Kentech Instruments Ltd.

High Rate Pockels Cell Driver

PLEASE READ THIS MANUAL CAREFULLY BEFORE USING THE PULSER

DISCLAIMER

This equipment contains high voltage power supplies. When covers are removed a dangerous high power 500 volt supply will be exposed together with ac power.

Do not operate the pulser with any cover removed.

Careless use could result in electric shock. It is assumed that this highly specialised equipment will only be used by qualified personnel.

The manufacturers and suppliers accept no responsibility for any electric shock or injury arising from use or misuse of this equipment. It is the responsibility of the user to exercise care and common sense with this highly versatile equipment.

INTRODUCTION

This manual describes the operation and use of the high repetition rate pockels cell driver. The pulser is designed to produce fast rise and fall pockels cell drive pulses at an amplitude up to 1.6kV. The rise and fall time are sub nano-second and the maximum repetition rate is 225kHz. The average power in the output pulse can reach ~75watts so a suitably rated load must be used. The pulse width is adjustable from ~1ns to ~4.5ns and all pulse parameters are set via a front panel LCFD/keypad. In addition RS232 and ethernet interfaces allow remote control of the pulser.

The output from the pulser has a high peak power and will damage test equipment if not attenuated or terminated suitably.

A proportional monitor signal is provided at the front panel. This is divided down from the high voltage output and is a good indicator of correct operation. Note that the bandwidth of this output is limited and it is not an accurate representation of the HV output. The monitor signal is reproducible however and may be used to confirm correct operation of the pulser and the load.

SPECIFICATIONS

Output	Positive going pulse into 50Ω
Voltage range	0 to >1.6kV
Maximum repetition rate	225kHz
Pulse width range	~1ns to ~ 4ns
Rise and fall time	<1ns, 10%-90%
Flatness and post pulse noise	<5%
Fast undershot adjustment	~ +/- 5% to adjust undershoot on falling edge to <2.5%
Trigger	-ve 0.8V edge, 50ohms
Monitor	Divided from HV output, ~1:200, 8V maximum into 50ohms NB this has limited bandwidth and should not be used for pulse shape measurement
Trigger input	-0.8 volt into 50Ω triggers on negative going edge
Trigger delay	~38ns
Jitter	~7ps RMS
Power input	Universal 90 to 264 volts A.C. at 47 to 63Hz. 10 amp fuse, type T (anti-surge) for ≥ 180 volts 15 amp fuse, type T (anti surge) for < 180 volts This unit contains an auto-resetting thermal trip rated at 70°
Maximum average power input	~500 watts at maximum trigger rate and maximum voltage.

Connectors	
Power	IEC
Trigger input	BNC
Monitor output	SMA
Main output	N
Ethernet	RJ45
RS232	9 way D sub

Indicators	
AC power	LED
Enabled	LED
Triggered	LED
Display	LCD

Controls via:
Keypad
RS232
Ethernet

GETTING TO KNOW THE INSTRUMENT

The pulser consists of a power supply, a trigger circuit and an array of 16 output stages each delivering ≥ 400 volts into 50Ω. These are combined in a transformer to deliver the full output voltage of >1.6kV.

The power supply delivers fixed voltages to the various components and a 0 to 500 volt supply to the output stages so that the pulse amplitude can be adjusted.

All pulse parameters are set via a front panel LCD and keypad with an embedded controller. This allows the setting of:

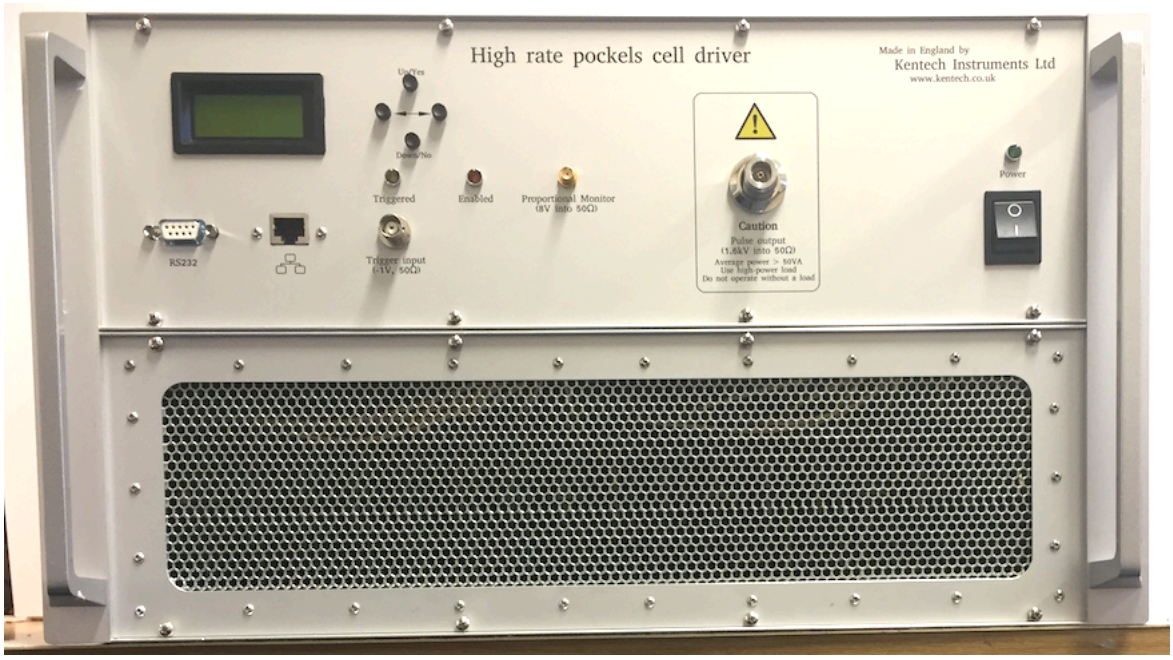
Amplitude	0 to >1.6kV
Pulse width	~1ns to ~4ns
Trigger mode	inhibit/enable
Tail	fast undershoot compensation
Communication channel	Ethernet or RS232

The trigger circuit processes the incoming trigger signal, prevents multiple triggers, sets the desired pulse width and delivers the trigger pulse to trigger distribution transformers which drive the 16 output stages.

Each of the 16 output stages uses a Blumlein pulse forming network to produce the two fast edges at an amplitude ~400V. The rise and fall time of the pulse is <1ns.

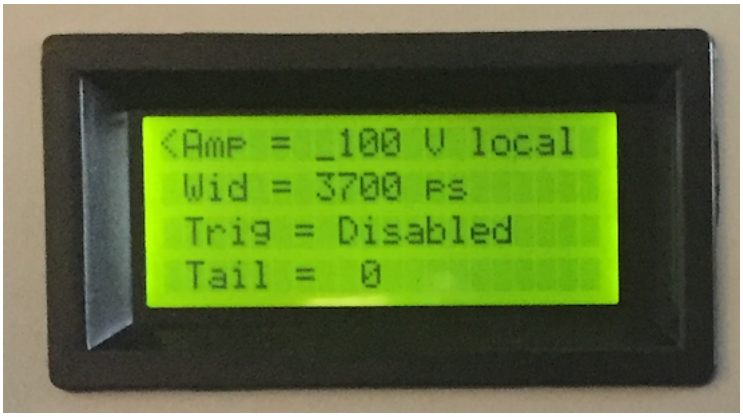
All aspects of the pulser operation are controlled via an embedded controller. This operates the front panel LCD and the communication interfaces. At power up the unit is controlled via the LCD and keypad.

Front panel controls, connections and indicators



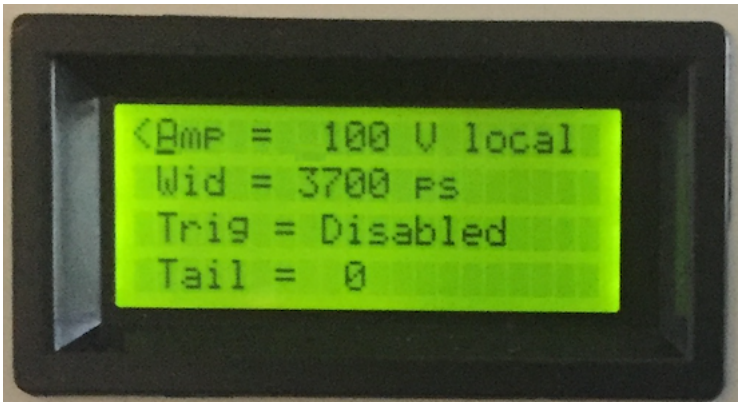
Front panel

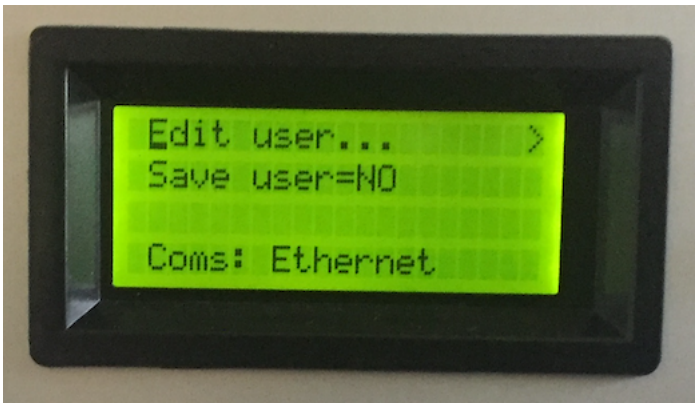
All pulser parameters are adjusted by placing the cursor below the parameter to be edited then using the up and down arrows.



In this screen the amplitude, width, trigger mode and tail (undershoot compensation) parameters are set.

The second page is accessed by navigating off this first page from the top left hand corner....





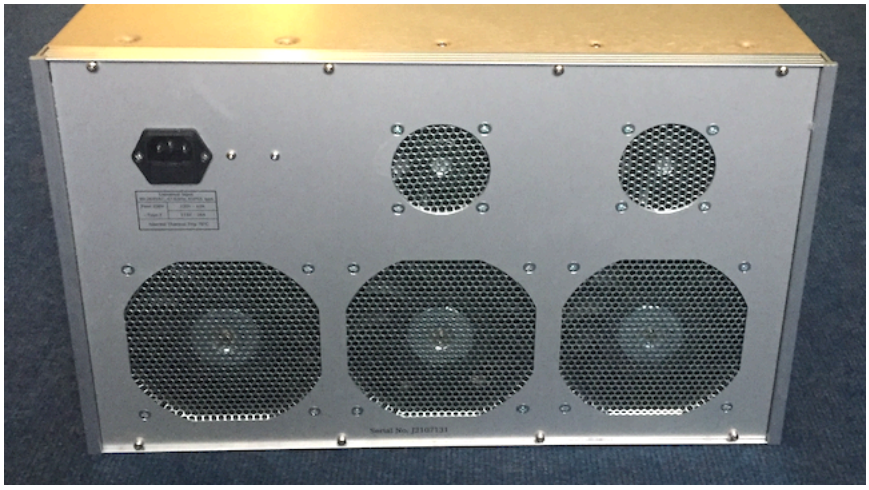
On this page the user can save the current pulse settings by changing NO to YES. These will be restored the next time the power is cycled.

The communications port is also selected on this page. This can be Ethernet, RS232 or USB.

The USB port is internal however and only used for engineering functions.

Rear panel

The only connection to the rear panel is the IEC power inlet. This also houses the ac fuse.
It is very important that the rear panel air inlet and front panel exhaust holes are not blocked or restricted. Good airflow is required to maintain the power supplies at their normal operating temperature.



Rear panel

Use

The unit should only be used with a suitably rated matched load, i.e. 50 Ω rated at ~100 watts. The fast edges mean that the load should be well matched at >1GHz or pulse distortion may occur.

Do not operate the pulser into an open or short circuit.

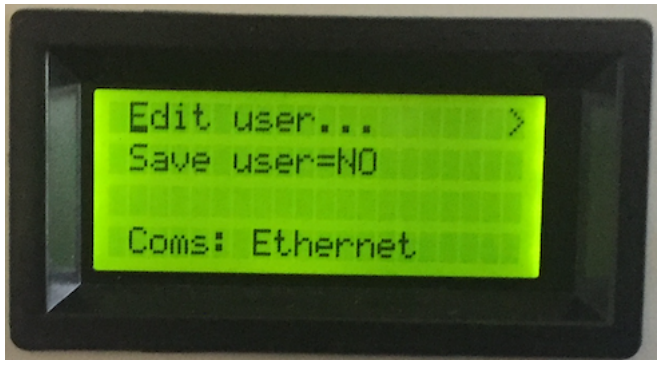
The unit needs only, power and a suitable trigger signal. As the trigger input is AC coupled any negative going edge is adequate (~ 0.8 volts into 50Ω).

It is very important that the rear panel air inlet and front panel exhaust holes are not blocked or restricted. Good airflow is required to maintain the power supplies at their normal operating temperature.

The pulse width changes slightly as the repetition rate is increased. Between 1kHz and 220kHz the pulse width will increase by approximately 200 psecs. See test data,

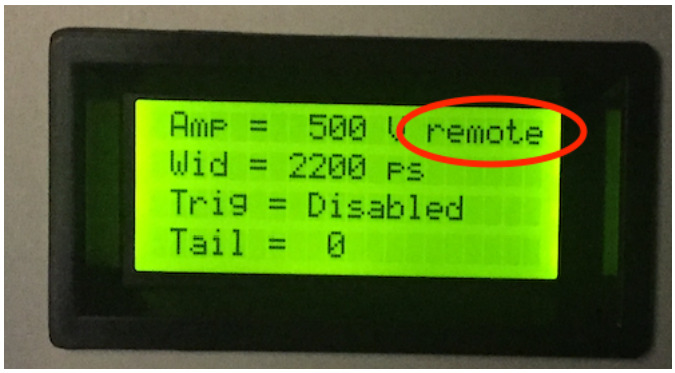
Remote control

All pulse parameters can be controlled via one of the communication interfaces. Choose the interface to be used here:



This is saved in EPROM on exiting the line.

The unit will respond to the first character it receives and will go into remote control mode:



The unit will now respond to commands sent via the serial link (TCP/IP or RS232). Use a terminal application such as Hyperterminal to drive the chosen interface.

There is a help function which describes the commands. Simply type help to the pulser and all commands are listed.

To return to local control (front panel LCD and push buttons) send the
local
command.

Note that all commands are followed by a carriage return.

Below is a record of a remote control session captured in the terminal application.

Command dialogue
Blue is the sent command and red is the returned text. All commands are followed by <cr>.

The green text is an explanation of the command and is not part of the dialogue.

These commands are common to the Ethernet and RS232 interfaces. The RS232 interface is set to 115200 baud, no parity, no flow control. The baud rate can be changed if necessary - consult factory.

After the first character is sent the pulser replies with the first red text. It then waits for commands:

```
*********************************
MPE ROM PowerForth for Cortex-M3
v7.06 [build 0480] 10 Mar 2022, 16:56:57
*********************************
11292 bytes free

  ok
help           print all the commands
Pulse control commands
xxx !enable    - enable/disable, xxx = 1 or 0
xxx !amplitude - set the amplitude, xxx in volts
xxx !width     - set the pulse width, xxx in psecs
xxx !tail      - set the undershoot value, xxx = 0 to 50

?enable        - return the enable status
?amplitude     - return the amplitude
?width         - return the width
?tail          - return the undershoot value

?triggering    - return the triggering status

Fine delay control, approx 2ns range
xxx !delay     - set the delay, xxx = 0-400, arbitrary units
?delay         - return the delay

Engineering commands:
?serial        - return the serial number
.status        - report internal settings
.cal           - report the calibration parameters
.user          - report the user setting
 ok
  ok
1 !enable  ok              enable the pulser
1500 !amplitude  ok        set the amplitude to 1500V
2500 !width  ok            set the width to 2500psecs
  ok
?enable 1  ok              check the enable status
?amplitude 1500  ok        check the amplitude
?width 2500  ok            check the pulse width
  ok
.status                    check all the internal parameters
Enable =       1
Triggering =   0

Amplitude =    1500
Width =        2500
Tail =         0
```

```
PSUs_enabled = 15
psu_fine =     7

Current =      0 mA
Voltage =      485 volts

PSU temp =     1906
Timing temp =  1902

pwm0 =         200
pwm1 =         400
pwm2 =         263
pwm3 =         1000
 ok
local                  return to front panel control
```

Ethernet interface

The ethernet interface is provided by a Lantronix Xport module. This is set up to obtain an IP address via DHCP however it can be configured to have a fixed IP address.

The default port for TCP/IP is 10001

e.g. 192.168.2.222:10001

There is a set up application available from Lantronix here:

http://www.lantronix.com/products/deviceinstaller/

which can be used to set a fixed IP address.

The MAC address is 00 80 A3 E2 89 F4

RS232 interface

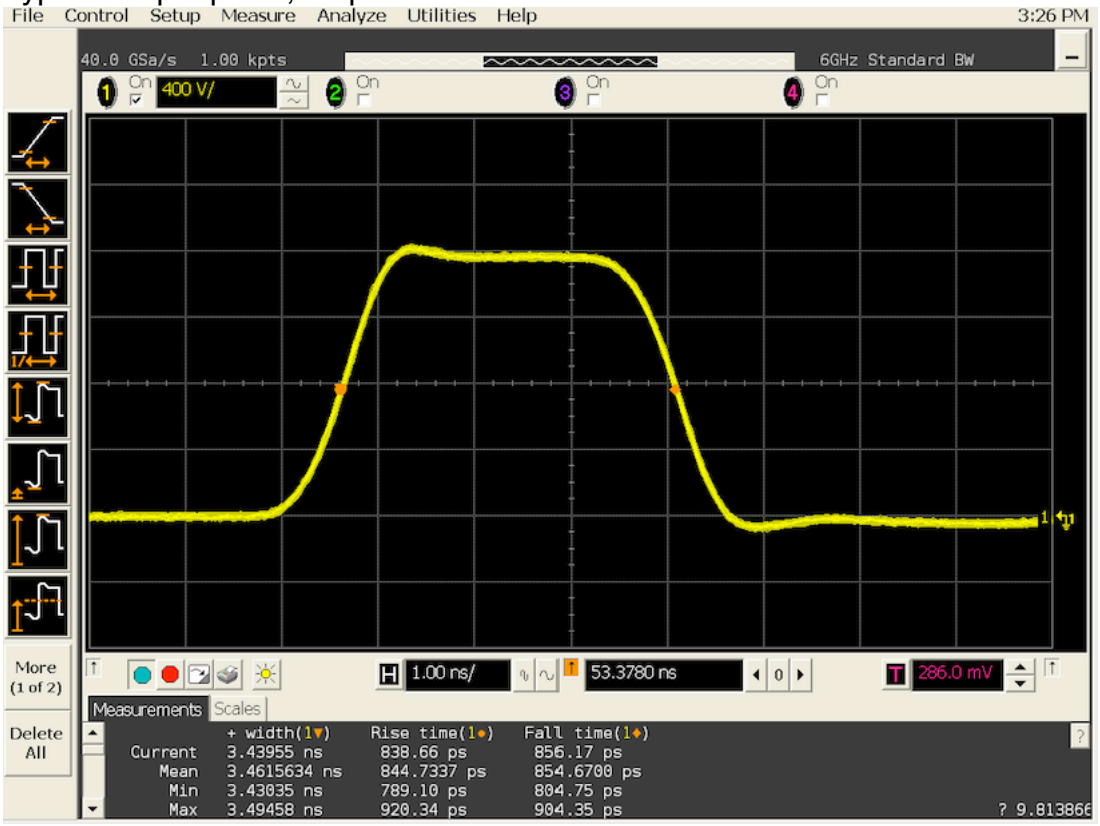
The RS232 interface is set to 115200 baud, no parity, no flow control. The baud rate can be changed if necessary - consult factory.

Test data

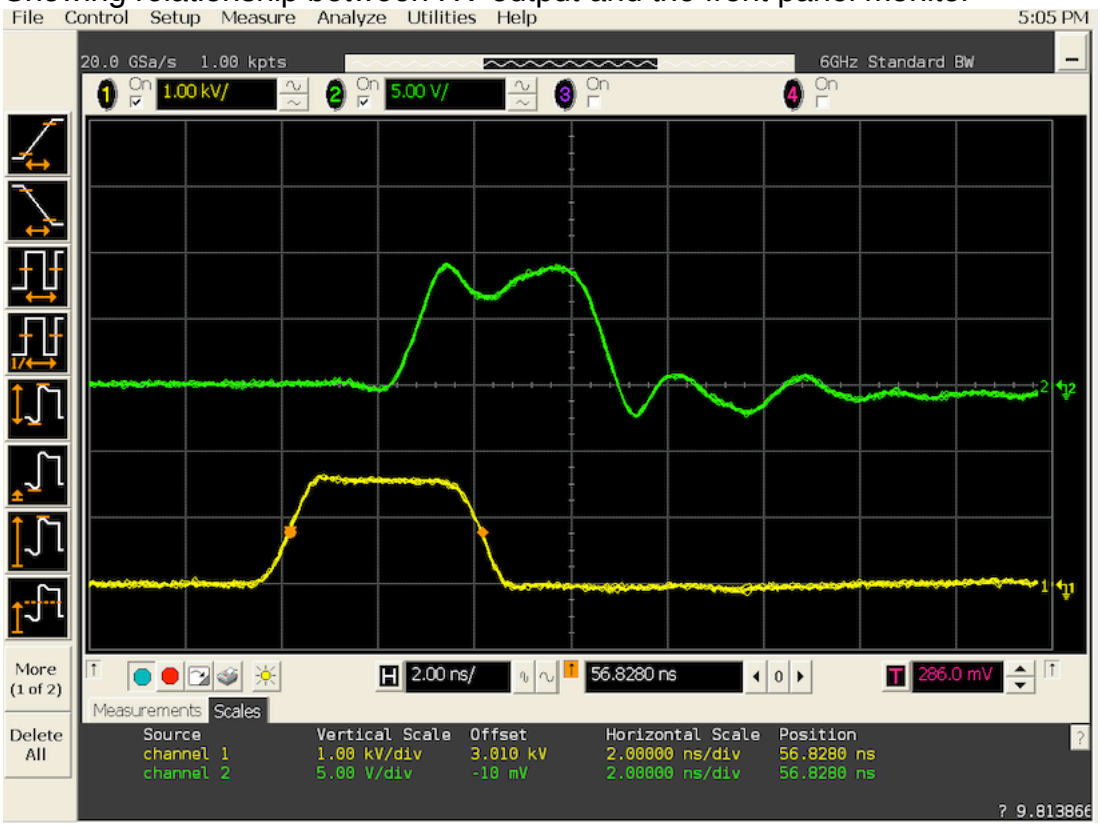
High fidelity waveform records were taken at 1kHz using a 10GHz attenuator chain. High repetition rate waveform were taken using a Bird/Tenuline 8329-300 high power attenuator.

1kHz, 2 x 20dB Barth 142, 1 x 20dB radial, Infineon DS80604B

Typical output pulse, amplitude set to 1600V

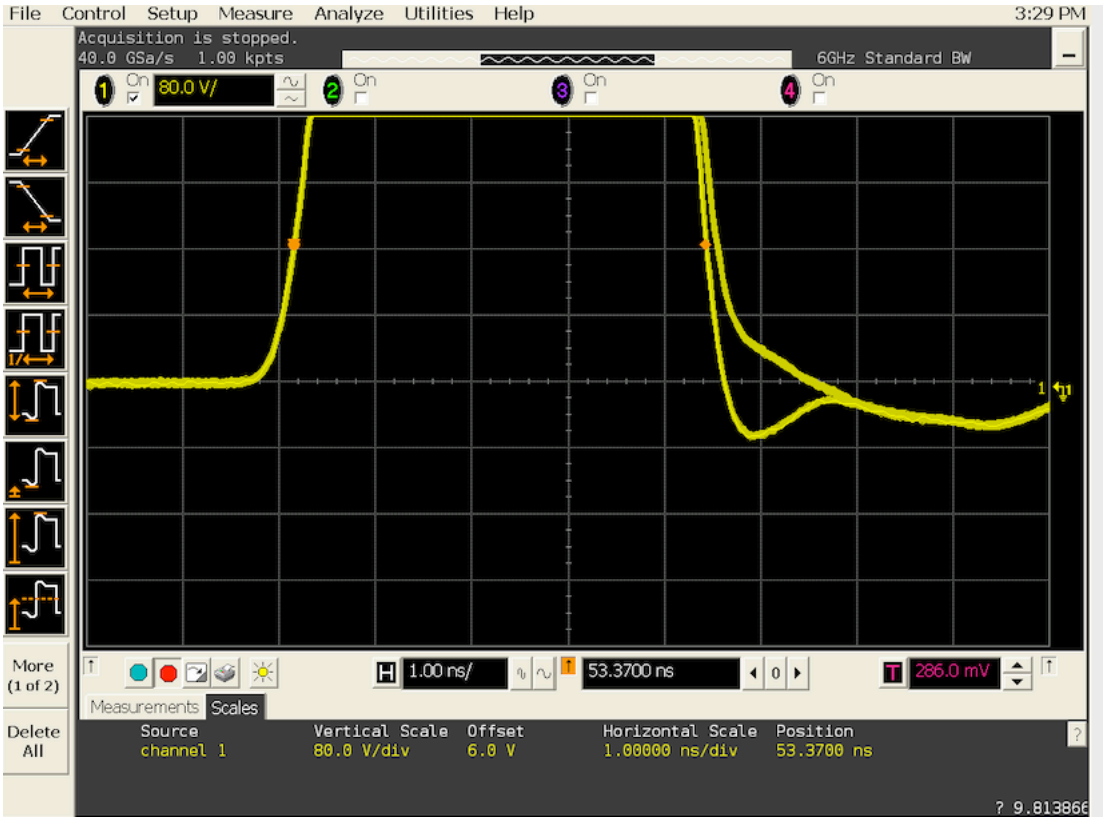


Showing relationship between HV output and the front panel monitor

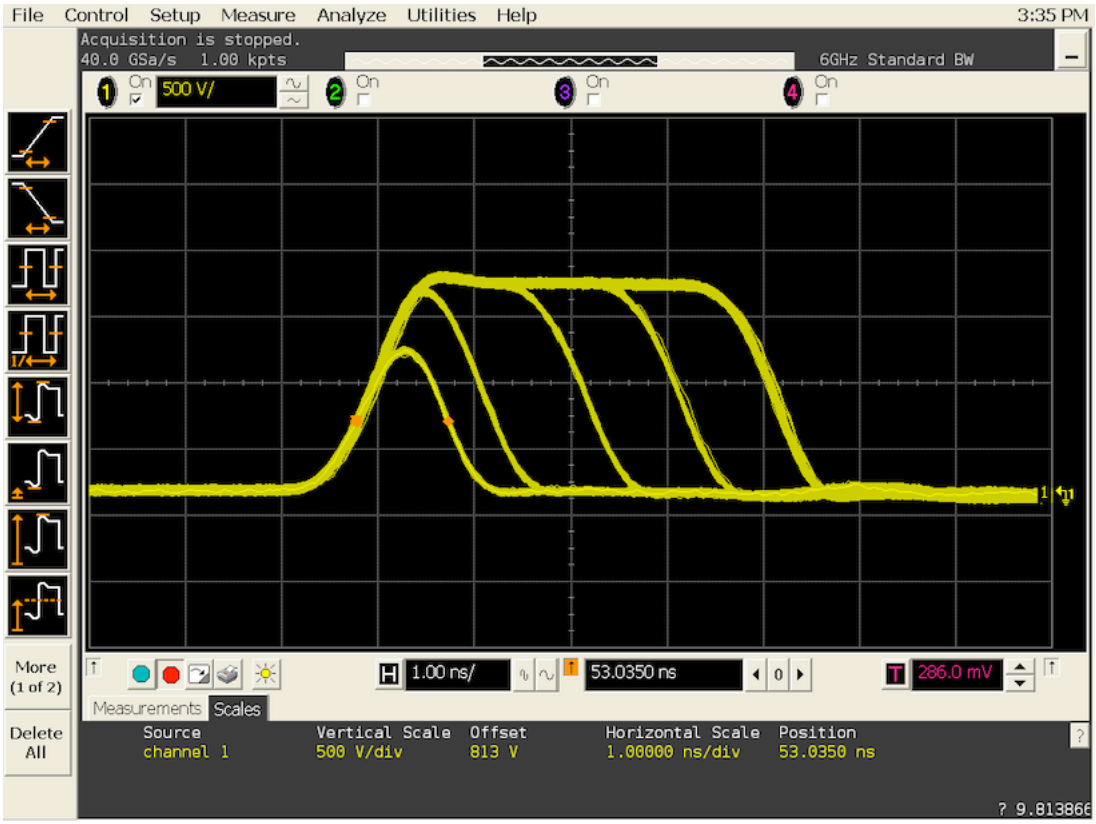


Post pulse noise at 80V, 5% per division

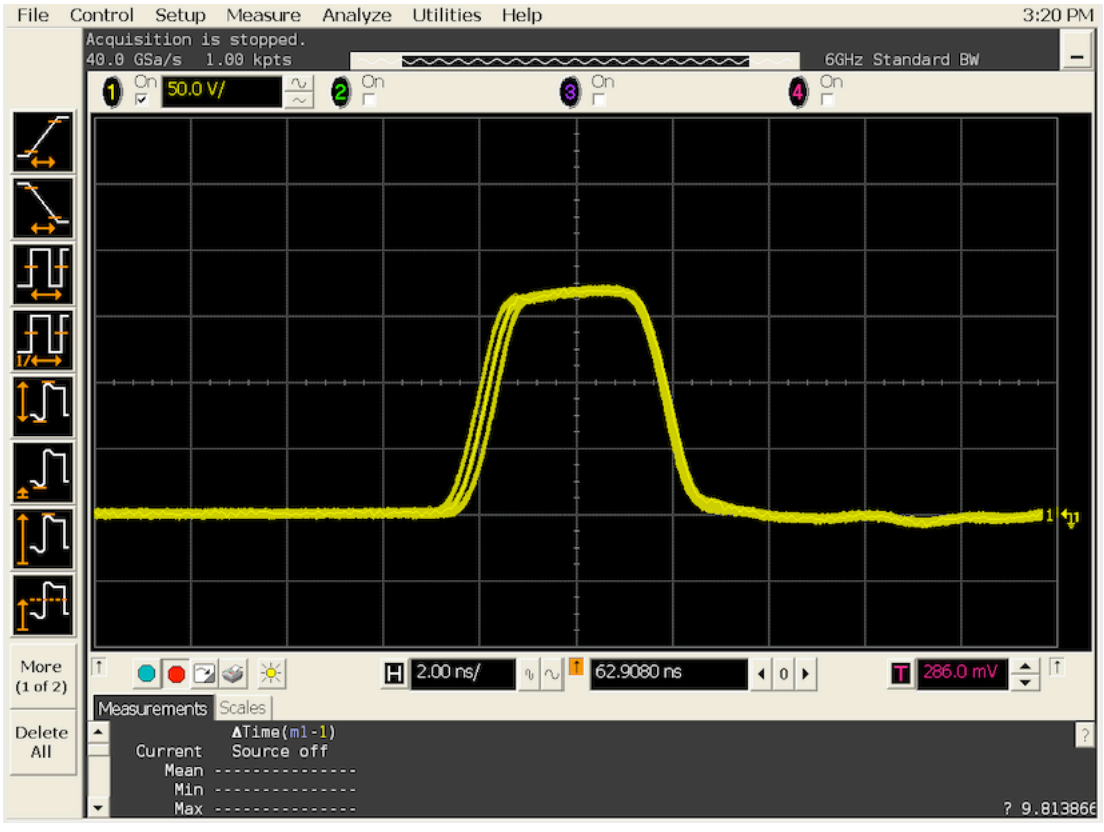
Effect of tail control (fast undershoot compensation) at 80V, 5% per division



Various pulse widths

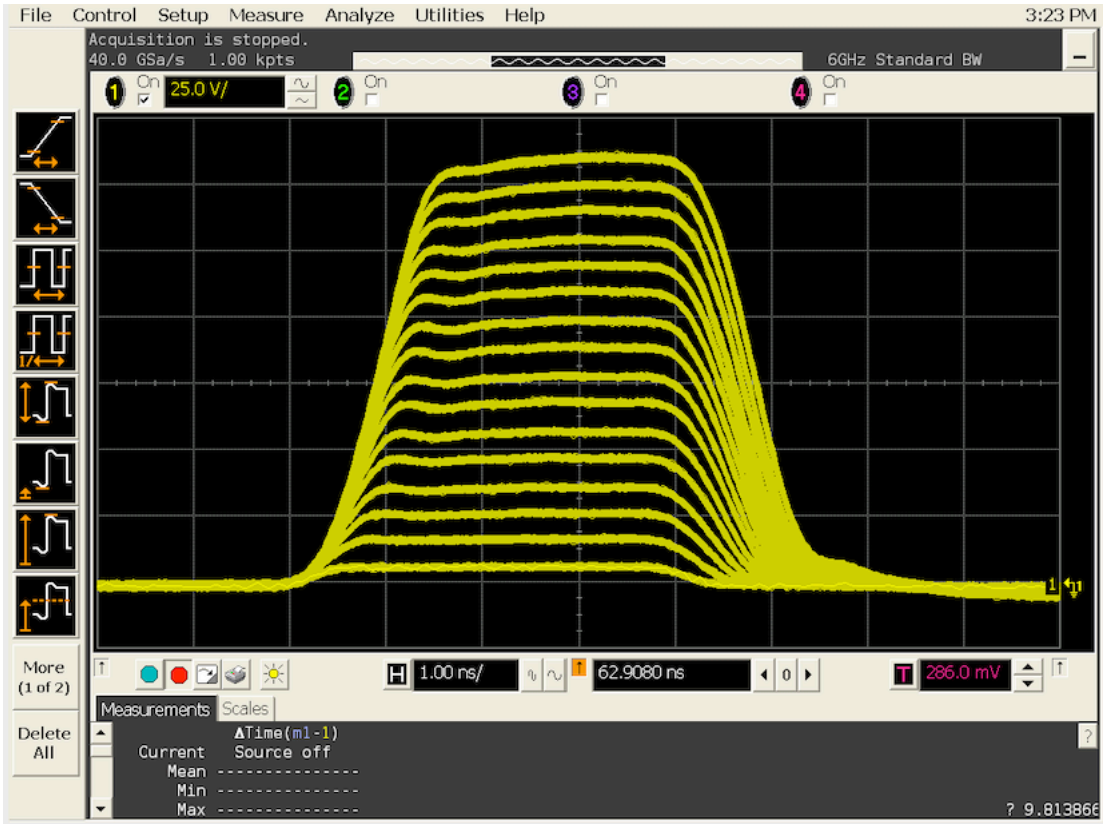


Pulse width change with increasing repetition rate
Repetition rate = 220kHz, 120kHz, 20kHz. Highest repetition rate = longest pulse duration
500V per division

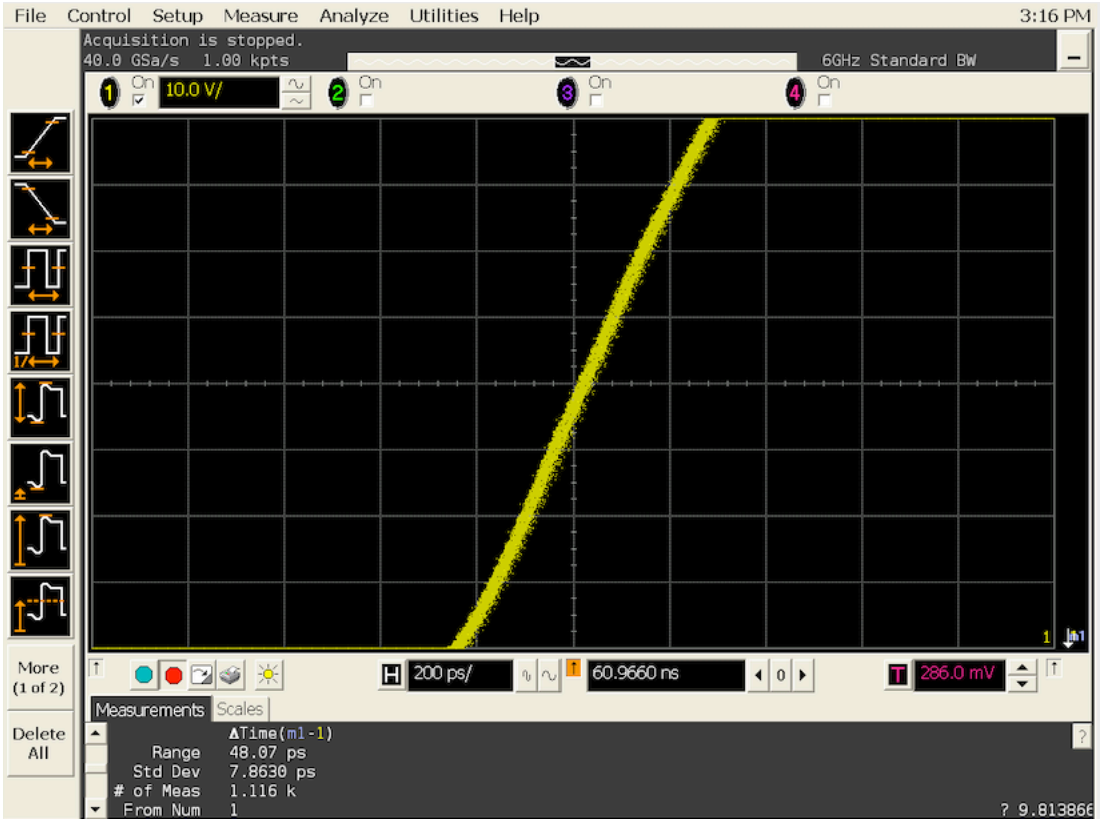


220kHz, 30dB Bird, 20dB Barth 142, 20dB radial, Infineon DS80604B

Various amplitude settings at 220kHz
250V per division



Jitter at 220kHz



Pulse width change with increasing repetition rate

Repetition rate = 220kHz, 120kHz, 20kHz. Highest repetition rate = longest pulse duration

500V per division