Kentech Instruments Ltd.

Manual for CPS2/D Special Pulse Generator

28th September 2018

Kentech Instruments Ltd.,
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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 (3kV) 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 is a research tool that has been 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 secure, do not operate the pulser with the covers removed. The pulser may interfere with sensitive equipment at short range.

We believe that with this type of unit it has to be the system builder's responsibility to verify that his pulser/load system complies with the EC directive unless the system is used in a screened electromagnetic environment.

We are not able to guarantee compliance with arbitrary loads but to minimise emissions we recommend:-

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, in particular RG303 type cable will need additional screening to control emissions.

Declaration of Conformity

We:- **Kentech Instruments Ltd**
Isis Building
Howbery Park
Wallingford
Oxfordshire OX10 8BD UK

Certify that this apparatus:-

CPS2/D Special Pulse Generator
Serial No.

Conforms with the protection requirements of European Community Directives:-

2014/35/EU Low Voltage Directive
2014/30/EU EMC Directive
768/2008/EC CE Marking Directive

The following harmonized standards have been applied:-

BS EN55011:2016+A1:2017 Industrial, Scientific and Medical equipment - Radio-Frequency disturbance characteristics.

BS EN61000-6-2:2005 Electromagnetic compatibility (EMC) Generic standards. Immunity for industrial environments.

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

Name: **Signature:**

On behalf of Kentech Instruments Ltd
Position: Director **Issued:** 28th September 2018

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 50 Ohms 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 5 Ohms 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.

Use

The pulser requires A.C. power of a nominal 100V to 240V AC to operate. The power on/off switch is mounted on the front panel, and a power led displays the status of the internal DC supplies.

An external trigger signal, applied to the front panel trigger input (BNC) should be >= 5 V amplitude into 50 Ohms with a fast rising edge (< 5 ns) to maintain the low jitter of the system. When triggered the "triggered" LED on the front panel will flash.

The output of the unit has a maximum amplitude in excess of 4kV which appears at the N type front panel connector. The output pulse width is fixed at approximately 2ns fwhm. The output can be operated into a wide range of loads from open circuit to short circuit but must be terminated with a load 50 Ohms to maintain the correct wave shape. The output amplitude of this particular unit is not adjustable.

The pretrigger output has fixed timing to the input trigger and before any internal delay settings.

In the internal trigger, single shot and "delayed" modes there is an internal delay which may be adjusted by the user. There are coarse (10ns per step) and fine (~12ns full scale) delay controls. In "direct" mode the trigger is applied directly to the avalanche stack and the low level circuitry is bypassed. In this mode the trigger delay is at a minimum of ~37ns. There is no pretrigger output in this mode. There are thermal drifts in the delay generator which will stabilise after the pulser has been switched on for ~20 minutes.

If it is necessary to monitor or characterise the pulse output then suitable attenuators should be used. The output may be observed with a >3GHz bandwidth single shot oscilloscope or a sampling type.

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.

Pulser Specifications

General:

Output:	Single 50 Ohm output N Type connector.
Output voltage	> =4 kV into 50 Ω.
Output polarity	Negative
Pulse shape	Fast rising edge followed by slower approx. exponential fall
Pulse width	approx. 2ns FWHM fixed
Rise time	<= 150 ps (10 to 90%)
Trigger	>= 5 V into 50 Ohms, < 5 ns rise. <= 2ns risetime for minimum jiitter
Jitter	<= 20 ps RMS
Repetition rates	0 to 100 Hz, repetition rate and delay generator internal.
Power supply	90-264V AC 50-60Hz
Maximum power	<25W

Outputs:

Pretrigger output:	BNC 8V into 50 Ohms
Pulse outputs:	N >= 4kV into 50 Ohms.

Inputs:

Trigger input:	BNC >= 5 V into 50 Ohms, less than 5ns rise time.
Power:	IEC power input with 3.15A T 20mm fuse on rear panel.

Controls:

Coarse rate/mode:	Sets one of the following modes:
	Single shot (delay active)
	0.01 - 0.1 Hz (delay active)
	0.1 - 1 Hz (delay active)
	1- 10 Hz (delay active)
	10 - 100 Hz (delay active)
	External trigger "delay" (delay active)
	External trigger "direct" (delay inactive)
Fine rate:	Single turn potentiometer varies internal rate by ratio of 10:1.
Coarse delay:	Sets internal delay in steps of 10ns up to 100ns.
Fine delay:	Single turn potentiometer sets internal delay up to 12ns.
Single shot:	Depressing this button causes a single trigger.
Power	Switches AC power in the pulser.

LED Indicators:

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

Environmental:

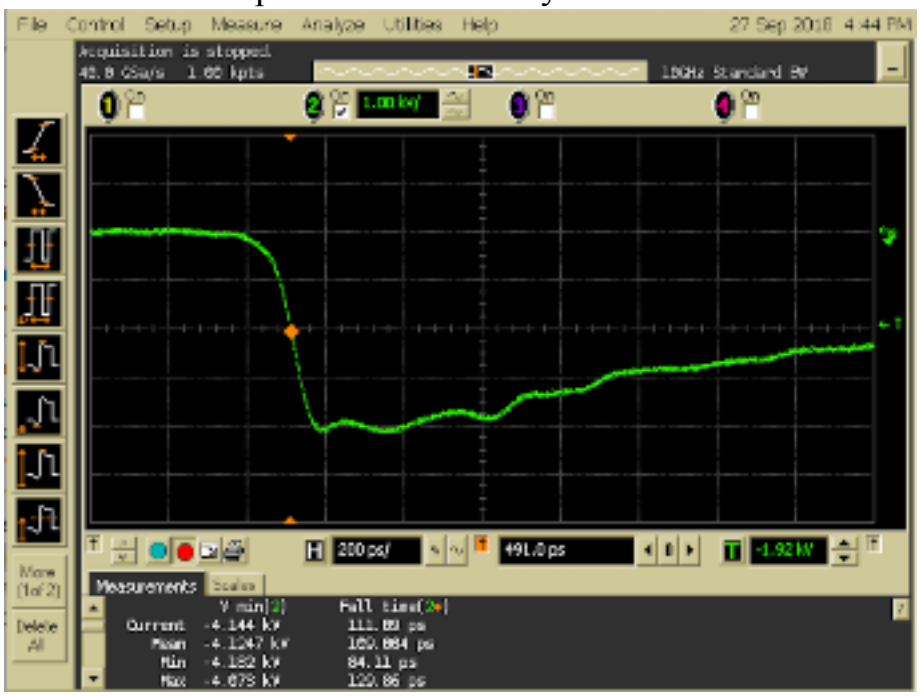
Dimensions	H = 133mm, W = 235mm, D=305mm.
Weight:	4.0kg approx.
Ambient temperature	5 to 35 degrees C
Humidity	< 95% non-condensing
Altitude	< 3000m

Test Results

Oscilloscope: Agilent DSO80804A Attenuators: 2 x Barth 142, 1 x Radiall SMA

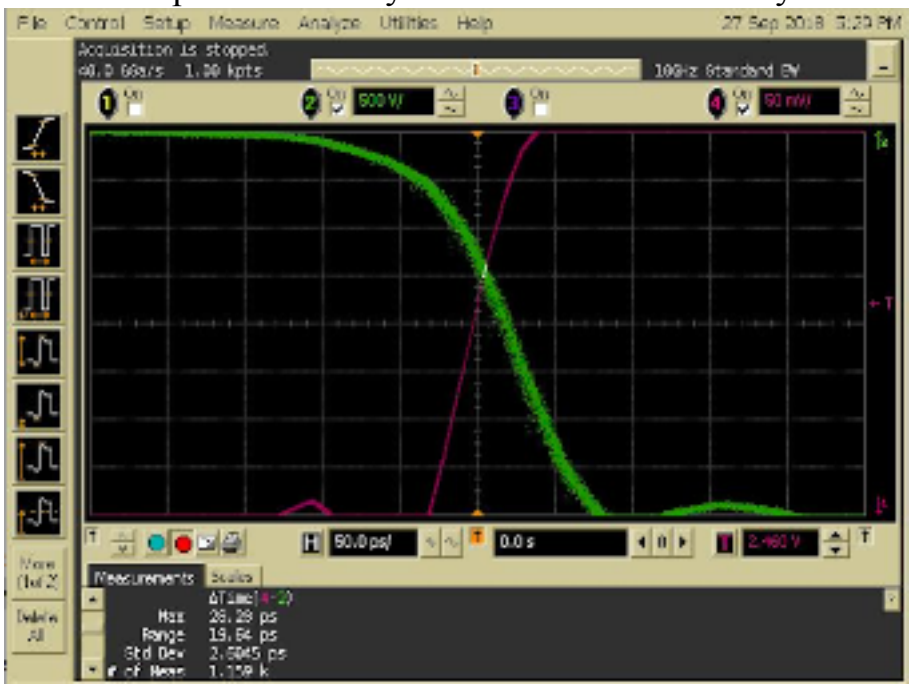
Output waveform directly into Barth

Output risetime directly into Barth

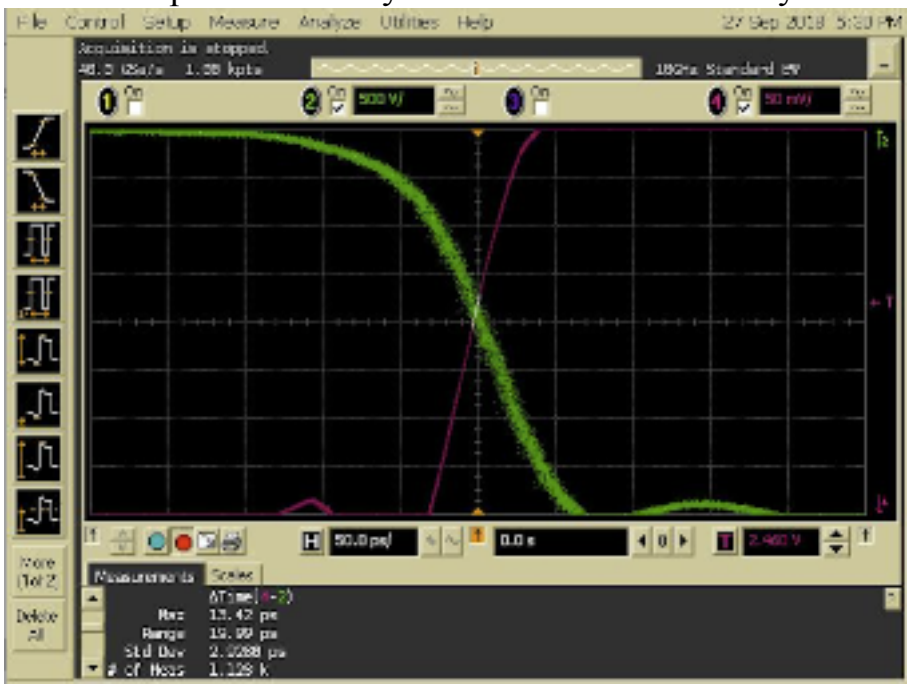


Output Jitter Direct Mode

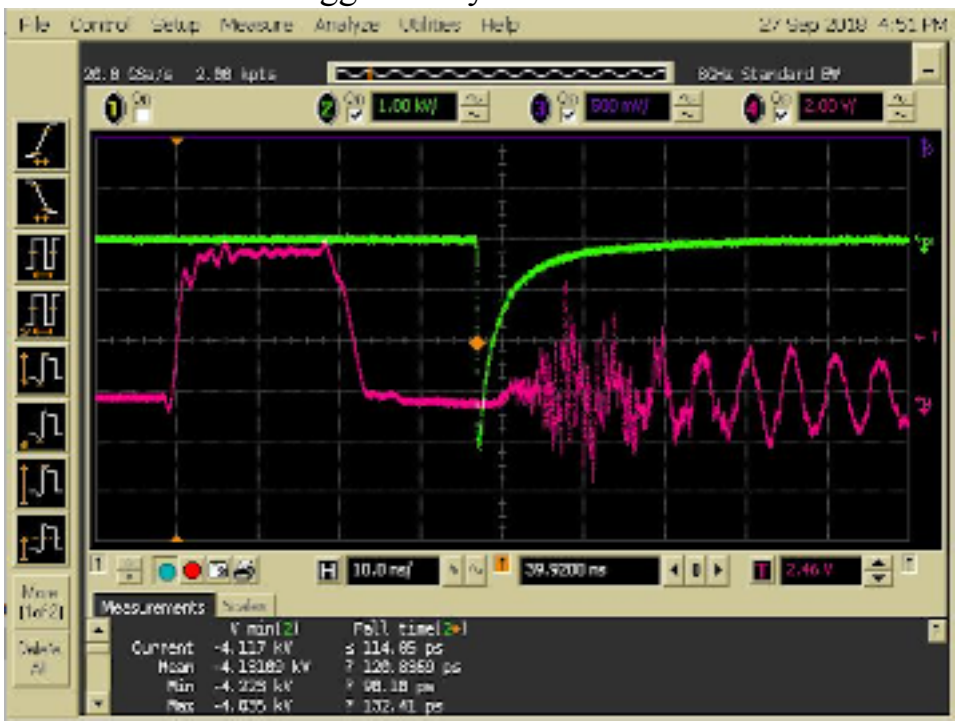
Output Jitter Delayed Mode Minimum Delay



Output Jitter Delayed Mode Maximum Delay



Trigger Delay Direct Mode



Trigger Delay Delayed Mode
Coarse steps with minimum fine delay

Trigger Delay Delayed Mode
Min and max fine delay with min coarse delay