Kentech Instruments Ltd

OPERATIONS MANUAL

for

FAST OPTICAL IMAGER

1   INTRODUCTION

The Fast Optical Imager provides intensified sub nanosecond gating over a 25mm aperture.

The FOI power supply provide programmable gate widths from 100ps to 10usecs, together with delay adjustment up to 10usecs.

Gate width, delay, gain and gate mode may be set via the front panel LCD and keypad. An RS232 interface is provided for remote control of the power supply.

The FOI provides two schemes for intensifier gating. The direct scheme, in which the gate pulse is applied directly to the photo-cathode, allows gating down to 5ns, The indirect scheme, in which a high voltage gate pulse is applied to the cathode by means of capacitive coupling, allows gating from 8ns to 100ps. These modes are set up by the internal microcontroller and may be selected via front panel controls.

The power supply contains a non-volatile memory which is used to store calibration and set-up data. As shipped the PSU will power up in the safe INHIBIT mode however the user may configure the PSU to power up in a pre-programmed state.

As with all image intensifier based cameras the user must be careful to control the exposure levels and the brightness of the image on the output phosphor. The PSU incorporates a phosphor current sense circuit and it will shut down the HV PSU if an overload condition resulting from an excessively bright image is produced, however this is not guaranteed to protect the intensifier.

When the FOI is used with a readout system the preferred method of obtained a 'DC' image for focussing and alignment is to pulse the PSU with a long gate pulse in time with the CCD trigger.

2   PSU OPERATING MODES

Four gate modes are provided:

SLAVE
The intensifier is turned on and off in direct response the to logic level of the trigger input.
The minimum gate width is ~10nsecs and there is no internal delay control.

SLOW_GATE
The gate width and trigger delay are determined internally and can be set on the front panel. The imager triggers in response to a +ve trigger edge.
The minimum gate width is 5ns

FAST_NO_DEL
Gate pulses below 8ns are produced by a high voltage avalanche pulse generator. The gate width is determined by means of a programmable passive delay line and this is activated and controlled via the Fast Gate modes. In the FAST_NO_DEL mode the delay circuitry is bypassed but the gate width is set via the front panel. Internally the Fast Gate modes are arranged as a number of discrete modes, each with a set of calibration data, but this is transparent to the user and the gate width is set via the front panel.*
The range of gate widths in the fast gate modes is 8ns to 100ps.

FAST
This mode is similar to the FAST_NO_DEL mode except that the internal delay circuitry is active and the trigger delay may be set on the front panel.

* When controlling the FOI from a remote computer the organisation of gate modes determines the command format. See section on remote control.

In addition to these gate modes the PSU may be set to either of:

INHIBIT
in which the MCP is set to minimum voltage and the cathode is biassed off

and

DC MODE
in which the user can hold the intensifier in the DC-on condition by means of pressing the DC button on the front panel.

TAKE CARE when using DC mode as an excessively bright image on the intensifier can reduce its life.

3   SPECIFICATIONS

Shortest frame time   100psecs FWHM

Frame times supplied   Fast gating   100ps - 8nsecs
                           Slow gating   5ns - 10,000ns
                           DC.

Tube type   25mm micro channel plate intensified wafer
                           tubes. Cathode gated.
                           P43 output. Fibre optic output coupling.

Power requirements   110/240 V ac <50watts.

PRF   Slow mode   2kHz
                           Fast mode   100Hz

Trigger delay   SLOW   typical
                           SLAVE
                           FAST_NO_DEL
                           FAST

Jitter   <50p.secs.

Trigger requirement   5-10V into 50ohms <5n.secs rise

Outputs:
Fast fiducial   Fast rise monitor output, derived directly from the fast gate pulse
                           generator
                           10V into 50Ω

CCD trigger   5V, 50Ω, 100usec duration
                           Leading edge fixed WRT slow gate pulse

4   PRINCIPLE OF INDIRECT GATING

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. This pulse is applied to the relatively high capacitance load presented by the cathode via a gating electrode close to the intensifier input window. 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 FOI camera.

The tube assembly is fed by 2 x 50 ohm cables, contained within the screened cable conduit. In the camera the signal is terminated at the gate electrode. The effective impedance driving the electrode is thus only 12.5 ohms giving a small (RC) risetime on the gating electrode.

The gate pulse is coupled to the outside of the photocathode via the metal cathode ring. The high conductivity of the photocathodes in the specially fabricated intensifier tube allows the gate pulse to propagate across the cathode rapidly. The gate width can be set to a minimum of 100ps.

5   OPERATION

As shipped the PSU powers up in the INHIBIT mode. Ensure that the cathode is covered and switch on the PSU.

The LCD displays this:

```
  Restore?        User>
  Restore = NO
  Save =    NO
 <View calibration
```

Press the right key to move the the settings editor page and the display changes to this:

```
  <Mode  =   Inhibit
```

indicating that the PSU is in Inhibit mode.
Press the left key to return to the startup page.
Navigate around this window using the arrow keys. The > and < symbols point to other pages. The 'Restore' and 'Save' items refer to the last settings saved. Move the cursor to down to the 'Restore' line with the down key and then to the right using the right key until the cursor is under 'NO' alongside the 'Restore' item. Use the up key to change NO to YES. Move the cursor to the left and the PSU will be restored to the last saved settings.
(In order to save the current settings do the same on the 'Save' line.)
In general, the left and right keys move the cursor. The up and down keys move the cursor if it is at the left hand side of the window but if the cursor is positioned under a variable then the up and down keys will change that variable.
To edit the settings move to the next page via the > symbol at the top right hand corner. The display will change to something like:

```
  <Mode  =   Slow gate
   MCP   =   700 volts
   Width =   100000 ns
   Delay =      0.0 ns
```

this being the previously stored set up.
This is the editor window for all the gating parameters. Move the cursor around using the arrow keys. The cursor will move up and down the left hand side but when it is positioned under a variable the up and down keys will edit that variable.
As a precaution the PSUs are shipped with the 'restore at power up' function disabled. The user can reinstate this function so the PSU powers up in the last saved state. This can only be done via the RS232 link - see remote control section.

PAGE 0   Start up page
Allows the user to save or recall the gating setup and provides access to the other pages via the <
and > symbols.
Example display:

```
 Restore?        User>
 Restore = NO
 Save =     NO
<View calibration
```

PAGE 1   Settings editor page
Set all the user gating parameters in this page (gate mode, gate width, gain and trigger delay)
Example displays;

```
 <Mode   =       Inhibit
```

```
 <Mode   =    Slow gate
  MCP    =    123 volts
  Width =     110   ns
  Delay =      12.30 ns
```

```
 <Mode   = Fast no del
  MCP    =    123 volts
  Width =        400 ps
```

```
 <Mode   =    Fast gate
  MCP    =    123 volts
  Width =        400 ps
  Delay =      12.30 ns
```

```
 <Mode   =        Slave
  MCP    =    123 volts
```

PAGE 2   Test/calibration page

Shows current gate mode and fast mode numbers together with some internal calibration parameters.

```
<Do tests?          >
 This channel is  1
 MODE# 5,F_MODE# 10
 PCB= 1 ,T_OFF= 750
```

PAGE 3   Hardware test page

Provides several test routines to check the HV PSUs, the avalanche supplies and PC bias circuits. NB - On leaving this page the PSU will be put in inhibit mode.

```
ΔNext test     Exit>
PC bias (0,1,2+DC)
20 , 40
60 , -180
```

Leave this page via the top right >. Go to the next test via the down button at the left hand Δ symbol.

PAGE 4   Remote control page

Indicates that the PSU is in remote control mode and shows the current hardware settings. The keypad is inactive in this mode.

```
█Mode  =    Fast gate
█MCP   =    123 volts
█Width =     400 ps
█Delay =   12.30 ns
```

This page can only be left by exiting the remote mode via and RS232 command or by powering down the PSU.

All functions (except activating the DC mode) can be controlled via the RS232 interface.

In order to use remote control an RS232 link must be provided. The default baud rate is 9600.

Remote control operates in the following way:

For the purposes of this description we will assume that the external controller is a dumb terminal.

In the main firmware loop the RS232 interface is checked. If any character is received the PSU drops into 'remote' mode in which the keypad is disabled. Type a <CR> and the display changes to:

```
■Mode  =    Fast gate
■MCP   =    123 volts
■Width =      400 ps
■Delay =    12.30 ns
```

and the front panel 'Remote' LED is illuminated to show that the PSU is in 'remote' mode.
A banner message is returned via RS232 and the PSU is now waiting for commands.

NB - commands are case sensitive and must be followed by a carriage return (<CR>). The PSU runs under a Forth operating system and all commands are Forth word definitions. A <CR> on a blank line will results in a 'ok' response. Type a few <CR>s as a check that communications are working.

All arguments are integers although the parameter for the !DELAY command is a double precision variable. See the details of its use below.

In order to return the PSU to local keypad control type:

```
-REMOTE <CR>
```

After this command the PSU will display the start up page.

Type another <CR> to return to remote control. The 'remote' LED is again illuminated.

Commands which can be used in 'remote' mode are:

−REMOTE
Return the PSU to keypad control

>DC
Set the PSU to DC mode

>SLAVE
Set the PSU to SLAVE mode

>INHIBIT
Set the PSU to INHIBIT mode

>FAST
Set the PSU to FAST mode

>FAST_NODEL
Set the PSU to FAST_NODEL mode

>SLOW
Set the PSU to SLOW mode

xx   !FAST_WIDTH
Set the fast width mode number. Requires an argument. Range is 0 - 12. Typical use:
10   !FAST_WIDTH <CR>
Sets the fast mode gate width to 6ns (see table below for other speeds)

xxx   !MCPV
Set the MCP voltage. Requires an argument. Range is 0 - 900. Typical use:
645   !MCPV
Sets the MCP voltage to 645 volts.

xxxxxx.   !DELAY

Set the delay. Requires an argument. Range is 0 - 1000000

NB The internal MPU is a 16 bit processor however the delay variable is a 32 bit number. In the Forth operating system a 'long' variable, which consists of 32 bits, is entered by following the numerical value with a 'dot' with no space between. This should NOT be confused with a decimal point.

The units of this variable are 10s of picoseconds. Examples are:

950.   (9.5ns)
or
123456.   (1234.56ns)

Typical use:
1050.   !DELAY <CR>

Set the delay to 10.5nsecs.

.DELAY

Print the current delay value

.MODE

Print the active gate mode

.GWIDTH

Print the current slow gate width

.MCPV

Print the MCP voltage

.FAST_WIDTH

Print the current fast width

+START_SAFE

Set the PSU to the safe startup mode in which the initial mode is always INHIBIT

–START_SAFE

After executing this function the PSU will start up with settings as stored with the last SAVE operation. The SAVE function can be accessed via the startup page.

Commands not requiring an argument:
 -REMOTE
 >DC
 >SLAVE
 >INHIBIT
 >FAST
 >FAST_NODEL
 >SLOW
 .DELAY
 .MODE
 .GWIDTH
 .MCPV
 .FAST_WIDTH
 +START_SAFE
 -START_SAFE

Commands requiring an argument:	Range	Units
xx !FAST_WIDTH	0 - 12	See table below
xx !MCPV	0 - 900	Volts

Commands requiring a double
 precision argument (eg 1234.):

xx. !DELAY	0 - 1000000.	10s of psecs

The fast width modes are:

Fast mode number	Gate width
0	<100 ps
1	100 ps
2	150 ps
3	200 ps
4	500 ps
5	1 ns
6	2 ns
7	3 ns
8	4 ns
9	5 ns
10	6 ns
11	7 ns
12	8 ns

The trigger signal should be between 5 and 10V and should have a risetime of <3ns to ensure low timing jitter.

In the fast modes the 'Fast fiducial' timing signal is the most accurate marker for the arrival of the gate pulse. This signal is divided down from the photocathode gate pulse and marks the position of the optical gate with virtually no timing jitter.

In the slow and slave modes the auxiliary trigger output may be used to time the start of the optical gate.

The timing of the various signals is listed below, measured with the delay set to 0.00ns.

Approximate delay to the start of the optical gate with respect to a 5V, +ve edge at the BNC trigger input:

Fast, no delay   40ns
Fast   61ns
Slow   86ns
Slave   40ns

In *Fast* and *Fast, no delay* modes the *Fast fiducial* timing marker (SMA connector) appears at the front panel approximately 6.2ns **before** the gate pulse appears on the photocathode.

In *Slow*, *Slave* and *Fast, no delay* modes the *Aux. trig. out* signal appears at the front panel BNC connector approximately 22ns **after** the leading edge of the gate pulse appears at the photocathode.

In *Fast* mode the *Aux. trig. out* signal appears at the front panel BNC connector 26ns **after** the leading edge of the gate pulse appears at the photocathode

11 <u>PACKING LIST</u>

1   Fast optical imager PSU

2   Fast optical imager intensifier head

3   Mains connecting lead

4   Manual