Notes on the use of

Kentech Instruments Ltd.
Injector pulser
Serial No. *(special)*

17th February 2004

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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. The output from this pulse generator will destroy some types of 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 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 securely fastened, do not operate the pulser with the covers removed. The pulser may still interfere with sensitive equipment at short range.

We believe that with this type of unit it has to be the system builders 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.

Introduction

Our range of solid state high voltage pulse sources (MPS and HMPS 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 2kV 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 ≥100Hz, although special units with a PRF >2kHz can be supplied. The high repetition rates allow sampling oscilloscopes to be used to characterize 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, a continuous RF source (typically around 500MHz) and a trigger signal to operate. The trigger signal amplitude should be 5 volts.

The pulser triggers on the rising edge of the trigger signal and the trigger input duration determines the length of the burst output, up to a maximum duration of approximately 30usecs. The maximum repetition rate is limited to approximately 150Hz. After each trigger edge the triggered LED will flash to indicate that a burst has been produced.

The RF input (nominally 500MHz) should have an amplitude around 10dBm. The presence of an RF input is indicated by the RF active LED. The burst rate is produced by the internal division of the input RF frequency. The division ratio is 16.

The main output of the unit appears at the N type front panel connector. If it is necessary to monitor or characterise this pulse appropriate attenuators should be used. The output may be observed with a high bandwidth oscilloscope. This must have a bandwidth of ≥1GHz. The amplitude of the output pulses (200V) might cause damage to small attenuators, particularly SMA types. Use a suitably robust attenuator.

There are amplitude and width controls for the output impulses. The amplitude varies from approximately 100V to 210V although the pulse width control also has some effect on the amplitude. The minimum pulse width is obtained with the amplitude set to maximum and the pulse width control set to give approximately 200V p-p. (See test data at the end).

A DC bias can be superimposed on the pulse output. This may be applied via the bias input on the front panel or may be applied to the load externally. If the bias is applied externally then the bias input may be used as a monitor point. In either case the bias range is limited to +/-500V. The series decoupling capacitor at the pulser output is 200pF.

There are several monitor signals available on the front panel. These are

i) Sync output - this is a pulse whose duration matches the envelope of the burst. The start and end are aligned with the RF drive. This signal may conveniently be used to trigger an oscilloscope

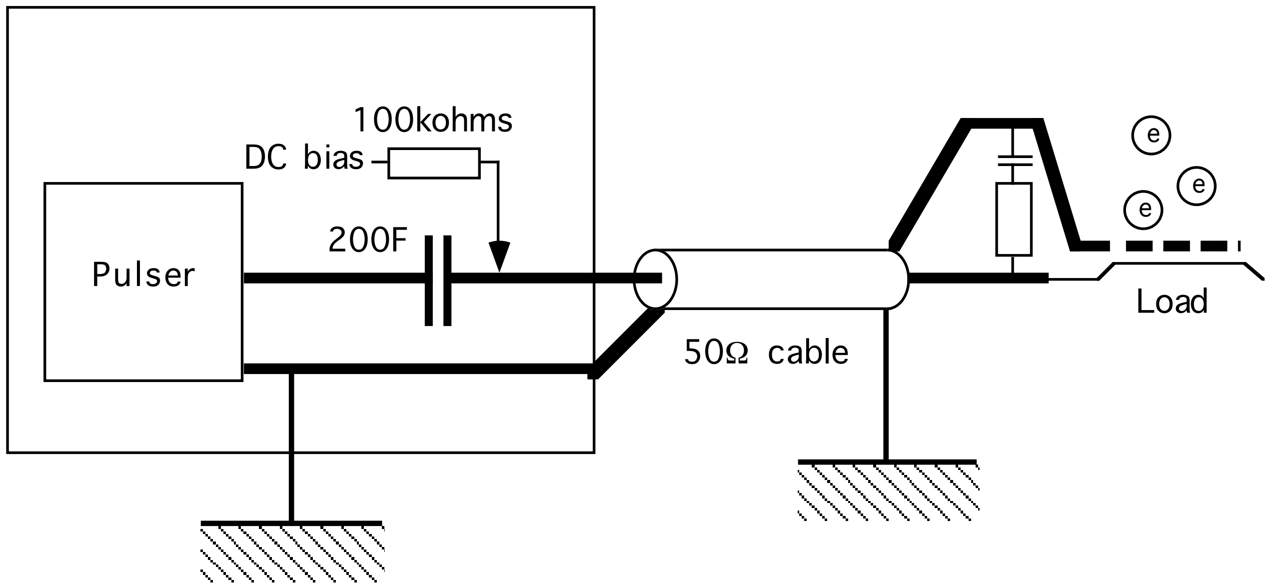
ii) /16 output - this is a continuous output at approximately 31MHz, being divided down from the 500MHz RF input

iii) Prop monitor - this is proportional to the pulse output and is a divided down monitor of the burst output (without the DC bias).

NB A quantitative measurement of the pulse output should be made with external attenuators.

In order to maintain the amplitude and phase of the output pulses during a burst, there is internal circuitry to compensate for droop and phase drift during the burst. These adjustments are set in the factory but are available on the circuit boards in the pulser.

Possible termination arrangements:



There is a resistor in series with a capacitor shown at the electron gun to make the load close to 50Ω. This must be chosen to minimise reflections up and down the connecting cable. (A typical value is 100Ω).

Specification

Bias decoupling	Internal decoupling capacitor, >=500V hold off.
Polarity	Negative
Pulse width (100V above -ve peak)	1ns to 1.5ns front panel control
Amplitude Vpeak	~200V adjustable from front panel
Output frequency	31.21MHz +/-1%
Input drive	499.758MHz, divide by 16 internally
Macro-pulse width	1 - 20us (slaved to TTL trigger pulse)
Macro-pulse rise time	<=0.4us
Macro-pulse PRF	100Hz
Negative noise pulses	Zero (with bias applied)
Positive noise pulses	<= 60V (with bias applied)
Output when TTL trigger is low	<= -40dB
Amplitude stability	<=2% (see adjustment)
Jitter	<=22ps
Phase stability (WRT 500MHz)	<=22ps (see adjustment)
Output cable	50ohms
RF drive	500MHz, 50ohm, 0.5 to 1.0 volts peak (2.5 - 10mW)
Power supply	100 - 220V ac 50/60Hz, ≤100VA
Size	19” rack, ≤4U, ≤397mm deep.

Connections and controls

Output	N	-200V pulse plus DC bias
Bias input	BNC	≤ +/-500V, 100kΩ to load
Trigger input	BNC	5V, +ve edge
Sync output	BNC	5V pulse
/16 output	BNC	5V RF
Prop monitor	BNC	~2V, proportional to output
Triggered light	LED	
RF active light	LED	
Power light	LED	
AC power on/off	Rocker switch on front panel	
AC power input	Filtered IEC on rear panel.	

Droop and compensation adjustment.

NB - When the cover is removed the ac wiring is exposed. Although this wiring is insulated the user should take great care to avoid contact with live wiring. These adjustments should only be carried out by a qualified electronics engineer.

Amplitude droop compensation.

The potentiometer marked “Amplitude droop compensation adjustment” allows the amplitude at the end and the start of the burst to be matched.

Phase drift compensation.

Phase drift can be compensated in either direction during the burst. The switch marked “Phase slide compensation enable” switches phase compensation on and off. The switch marked “Phase slide direction setting” changes the direction in which the phase compensation circuit slides the phase during the pulse.

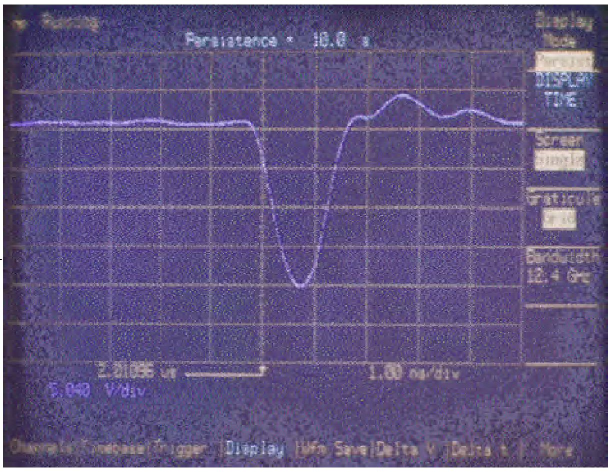
The potentiometer marked “Phase gain adjustment” sets the magnitude of the phase shift compensation during the burst and should be set to match the phase at the beginning and end of the burst.

As shipped the amplitude and phase adjustments are set however the user may which to trim these adjustments. The relative phase adjustment is difficult to measure to great precision and it may be more appropriate to make this adjustment with the pulser installed in the accelerator.

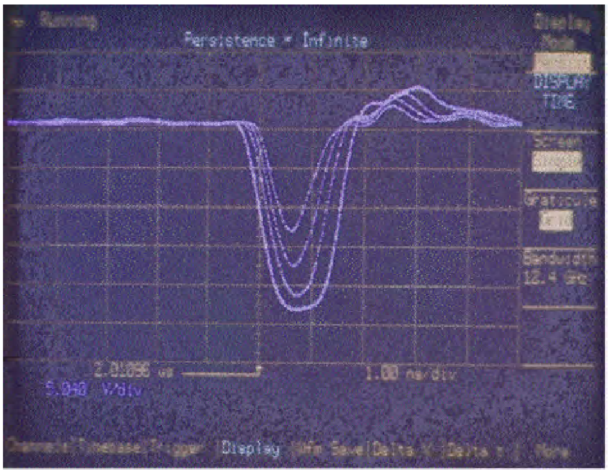
Note that the “Phase gain adjustment” may change the end AND start phase of the pulse output so when making this adjustment be sure to check the CHANGE in phase during the burst, rather that the absolute phase at the end of the burst.

Test data - xxxx
50V/division, HP54120A

50V per division

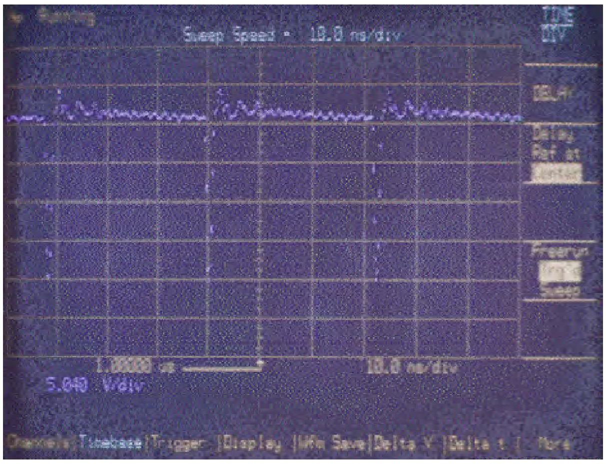


1ns per division

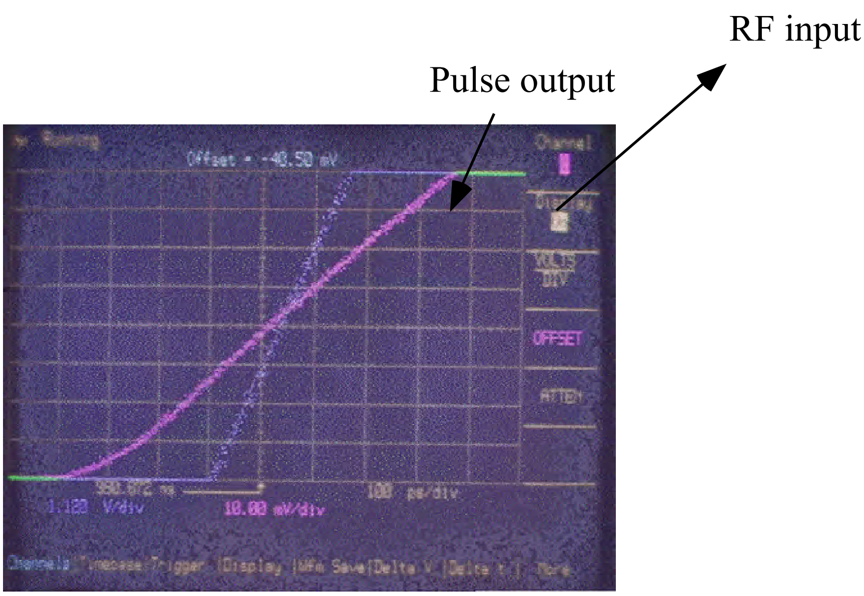


Showing the effect of the pulse width control

Test data - xxxx
50V/division, HP54120A

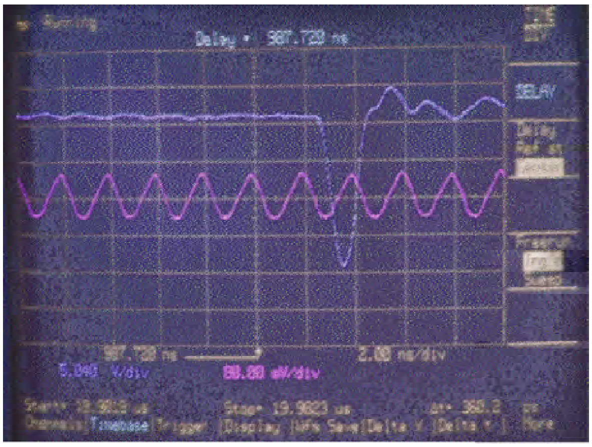


Showing the signal behaviour between pulses

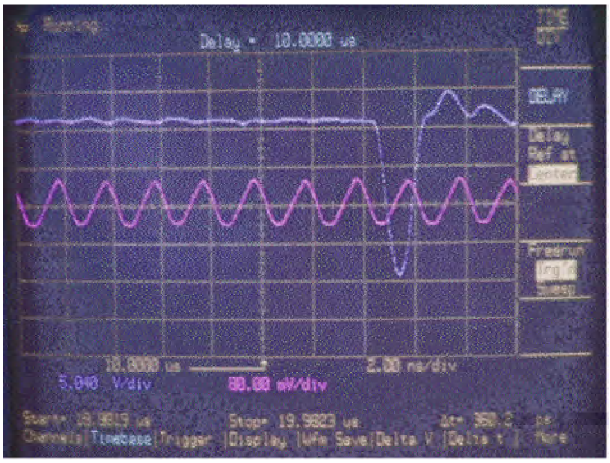


Showing the jitter with respect to 500MHz input (approx 10ps RMS)

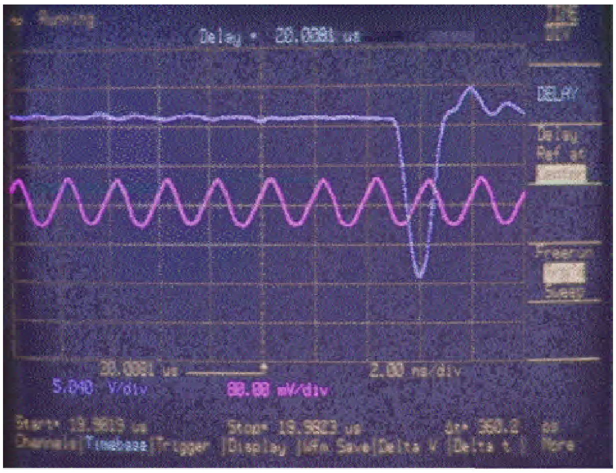
Test data - xxxx
50V/division, HP54120A



1 microsecond



10 microseconds



20 microseconds

Showing the RF and the pulse output at various times during the burst

Phase and amplitude trimmer adjustment positions