Kentech Instruments Ltd

High frequency special burst grid pulser

Sections:
i) Figure of completed pulser
ii) Operation manual
iii) Test setup
iv) Test results

(special)
12/5/04

Kentech Instruments Ltd., Unit 9, Hall Farm Workshops,
South Moreton, Didcot, Oxon, OX11 9AG
VAT Registration number: 394 5266 20
Registered in England No. 1742794
Registered office: Offce 6a, 1st Floor, Popin Business Centre,
South Way, Wembley HA1 1TG.

Directors:
P.A. Kellett BA (Oxon.),
J.D. Hares PhD
A.K.L. Dymoke-Bradshaw PhD,
(tel+44 1753 64 7223 fax +44 870-135-9454)

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Notes on the use of

High frequency burst grid pulser

(J22 and 89MHz)

12/5/04

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Specifications

Micropulse amplitude	50 to 140V adjustable
Polarity	Negative
Amplitude stability	Similar to previous FEL pulsers
Micropulse shape	The impulse is the part of the pulse which is more negative than the noise between pulses. Normally the injector will be biassed above this noise level. The pulse width at the half height of the negative impulse is <500psecs FWHM.
Trigger jitter	<=10ps RMS with respect to the RF input
Macropulse width	Programmable from 0.2us to 12us in steps of 20nsecs
Load	Electron gun, nominal 50 ohms but tolerance of a mismatch
Control	Remote - RS232

Functions
- Amplitude
- Macropulse length
- Micropulse frequency (low or high)
- Enable/disable
- Read triggering status

Inputs:
- Trigger - BNC
- RF - BNC
- RS232 - 9 pin
- AC power - IEC

Outputs:
- ~1:25 micropulse monitor - BNC
- TTL macropulse monitor (synchronous with RF) - BNC
- Pulse output - N

Micropulse frequency:
- 22.3MHz or 89.2MHz (bandwidth >5%)

Max macropulse frequency:
- Up to 100Hz

Bia	To be provided at the gun. There is no bias decoupling in the pulser.
Size	330 wide x 130 high x 300 deep
Power	100 - 240V ac, 50/60Hz

Operational notes

General

The pulser is driven by a 178.5MHz master clock input. The /2 and /8 frequencies are generated internally and are selected under software control. The macro-pulse trigger is applied to the trigger input. The envelope monitor output is a TTL pulse with a duration equal to the length of the macropulse. The rising edge of this pulse is synchronous with the divided clock and may be used for low jitter scope triggering.

The pulser setup is controlled by the internal microprocessor. At power-up the processor takes the setup parameters from internal EEPROM and sets the pulse width, voltage, divide mode (/2 or /8) and timing compensation. The user can alter the pulser settings via the RS232 link (9600 baud) and can change the power-up settings. (See the software section.)

Description of inputs, outputs and indicators

RF i/p

The RF source should be a sine wave, amplitude between 0.5 and 2 volts p-p. The frequency can be between ~170 MHz and ~190 MHz.

The source must be continuous.

Envelope monitor output

This output is a pulse whose length is equal to the macro-pulse duration. It can drive a 50ohm load to TTL levels and can be used for monitoring or to drive other equipment. The rising edge of this pulse is synchronous with the divided clock and may be used for low jitter scope triggering.

Trigger input

This input initiates the generation of a macro pulse on a TTL rising edge. The maximum PRF is 100Hz. If an excessive PRF trigger is applied, the pulser will reject trigger pulses for approximately 7msecs after generating a pulse output.

Pulse output

The pulse output must be connected to the load via 50ohm high quality cable. The load must be capacitively coupled if a DC bias is required as there is no internal bias blocking capacitor in the pulser and it presents an internal DC path to ground.

The pulser is able to drive non-matched loads however standing waves will affect the noise level between pulses. We suggest that a passive network is used at the injector to optimise the matching. Typically this will be a 100ohm resistor in parallel with the gun at the injector.

The pulser will not be damaged by a mismatched load and the pulse generator circuitry is partially isolated from reflections and is tolerant of a mismatch.

Proportional monitor

The proportional monitor is a divided replica of the main output. The attenuation is approximately 25:1 into a 50ohm load.

NB This output is not suitable for a quantitative measurement of the pulse output. Use high

quality attenuators for this purpose.

RS232

The internal microprocessor is controlled by a 9600 baud RS232 serial link. This is connected to the 9 pin D connector as follows:
PIN 2 Data from pulser
PIN 3 Data to pulser
PIN 5 Ground

Communications are in ASCII codes. Commands to the pulser are all upper case. There is a HELP function in the pulser. Type HELP followed by carriage return <CR> and the pulser will list all the control functions. Connect a terminal or computer with a terminal emulator programme to the D connector. Simply type commands to the pulser. It should respond to a carriage return with 'ok'. The microprocessor is programmed in FORTH and the FORTH system is active at startup. The syntax of commands is listed by the HELP command. If there is no response check the serial link and check that the pulser is powered. The pulser can be operated without any signal inputs or outputs (except RS232) in order to test these communications on the bench.

/2 and /8 indicators

These show which divide mode is active.
NB they will not be illuminated if there is no RF input present.

Triggered LED

This flashes each time a trigger signal is received.

POWER (Toggle switch and LED)

Switches ac power to the pulser. The LED is illuminated when the pulser is powered. The power supply should be 95 - 110 volts, 50-60Hz. Power consumption is ~40 watts.

NB - After applying power it will take some time for the pulser to reach an equilibrium temperature so the output phase stabilizes. The output amplitude may be slightly reduced at switch-on. It is suggested that the pulser is switched on at least 15 minutes before it is required.

Timing stability during the burst

There are slight timing drifts in the pulse circuitry during the burst. In order to correct for these effects there is timing compensation circuitry which provides a compensation delay change during the burst. The magnitude of the correction is set under software control.

As shipped the pulser is set so the phase of the output pulses match the phase of the 178MHz RF input throughout a 12us burst. The user may adjust the compensation via the RS232 link. The compensation is different for the two divide modes and the magnitude of the compensation is stored in EEPROM. There are simple commands to changes these settings.

Software

At power up the pulser copies the pulse width, voltage and divide mode from EEPROM and starts in ENABLE mode.

Settings may be changed via the RS232 link as below. These settings will only be active until the power is removed unless they are stored in EEPROM using the EE!SETUP command.

List of commands:

All functions are upper case.
Numbers are integers.
Insert a space between numbers and the command.
Terminate all commands with a carriage return <CR>.

Functions:	Argument range	Action
HELP	none	On line help
ENABLE	none	Enable the pulse output
DISABLE	none	Disable the pulse output
xxx !VOLTS	50 - 145	Set the pulse voltage
xxx !PW	200 - 12000	Set the pulse width in nanoseconds (rounded to nearest 20ns)
DIV2MODE	none	Set /2 mode (89.2MHz)
DIV8MODE	none	Set /8 mode (22.3MHz)
EE!SETUP	none	Save current settings to EEPROM
xxx EE!SLIDE	-100 to 100	Set the timing compensation and store in EEPROM
?SLIDE	none	Report the slide value
.STATUS	none	Report the current status

The internal microcontroller runs a FORTH operating system and all commands are FORTH definitions. The successful execution of a command is followed by the ‘ok’ prompt. A carriage return on an empty line will also cause an ‘ok’ response and is a convenient way to check RS232 link activity.

Typical RS232 dialogue:

Key:
Black =command
Red = response
Text in blue is not part of the dialogue

```
High Frequency Burst Grid Pulser    Start up message
Copyright Kentech Instruments 2004
Type HELP for instructions

ok
<CR>  ok
<CR>  ok
<CR>  ok
<CR>  ok
HELP <CR>                           On line help

        ******** HELP **********
All commands are upper case. All values are integers.
Follow each command with a carriage return.

xxx !VOLTS          Set pulse voltage
                    [ 50 - 145 ]
xxx !PW             Set PW in nanosecond
                    [ 200 - 15000 ]
DIV2MODE            Divide by 2 mode
DIV8MODE            Divide by 8 mode
DISABLE             Disable output
ENABLE              Enable output
EE!SETUP            Store current V,PW and MODE in NV memory
.STATUS             Report current pulser setup


More ............

      ****** Saving settings *******
At power up the pulser uses the last stored settings. When
adjustments
are made the values are only stored in RAM and are lost when
the power
is removed. In order to change the power-up settings execute a
EE!SETUP command which saves these RAM settings into
```

electrically
erasable non-volatile memory.

More .....

****** Timing drift compensation *******

xxx EE!SLIDE Fix timing drift
[-100 to 100]

This function adjusts the SLIDE parameter for the active mode and stores it in NV ram.
The SLIDE polarity determines which way the timing is corrected during the burst. The range of adjustment is +/- 100.

In DIV8MODE setting a SLIDE value of 0 fixes the timing adjustment
in the middle of the range.
A negative value causes the timing to start at minimum delay and
slide towards larger delay whereas a positive value causes the timing
to start at maximum delay and slide towards smaller delay.
A value of zero sets the delay in the middle of the range.

In DIV2MODE the adjustment is continuous. The greatest effect on
the delay occurs at the beginning of the burst.

A separate SLIDE parameter may be stored for each mode.

?SLIDE Report the current SLIDE parameter
NB There are separate values for each mode.
ok
<CR> ok
.STATUS *Report the current status*
Enabled
Mode = /2
Output voltage = 145 volts
Pulse width = 12000 ns
No trigger in last 200 msecs *No trigger is applied*
No RF detected *No RF is applied*
ok
<CR> ok
100 !VOLTS <CR> *Set pulse amplitude to 100volts*
ok

```
1500 !PW  <CR>                          Set pulse width to 1.5usecs
 ok
DIV8MODE  <CR>                          22.3MHz mode
 ok
.STATUS  <CR>                           Report the current status
Enabled
Mode = /8
Output voltage = 100 volts
Pulse width = 1500 ns
No trigger in last 200 msecs
No RF detected
 ok
<CR>  ok
?SLIDE  <CR>                            Report the current SLIDE value
40
 ok
0 !PW  <CR>                             Set a PW outside the range
 ok
3000 !VOLTS  <CR>                       Set a voltage outside the range
 ok
.STATUS  <CR>
Enabled
Mode = /8
Output voltage = 145 volts
Pulse width = 200 ns
No trigger in last 200 msecs
No RF detected
 ok
<CR>  ok
30 EE!SLIDE <CR>                        Set the timing compensation
                                        value for the active divide mode
 ok
```

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Test data

High frequency burst grid pulser

(J03***** - 22 and 89MHz)

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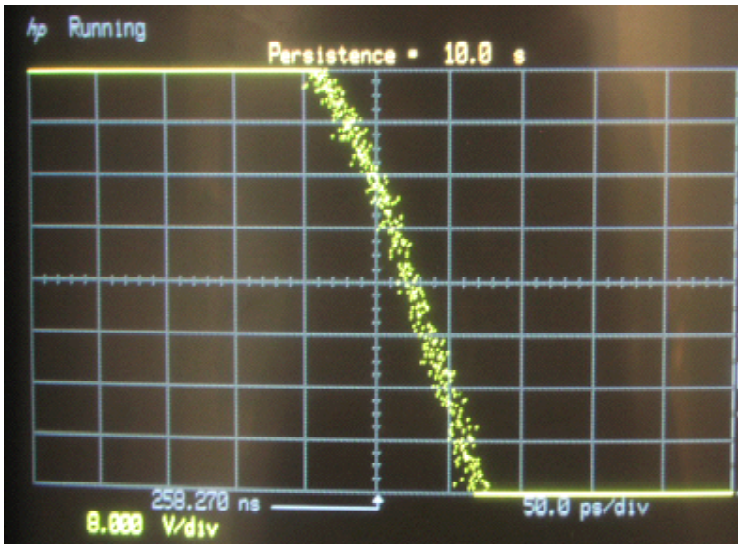
Test equipment

HP54120 sampling scope, HP54121 test set, HP8340B signal generator
Barth 142 10x, SMA 5x, SAM 10x
Kentech rate generator

xxxx test data

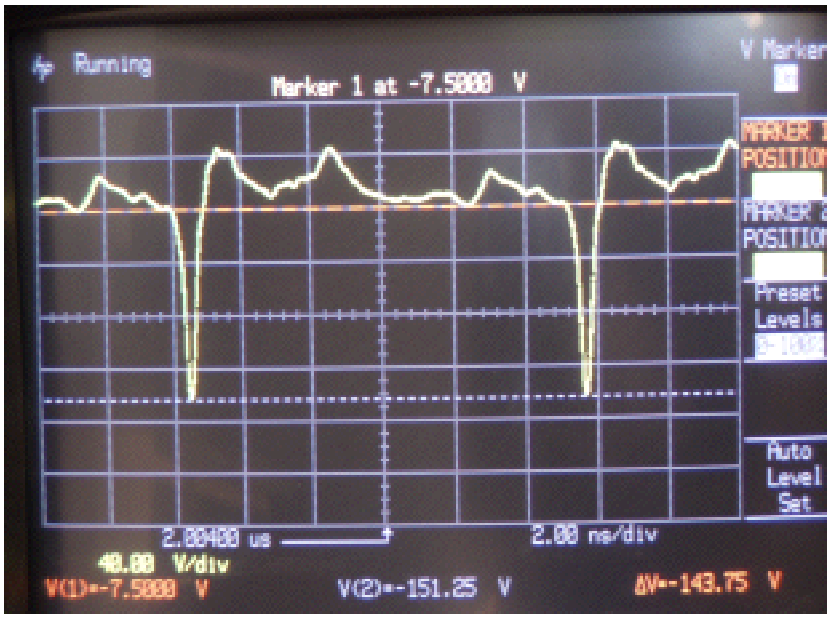
Timing jitter:

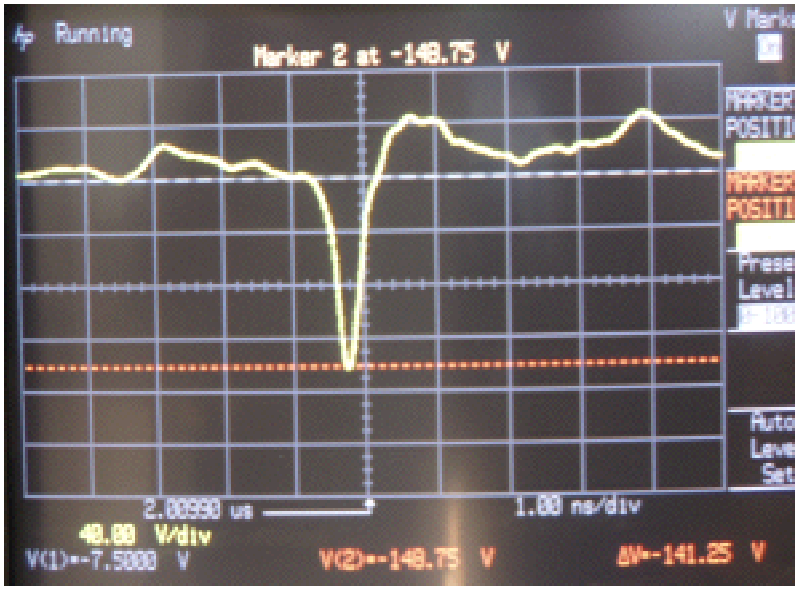


Showing the timing jitter with respect to the 178MHz clock input

xxxxxxxx **/2 output**

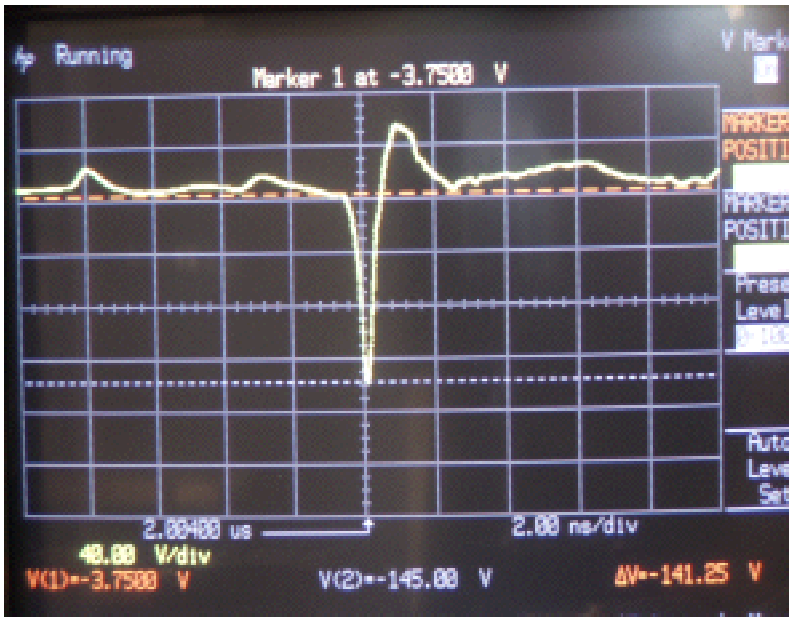
Attenuation = 500x

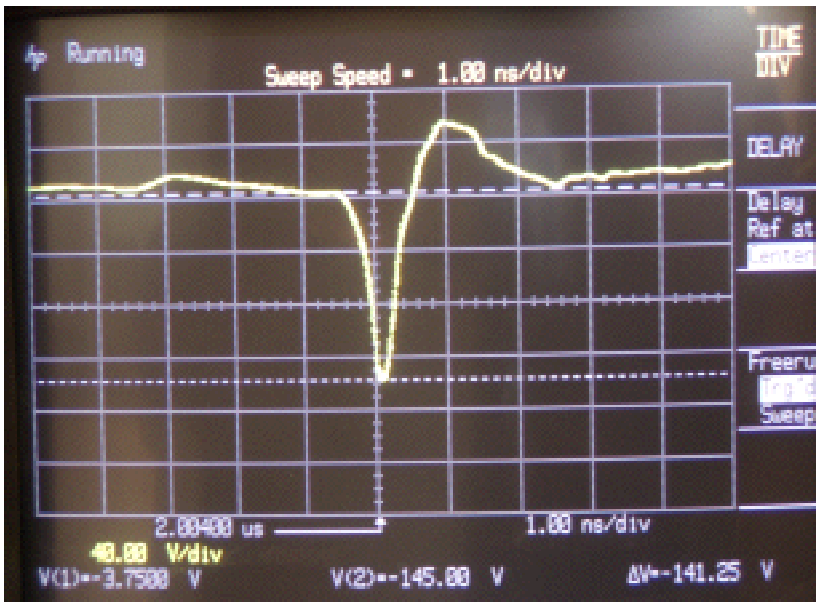




xxxxxxxx **/8 output**

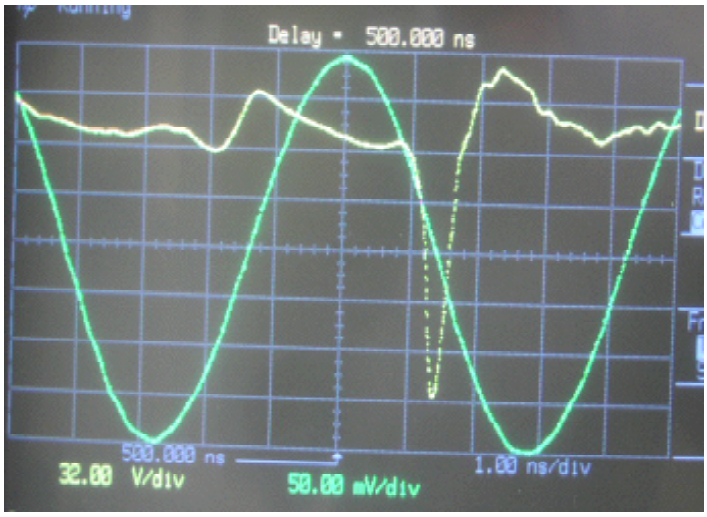
Attenuation = 500x



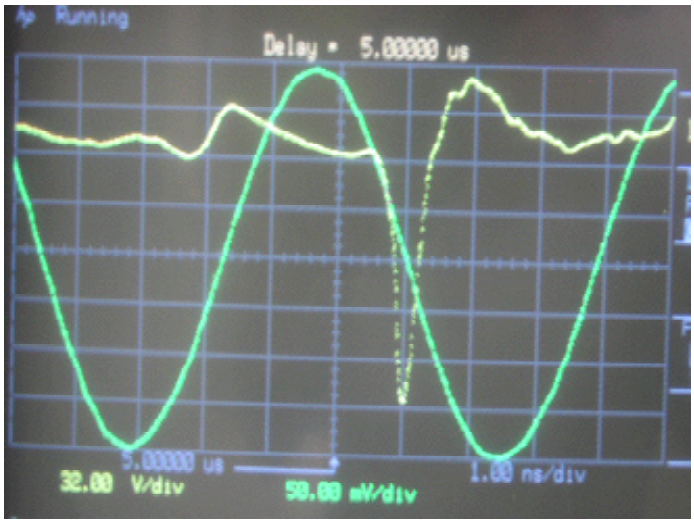


xxxxxxxx **Pulses with RF input**

Start of burst



Middle of burst



End of burst