Kentech Instruments Ltd

OPERATIONAL NOTES
for
Electron Detector
Pulser
xxxxxxx

31/7/04

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Caution

High Voltage Pulser Serial No. xxxxx

This equipment is a research tool that has been intentionally designed to generate high energy electromagnetic pulses and the EM emissions will be highly sensitive to the load applied by the user. Within the EU it is suitable for use only in a sealed electromagnetic environment, unless it is used in a system that has been verified by the system builder to comply with EU directive 89/336/EEC.

With an appropriate load and adequately insulated connecting leads, the unit is safe for use by an educated user in a laboratory environment. You are warned however that the radiation from the system with an antenna or inappropriate load attached can damage sensitive equipment and corrupt data stored in computer and microprocessor based systems. It can cause terminal failure of vital medical electronic systems such as pacemakers. This equipment is be supplied on the understanding that the user will analyse these risks, accept responsibility for them and take appropriate precautions in the use of this instrument.

The output from this pulse generator will destroy many types of power attenuators and electronic test equipment. It is the users responsibility to ensure that any apparatus connected to the output is suitably rated.

Kentech Instruments Ltd accepts no responsibility for any damage or liabilities incurred in the operation of this equipment.

Please read the manual before applying power.

THERE ARE DANGEROUS HIGH VOLTAGES (1kV) PRESENT IN THIS PULSER WHEN THE UNIT IS OPERATING. DISCONNECT THE POWER SUPPLY BEFORE REMOVING THE COVERS.

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DISCLAIMER

This equipment contains high voltage power supplies. Careless can result in electric shocks. It is assumed that this highly specialised equipment will only be used by qualified personnel.

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.

The main output can be very dangerous, particularly when the pulser is triggered at a high frequency. Take great care to insulate the output adequately.

Introduction

Our range of solid state high voltage pulse sources allows very high voltage, fast rising pulses to be obtained from compact bench top units. Our avalanche technology allows the generation of 20kV voltage pulses rising in 100ps into 50Ω. Our Range of FET pulse generators provides sub-nanosecond switching speeds, kilovolt amplitudes and repetition rates in excess of 1MHz. The performance of our compact, convenient and reliable pulsers is to our knowledge exceeded only by laser driven photoconductive switches in terms of voltage switching speeds. These pulsers will find applications in many fields such as high speed camera research, electro-optic switching, triggering systems, time of flight mass spectroscopy and radar.

Specification

Pulser 1

Load	Phosphor at the open circuit end of 4 x 50ohm drive cables
Waveform	Fast rise step, then flat to <+/-10% for >=10ns, followed by slow return to zero over a few usecs.
Risetime	Electrical rise, no load, <=150psecs
Voltage at phosphor	0 to >= +ve 4.5kV (plus bias)
Adjustment	Approximately 60% to 100%
Trigger	5V into 50ohms, risetime <3ns
Jitter	<50ps
Trigger delay	Typically 30ns, fixed
Bias	Front panel control, 0 to +ve 300 volts

Pulser 2

Load	M1, open circuit at the end of 75 ohms cable, length 2 metres
Voltage	0V to +ve 5kV to 0V (plus bias)
Adjustment	Approximately 30% to 100%
Rise/fall	~50nsecs
Trigger	5V into 50ohms
Jitter	<1ns
Trigger delay	Typically 80ns, fixed
Bias	Front panel control, 0 to -ve 300 volts

Pulser 3

Load	M2 at the open circuit end of 4 x 50ohm drive cables, 2metres
Waveform	Fast rise step, then to <+/-10% for >>10ns, followed by slow return to zero over a few usecs
Risetime	Electrical rise, no load, <=150psecs
Voltage	Approx 0V to -ve 500V (plus bias)
Adjustment	Approximately 60% to 100%
Trigger	5V into 50ohms
Jitter	<50ps
Trigger delay	Typically 30ns, fixed
Bias	Front panel control, 0 to +ve 200 volts

For all pulsers:

Power supply	100 - 230V ac
Cooling	Fan
PRF	100Hz
Package	19" rack mount
Adjustments	Manual

The pulser is not tested for compliance with EU RF emission standards and is suitable for screened room use only.

Overview

The pulser requires A.C. power and a trigger signal for each of the three pulser modules. The three modules are completely independent and can be triggered at any time, up to the maximum repetition rate of 100Hz. The trigger signal, which is applied to the trigger input (BNC), should be TTL (50Ω) compatible. The pulse modules are triggered on the rising edge of the trigger pulse. Each module has a trigger indicator LED to show it has been triggered.

There is a bias supply in each module which superimposes a DC bias voltage on the pulse, therefore the load must be purely capacitive to avoid short-circuiting the bias. The impedance of the bias supply is high so no damage will result so it is allowed to connect a high voltage attenuator to the outputs for test and monitoring purposes. IMPORTANT - the fast 5kV pulse module must not be operated without the four HN-HN connecting cables or else reflections will cause the output voltage at the front panel to exceed 5kV and the resulting breakdown may cause damage.

Each module has a monitor output. These monitors provide a divided down signal derived from the bias voltage. This voltage may be measured with a DMM and is used to set the reverse bias voltage. In addition these monitor outputs provided a divided down version of the pulse signal at the output of the pulse card. Although this signal is not an accurate replica of the pulse output (due to HF noise), the signal does provide an accurate marker for the timing of the fast pulse signal and should be used in conjunction with a fast scope when setting up the timing of the three modules.

The outputs of the various modules are connected to the experimental apparatus with the 2 metre long leads provided. It is important that the leads for each of the fast modules are the same length so that the fast edge reaches the load at the same time for all four connection points. This will give optimum risetime.

The generation of fast risetimes necessarily involves high voltages over short distances and high dielectric stresses are present during switching. The lifetime of high voltage switching electronics can be extended by removing the trigger signal or the power supply when the pulse output is not required.

Use of each module

Pulser 1

+4.5kV fast rising step

The four HN connecting cables MUST be attached before operating this module at anything other than minimum pulse amplitude.

The signal at the open circuit end of the cable is a 4.5kV step, rising in <=150psecs. The step stays flat to better than +/-10% for 10ns then starts to decay. There are various reflections back and forth followed by an exponential decay over a time of a few microseconds.

The user can monitor the HV signal by attaching a suitable HV attenuator (eg Barth type 142) to one of the cables. This will show a 2.25kV step into a terminated load.

The bias monitor output provides a 100:1 DC output from a source impedance of 10kΩ and should be used with a DMM to set the bias voltage. In addition there is a divided down version of the pulse output at the module which is AC coupled to the bias monitor connector. There is a scope trace of this signal in the test data. Although the signal is not an accurate picture of the output voltage it does provide an accurate timing marker for the arrival of the fast edge at the end of the connecting cables. The test data shows the relative timing of the signals.

Note that the monitor signal shows the outgoing edge generated at the pulser and the return edge reflected from the open circuit cable end. This provides a useful diagnostic of the connections in the detector and the timing between the outgoing and return pulses show the length of the cable between the monitor point and the open circuit load.

Do not exceed a trigger rate of 100Hz.

Pulser 2

+5kV impulse ~50ns rise and fall

The SHV connecting cable MUST be attached before operating this module at anything other than minimum pulse amplitude.

The signal at the open circuit end of the cable is a 5kV impulse, rising in approximately 50ns. The user can monitor the HV signal at the cable end with a suitable HV high impedance probe. Although the pulser will not be damaged by attaching a low impedance attenuator this will not give an accurate measurement of the voltage into a purely capacitive load.

The bias monitor output provides a 100:1 DC output from a source impedance of 10kΩ and should be used with a DMM to set the bias voltage. In addition there is a divided down version of the pulse output at the module which is AC coupled to the bias monitor connector. There is a scope trace of this signal in the test data. This signal provides an accurate timing marker for the arrival of the HV impulse at the end of the connecting cables. The test data shows the relative timing of the signals.

Pulser 3

-0.5kV fast rising step

All four SMA connecting cables should be attached before operating this module or else the output waveform will be distorted. There is no danger of breakdown however.

The signal at the open circuit end of the cable is a -0.5kV step, rising in <=150psecs. The step stays flat to better than +/-10% for many microseconds then returns to zero (or the bias voltage) slowly..

The user can monitor the HV signal by attaching a suitable HV attenuator (eg Barth type 142) to one of the cables. This will show a -250V step into a terminated load which starts to decay after a fed 100ns.

The bias monitor output provides a 100:1 DC output from a source impedance of 10kΩ and should be used with a DMM to set the bias voltage. In addition there is a divided down version of the pulse output at the module which is AC coupled to the bias monitor connector. There is a scope trace of this signal in the test data. Although the signal is not an accurate picture of the output voltage it does provide an accurate timing marker for the arrival of the fast edge at the end of the connecting cables. The test data shows the relative timing of the signals.

Note that the monitor signal shows the outgoing edge generated at the pulser and the return edge reflected from the open circuit cable end. This provides a useful diagnostic of the connections in the detector and the timing between the outgoing and return pulses show the length of the cable between the monitor point and the open circuit load.

Do not exceed a trigger rate of 100Hz.

Controls

Power switch	Toggle
Power indicator	LED

Pulse module 1

Pulse amplitude	Sets the step height Range 2.5kV to 4.5kV approx
Bias amplitude	Sets the DC bias Range 0 to +300V
Trigger input	5V, 50Ω, rise <5ns
Bias monitor	100:1 monitor of DC bias (10kΩ source) AC couple pulse monitor Approx 5V into 50Ω
Pulse output x 4	4.5kV step at open circuit load Do not operate the pulser without the four cable connected
Triggered LED	Trigger indication

Pulse module 2

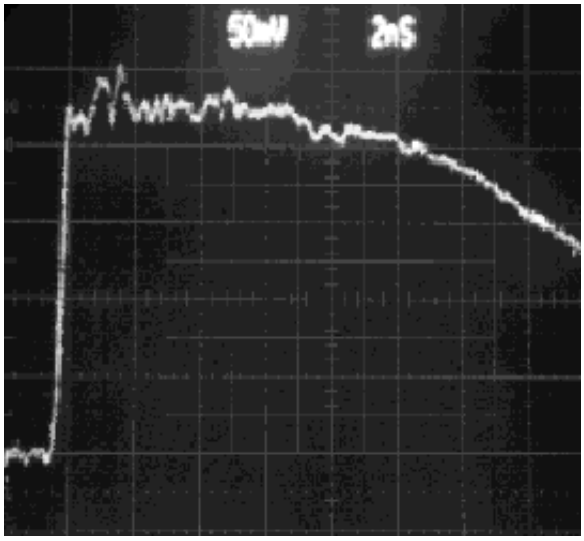
Pulse amplitude	Sets the impulse height Range 0kV to 5kV approx
Bias amplitude	Sets the DC bias Range 0 to -300V
Trigger input	5V, 50Ω, rise <5ns
Bias monitor	100:1 monitor of DC bias (10kΩ source) AC couple pulse monitor Approx 5V into 50Ω
Pulse output x 4	5kV impulse at open circuit load Do not operate the pulser without the pulse cable connected
Triggered LED	Trigger indication

Pulse module 3

Pulse amplitude	Sets the step height Range 0V to -500V approx
Bias amplitude	Sets the DC bias Range 0 to 200V
Trigger input	5V, 50Ω, rise <5ns
Bias monitor	100:1 monitor of DC bias (10kΩ source) AC couple pulse monitor Approx 5V into 50Ω
Pulse output x 4	-500V step at open circuit load Do not operate the pulser without the pulse cable connected
Triggered LED	Trigger indication

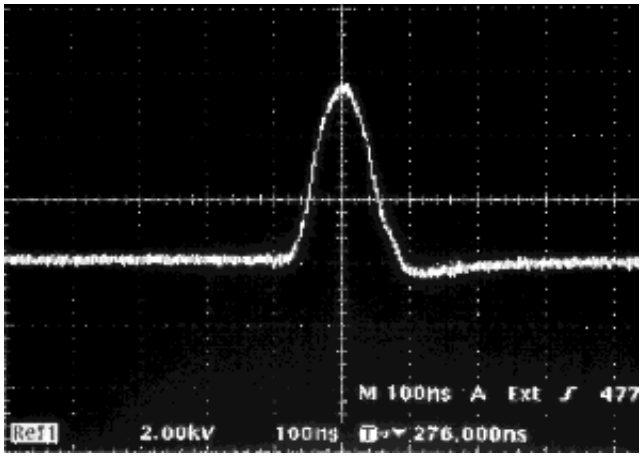
Test data xxxxxx

Pulse module 1



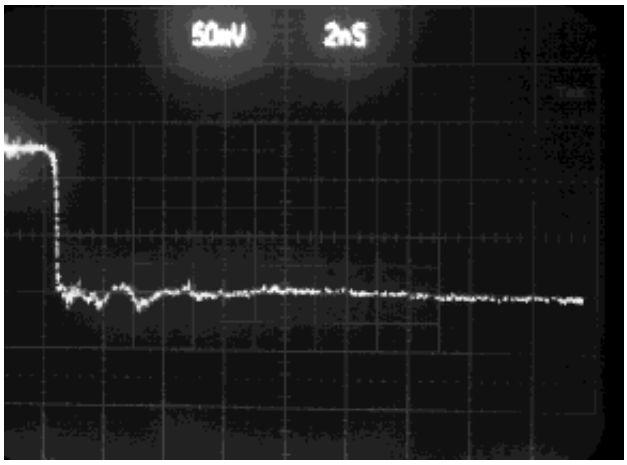
Step at max amplitude, 2ns per division, showing duration

Pulse module 2



Impulse at max amplitude, 100ns per division

Pulse module 3



Step at max amplitude, 2ns per division, 100V per division