Notes on the use of

Kentech Instruments Ltd.
SPSV pulser
Serial Nos. xxxxx

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CAUTION

With an appropriate load, this 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 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 high voltages (4kv) present in this pulser when the unit is operating. Do not remove the covers, return to Kentech Instruments Ltd or its appointed agent for servicing.

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.

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

RF emissions and EC directive 89/336/EEC

This equipment includes circuits intentionally designed to generate short high energy electromagnetic pulses and the EM emissions will be highly sensitive to the load applied by the user, for example the radiation just from some types of output cable may exceed EC permitted levels.

The level of RF radiation generated by the circuit boards within the instrument is inevitably high but the emissions are largely contained by the instrument enclosure. It is therefore very important that all fasteners are securely fastened, do not operate the pulser with the covers removed.

The emissions from this pulser may exceed the limits specified in EN55011 “Emissions Specification for Industrial, Scientific and Medical equipment” and the unit may cause interference with other equipment in its immediate environment. It is 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.

We recommend the following precautions to minimise emissions from the load:-

1) that any load is fully contained within a conductive metal screened box, with all joint surfaces gasketed or fitted with conductive fasteners at less than 5cm intervals.

2) that the load is connected to the pulser output with semi-rigid cable, the cable outer must be carefully connected to the N type output connector at one end, and must be connected directly to the screened box containing the load at the point of entry. Flexible cables should only be used with caution, and generally will need additional screening.

Introduction

Our range of solid state pulsers (ASG, SPS, HMPS and PBG series) allows very high voltage, fast rising pulses to be obtained from compact bench top units. Voltage pulses as short as 100ps FWHM, in excess of 4kV peak voltage into 50Ω, and with a pulse repetition frequency (PRF) >1kHz can be produced. 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 and radar.

A large range of output pulse lengths can be provided by the incorporation of internal passive pulse forming networks. There is very little jitter in the output of the pulsers and two independent pulsers can be used in parallel to drive low impedances. This aspect makes the pulsers particularly useful for driving microchannel plate systems. Transformers with output impedances as low as 5Ω are available.

The standard drivers and speed-up modules have a life of $>10^{10}$ pulses and have a PRF of ≥1000Hz, although special units with a PRF >50kHz can be supplied. The high repetition rates allow sampling oscilloscopes to be used to characterise a system and verify the pulse shape.

The pulsers can feed into a short circuit load without damage. This allows them to be used in sub-nanosecond pulse chopping systems by feeding through a pockels cell into a shorting stub. Variations on the standard driver are available.

Lifetime

Solid state high voltage avalanche pulsers have a long but finite lifetime, generally characterised by the integrated number of output pulses. Fast risetime and high voltage lead to high electrical stress and such processes as partial discharges and other minor breakdown effects can gradually degrade insulation and reduce the lifetime.

With this in mind we recommend that pulsers are not operated unnecessarily and that arrangements are made to remove the trigger pulses when the pulse output is not required. This is most important when pulsers are operated near their maximum repetition frequency.

Use

The pulser requires A.C. power and a trigger signal to operate. The trigger signal can be

generated internally or applied externally. When triggered the "triggered" light on the front panel will flash. When external triggering is used, the trigger signal, which is applied to the trigger input (BNC), should be ≥5 volts with a fast rising edge (<5ns) to maintain the low jitter of the system

In the internal trigger, single shot and external "delayed" modes there is a trigger delay generator which may be adjusted by the user. There are coarse (10ns per step) and fine (~12ns full scale) delay controls. A “pretrigger” output pulse is available which has fixed timing with respect to the trigger (i.e. before the delay). This monitor may be used to trigger ancillary pieces of equipment, e.g. intensifiers etc. An “auxiliary” output is provided which has fixed timing with respect to the main output (i.e. after the delay). It appears within ~5ns of the main output.

In "direct" mode the external trigger is applied directly to the avalanche stack and the low level trigger delay circuitry is bypassed. In this mode the trigger delay is at a minimum of ~20ns. There are no “pretrigger” or “auxiliary” outputs in this mode.

The main output of the unit appears at the front panel connector (BNC type). If it is necessary to monitor or characterise this pulse suitable attenuators should be used. We recommend the use of a high voltage, high speed attenuator manufactured by Barth™ as the first attenuator in a series.

Caution

The output of this unit will damage or destroy many types of high voltage and high power attenuators. We recommend the use of a high voltage, high speed attenuator manufactured by Barth™ as the first in a series. Consult the attenuator manufacturer before using any other configuration.

The output may be observed with a high bandwidth oscilloscope. This may either be a fast (>3GHz) direct access type or a sampling type.

If the output of the pulser is to be used directly or via any passive network it is essential that cable lengths are kept as short as possible and that only high quality cable is used.

The maximum frequency of the internal rate generator is 1kHz, but the pulser has a maximum rate of 500Hz (above which both amplitude and jitter will be out of spec.). No damage to the pulser will occur above 500Hz.

There are thermal drifts in the delay generator which will stabilise after the pulser has been switched on for ~20 minutes.

SPECIFICATIONS

Output voltage:	≥1kV into 50Ω	
Rise time:	<700ps	
Pulse length:	1, 2, 4, 8, 10, 12ns switchable	
Polarity:	Negative	
External trigger:	Requires ≥5V into 50Ω, ~5ns rise time.	
Jitter:	~10ps rms, <20ps peak	
Trigger delay:	~20ns in direct mode	
Repetition rates:	Single shot to 1000Hz	
Power supply:	100 - 240VAC	
Outputs:		
Pulse output	BNC	≥1kV pulse
Pretrigger output	BNC	10V into 50Ω, leads main output by the delay when the delay is active
Auxiliary output	BNC	10V into 50Ω, after delay (i.e. fixed timing with respect to main output)
Inputs:		
Trigger input	BNC	≥5V, 50Ω

Controls:

Pulse width	Sets pulse width to 1, 2, 4, 8, 10, 12ns
Mode	Sets one of the following modes:- Single shot (delay active) 0.1-1Hz (delay active) 1-10Hz (delay active) 10-100Hz (delay active) 100-1000Hz (delay active) External trigger (delay active) "Delay" External trigger (delay inactive) "Direct"
Fine rate	Varies internal rate. Min = x1, Max = x10
Delay	Internal delay, 0 - 100ns in 10ns steps.
Fine delay	Internal delay potentiometer 0 - 12ns.
Single shot button	Depressing this button cause a single trigger when single shot mode selected
Power	Switches AC power in the pulser

Indicators:

Power	Shows that AC power is applied and the unit is switched on
Triggered	Illuminates while the unit is being triggered

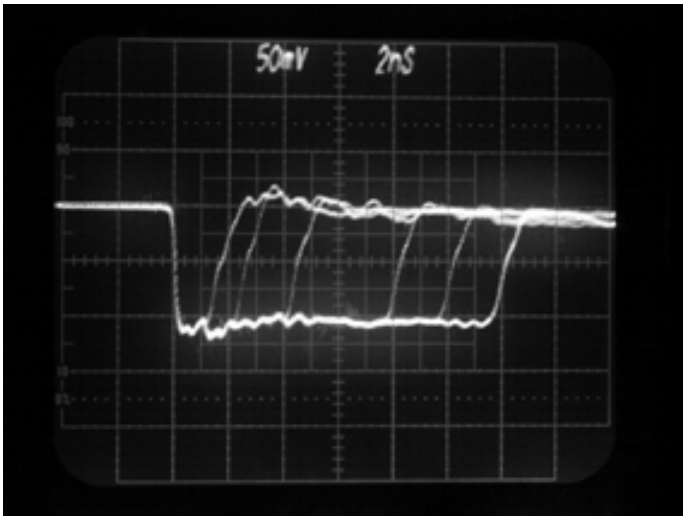
Environmental:

Ambient temperature	5 to 35°C
Humidity	< 95% non-condensing
Altitude	< 3000m

Test data for SPSV pulse generator Serial No. xxxxxxx

Test equipment: Scope: TEK 7834, 7S11 + S6, 7T11
Attenuators: 2x Barth 142 (x10)
2x Radial SMA (x10), total attenuation x10000
Trigger source: Kentech APG1 auxilliary output

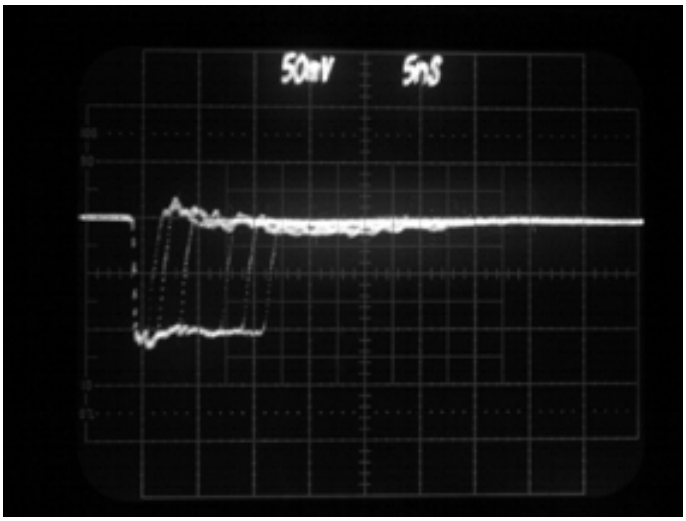
Output Waveforms



Pulse shape

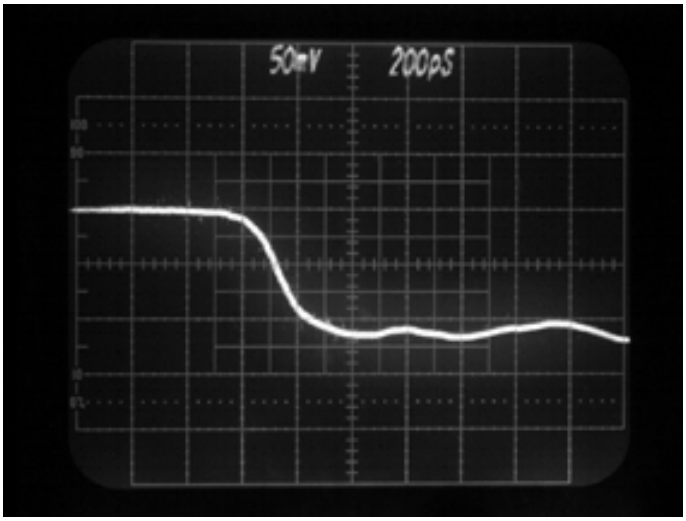
1ns, 2ns and 4ns
8ns, 10ns and 12ns

Vertical: 500V / div
Horizontal: 2ns / div
Repetition rate: 500Hz



Post pulse noise

Vertical: 500V / div
Horizontal: 5ns / div
Repetition rate: 500Hz



Rise time and jitter

Typical of all pulse widths

Vertical: 500V / div
Horizontal: 200ps / div
Repetition rate: 500Hz