Kentech Instruments Ltd.
Gated Optical Intensifier
Non Magnetic option

J20*****

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PLEASE READ THIS MANUAL CAREFULLY BEFORE USING THE units

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1 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.

2 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 and with the two EMC clamps supplied fitted to the two ends of the umbilical.

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.

3 ABBREVIATIONS

ASCII	American Standard Code for Information Interchange
ADC or adc	Analogue to Digital Convertor
AF	Accross 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
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

4 INTRODUCTION

This manual describes the operation and use of a single channel gated optical intensifier. The intensifier can be gated over the range ~70ps to DC, over an 18mm diameter cathode aperture. .

The image intensifier 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 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).

5 SPECIFICATIONS OF THE SYSTEM

Number of frames	1	
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) voltage	Minimum 260V	
	Maximum as per manufacturers data sheet supplied	
	Adjustable in 1V steps	
Phosphor voltage	Approximately +6kV relative to MCP out.	
Gating times	<100, 100, 150, 200 and 250ps in FAST mode	
	500ps to 9 ns in 100ps steps in MEDIUM mode	
	100ns to 1ms in 1ns steps in SLOW mode	
Spatial resolution	10 1pmm^{-1} typically	
Power requirements	110/240 VAC <100W.	
PRF	100Hz.	
Trigger delay		
Fast mode	speed 0	54ns
Medium mode	speed 3	65ns
Slow mode		104ns
	Jitter SD	<20ps , typical figures <4ps
Trigger requirements	5V into 50Ω with <5ns rise.	
Length of umbilical	nominally 3m	

6 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.

6.1 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

6.2 SLOW MODES

The gating pulse is conventionally driven by a suitable pulse applied directly to the cathode.

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.

7 POWER SUPPLY

The electronic package which drives the intensifier 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 is 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.

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 in ?1V steps to adjust the intensifier gain

In the 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 cannot 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 ?10ns to 10μs, 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 ?100, 100, 150, 200 and 250 ps. 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.

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 5 on page 6.

8 CONNECTIONS AND MECHANICS

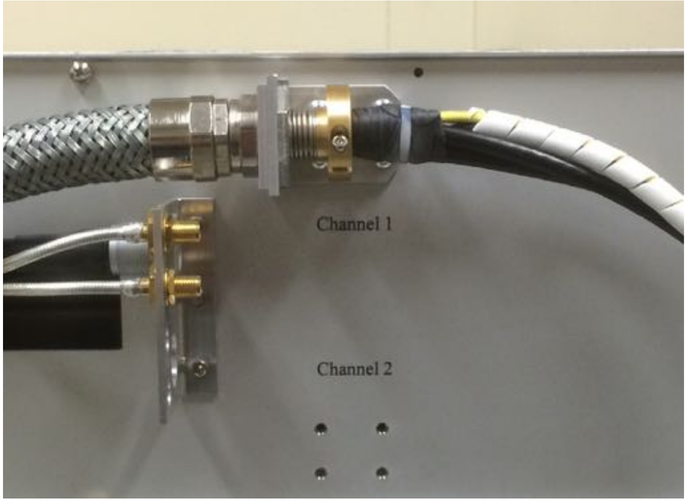
The unit is supplied with the detection head disconnected from the control unit.

This needs to be connected before use.

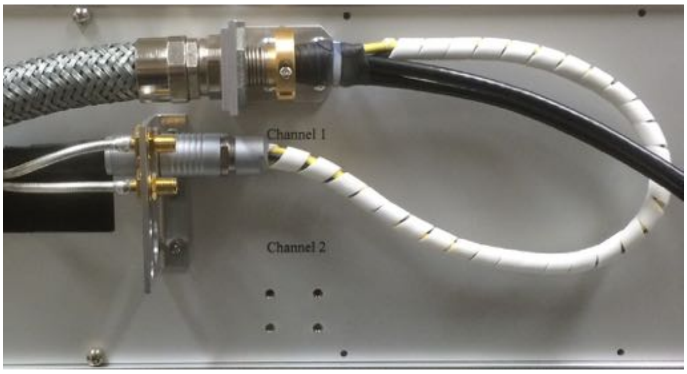
8.1 ATTACHING THE HEAD TO THE CONTROL UNIT

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. 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.



4. 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.



5. Attach the two SMA connectors. They can fit either jack on the bracket. 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.

6. Refit the plastic cover.

8.2 THE HEAD

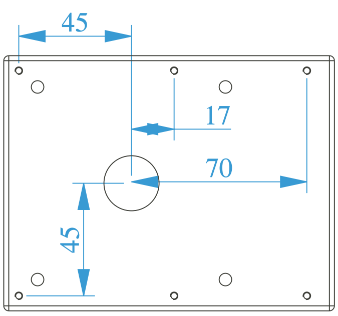
The head contains the intensifier which is fragile, mechanically, electrically and optically. Appropriate care must be taken. See section Figure 2 on page 10 for safety considerations.

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

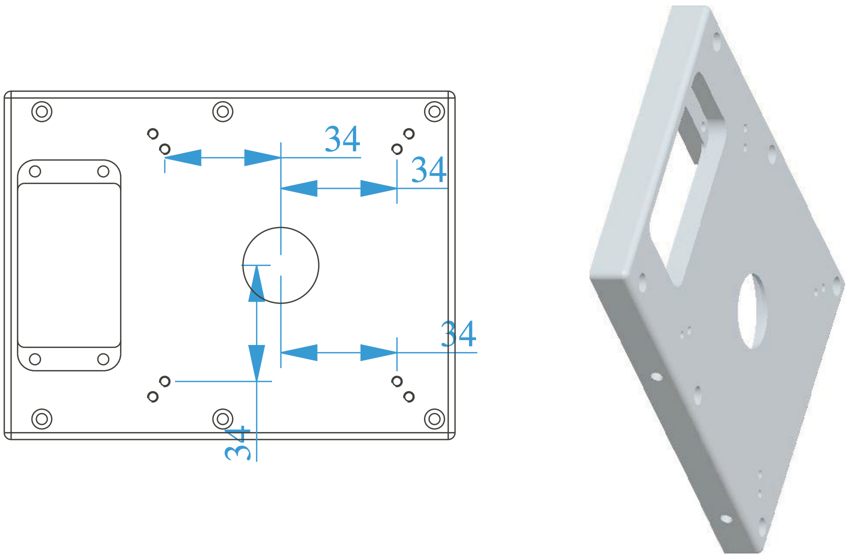
8.3 ATTACHING EQUIPMENT TO THE HEAD

If it is necessary to attach equipment to the head several screw holes can be used.

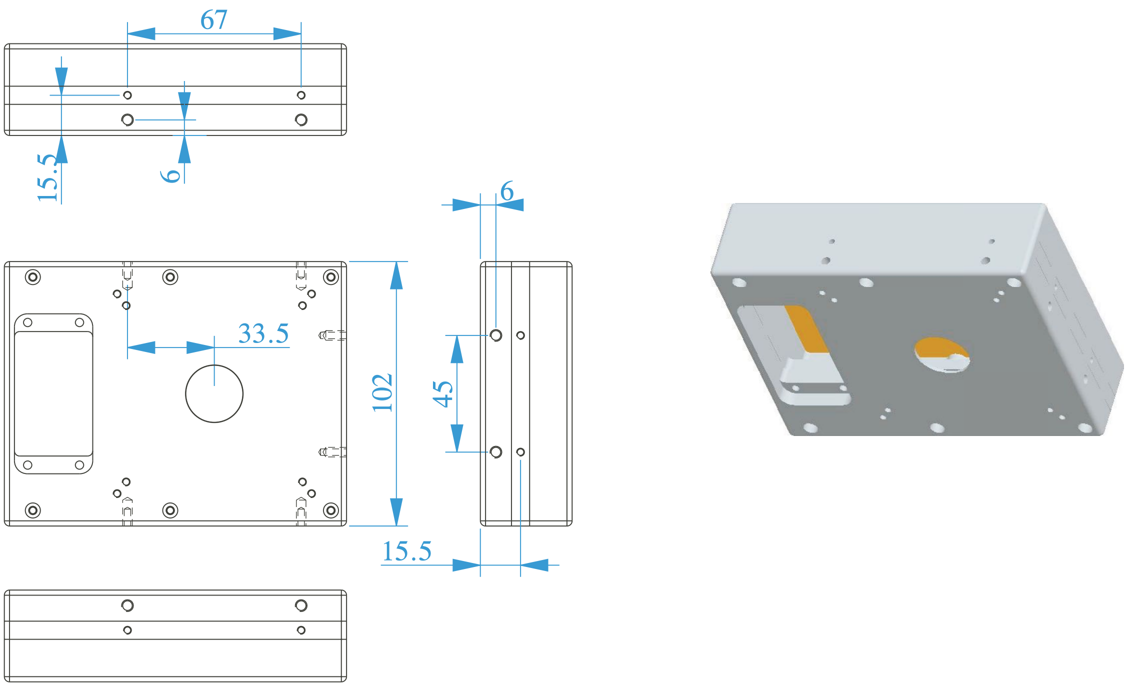
On the front face are 6 M3 tapped holes at positions shown above. Screws may only protrude into the head by 9 mm into these holes.



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.



8.4 POWERING UP THE SYSTEM

Applying power and switching on the control unit will not turn on the intensifier. The intensifier can be turned on though the front panel LCD display and navigation buttons or under software control via either the RS232 connection at the rear panel or the Ethernet connection at the front panel.

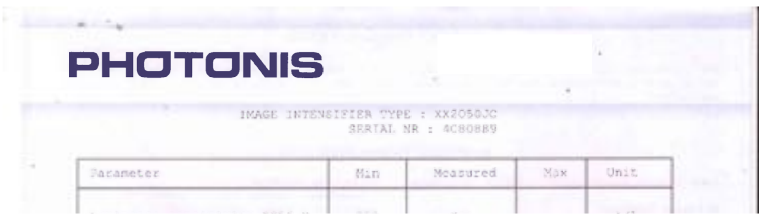


Figure 2 The front panel with BNC link through lead fitted.

Use the supplied BNC to BNC lead to connect the front panel socket labelled “Output ~500V into 50Ω ~1ns pulse” to the socket labelled “Trigger input ~500V into 50Ω ~1ns pulse”.

These connections are linked when a single channel is in use. If multiple channels are in use and a multi channel trigger unit is available, then the trigger unit connects directly to the high level trigger input instead of the short BNC cable. This enable multiple channels to be used with very low relative timing jitter.

Read section 11 on page 15 about how to control the system.

Before the intensifier is powered up, the photocathode input should be shielded from any ambient light. A large signal on the 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 the 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 about 10 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 10μs and apply gate pulses to the trigger input at the rate of one or two 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.

The imager is most conveniently characterised by the use of a laser diode pulser. The cathode will respond to 840nm or shorter wavelength light. 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 with a well coupled scientific CCD camera.

9 OPERATIONAL NOTES

9.1 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 5 on page 6. 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.

9.2 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.

10 TESTS

10.1 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 500V. Activate the DC mode and gradually turn up the lamp until a dim image is seen. Then turn up the gain in 10V steps until a relatively bright image of the resolution mask is present on the output. Note that the DC mode only remain 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.

10.2 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.

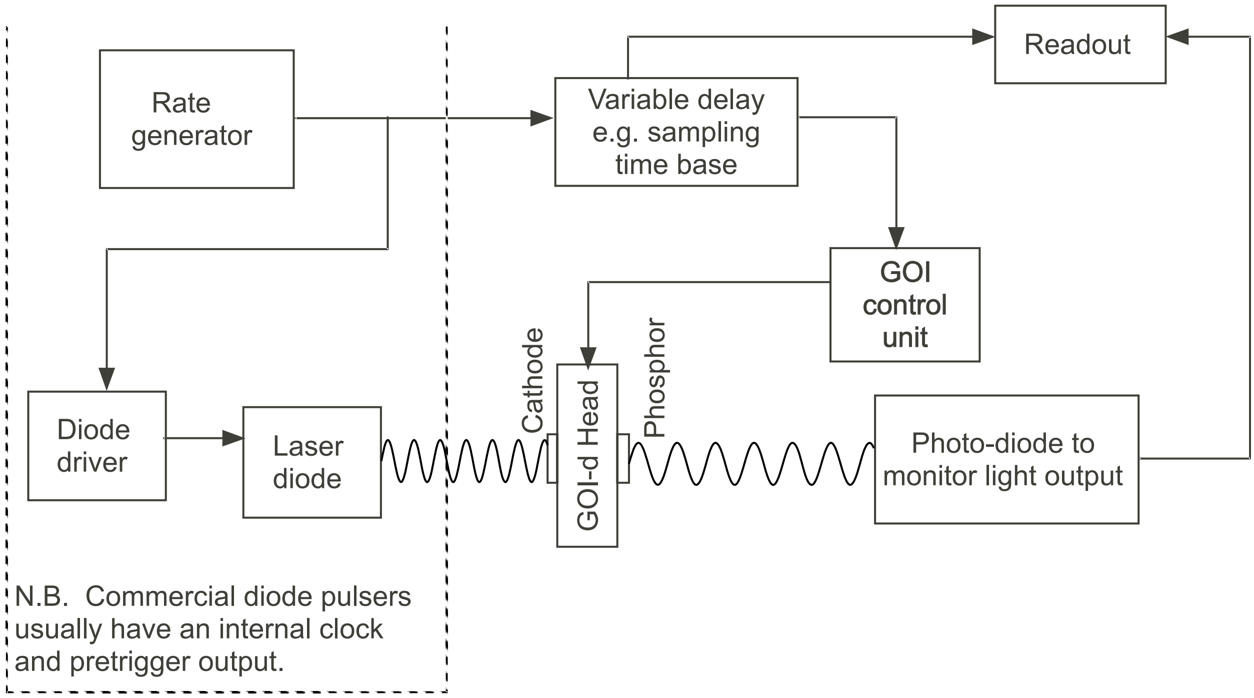


Figure 1 Set up for testing the gating.

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 500V. Activate the DC mode and turn up the source brightness until a dim image is seen. Increase the MCP voltage in 10V steps 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.

11 GOI SOFTWARE INTERFACE

11.1 REVISIONS

0.0 21 Jan 2015

11.2 INTRODUCTION

The GOI has both an Ethernet and RS232 serial interfaces as well as a front panel mounted LCD/ keypad.

The instrument can be controlled or monitored from any of these interfaces .

The commands via the the ethernet and the RS232 ports are the same. The active serial port is determined by which first receives a character after power up.

The LCD/keypad allows the user to control or monitor the instrument locally by displaying and editing the system variables.

It is not recommended to control the GOI from the front panel and the serial port simultaneously. For remote control via the serial port the LCD may be used as a local monitor and debugging aid for the control software. For local control by the keypad, the serial port may be used as a remote monitor.

11.3 SYSTEM VARIABLES

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

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

There is an additional set of variables which may be recognised or have values returned by some commands but which are ignored in this instrument. These words are intended to control a second channel which is not fitted.

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

11.4 GOI MODES

The GOI has 4 primary operating modes, INHIBIT, FAST, SLOW and DC.

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

0 = Inhibit
1 = Fast
2 = Slow
3= DC

The current operating mode can be determined by reading b_goi_mode.

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

The mode is also indicated by the front panel LEDs,

11.4.1 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.

11.4.2 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 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.

11.4.3 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 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.

11.4.4 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 b_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 b_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.

11.5 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 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.

11.6 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 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.

11.7 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 b_status

0 = normal
non zero = self test fail

11.8 DEFAULT SETTINGS

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

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

11.9 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 Figure 2 on page 10.

11.10 RS232 INTERFACE

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

11.10.1 THE PROTOCOL

The GOI uses a protocol that is very similar to the GXD. 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.

In the interest of simplicity all commands are parsed by the GOI using the Forth interpreter, so the 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:-

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.

11.11 COMMANDS

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

Note: *r1 = 0 - no fault*

r1 = 1 - stack fault

r1 = 2 - total voltage fault

r1 = 3 - stack and total voltage fault.

Name **b@all**

Explanation read all variables

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

Name **@aipbytes**

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 GOI in inhibit mode

Format **safe**

Parameters none

Returned values none

11.12 EXAMPLE COMMS

11.12.1 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 }

11.12.2 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}

Checked the GOI passed the self test.....

b@tst

{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

{3 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

{3 b!dc}

Etc.

11.12.3 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 }

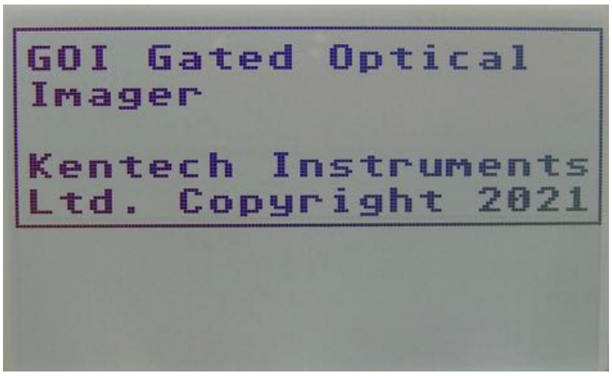
Now apply a trigger signal, and check triggered flag again...
b@tr

{b@tr;1}

Success

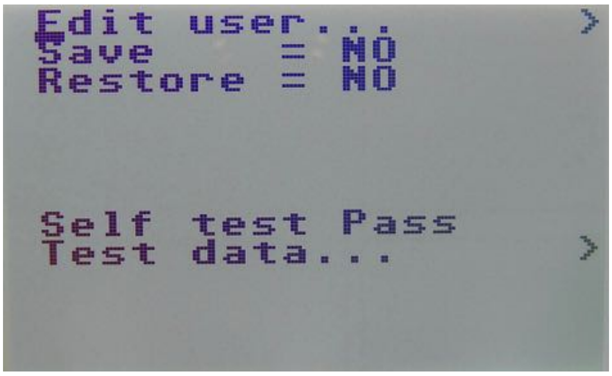
11.13 FUNCTION OF THE LCD/KEYPAD

On power up the LCD displays the startup banner for a few seconds



Then the LCD will change to the menu page

11.13.1 THE MENU PAGE



The motion of the cursor on the screen is controlled by the up/down/left/right buttons.

From the starting position under “Edit”, pressing RIGHT will take you to the USER page to control or monitor the instrument via the system variables, see section 11.13.2 on page 28

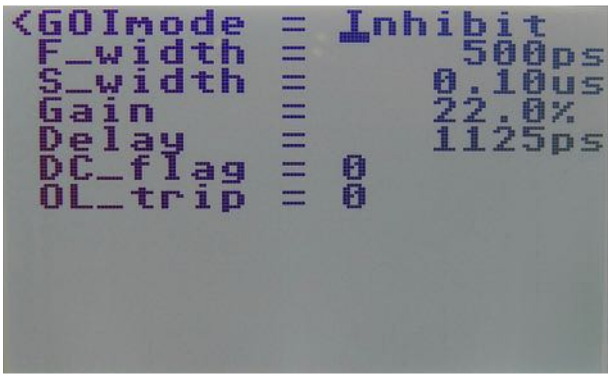
Alternatively pressing down will put the cursor under “Save” on the second line. To save the current state of the system variables, press RIGHT to move the cursor under NO, then UP/DOWN to edit NO to YES, then press LEFT to save the system variables to EEPROM.

Similarly on the third line you can restore the state of the system variables from the values stored in EEPROM.

Towards the bottom of the screen is a display of the self test status. The test is executed at power up and after system reset and the result is displayed here.

If the self test has failed you should take a photograph of the test data which can be accessed on the bottom line and contact Kentech for further advice.

11.13.2 THE USER PAGE



The USER page allows you to control the instrument locally or to monitor locally the remote control.

On line 1 by use of the RIGHT/LEFT/UP/DOWN cursor buttons you can select the GOI mode, see section 11.4 on page 15

On line 2 you can set the fast mode gate width, see section 11.4.2 on page 16

On line 3 you can edit the slow gate width (see 11.4.3)

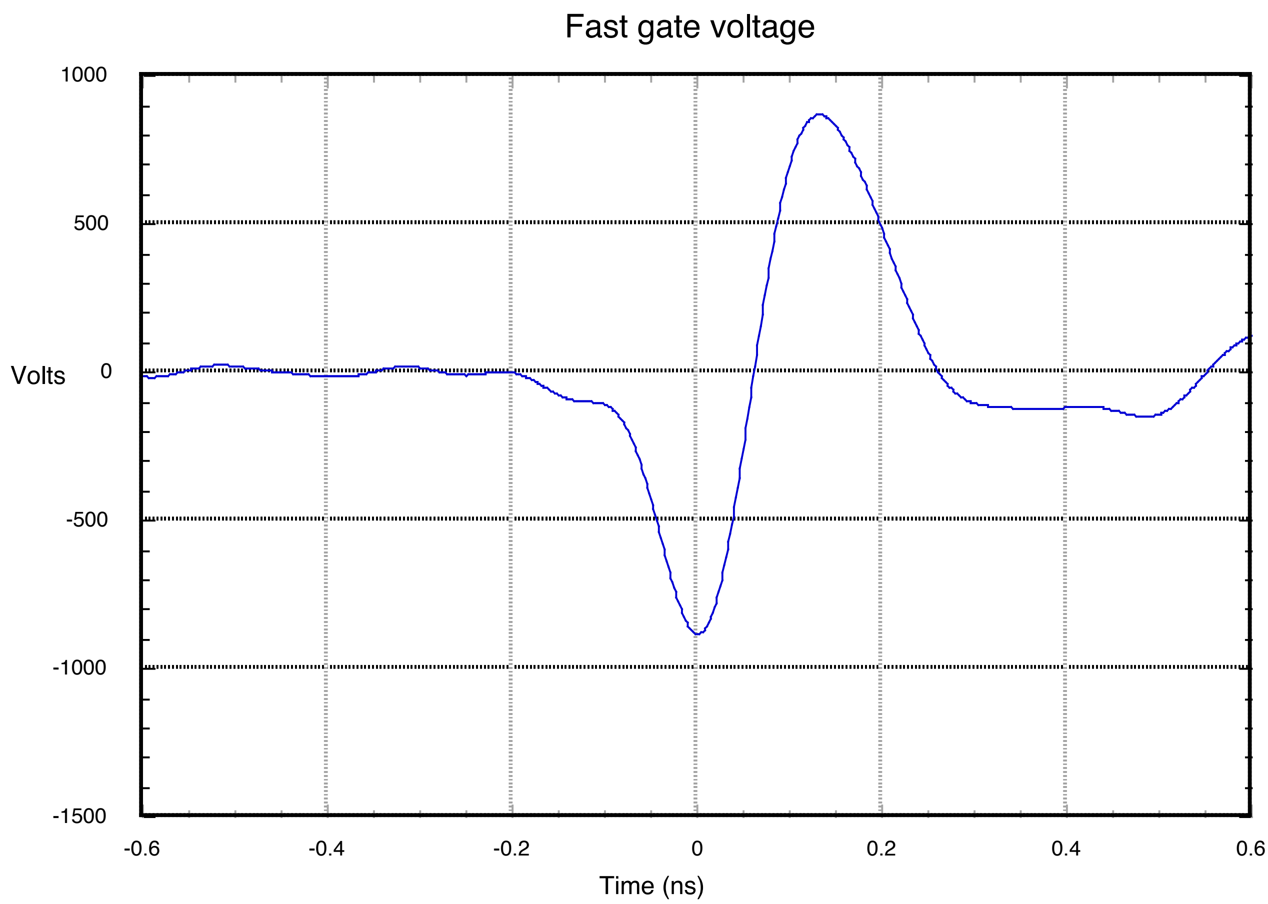
You can set MCP gain and trigger delay on lines 4 and 5 respectively.

With the GOI in DC mode, to get a DC image you have to set the DC_ON flag (see section 11.4.4). This can be done on line 6. Note that if you set the flag it will be automatically reset after a few seconds.

If there is a high level of phosphor current this will trip the overload latch as described in section 11.6. This trip is shown and can be reset on line 7.

If you edit the system variables, you can save them on the menu page as described earlier, and you can restore them again after the power is cycled. All changes not save like this are volatile, they will be lost if the power is cycled. After reset or power up the default settings are used, see section 11.8.

12 ELECTRICAL WAVE FORMS



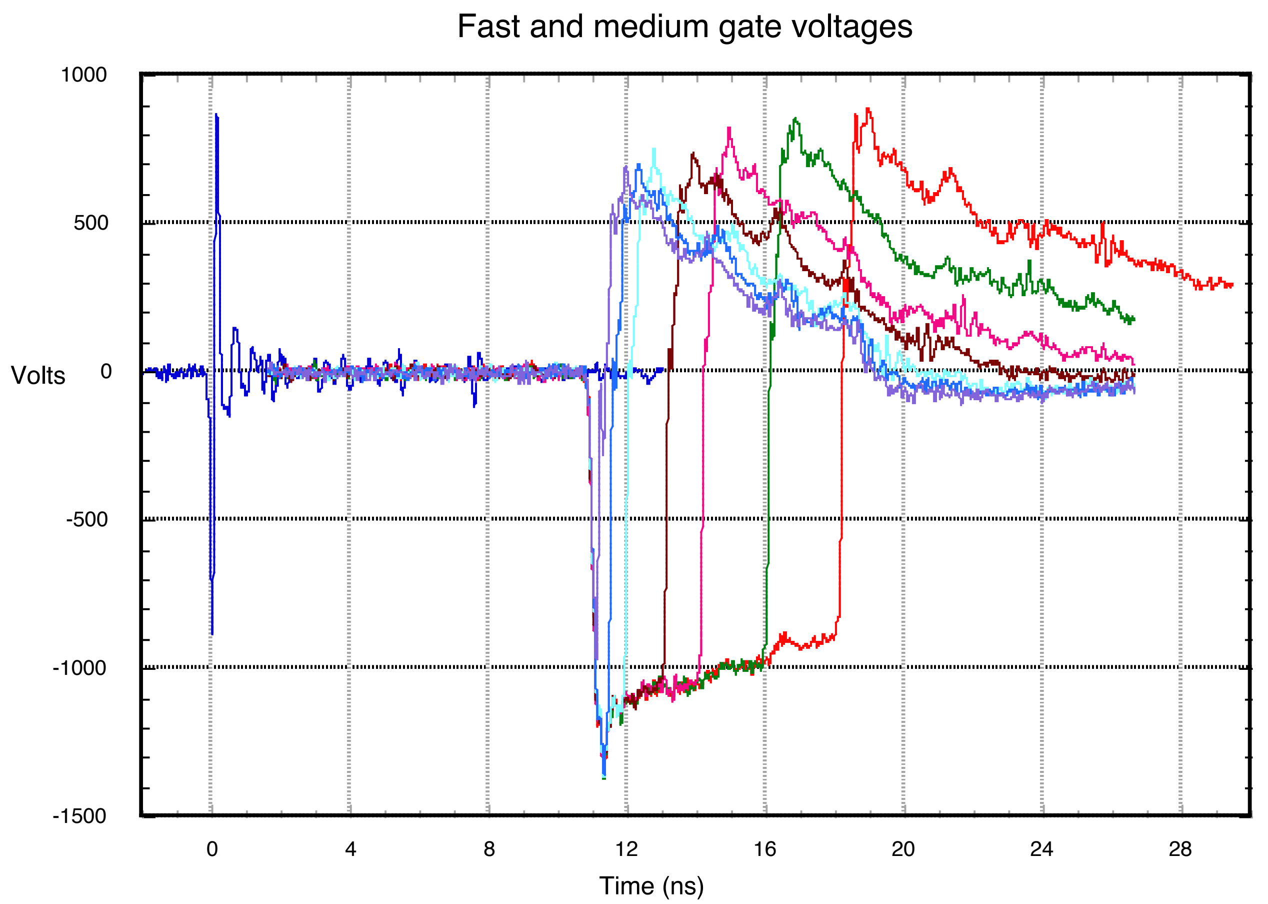
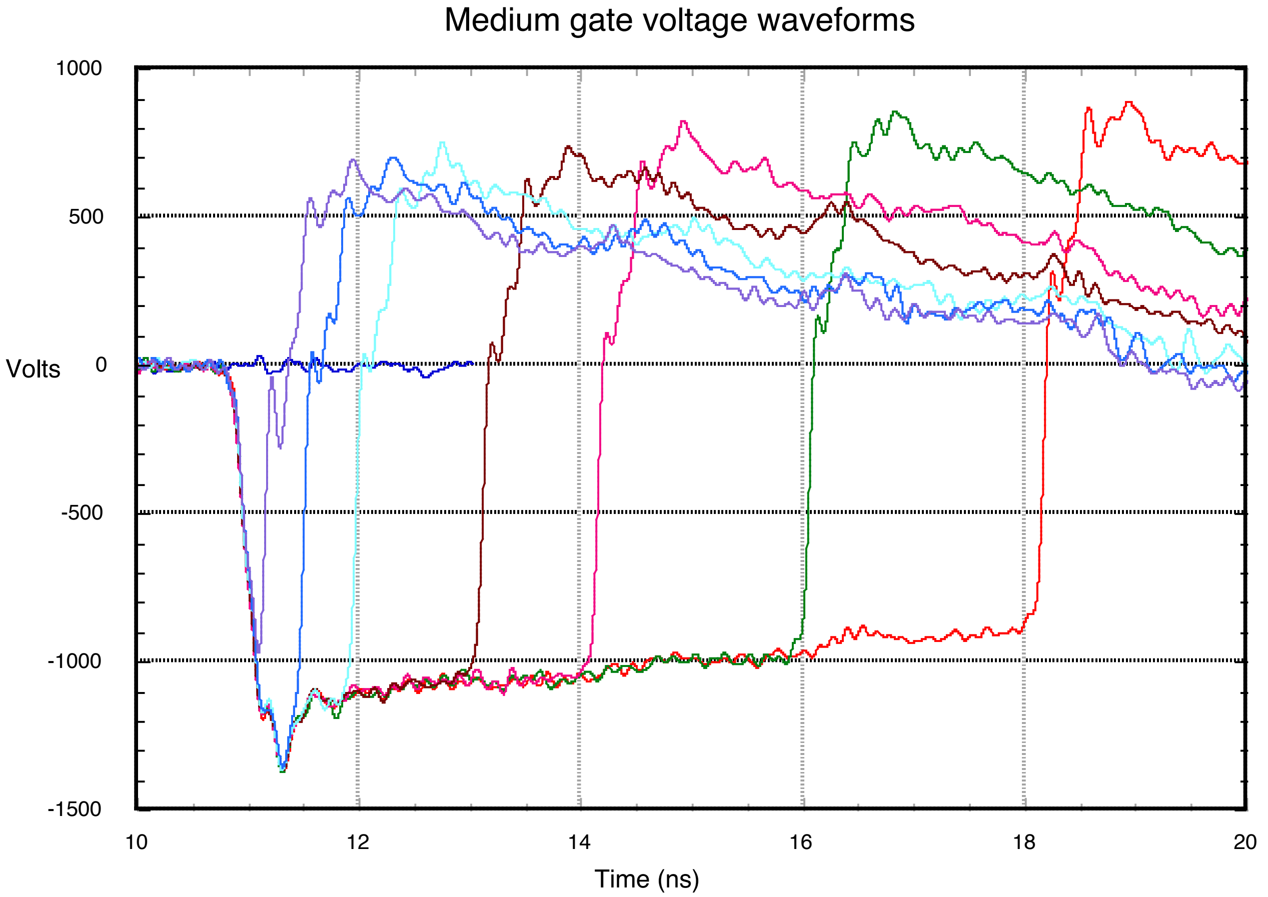


Figure 3 Fast and medium gate waveforms
Showing relative timing



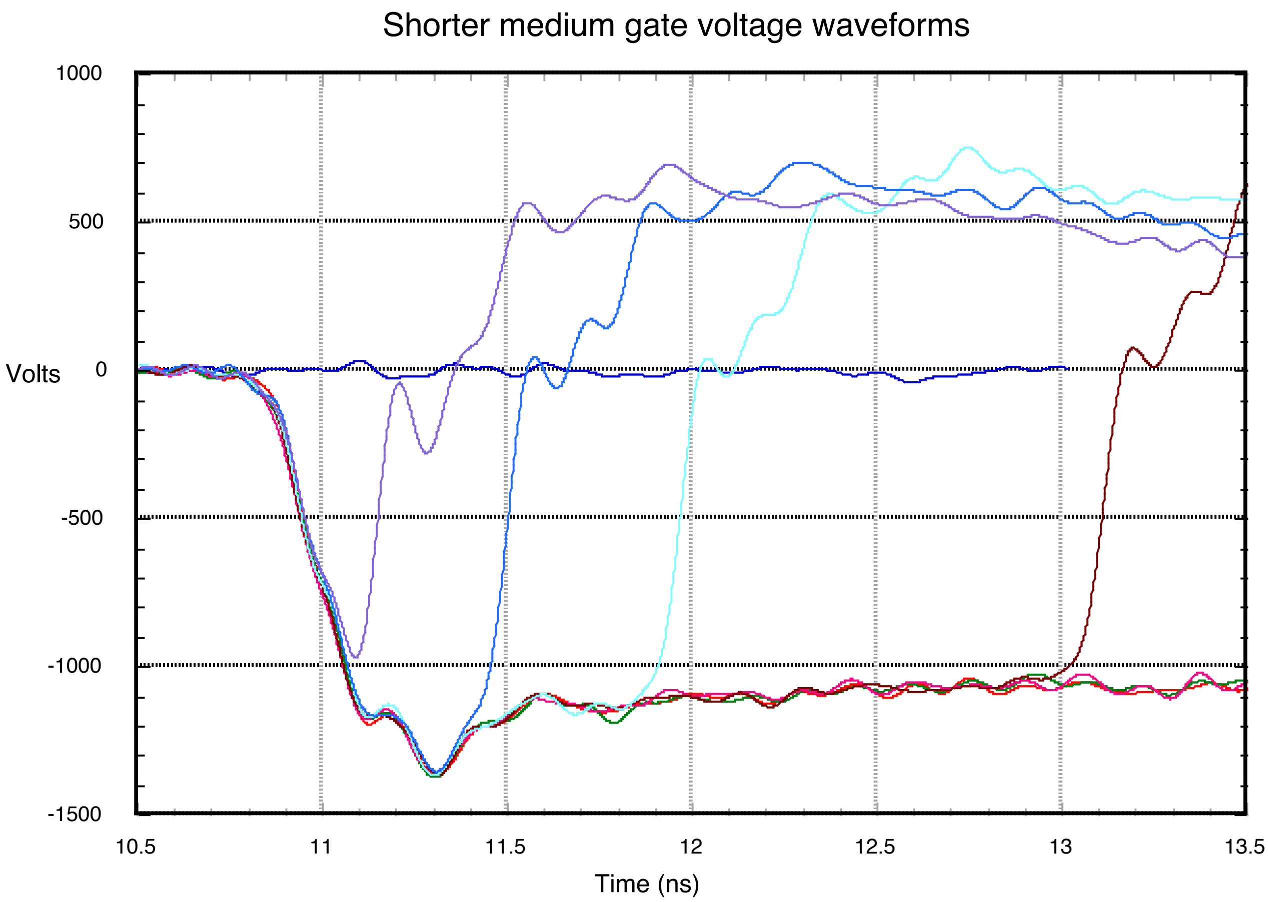


Figure 4 Medium gate waveforms
showing relative timing of the edges.

13 OPTICAL GATE WAVEFORMS

Made with a 60ps laser diode.

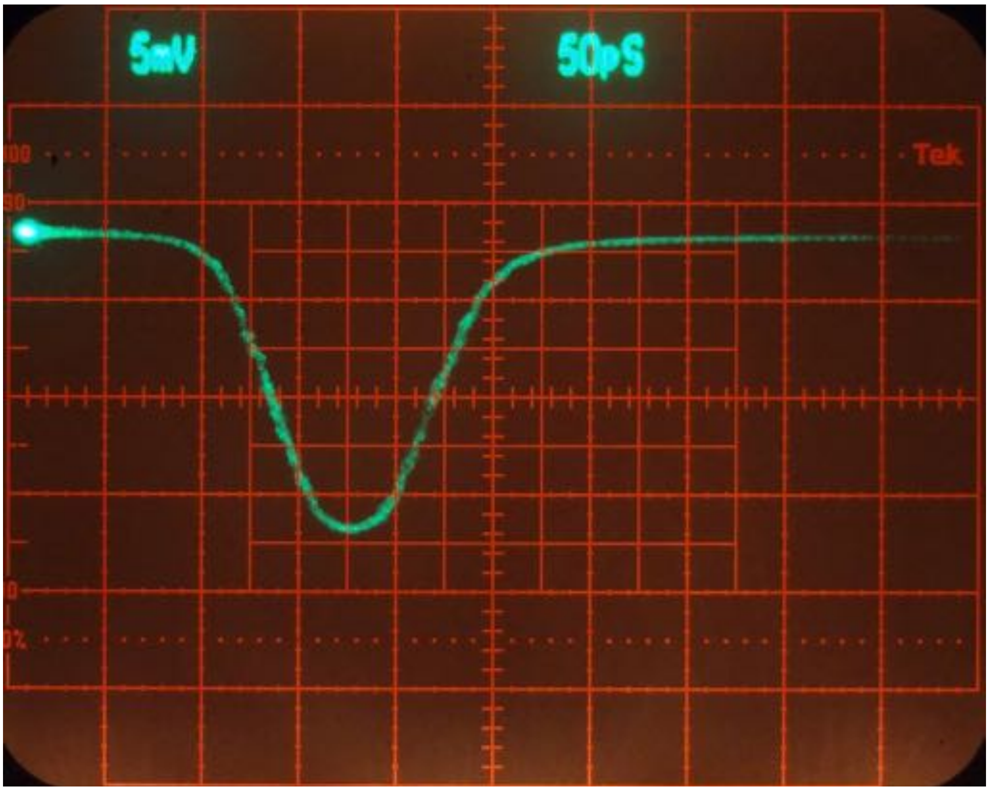


Figure 5 Speed 0 Time right to left

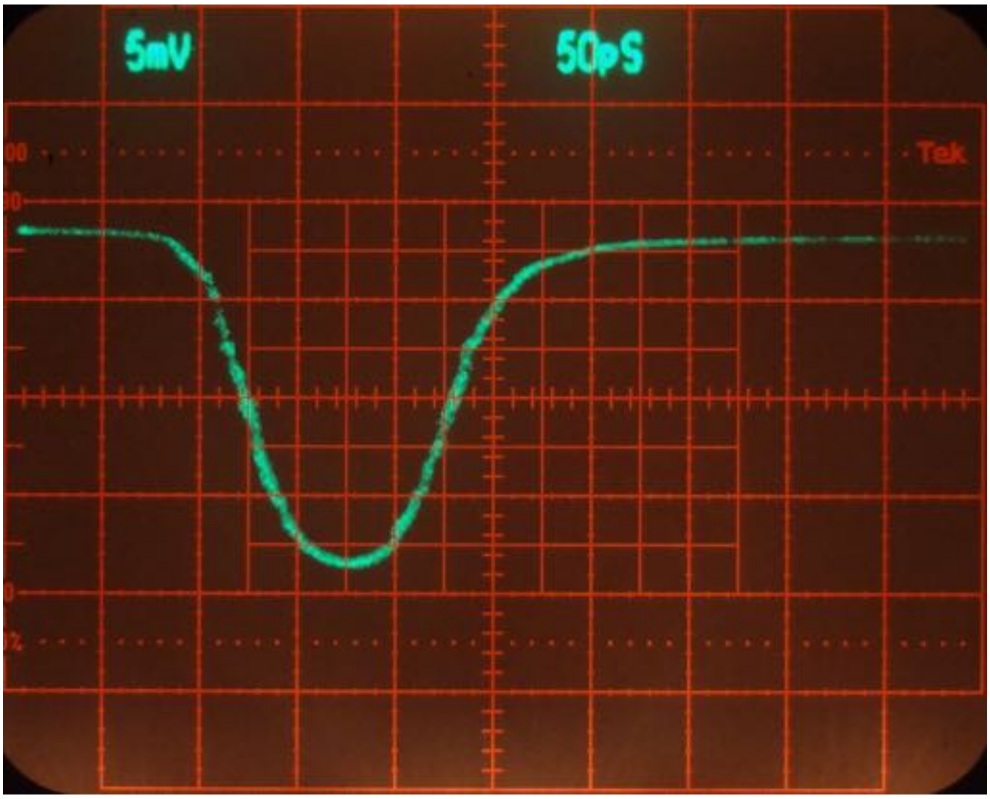


Figure 6 Speed 1 Time right to left

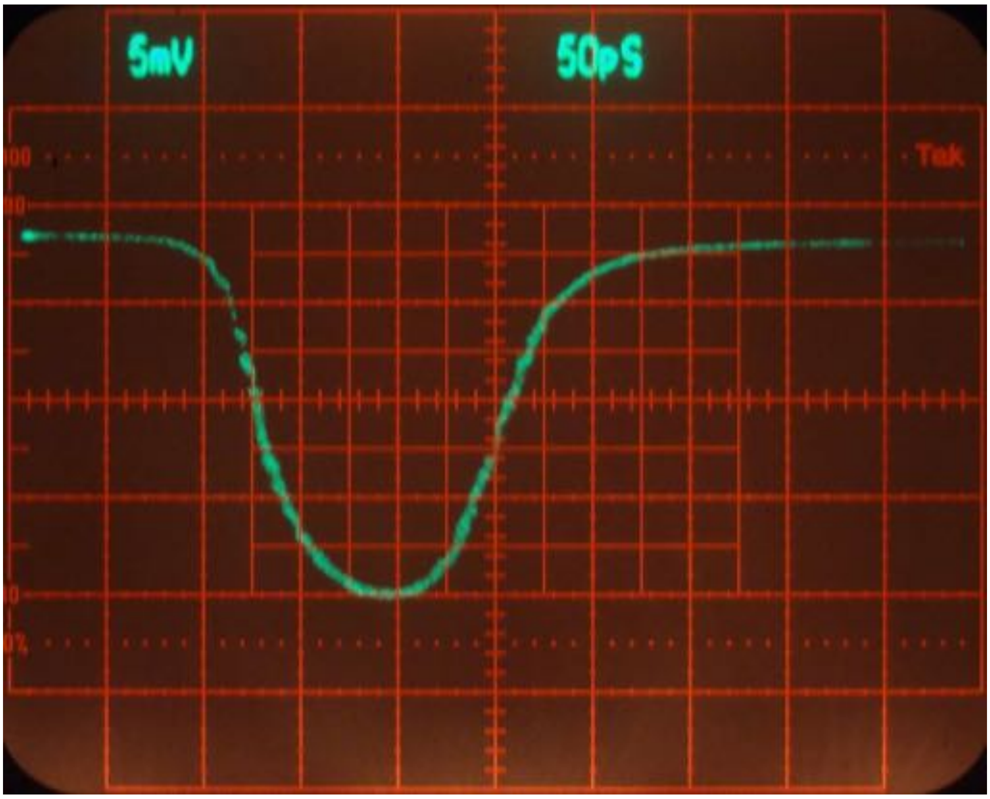


Figure 7 Speed 2 Time right to left

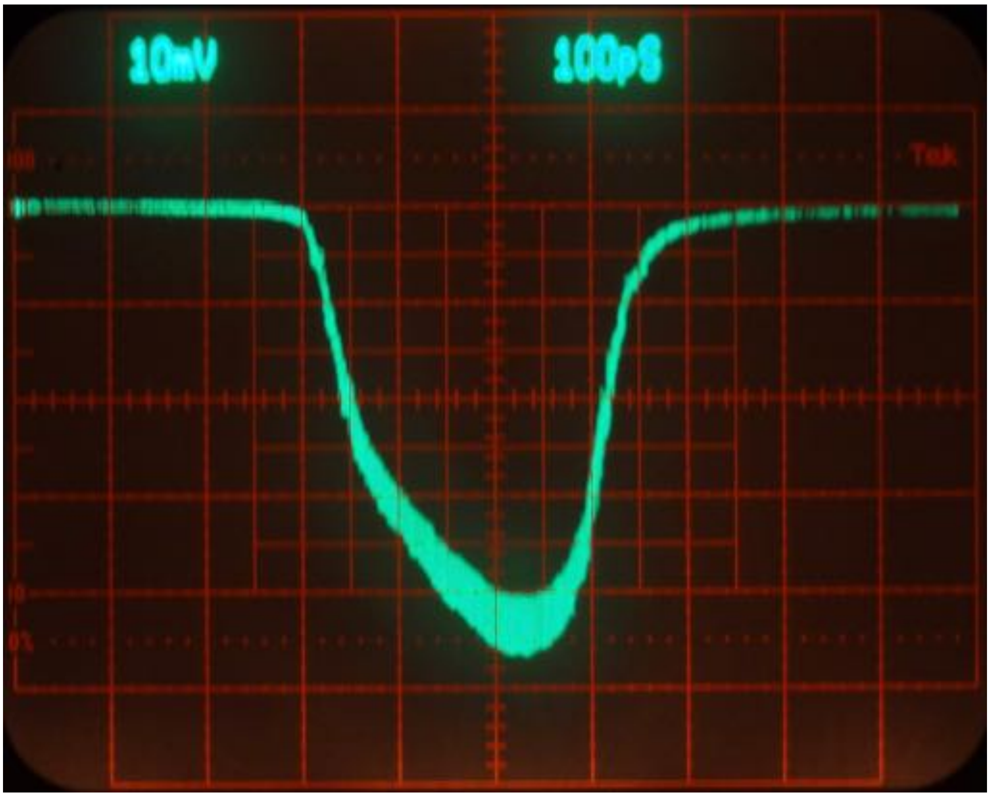


Figure 8 Speed 3 Time right to left

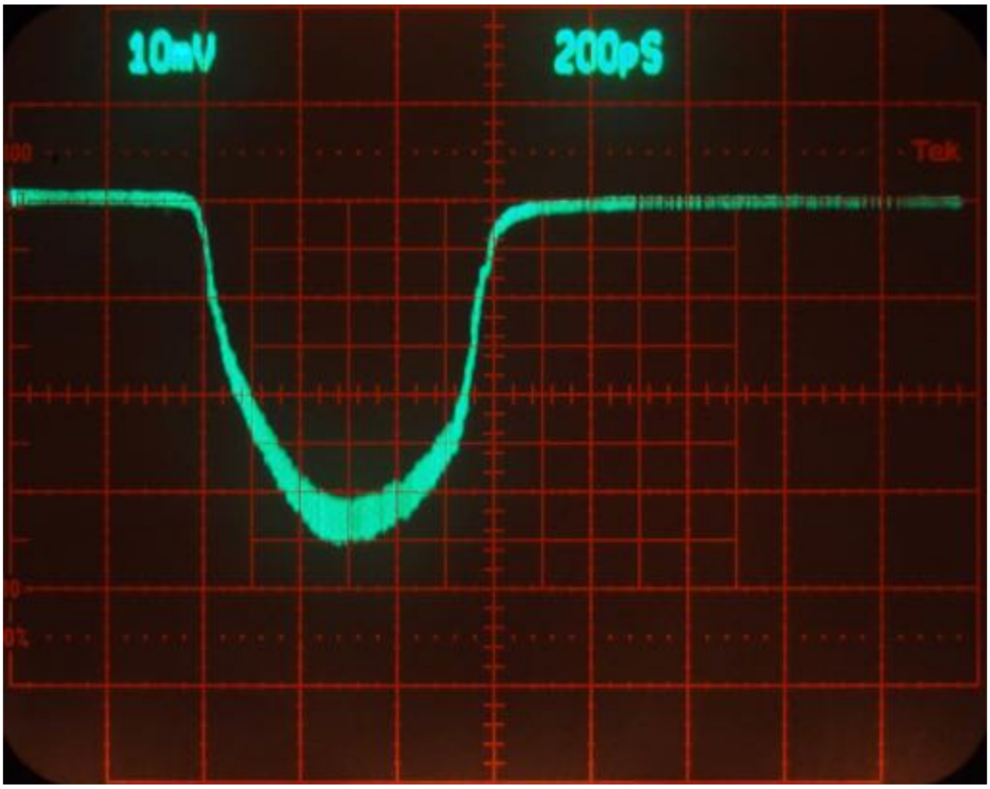


Figure 9 Speed 4 Time right to left

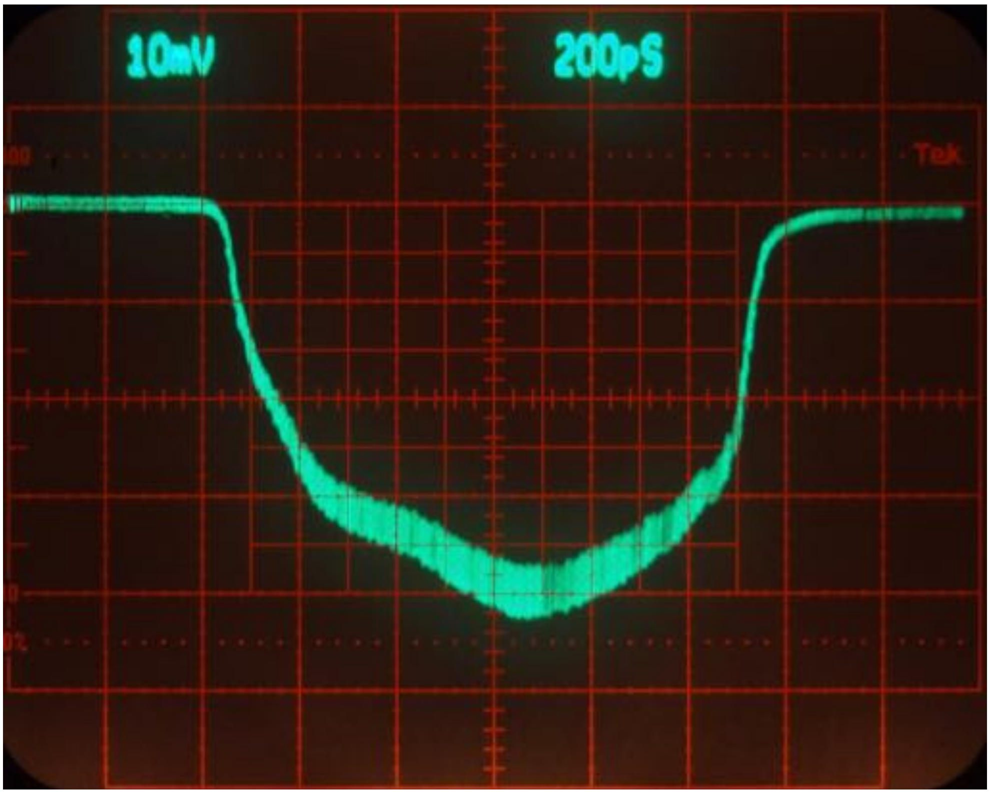


Figure 10 Speed 5 Time right to left

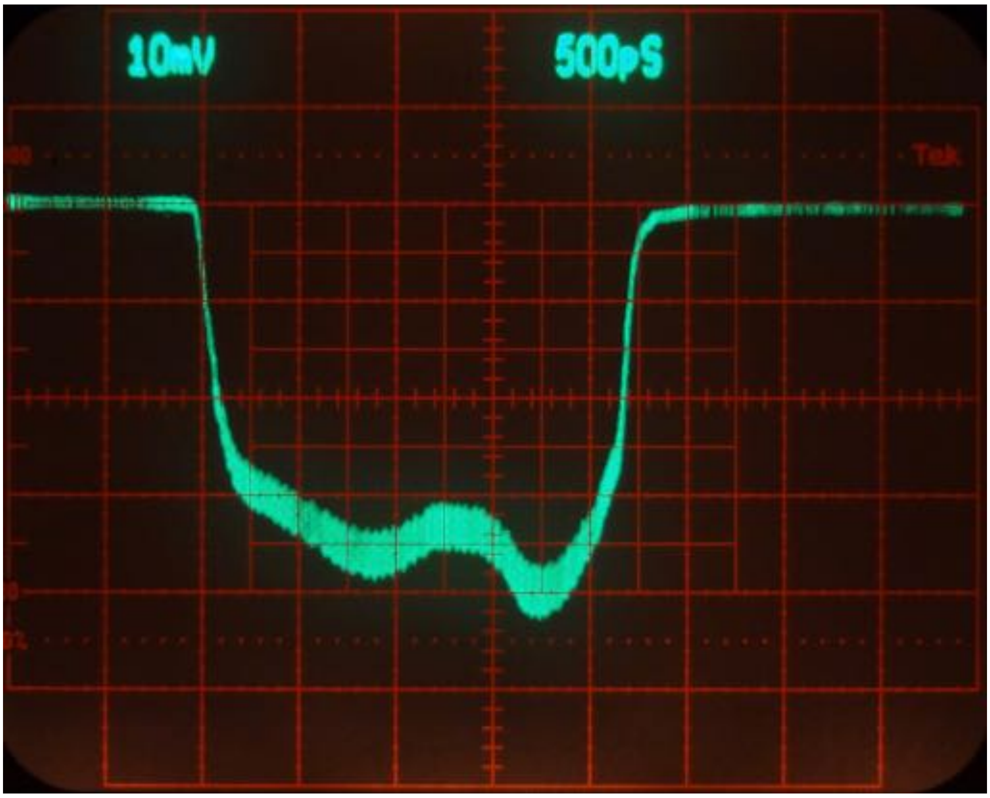


Figure 11 Speed 6 Time right to left

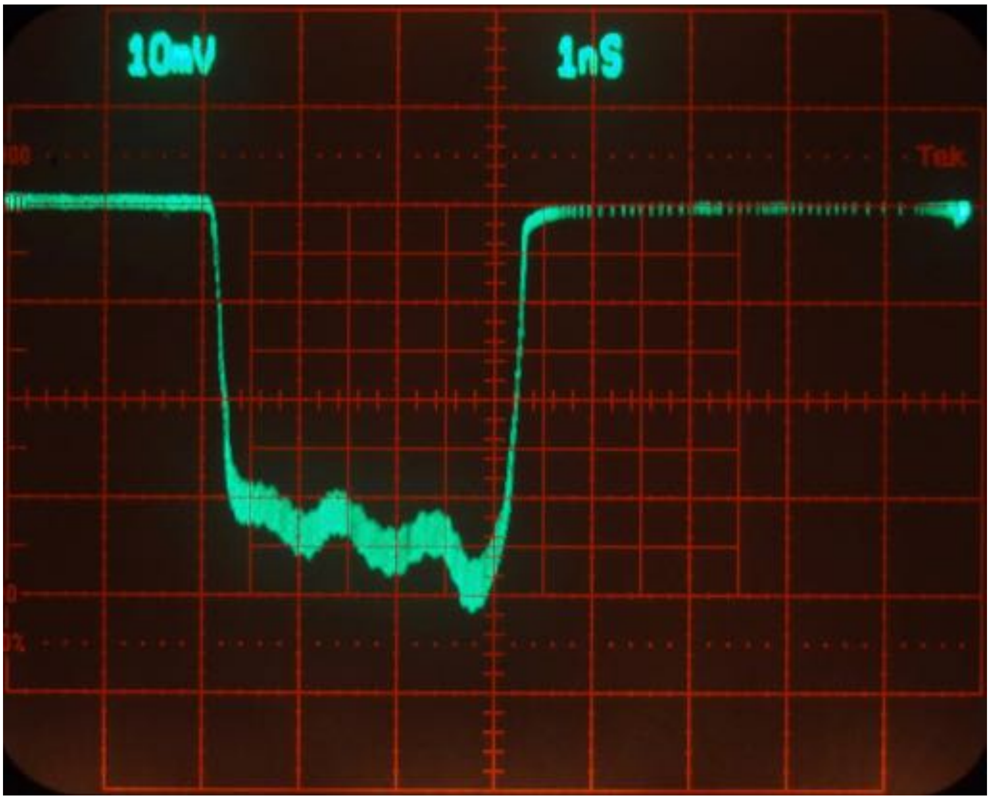


Figure 12 Speed 7 Time right to left

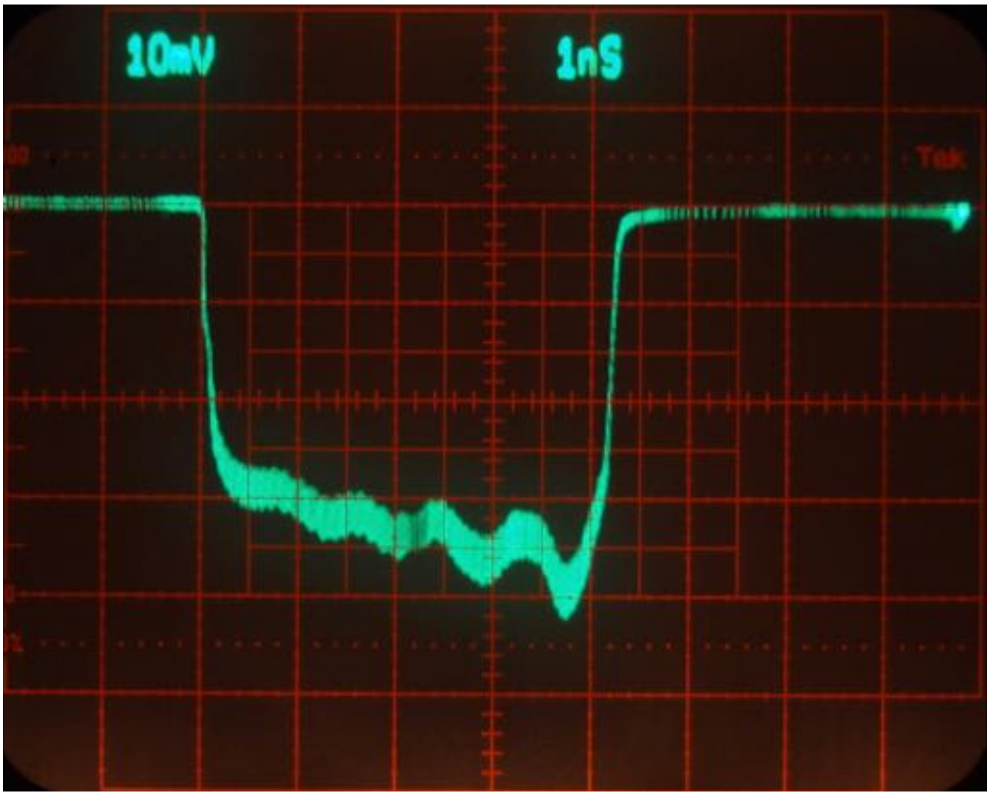


Figure 13 Speed 8 Time right to left

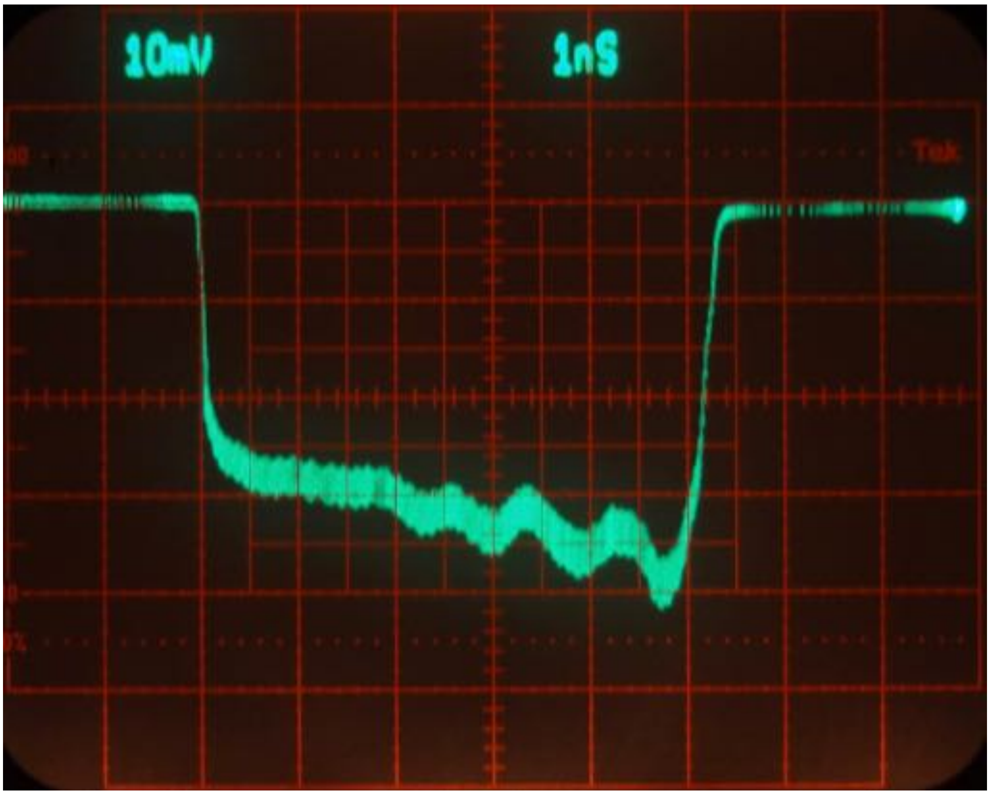


Figure 14 Speed 9 Time right to left

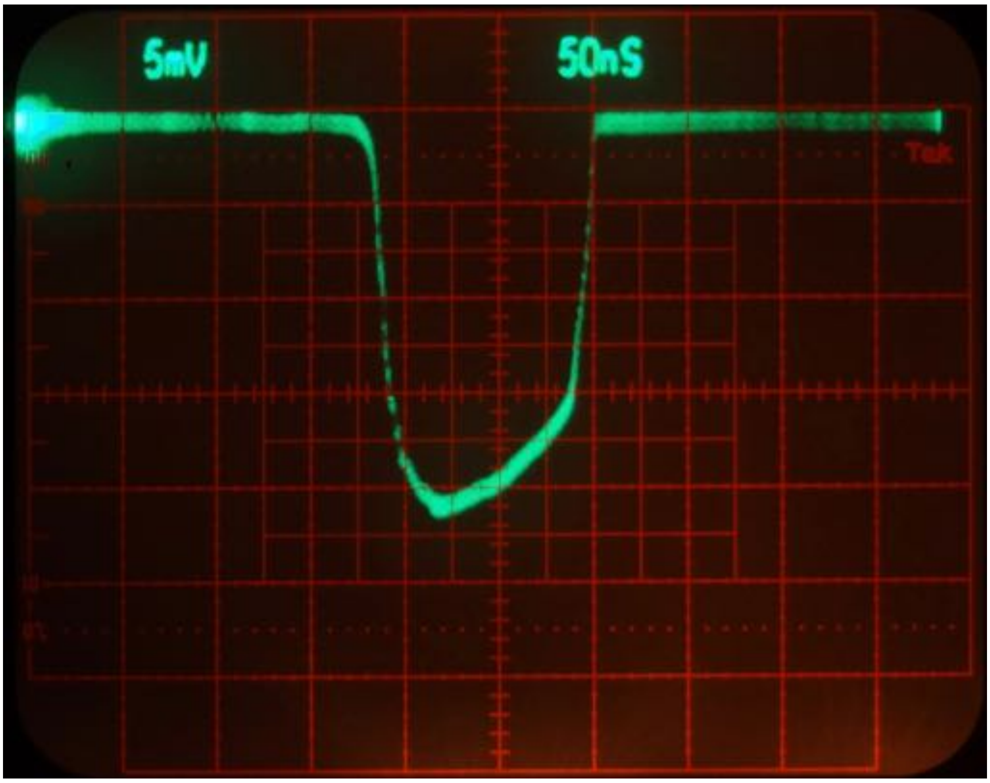


Figure 15 Slow gate Time left to right

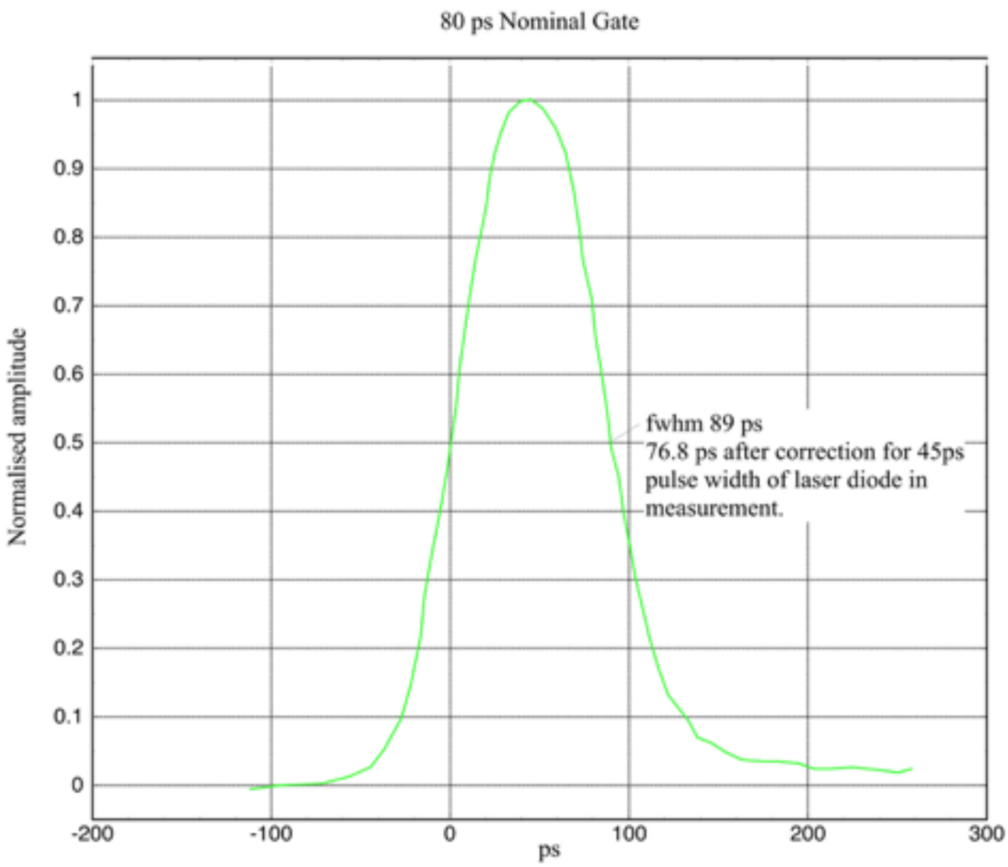


Figure 16 Shortest gate - digitised and normalised
Time left to right The pre-cursor is due to the sampling laser diode not turning fully off at the end of its pulse.

14 TUBE DATA

PHOTONIS

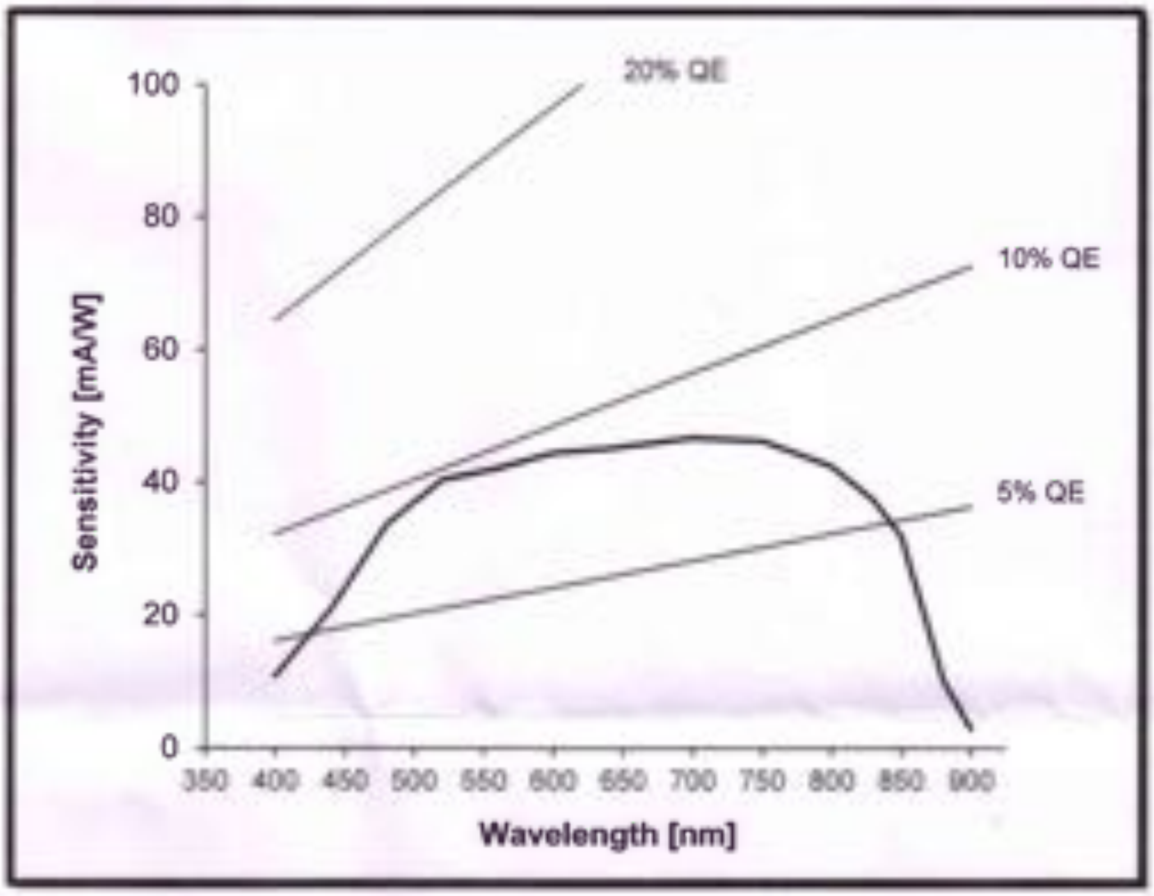
IMAGE INTENSIFIER TYPE : XX2050JC
SERIAL NR : 4080889

Parameter	Min	Measured	Max	Unit
Luminance sensitivity 2856 K	350	See curve		µA/lm
Radiant sensitivity 400 nm	9			mA/W
830 nm	30			mA/W
Luminance gain= 5000 cd/m²/lx MCP volt. =		804		V
Max. MCP voltage		855		V
Resolution center	50	58		lp/mm
peripheral		58		lp/mm
Equiv. background illumin.		0.14	0.25	µlx
Input useful diameter	17.0	>17.0		mm
Iris delay		0.1	0.2	ns
MTF @2.5 lp/mm				%
@7.5 lp/mm				%
@ 15 lp/mm				%
Photocathode gap	150	150	200	µm
Photocathode to MCP-input capacitance		25		pF
Remarks:				tested by

Table 1 Tube data

Cathode sensitivity

Serial number
4080889



Wavelength [nm]	Sensitivity [mA/W]	QE [%]
400	10.8	3.3
440	21.0	5.9
480	33.6	8.7
520	40.3	9.6
560	42.0	9.3
600	44.3	9.2
640	45.0	8.7
700	46.5	8.2
750	46.1	7.6
800	42.3	6.6
830	37.4	5.6
850	31.9	4.6
880	10.1	1.4
900	2.8	0.4

PR White	409	µA/lm
PR 800	42	mA/W
PR 850	32	mA/W

Figure 17 Tube response