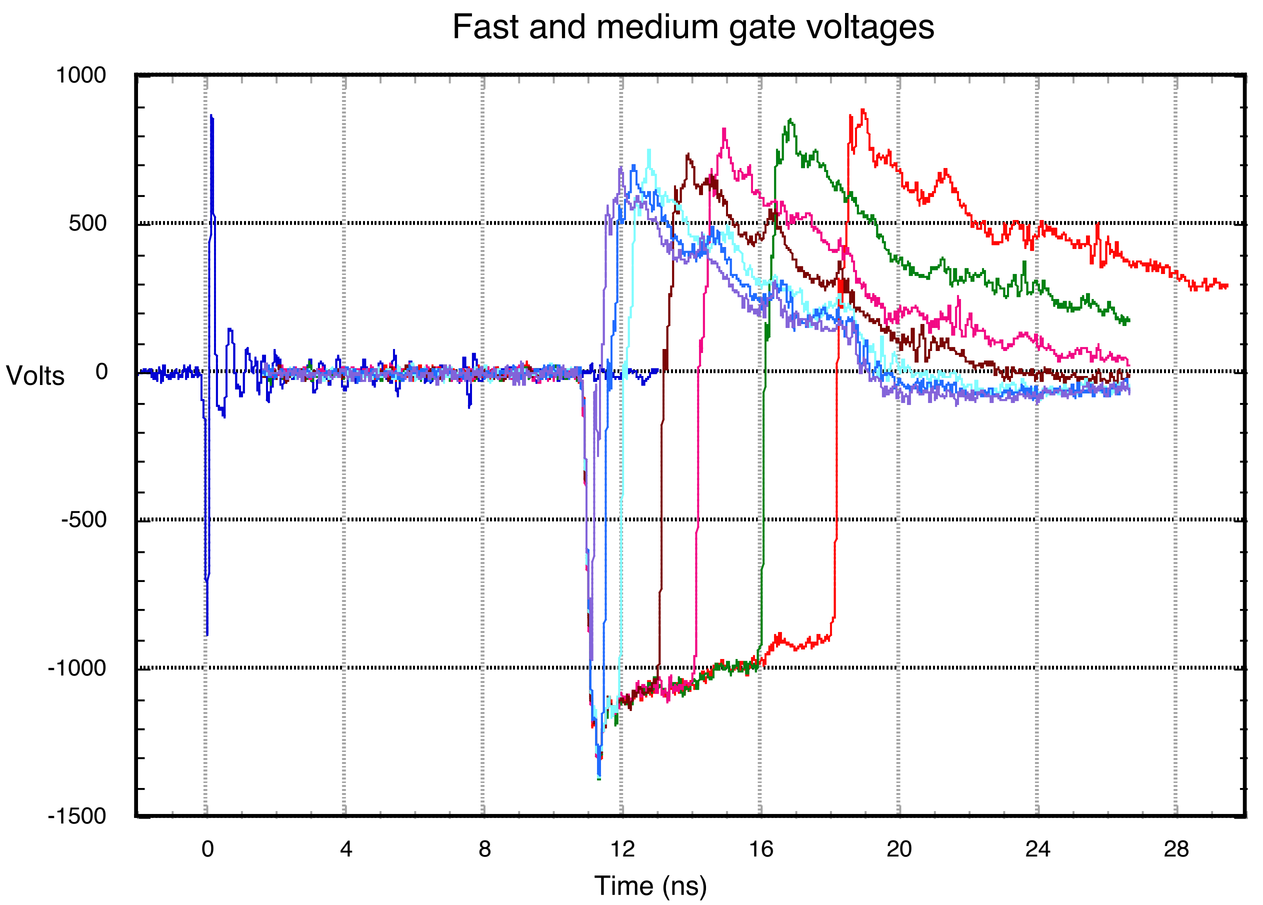
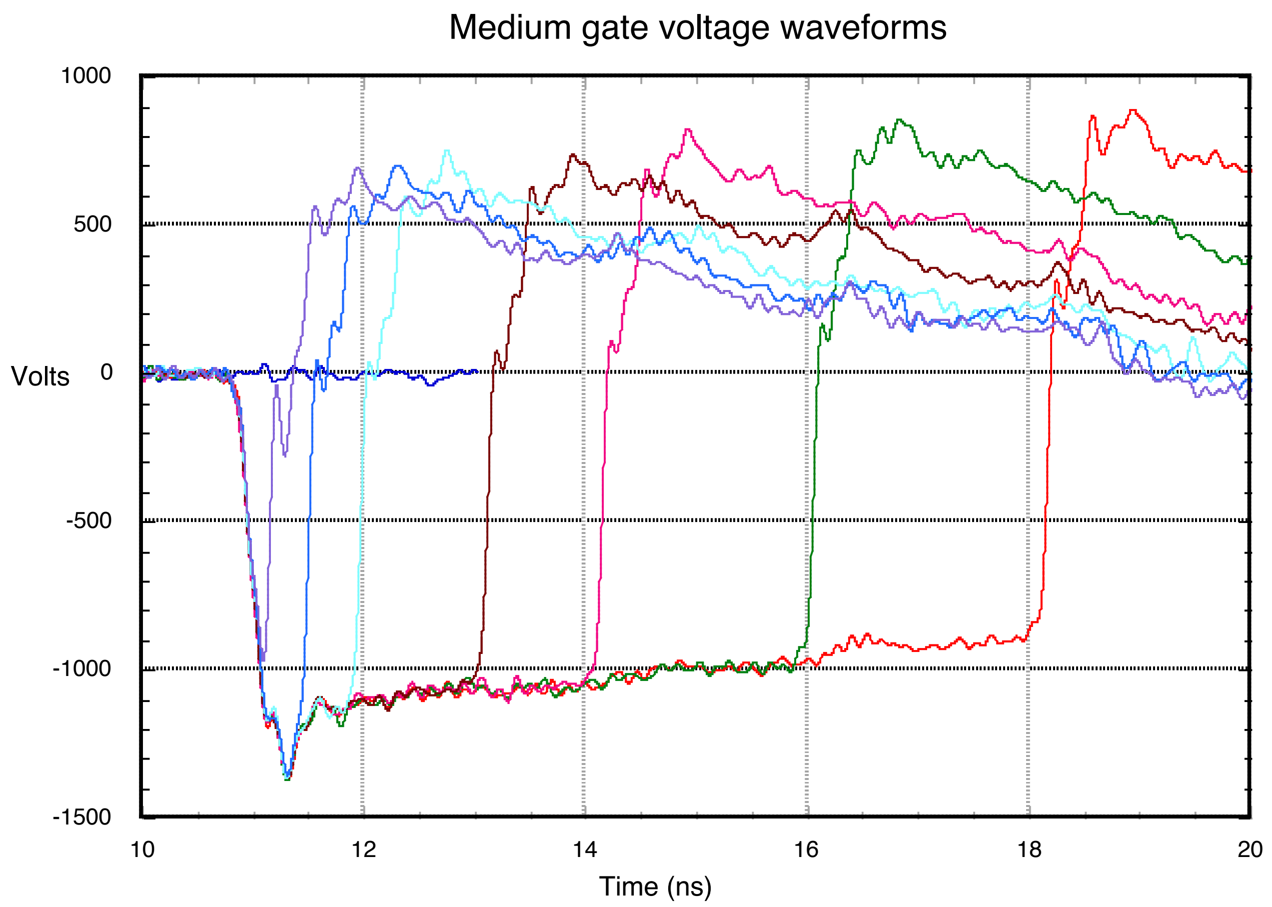


Figure 10 Fast and medium gate waveforms
Showing relative timing (typical data)



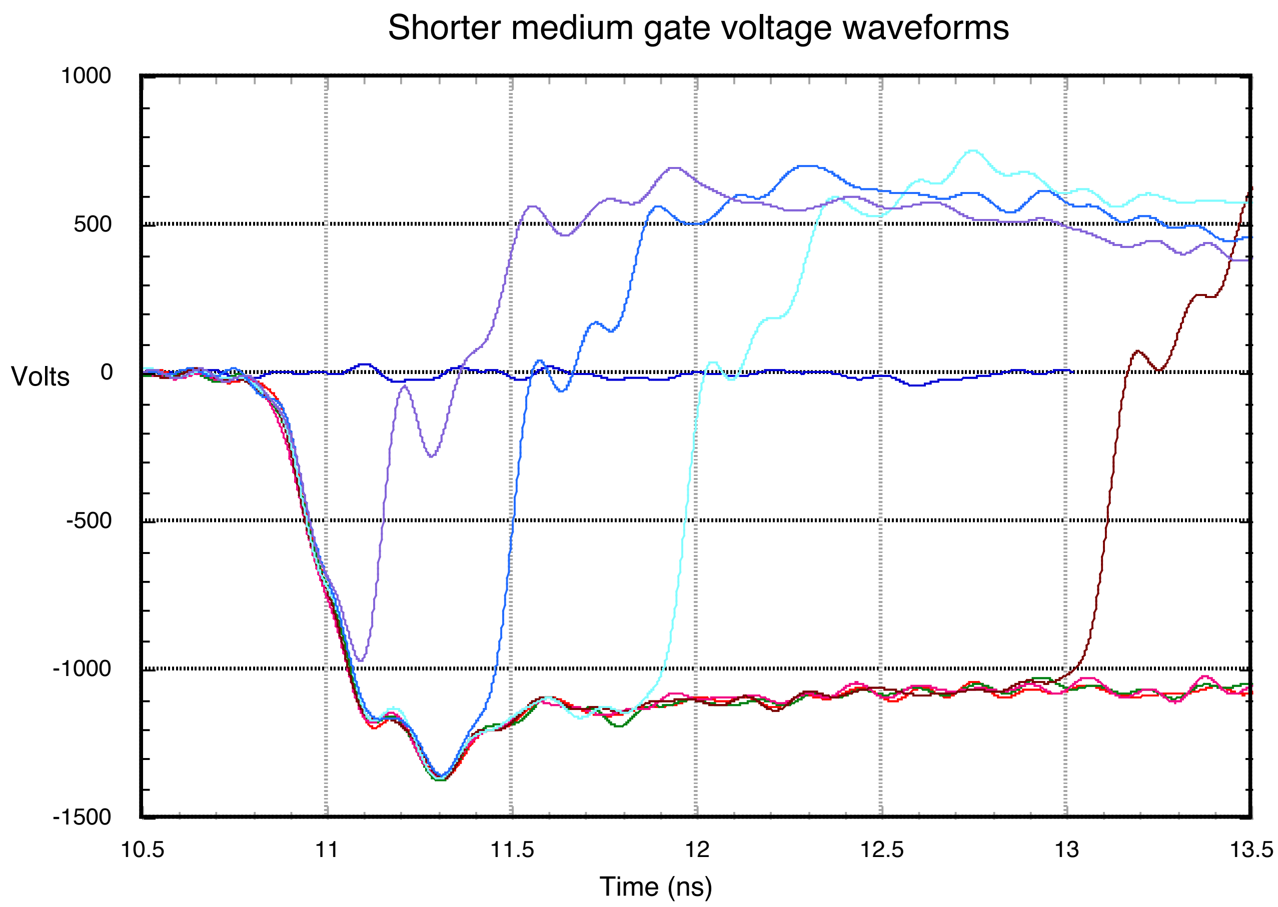


Figure 11 Medium gate waveforms
showing relative timing of the edges (typical data).

15 OPTICAL GATE WAVEFORMS CHANNEL 1 (a)

Made with a 40ps laser diode.

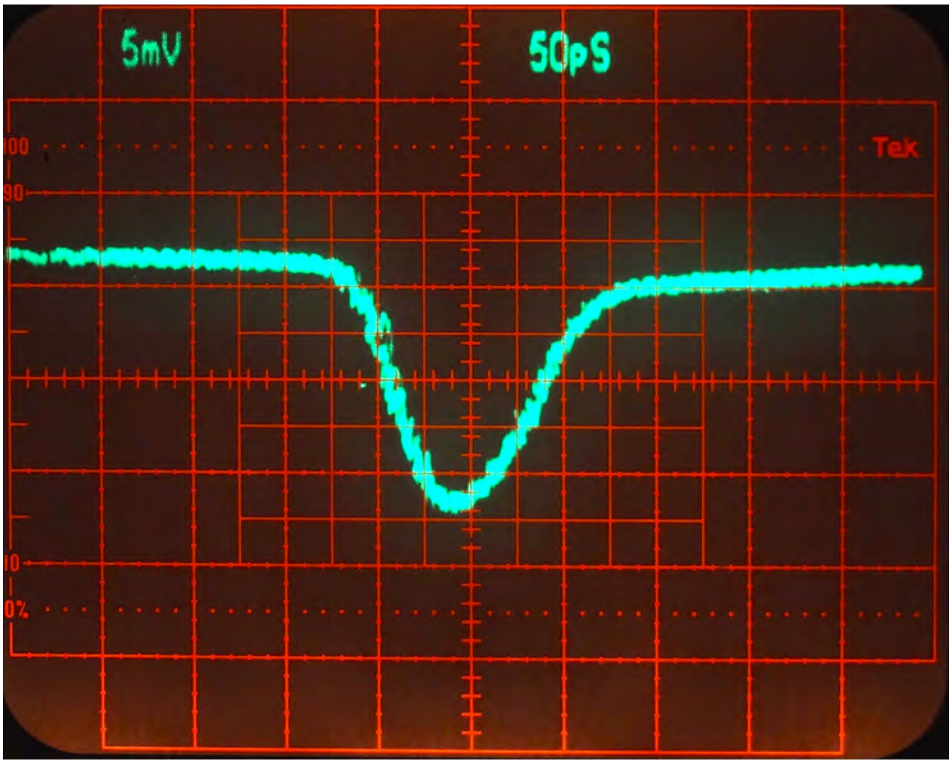


Figure 13 Ch1 Speed 0 Time right to left ~90 ps.

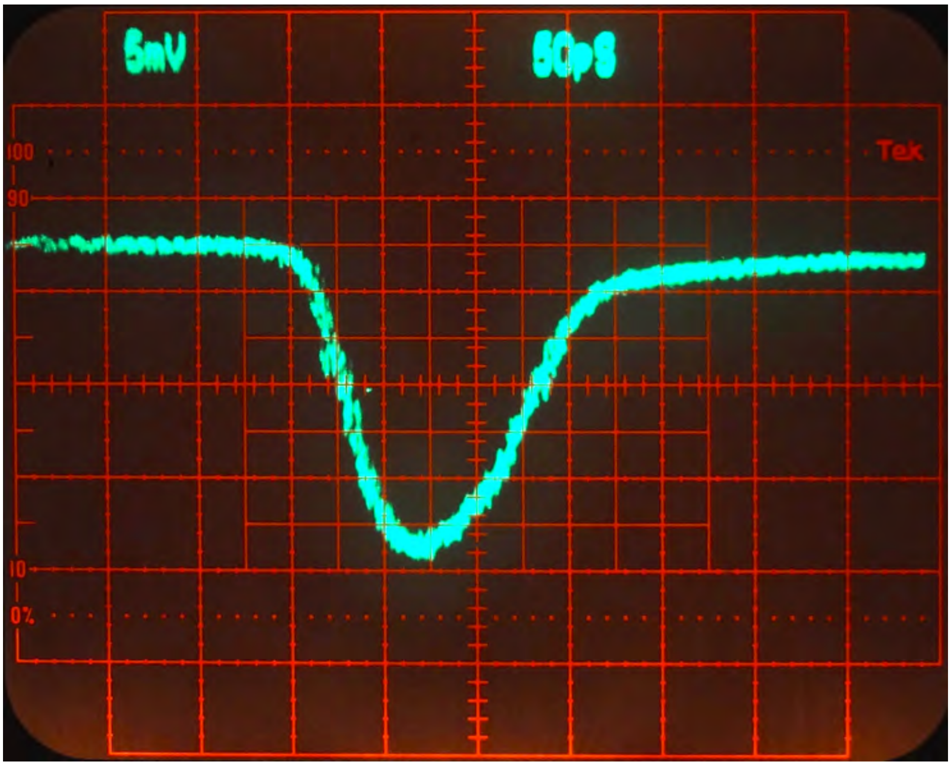


Figure 12 Ch1 Speed 1 Time right to left ~ 105ps

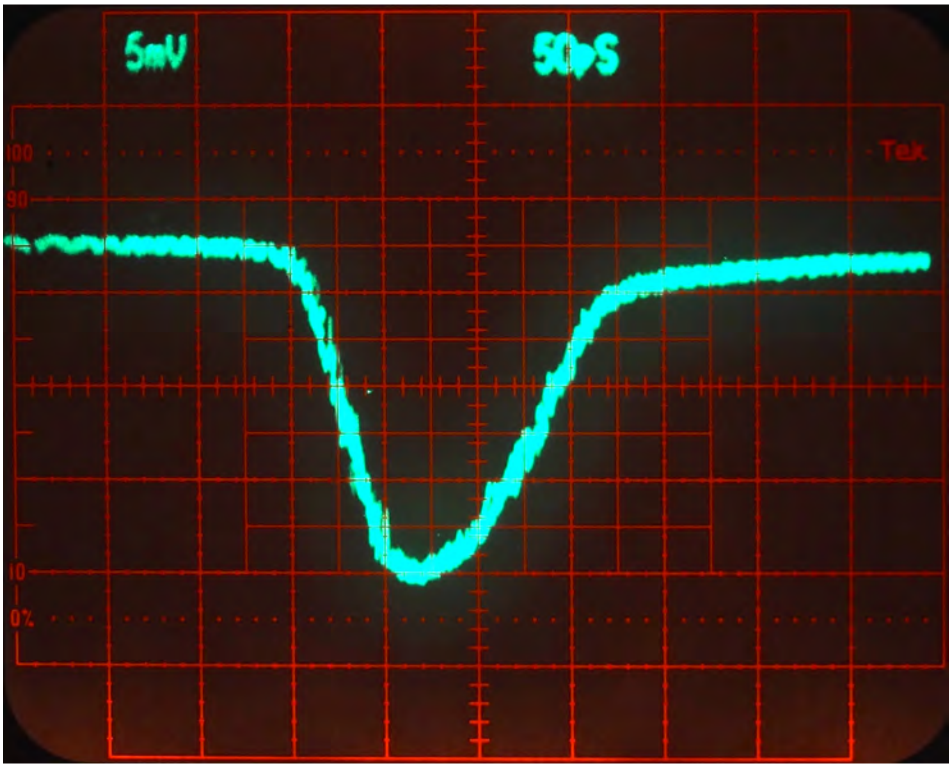


Figure 14 Ch1 Speed 2 Time right to left ~ 130ps

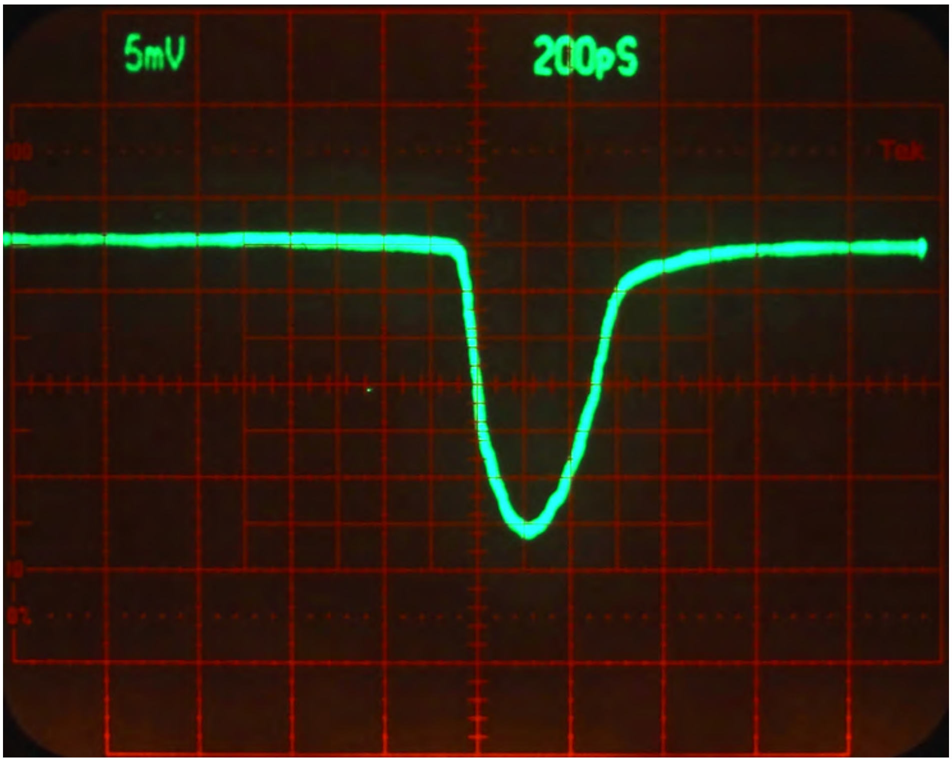


Figure 15 Ch1 Speed 3 Time right to left ~ 270ps

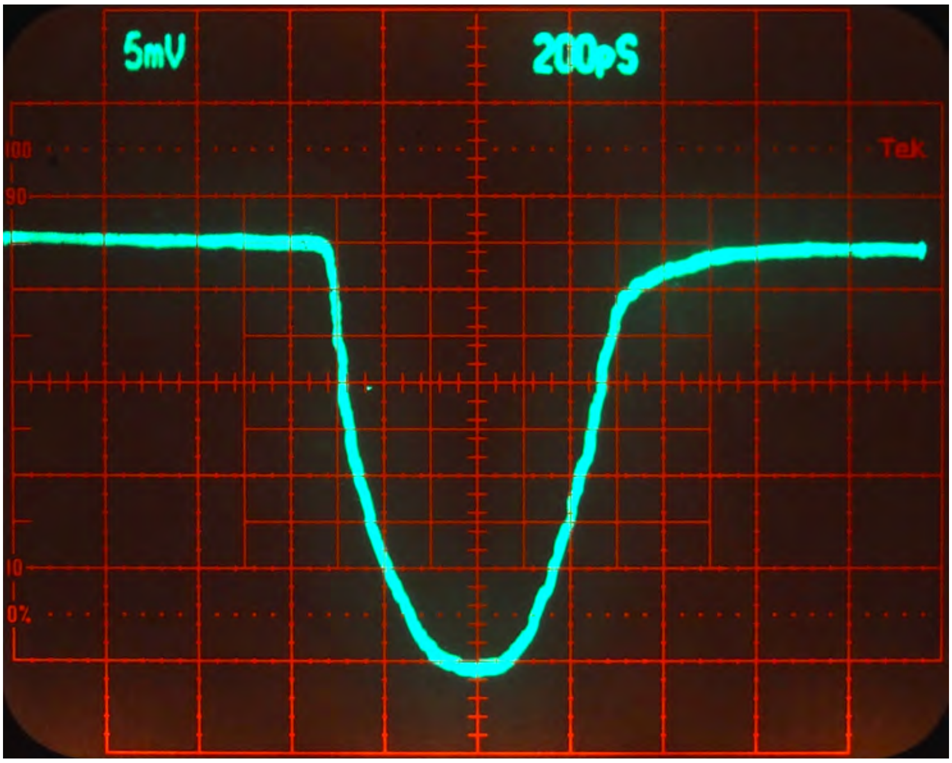


Figure 16   Ch1 Speed 4   Time right to left ~ 500ps.

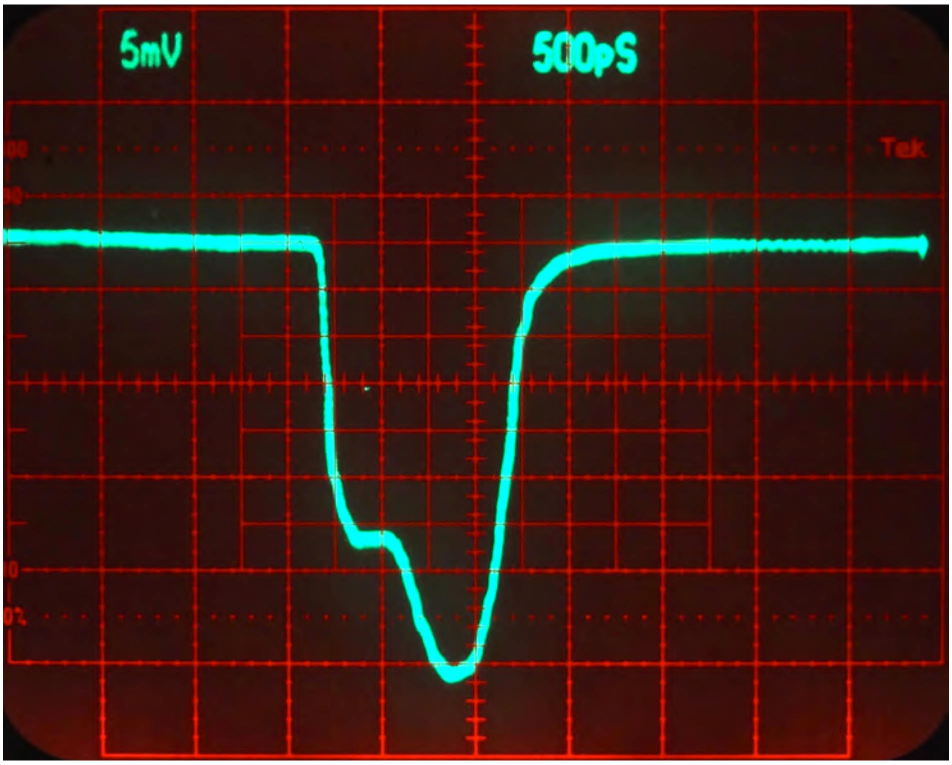


Figure 17   Ch1 Speed 5   Time right to left ~ 1ns

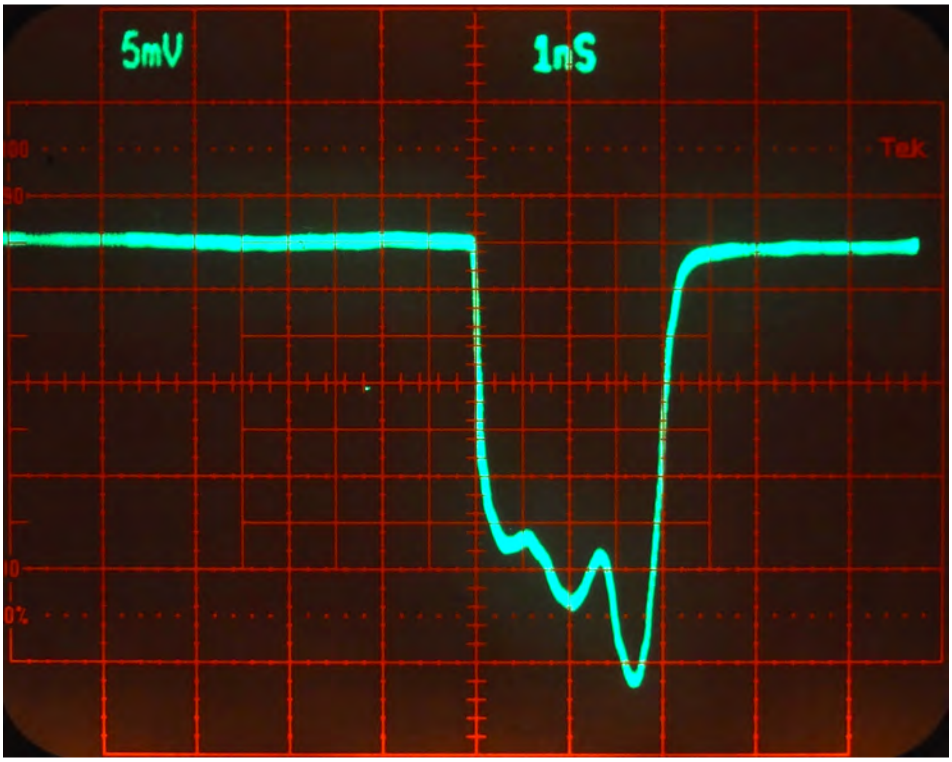


Figure 18   Ch1 Speed 6   Time right to left ~ 2ns.

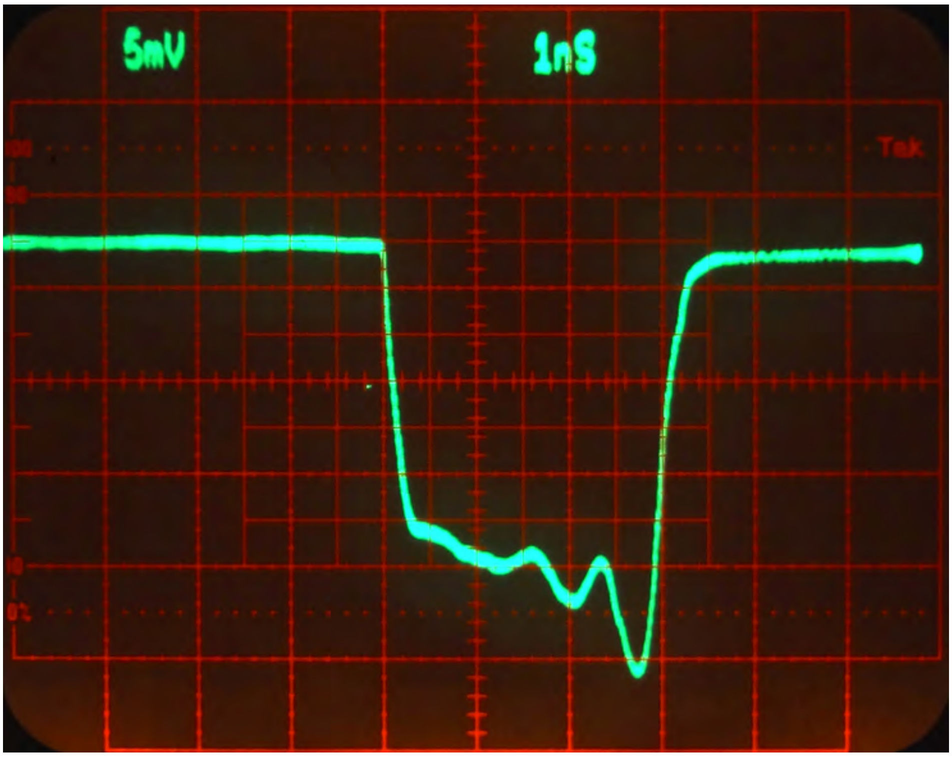


Figure 19   Ch1 Speed 7   Time right to left ~3.5ns

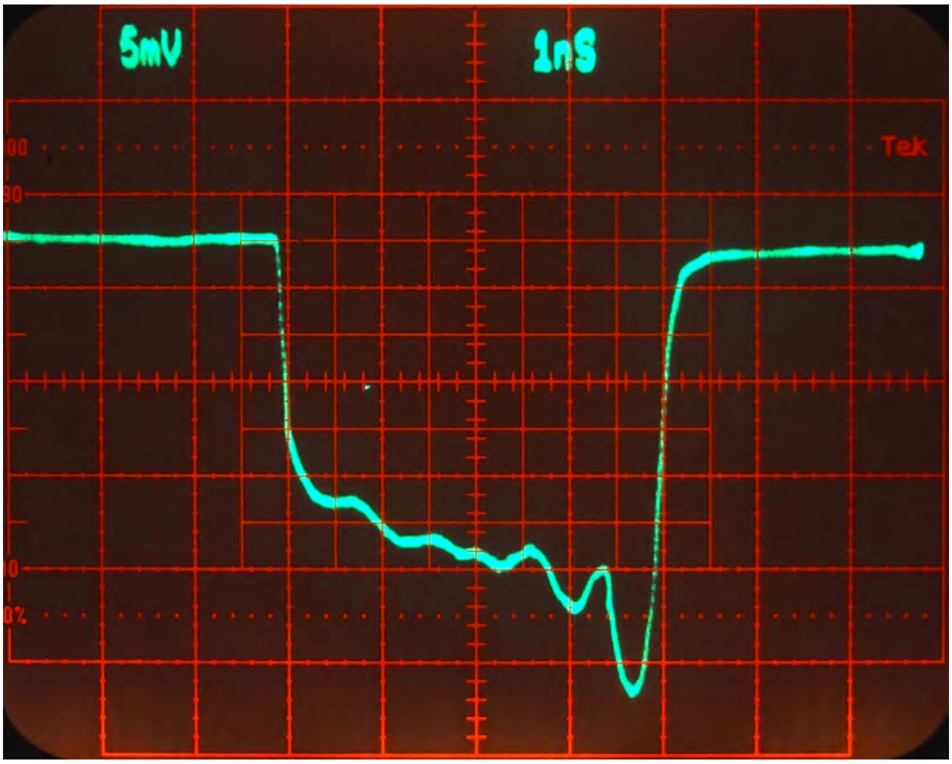


Figure 20   Ch1 Speed 8   Time right to left ~ 4ns.

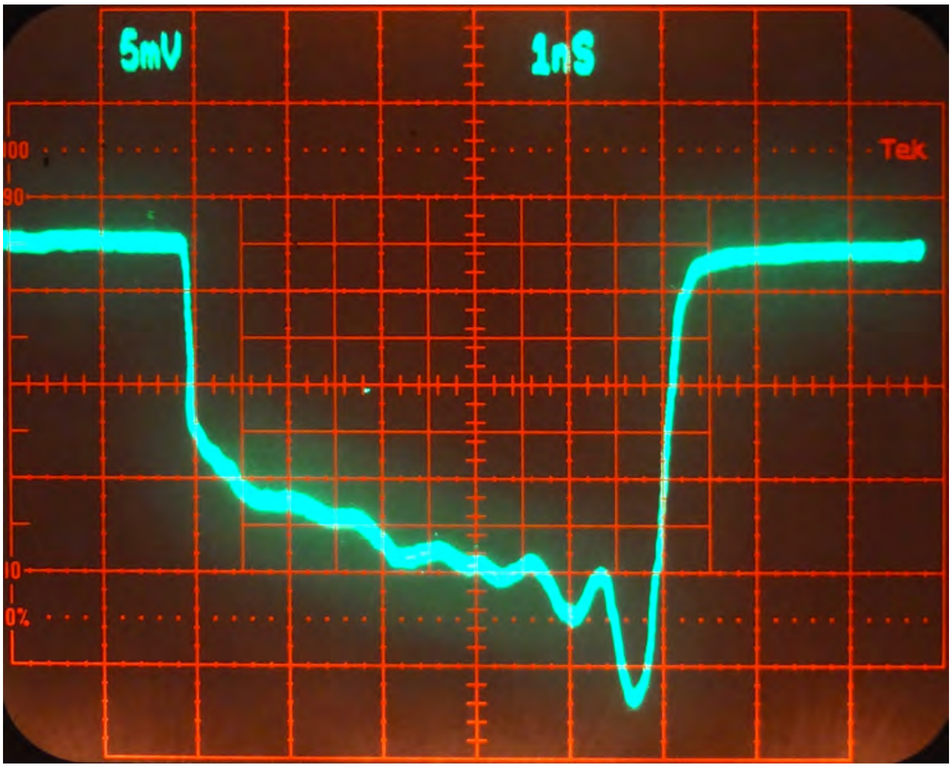


Figure 21   Ch1 Speed 9   Time right to left ~ 5ns

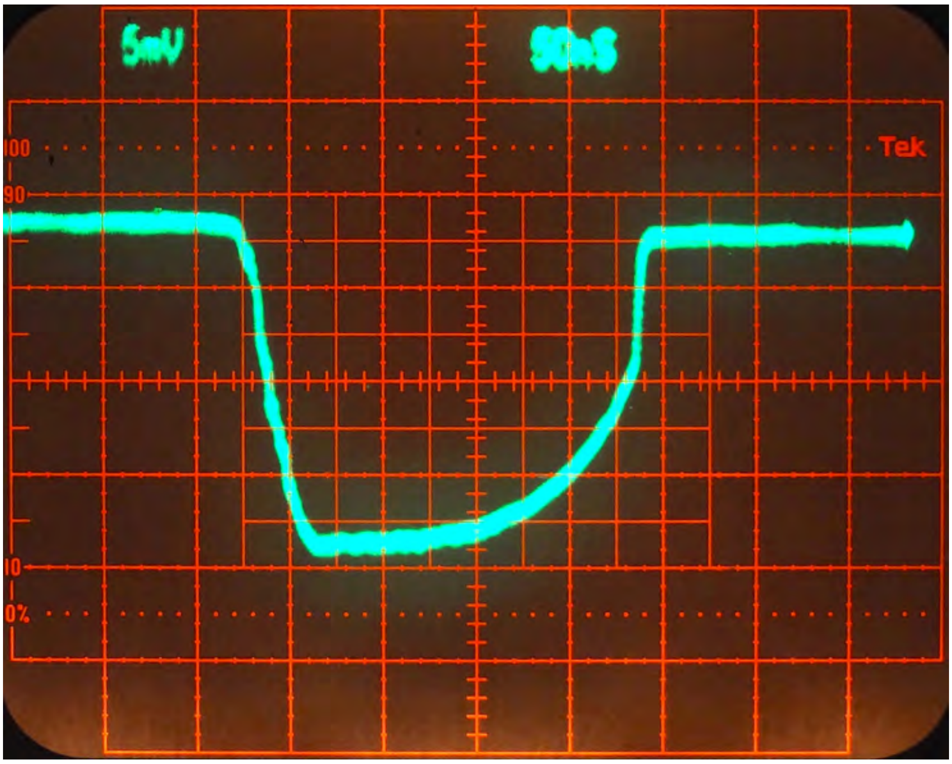


Figure 22 Ch1 Slow gate Time right to left ~ 210ns.

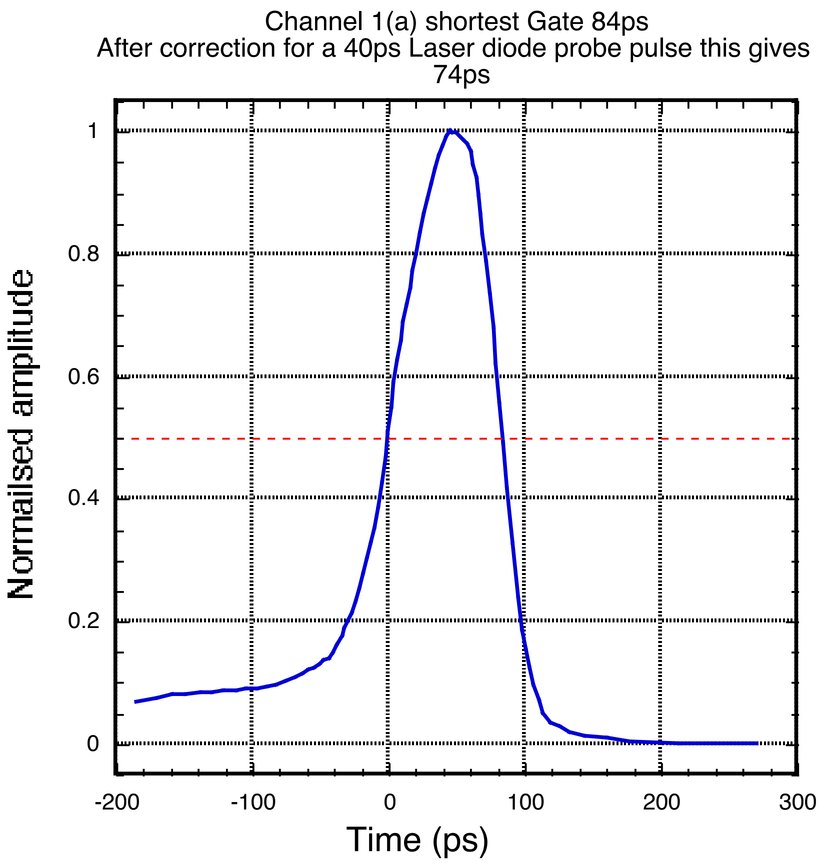


Figure 23 Ch1 Shortest gate - digitised and normalised
Time left to right The pre-cursor is due to the sampling laser diode not turning fully off at the end of its pulse.

16 OPTICAL GATE WAVEFORMS CHANNEL 2 (b)

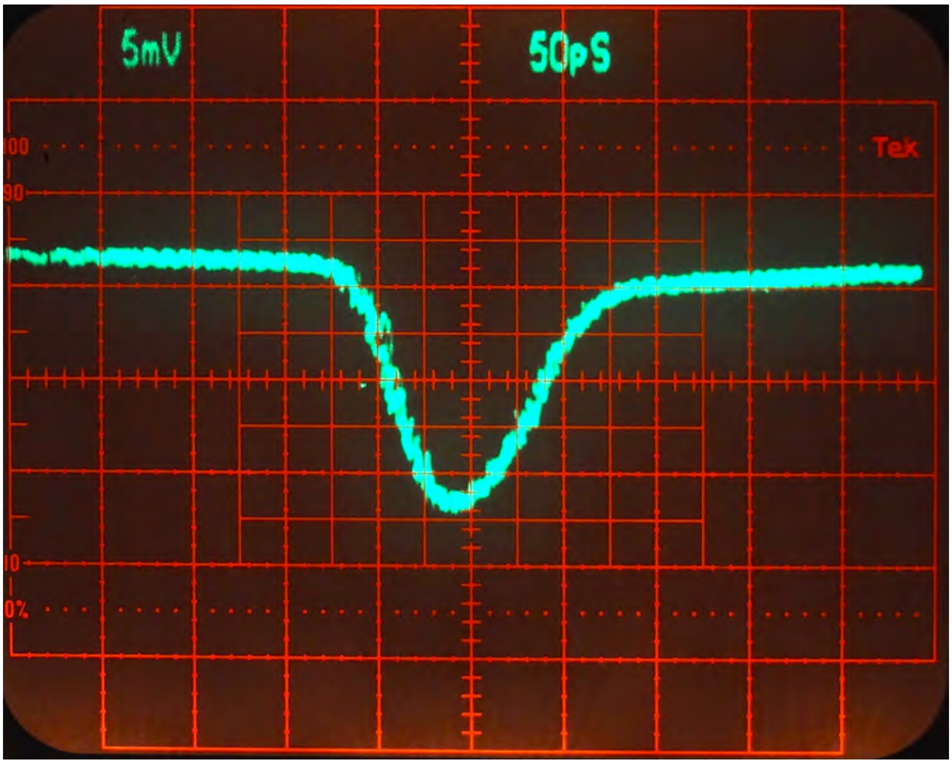


Figure 24 Ch2 Speed 0 Time right to left ~90 ps.

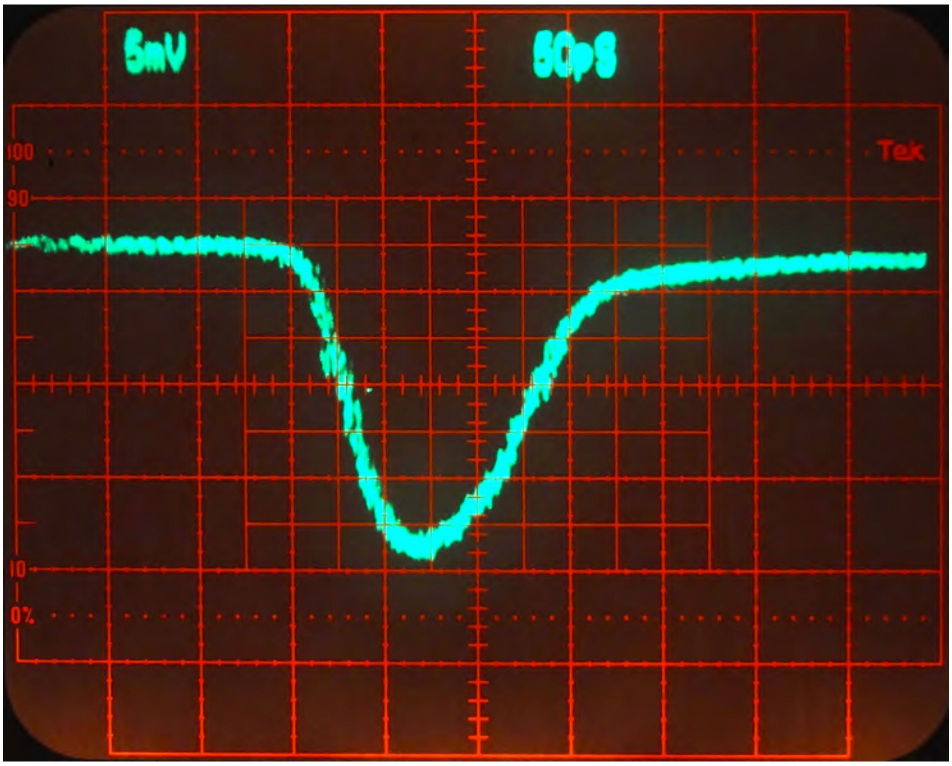


Figure 25 Ch2 Speed 1 Time right to left ~90 ps.

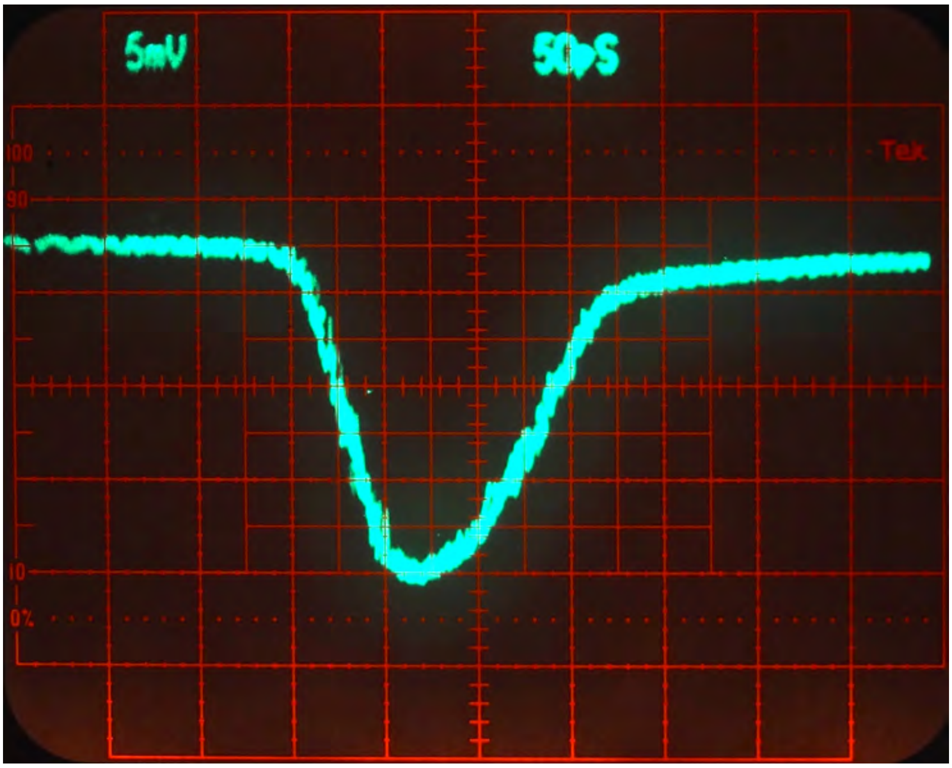


Figure 26 Ch2 Speed 2 Time right to left ~90 ps.

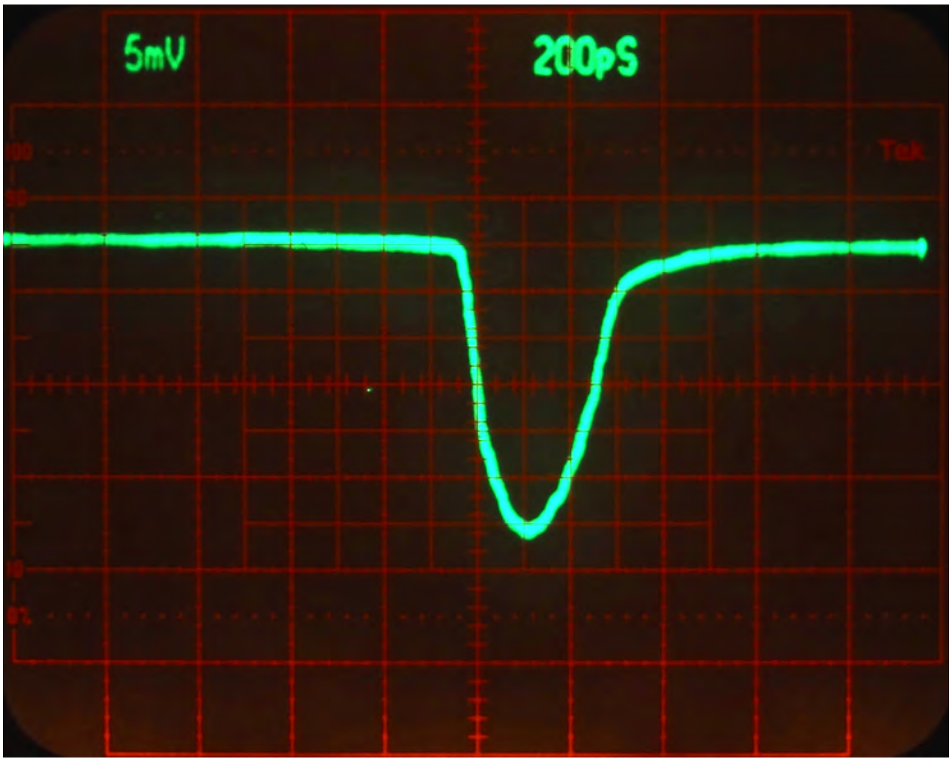


Figure 27 Ch2 Speed 3 Time right to left ~90 ps.

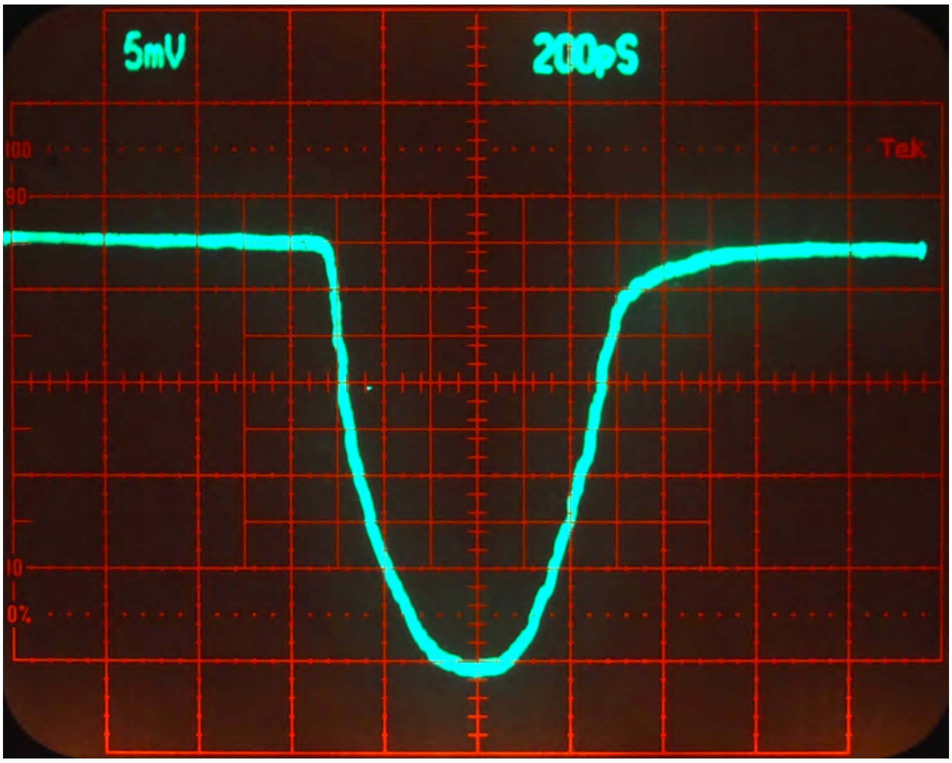


Figure 28 Ch2 Speed 4 Time right to left ~90 ps.

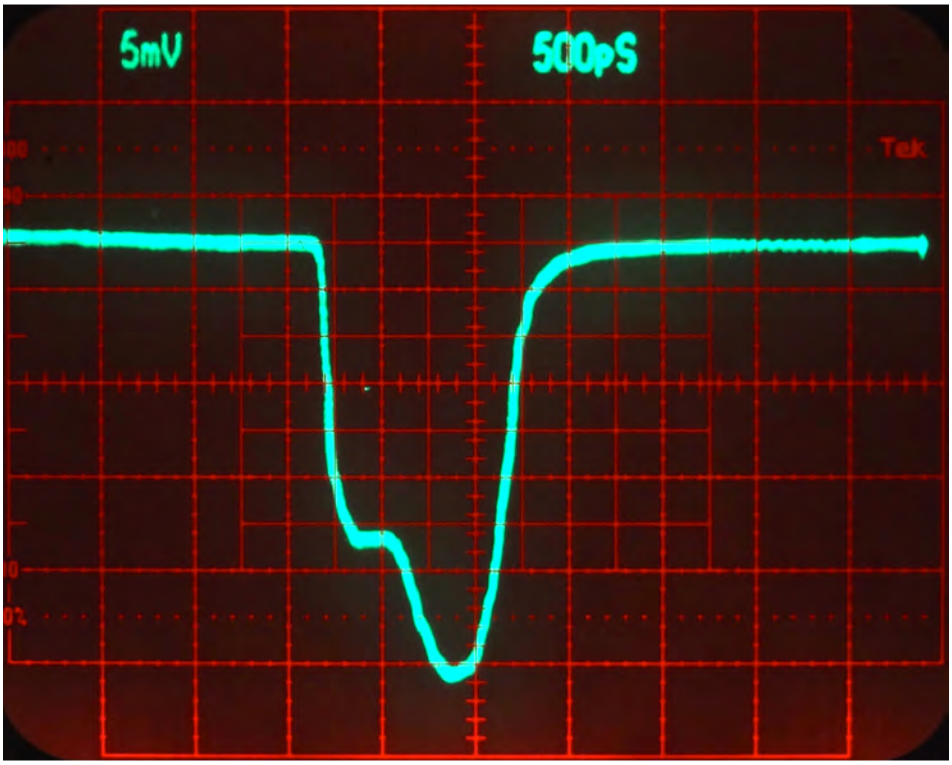


Figure 29 Ch2 Speed 5 Time right to left ~90 ps.

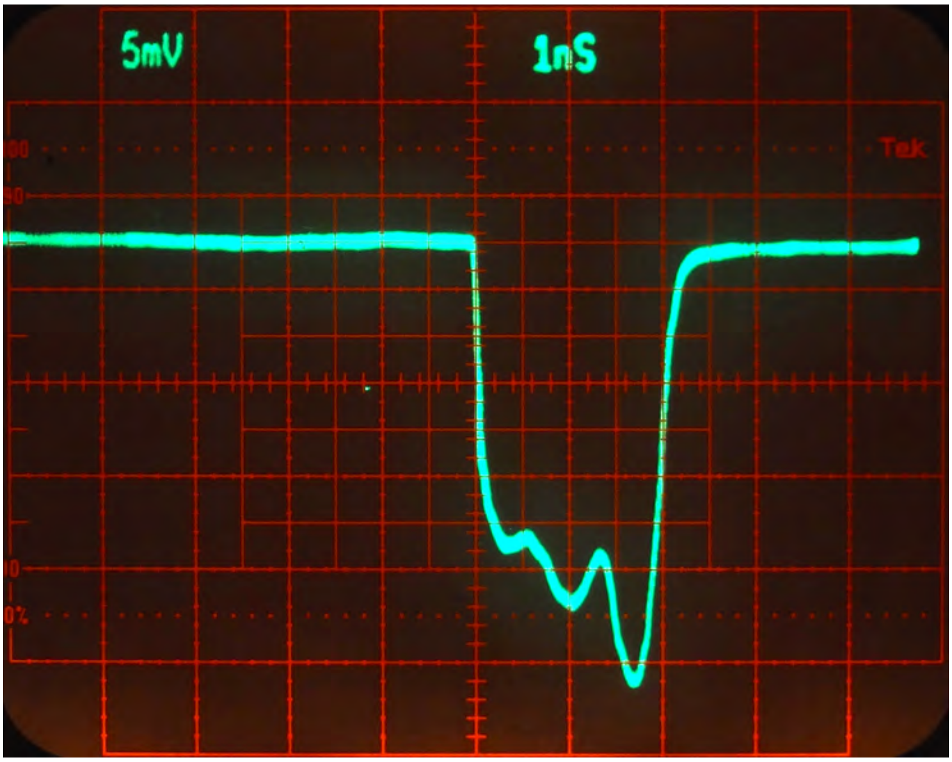


Figure 31 Ch2 Speed 6 Time right to left ~90 ps.

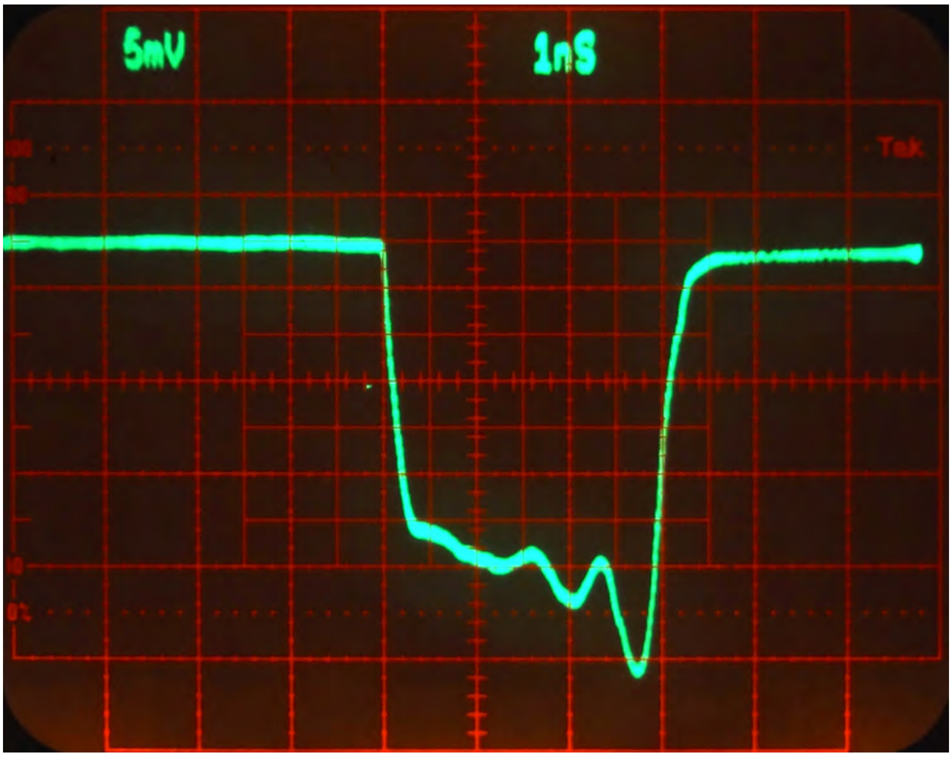


Figure 32 Ch2 Speed 7 Time right to left ~90 ps.

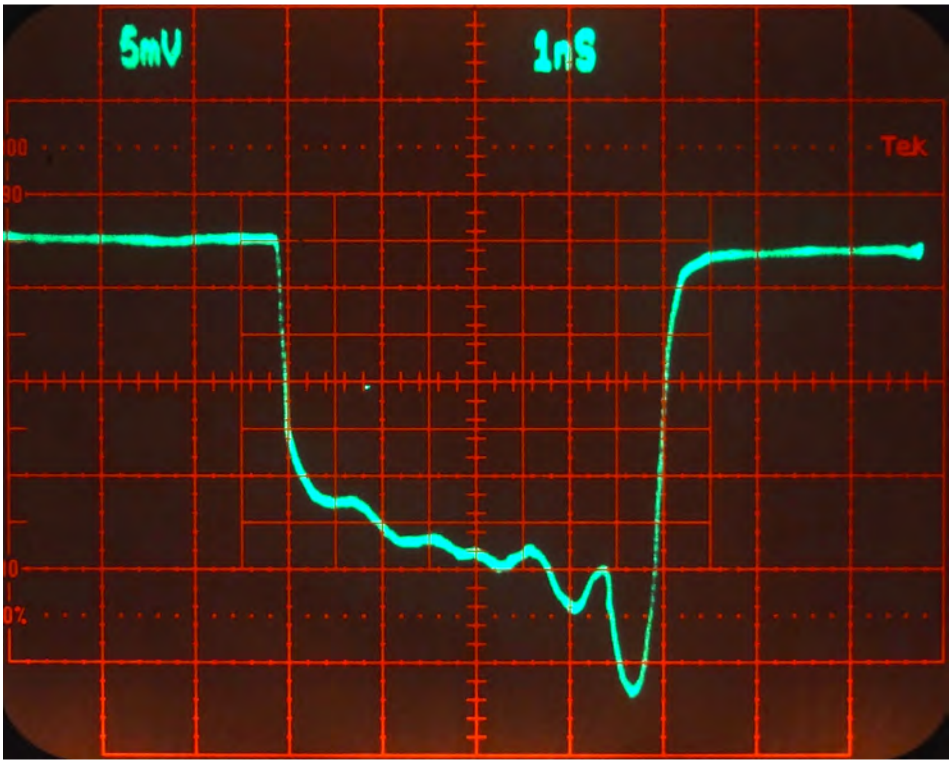


Figure 33 Ch2 Speed 8 Time right to left ~90 ps.

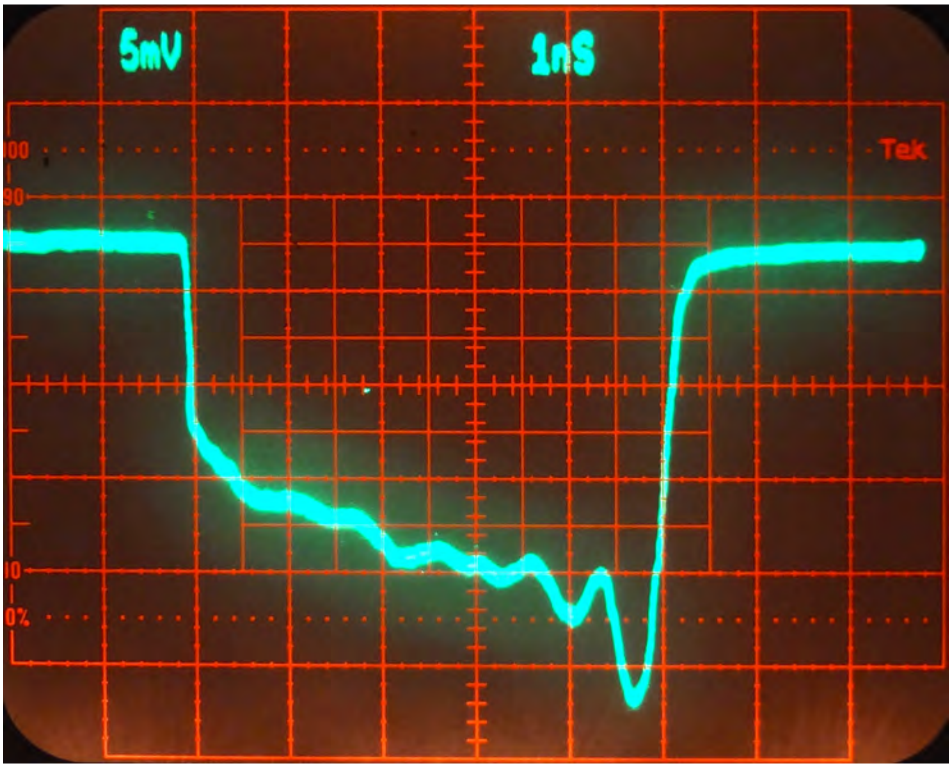


Figure 34 Ch2 Speed 9 Time right to left ~90 ps.

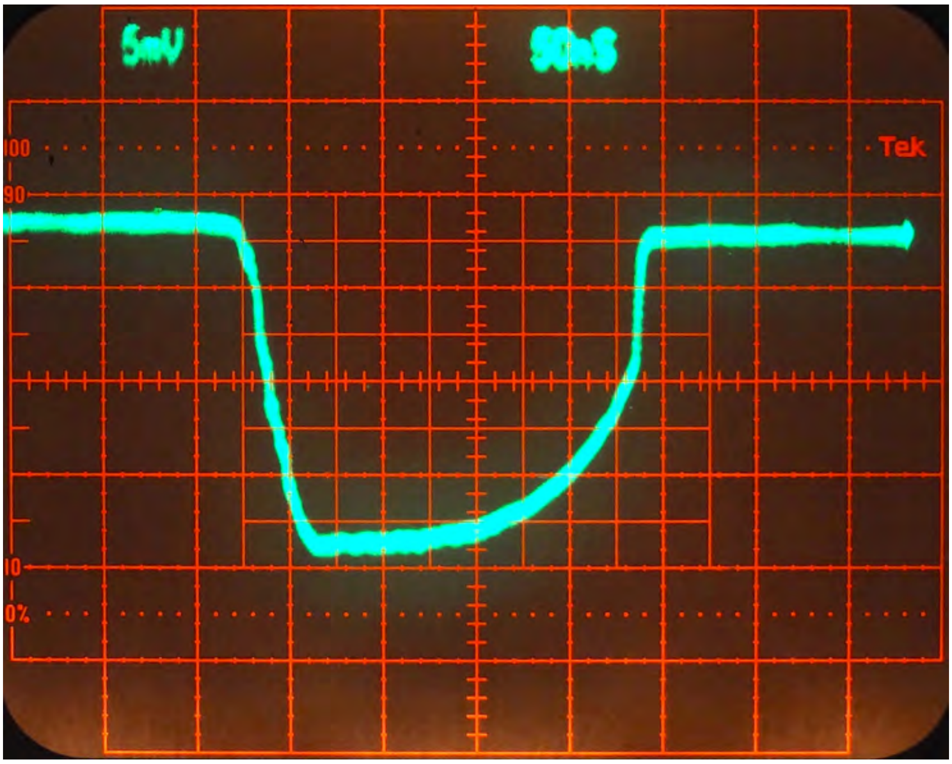


Figure 35 Ch2 Slow gate Time right to left ~ 210ns.

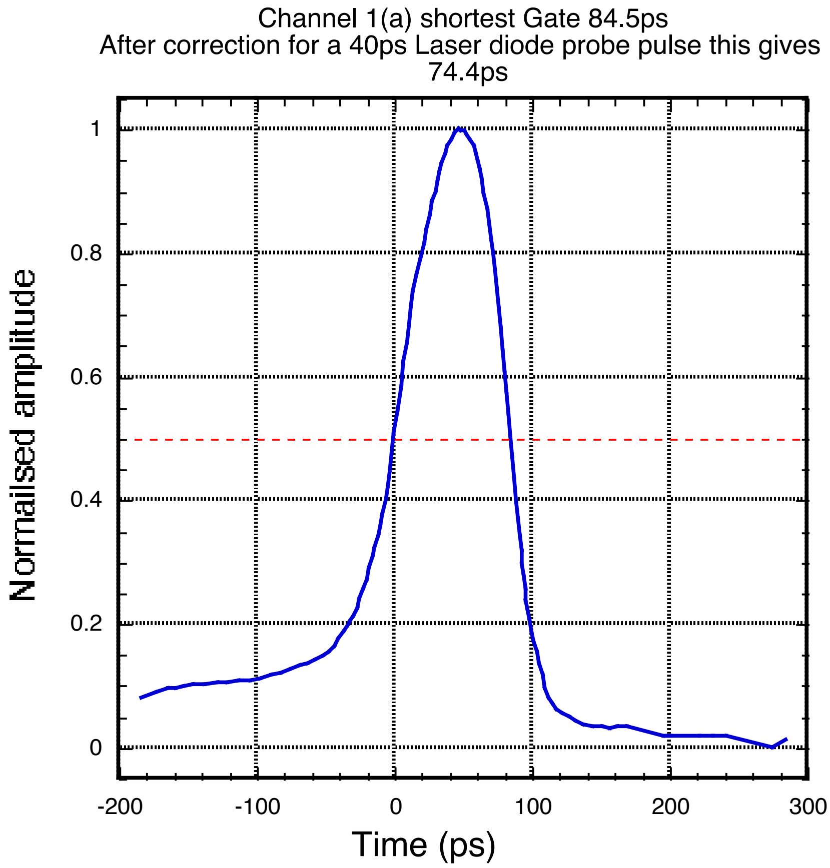


Figure 36 Ch1 Shortest gate - digitised and normalised
Time left to right The pre-cursor is due to the sampling laser diode not turning fully off at the end of its pulse.

17 TUBE DATA

PHOTONIS

Date : 14-05-13

IMAGE INTENSIFIER TYPE : XX2050JD
SERIAL NR : 2480238 Channel 1/a

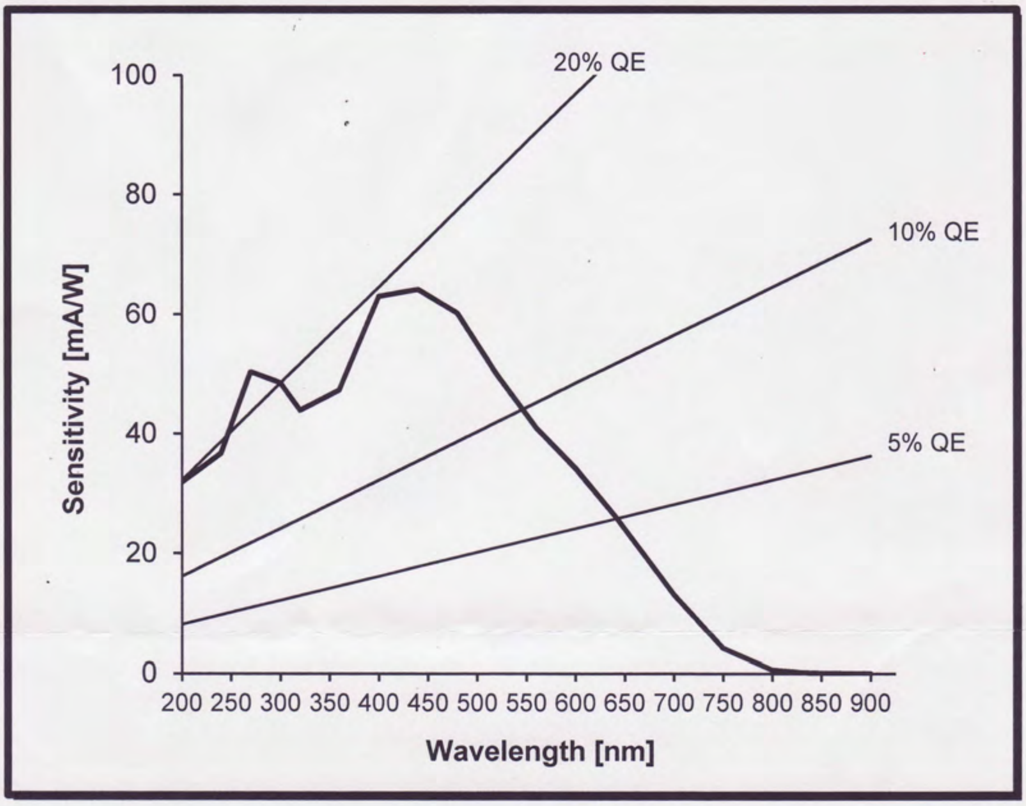
Parameter	Min	Measured	Max	Unit
Radiant sensitivity 270 nm 450 nm 520 nm	25 40 32	See curve		mA/W mA/W mA/W
Luminance gain 5000 cd/m²/lx MCP volt. =		871		V
Resolution	45	52		lp/mm
Equiv. background illumin.		0.07	0.25	µlx
Input useful diameter	17.5	18.0		mm
Iris delay		0.1	0.2	ns
MTF @2.5 lp/mm @7.5 lp/mm @ 15 lp/mm		88 67 41		% % %
Photocathode gap	150	150	200	µm
Photocathode to MCP-input capacitance		25		pF
Remarks:				tested by

Table 1 Tube data Channel 1/a

Cathode sensitivity

Serial number 2480238

Date 14-5-2013



Wavelength [nm]	Sensitivity [mA/W]	QE [%]
200	32.0	19.8
240	36.8	19.0
270	50.3	23.1
300	48.4	20.0
320	43.9	17.0
360	47.3	16.3
400	63.0	19.5
440	64.2	18.1
480	60.2	15.5
520	49.8	11.9
560	41.0	9.1
600	34.3	7.1
640	26.3	5.1
700	13.1	2.3
750	4.1	0.7
800	0.6	0.1
830	0.2	0.0
850	0.1	0.0
880	0.0	0.0
900	0.0	0.0

PR White	143	μA/lm
PR 800	1	mA/W
PR 850	0	mA/W

Figure 37 Tube response

PHOTONIS

Date : 14-05-13

IMAGE INTENSIFIER TYPE : XX2050JD
SERIAL NR : 2480239 Channel 2/b

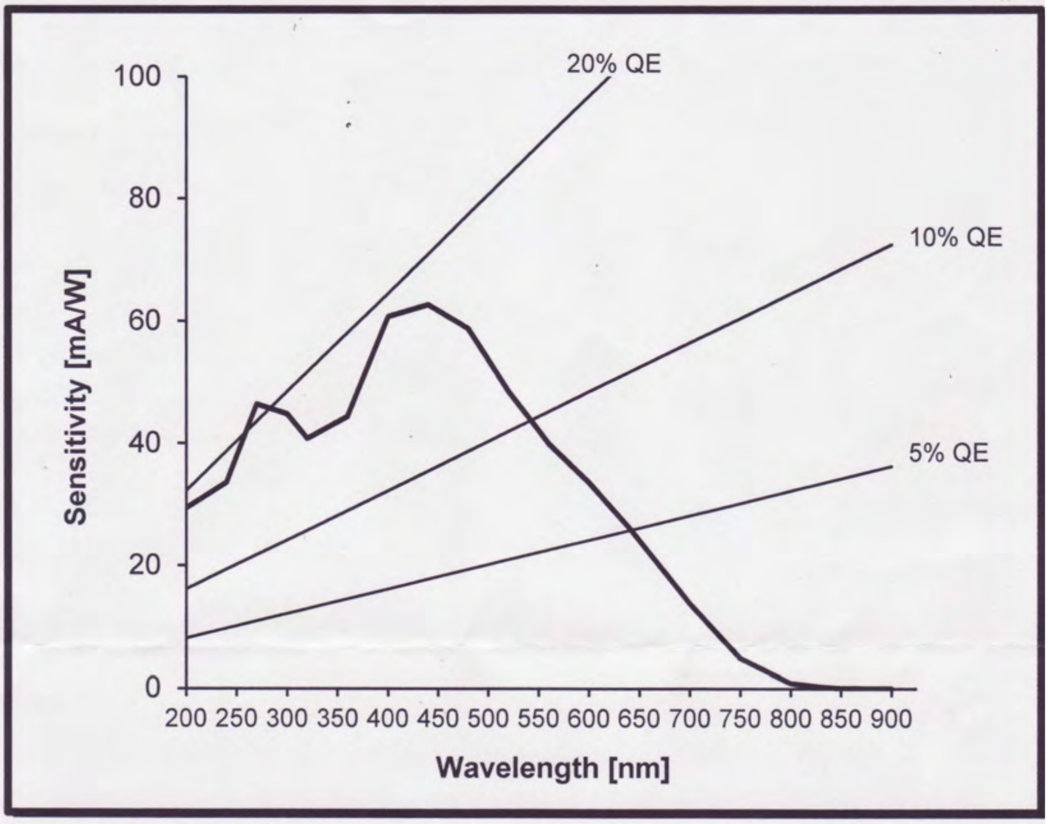
Parameter		Min	Measured	Max	Unit
Radiant sensitivity	270 nm 450 nm 520 nm	25 40 32	See curve		mA/W mA/W mA/W
Luminance gain	5000 cd/m²/lx MCP volt. =		908		V
Resolution		45	55		lp/mm
Equiv. background illumin.			0.01	0.25	µlx
Input useful diameter		17.5	18.0		mm
Iris delay			0.1	0.2	ns
MTF	@2.5 lp/mm @7.5 lp/mm @ 15 lp/mm		92 76 55		% % %
Photocathode gap		150	150	200	µm
Photocathode to MCP-input capacitance			27		pF
Remarks:					tested by

Table 2 Tube data Channel 2/b

Cathode sensitivity

Serial number 2480239

Date 14-5-2013



Wavelength [nm]	Sensitivity [mA/W]	QE [%]
200	29.5	18.3
240	33.7	17.4
270	46.4	21.3
300	44.7	18.5
320	40.8	15.8
360	44.3	15.3
400	60.8	18.8
440	62.7	17.7
480	58.8	15.2
520	48.5	11.6
560	40.0	8.9
600	33.7	7.0
640	26.2	5.1
700	13.8	2.4
750	4.8	0.8
800	0.8	0.1
830	0.3	0.0
850	0.1	0.0
880	0.0	0.0
900	0.0	0.0

PR White	143	µA/lm
PR 800	1	mA/W
PR 850	0	mA/W

Figure 38 Tube response

SAFETY PRECAUTIONS

Normal safety precautions should be observed with regard to electrical shock hazards. Image intensifiers should be installed, used and serviced only by qualified personnel. They must be operated strictly in accordance with the instructions for use below and those supplied with the tubes.

INSTRUCTIONS FOR USE

Failure to observe these instructions will invalidate the guarantee.

A) Storage Conditions
Image intensifier tubes are packed in sealed boxes. Preferably keep them stored in this original packaging under the specified conditions. If the tubes must be unpacked the following conditions apply:

- **Luminance**: Store in darkness
- **Temperature**: Store within the temperature range indicated in the specification
- **Humidity**: Store in a dry atmosphere
- **Helium**: Do not store in an atmosphere containing an excessive amount of helium. Helium will penetrate the glass envelope and will degrade the vacuum

B) Cleaning
The usual detergents and solvents (e.g. water, alcohol, acetone) can be used to clean the envelopes and windows. UV-transmitting glass windows must only be cleaned with alcohol; protect from water and acetone at all times.

C) Mounting
The image intensifier should be mounted such that the axial force is absorbed on the bearing surface and not on the input or output windows. If the image Intensifier is delivered with a coupled CCD, read the specific instructions on the final test sheet carefully to avoid irreversible damage due to electrostatic discharge.

D) Operating conditions

- **Illumination**: Image intensifiers tolerate intermittent burst of photocathode illumination. However - prolonged exposure to any source of bright light can damage the tube. Image intensifiers should not be exposed to direct sunlight.
- **Voltages, Temperatures**: Do not exceed the specified maximum ratings. When the image intensifier is delivered without integral power supply, take precautions to protect the device against switching transients, e.g. by connecting a 10 µF capacitor in series with each supply terminal.
- **Humidity**: Operate in a dry atmosphere (see storage conditions).
- **Helium**: Do not operate in an atmosphere containing an excessive amount of helium.
- **Pressure**: Tubes can be operated in a vacuum, or up to one (1) atmosphere of over-pressure.
- **Window potential**: The potential difference between the input or output windows and any close objects must be kept to a minimum to prevent electrostatic discharge.

WARRANTY

Unless otherwise agreed, the Seller guarantees to the original Buyer to refund the price paid for, or at the Seller's discretion, to repair or replace, those tubes which proved to the Seller's reasonable satisfaction not to conform to the published specifications at the time of receipt by the Buyer or to have failed for any reason of faulty design, material or workmanship for a period of twelve (12) months following the date of shipment.

This guarantee is subject to the following provisions:

a) Claims for damage In transit will be considered only if the Buyer promptly notifies the Seller upon receipt of the tubes.

b) The guarantee shall not extend to failures by reason of defects, which ought reasonably to have been discovered by the Buyer upon inspection and testing of the tubes and were not reported to the Seller within thirty (30) days after such inspection or testing.

c) The Buyer informs the Seller promptly on discovery of any alleged defect and, if and when requested returns the tubes, carriage paid, at the Seller Directs with the full written report of the defect together with the original sheet of the tubes.

d) The tubes have been stored, installed, maintained and used properly, having regarded in particular to the applicable specifications and instructions for use as published by the Seller.

e) The Seller's liability in the case of the tubes or components not of the Seller's manufacture shall in no circumstances extend beyond any corresponding liability to the Seller of the manufacturer of such tubes or components.

All express and implied conditions, warranties and other liability arising under common law or statute are expressly excluded. Save as in this guarantee herein before expressed, the Seller shall be under no liability in contract, tort or otherwise for any personal injury, loss or damage of whatsoever kind, however caused, or for anything done or committed in connection with the tubes or any work in connection therewith.

Figure 39 Tube manufacturer's instructions

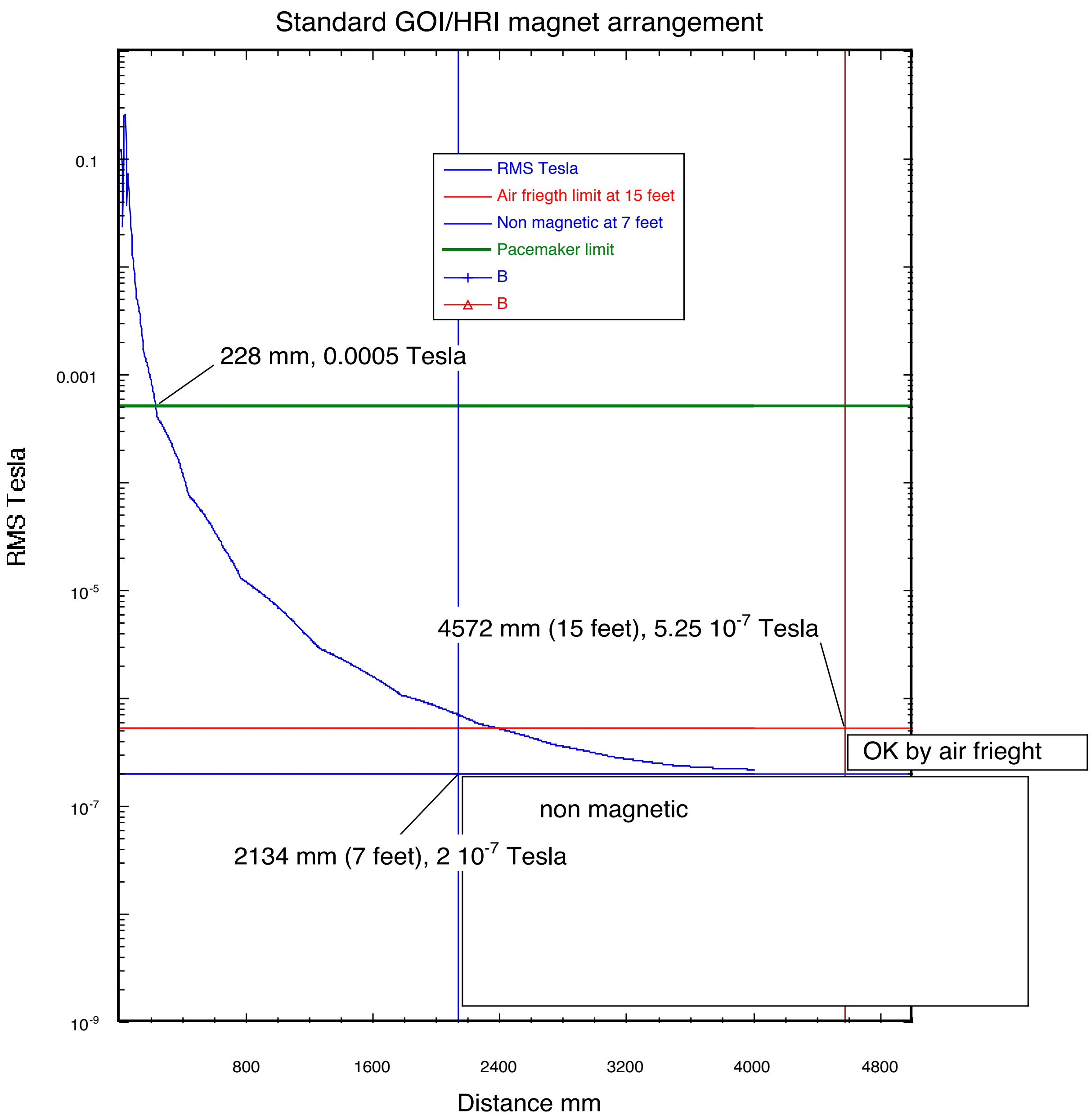
APPENDIX 1 MAGNETIC FIELD COMPUTED DATA AND VARIOUS LIMITS

The standard arrangement is OK by air freight with no additional screening. It must be marked as magnetic etc.

People fitted with pacemakers should not come within 228 mm of the centre of the head.

With suitable screening the “non-magnetic” status is easily achievable.

This data is obtained computationally and is advisory only. Always check actual units in critical situations.



APPENDIX 2 XML RESPONSE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            <element>1</element>
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         <max>1000</max>
      </a_mcp_gain>
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    <min>0</min>
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        <element>1</element>
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        <element>3</element>
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<dp>0</dp>
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<words>

</words>
</response>

APPENDIX 3 JSON RESPONSE

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APPENDIX 4 OPERATION WITHOUT MAGNETS IN THE HEAD

The head can be operated without magnets for applications where the magnetic field causes problems, e.g. near to a streak camera. However, one magnet is also used as a ground connection for the fast gating. It is not possible to simply replace a magnet with a non magnetic blank as the force between them holds them in place and a blank would have no such force.

We have designs for a dummy magnet that has ears to enable fixing it in place. This has not been tested. An alternative would be to use two dummies and drill holes through the slow gate PCBs to enable them to be clamped together. To do this the holes must miss the slow gate drive connection in the PCBs.

Removing the magnets will result in a loss of spatial resolution, particularly at short gates where the gate voltage coupled onto the cathode is small (in spite of the >1kV drive).

The resolution at the fastest gate speed with magnets is likely to be around twice that of without magnets, i.e. 4 times the information in the image.

Should it be necessary to remove the magnets please contact the factory. To do it yourself, you will need the dummy or dummies and instructions. You will also need a suitable container to store the unused magnets.

Removing the magnets is not difficult but must be done with care as the forces between them when they touch is about 30kg and as the force scales like inverse cube, they accelerate together very non linearly.

We can supply a set of suitable tools, alignment rods and jacking screws to remove the magnets.

Alternatively we will remove the magnets if the unit is returned to us, only the head is needed.

Do not attempt to remove the magnets without the relevant jacking screws and guides as there is a real risk of damage to both the intensifier and one's fingers.