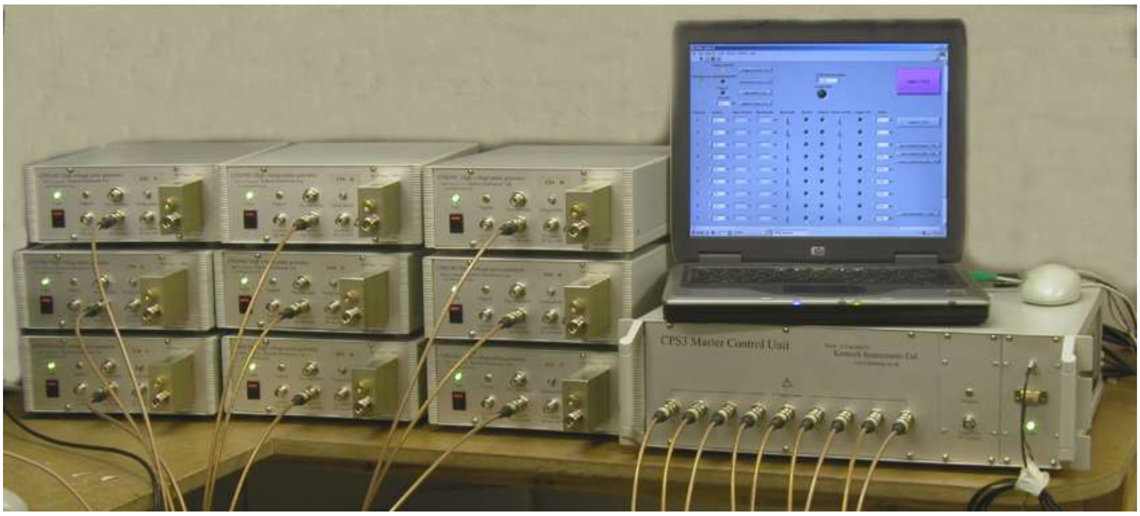
Notes on the use of

Kentech Instruments Ltd.

9-Channel Pulser System
Serial number J05*****



26th July 2005

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i) Caution

9-Channel Pulser System, serial number J05*****

This equipment is a research tool that has been intentionally designed to generate high energy electromagnetic pulses and the EM emissions will be highly sensitive to the load applied by the user. Within the EU it is suitable for use only in a sealed electromagnetic environment, unless it is used in a system that has been verified by the system builder to comply with EU directive 89/336/EEC.

With an appropriate load and adequately insulated connecting leads, the 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 be 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 DANGEROUS HIGH VOLTAGES (1kV) PRESENT IN THIS PULSER WHEN THE UNIT IS OPERATING. DISCONNECT THE POWER SUPPLY BEFORE REMOVING THE COVERS.

ii) Disclaimer

This equipment contains high voltage power supplies. Careless can result in electric shocks. It is assumed that this highly specialised equipment will only be used by qualified personnel.

Kentech Instruments Ltd accepts no responsibility for any electric shock or injury arising from use or misuse of this product. It is the responsibility of the user to exercise care and common sense with this highly versatile equipment.

The main output can be very dangerous, particularly when the pulser is triggered at a high frequency. Take great care to insulate the output adequately.

1. Introduction

Our range of solid state high voltage pulse sources allows very high voltage, fast rising pulses to be obtained from compact bench top units. Our avalanche technology allows the generation of 10kV voltage pulses rising in 100ps into 50Ω. Our range of FET pulse generators provides sub-nanosecond switching speeds, kilovolt amplitudes and repetition rates in excess of 1MHz. 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 and versatility. These pulsers will find applications in many fields such as high speed camera research, electro-optic switching, triggering systems, time of flight mass spectroscopy and radar.

2. Description of the 9-Channel Pulser System

The Kentech Instruments 9-Channel Pulser System (J05****) is designed to generate -3kV pulses on nine separate outputs, each with a programmable delay of up to 50ns and a programmable bias voltage in the range +/-500V. The Pulser System is controlled and monitored via a serial interface.

The Pulser System consists of:

- nine high voltage pulse generators (CPS3/M1) which produce the HV output pulses;
- one CPS3 Master Control Unit (MCU) which generates the bias voltages and the delayed HV trigger pulses required by the pulse generators;
- nine Pulse Forming Modules (PFM) which shape the pulse as required by the user;
- RF and power cables;
- LabView control interface software to control the Pulser System.

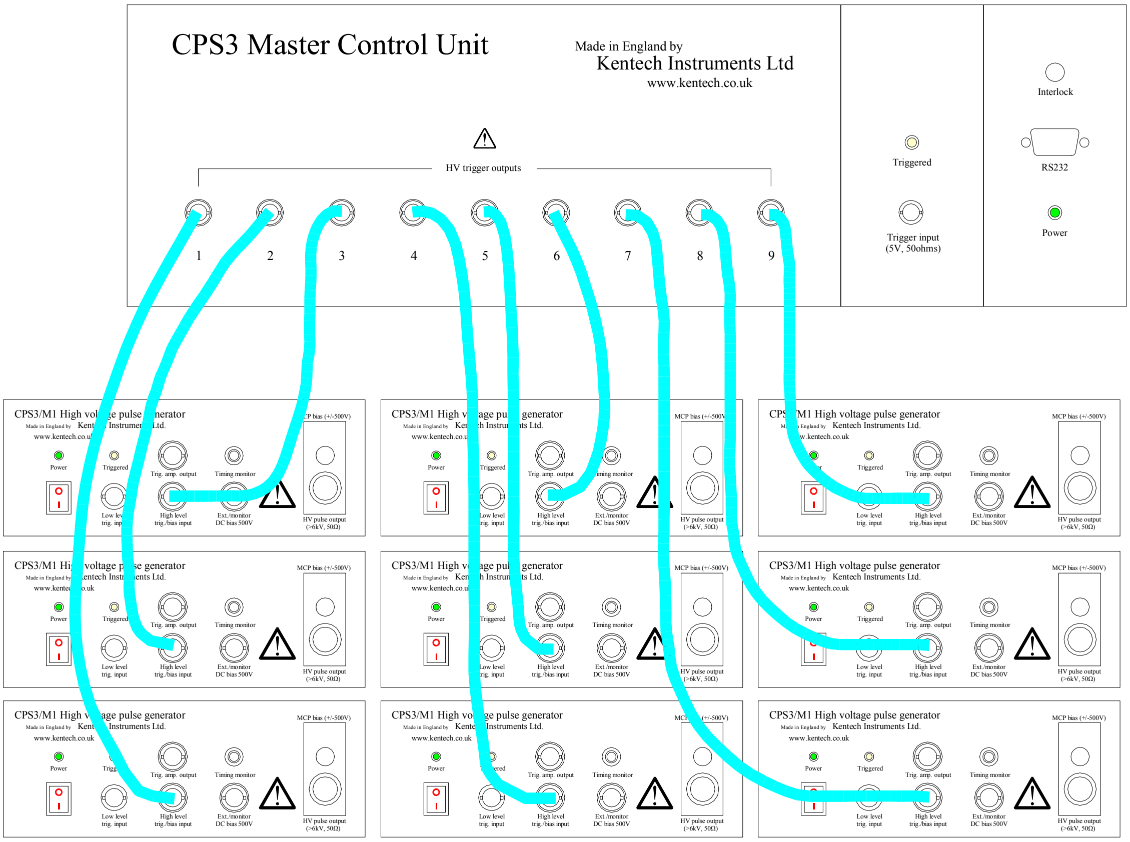

Figure 1 9-Channel Pulser System

3. 9-Channel Pulser System Specification

3.1. Pulse Generator (CPS3/M1) Specification

Output pulse amplitude:	≥ 6kV negative pulse into 50Ω
Permitted bias voltage:	-500V to +500V
Timing monitor:	≥ 5V negative pulse
Maximum rep rate:	10Hz
Connectors & Interface:	Low level trigger input (BNC) Trigger amplifier output (SHV) External bias input OR monitor (SHV) High level trigger and bias input (SHV) Timing monitor (SMA) HV pulse output (TNC) MCP bias output (LEMO-'00' series) Mains Power (IEC rear panel)
Size:	235mm wide x 98mm high x 30.6mm deep without PFM
Power supply:	110 – 240V AC, 50-60Hz, ~20W
Indication:	Power led Trigger led

3.2. Pulse Forming Module (PFM) Specification (when used with CPS3/M1)

Output pulse amplitude:	≥ 3kV near square negative pulse
Rise time:	< 150ps
Fall time:	< 250ps
Flatness of top:	< 5%
Pulse width:	380 - 400ps near flat top, approx 500ps fwhm

3.3. Master Control Unit (MCU) Specification

Nine independent bias supplies	
Bias voltage range:	-500 to +500V
Bias voltage monitor tolerance:	± 1% with 1GΩ load (± 5% with 10MΩ load)
Maximum bias current:	50µA
Bias current monitor tolerance:	± 1%
Nine independent current trips	
Bias trip current tolerance:	± 5µA
Nine independent delay generators	
Maximum delay:	50ns
Delay resolution:	25ps
RS232 settings:	9600 baud
Connectors & Interface:	Low level trigger input (BNC) RS232 port (9 way socket) Interlock connector (LEMO coaxial) 9 x HV trigger and bias outputs (SHV) Mains Power (IEC rear panel)
Maximum rep rate:	10Hz

Power supply:	110 – 240V AC, 50-60Hz, <20W
Size:	19" wide x 3U tall x 400mm deep
Indication:	Power led Trig led

3.4. System Specification

Jitter between outputs:	<20ps rms
Power consumption:	<250W

3.5. Control Interface

1 x Labview driver (virtual instrument) for Master Control Unit

Commands include:-
- write desired value for channel n bias voltage
- read back desired value for channel n bias voltage
- read measured value from ADC for channel n bias voltage
- read measured value from ADC for channel n bias current
- set bias current trip level
- read back trip status
- enable all bias voltages individually
- disable all bias voltages individually
- read back bias enable status
- write desired value for delay n
- read desired value for delay
- enable all trigger outputs individually
- disable all trigger outputs individually
- read back trigger enable status
- read interlock input status

3.6. Cables

9 x N type to SMA 50Ω coaxial output cables 2m length
9 x SHV to SHV 50Ω coaxial trigger leads 2m length
9 x SHV to SHV 50Ω coaxial trigger short leads (30cm for stand-alone operation)
1 x Lemo connector with 2m flying lead (for interlock input)
10 x US AC IEC power leads.

4. Instrument Description

4.1. Master Control Unit

The Master Control Unit (MCU) consists of a microcontroller module, a high voltage trigger generator module and nine Bias/Delay channels. The MCU may be controlled by a PC connected to the front-panel RS232 port. The MCU has a front panel *Interlock* socket; the interlock signal must be shorted to ground in order to enable the bias voltages on the *HV trigger output* connectors.

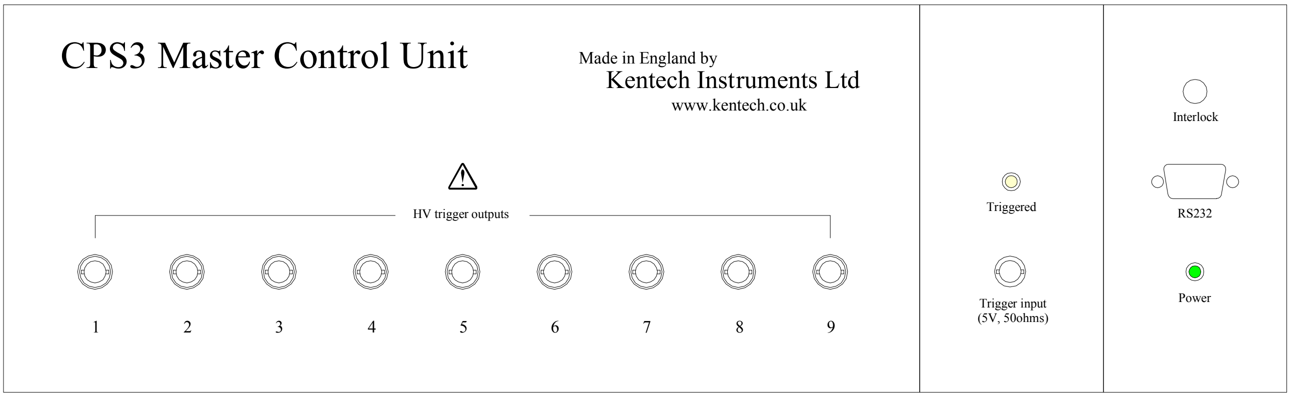

Figure 2 MCU Front Panel

The MCU is triggered by a 5V positive edge on the *Trigger input* (BNC) connector. A high voltage pulse is generated and split into each of the nine channels. These 500V pulses propergate in parallel through the nine programmable delay channels and are finally combined with the programmable bias voltages at the *HV trigger output* (SHV) connectors.

An EEPROM Write Enable button has been fitted to the rear of the MCU. This button should be used only when reprograming the calibration data. Contact Kentech Instruments for more information.

The MCU contains nine separate bias generators which can be individually programmed to give different bias settings on each channel. A single current limit can be set for all the channels. If the bias current on any channel exceeds this limit, the bias will be disabled.

Each channel has its own programmable delay generator. The user may delay each output pulse by up to 50ns, with a resolution of approximately 25ps.

4.2. CPS3/M1 pulse generators

The CPS3/M1 pulse generators produce ≥6kV negative unshaped pulse with a rise-time of approximately 100ps. The Pulse Forming Modules (PFMs) shape the output waveform to produce a ≥3kV negative pulse with a length of approximately 500ps.

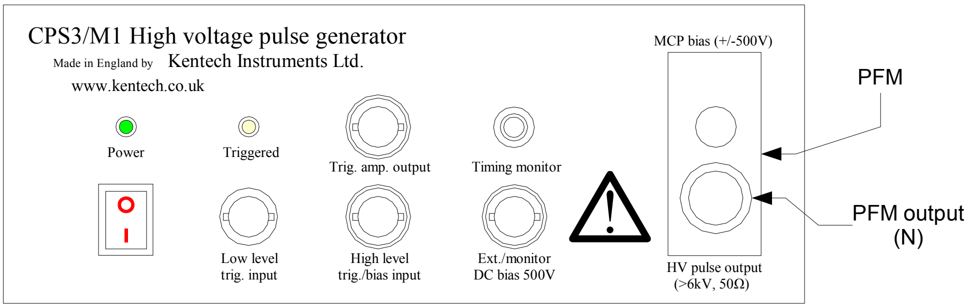

Figure 3 CPS3/M1 Front Panel

Note: these pulse generators must NOT be operated without a Pulse Forming Module. Operating without proper termination may damage the equipment.

As part of the Nine-Channel Pulser System, each CPS3/M1 pulse generator is triggered by one of the *HV trigger output* signals from the MCU. This signal is fed into the pulse generator's *High level trig./bias input* (SHV) connector (see Figure 4). Within the pulse generator, the high voltage trigger signal is stripped away from the bias and used to excite the avalanche transistor stacks to produce a -3kV output pulse. This output pulse is then recombined with the bias within the Pulse Forming Module.

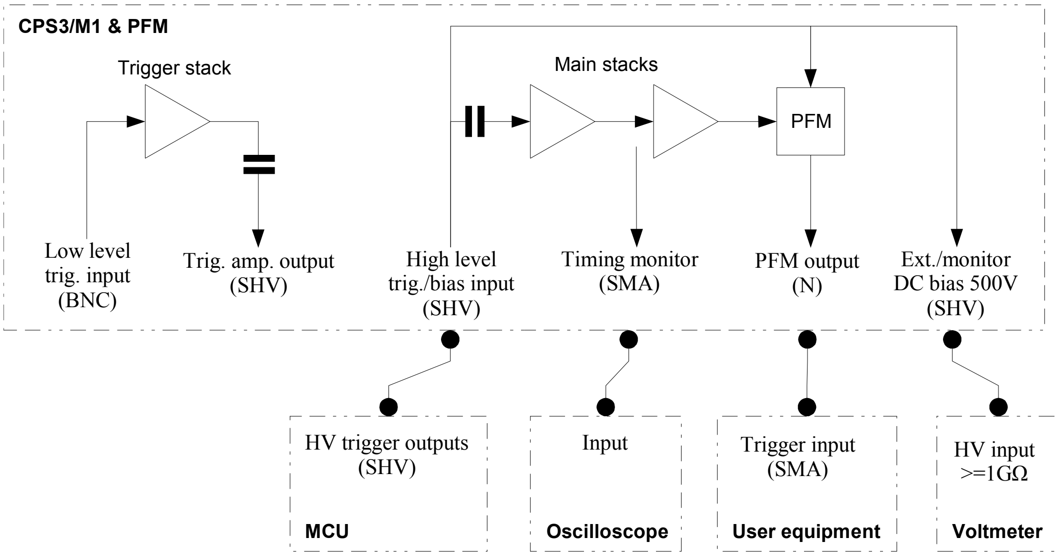

Figure 4 CPS3/M1 Pulser System Operation

The user may monitor the timing and amplitude of the output pulse by observing the *Timing monitor* (SMA) output. The output signal at this point is approximately 5V into 50Ω for a 3kV output pulse.

The bias voltage may also be monitored at the *Ext./monitor DC bias 500V* (SHV) connector. The impedance of the monitoring circuit should be ≥1GΩ.

4.3. Use of the CPS3/M1 in Stand-Alone Operation

The CPS3/M1 may be triggered directly from a low voltage signal when not used as part of this pulser system. In stand-alone operation, a HV trigger signal is produced within the pulse generator and is available at the *Trig. amp. output* (SHV) connector. This trigger signal must be connected directly to the *High level trig./bias input* (SHV) connector (see Figure 5). If a bias voltage is required at the output, it must be generated by external equipment and introduced at the *Ext./monitor DC bias 500V* (SHV) connector. The bias will be combined with the HV output pulse within the PFM.

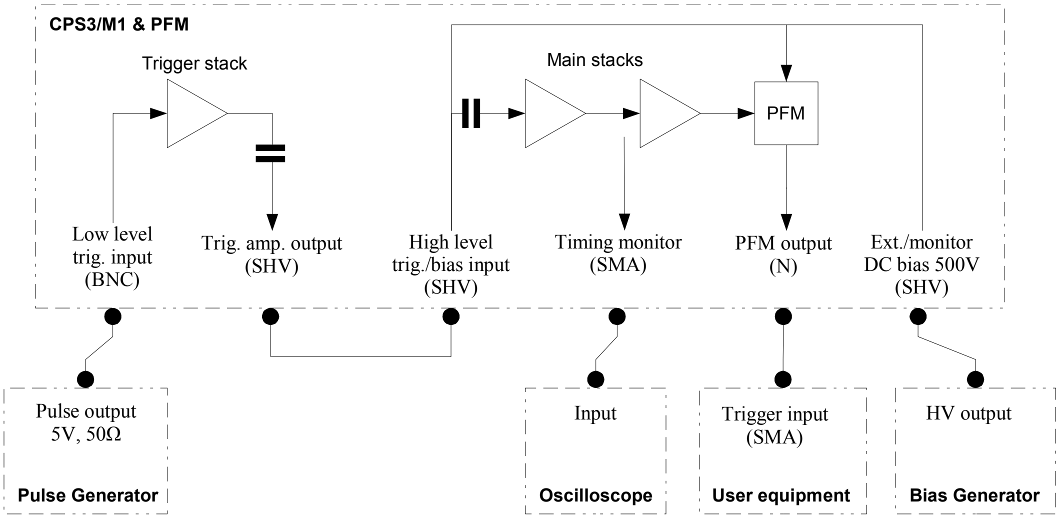

Figure 5 CPS3/M1 Stand-Alone Operation

4.4. The Pulse Forming Modules (PFMs)

The PFM sets the length of the pulse and couples it onto the output N-type connector, which is held at the bias voltage. Although the pulse generators produce very similar pulses, and the PFMs have similar characteristics, it is intended that the pulse generators are matched with specific PFMs. For example, it is recommended that Channel 1 of the MCU is connected to the pulse generator number J05*****/CPS3/1 using the SHV cable marked '1' and that the PFM J05*****/PFM1 is used with this channel.

The HV pulses produced by both the MCU and the CPS3/M1 will cause damage to test equipment if precautions are not taken. If it is necessary to monitor or characterise the output 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.

5. LabView Control Interface Program

The 9-Channel Pulser System may be controlled and monitored by means of a LabView virtual instrument. Commands may also be transferred directly using any standard terminal program. Commands and data are transferred through the RS232 interface.

5.1. Starting the Control Interface Program

1. Copy the file called **"cps9.cfg"** to the Labview main directory (for example c:\Program Files\National Instruments\LabVIEW 7.1).
2. Start Labview.
3. Click the Open buttton and open the library file "**cps3x9_Control_Interface.llb**". From the File Dialog choose **CPS3x9_Control_Interface_main.vi .**
4. Before running the instrument you will need to select the apropriate COM port in the "**VISA resource name"** combox. (Click Cntl-M and select port).
5. Click the "**Run**" button in the main Labiew menu.
6. The VI starts. If there is a problem in communcation between the program and the instrument the **"Comm Error"** LED will change to red. If **"Comm Error"** is dim the communication between the program and the instrument is ok.

5.2. Using the Control Interface

The Control Interface is a set of LEDs, buttons, switches and edit boxes to help you to send commands and get the status of the system.

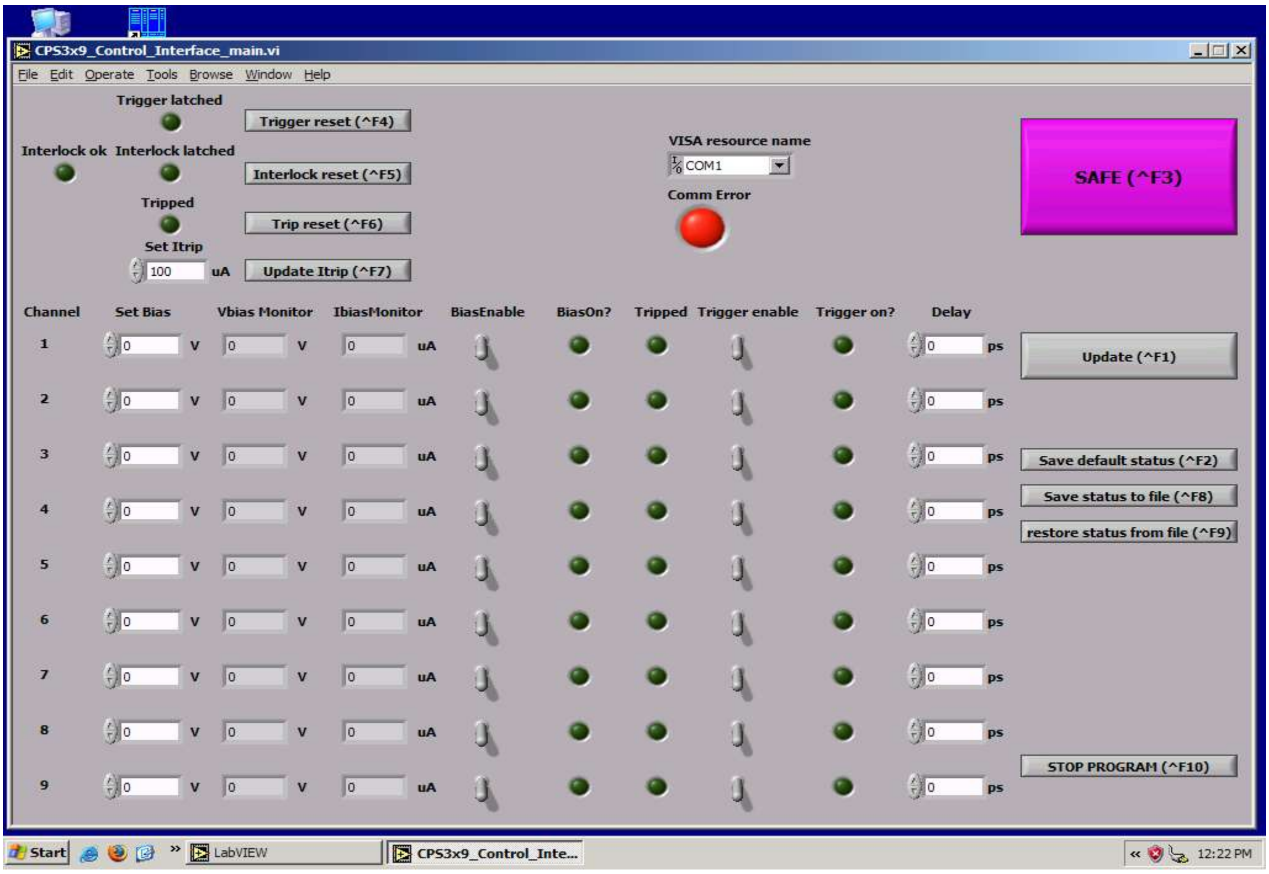

Figure 6 LabView Control Interface

“Trigger latched” will be ON (yellow) after the first triggered event and stay on until you press the **“Trigger reset”** button.

“**Interlock ok**” will be ON (green) while the interlock is connected and off when you pull out the interlock plug. In this case “**Interlock latched**” will come ON (red). All Trigger enable signals will be switched off. **“Update Itrip”** and **“Update”** buttons will flash to remind you to update the system.

“**Tripped**” will be ON (red) if the current taken from any of the 9 channels has exceeded the preset Itrip level. All Biases and Trigger enable signals will be switched off.
To reset the tripped state press the “**Trip reset**” button. The “**Itrip Update**” and “**Update**” buttons will flash to remind you to update the system.
You can set the trip current level with “**Update button**”.

Each channel is represented within a single line of controls and indicators (marked 1-9).
“Set Vbias” - is a control to set the bias voltage.
“Vbias Monitor” - is an indicator to show the bias on the output of the channel.
“IbiasMonitor” - is an indicator to show the current taken from the output of the channel.
“BiasEnable” - is a control to switch on the bias voltage on the output of the channel.
“BiasOn?” - is an indicator to show if the bias voltage is enabled on the output of the channel.
“Tripped” - is an indicator to show the bias current tripped state for that channel.
“Trigger enable”- is a control to enable triggering of the channel.
“Trigger on?” - is an indicator to show the trigger enable state for the channel.
“Delay” - is a control to set the delay of the output signal to the pulser in relation to the trigger signal.

“Update” button will send the commands to the intrument (all 9 chanels are being updated).
Whenever you change one of the settings in any of the controls, the “**Update**” button will flash.

“Safe” button will switch off all the Biases and Trigger enable signals.

“Save default status” will save the present settings of all the channels and **Itrip** setting in the default config file **“cps9.cfg”**. When the program starts it restores all the setting from **“cps9.cfg”** file.
You can save the present settings in a different config file by pressing **“Save status to file”,** and restore the settings from the saved file by pressing **“Restore status from the file”**.
“Stop program” - to stop running the program.

To communicate with the instrument you will have to set the right COM port in the **“Visa resource name”** combox. The port setting will be remembered when you stop the program. Next time you run the program it will restore the port settings from the default config file.

Each button can be operated by a “Hot Key” as indicated on each button, see figure above.

6. Output Waveforms

Output pulse (brown trace) 500V/div
Timing monitor (green trace) 5V/div
All traces 1ns/div

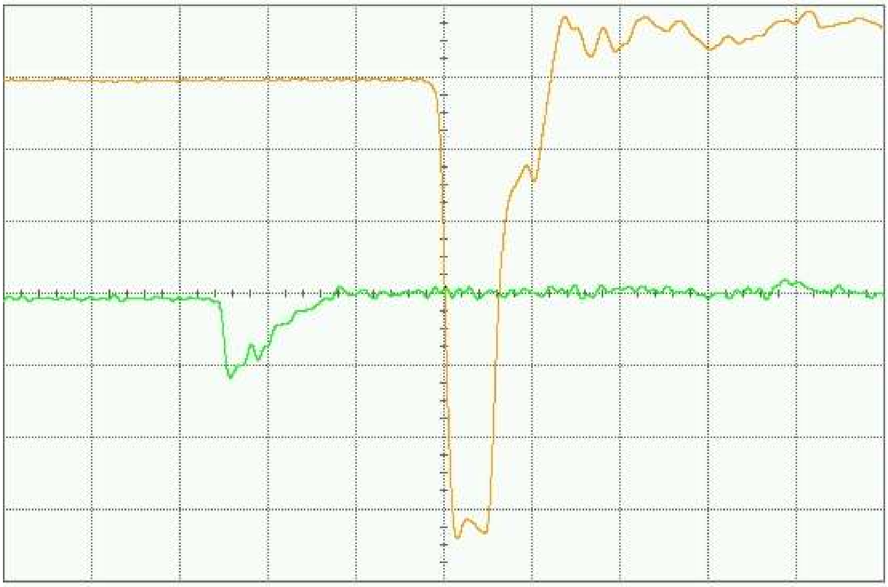

*Figure 7 J05*****/CPS3/1*

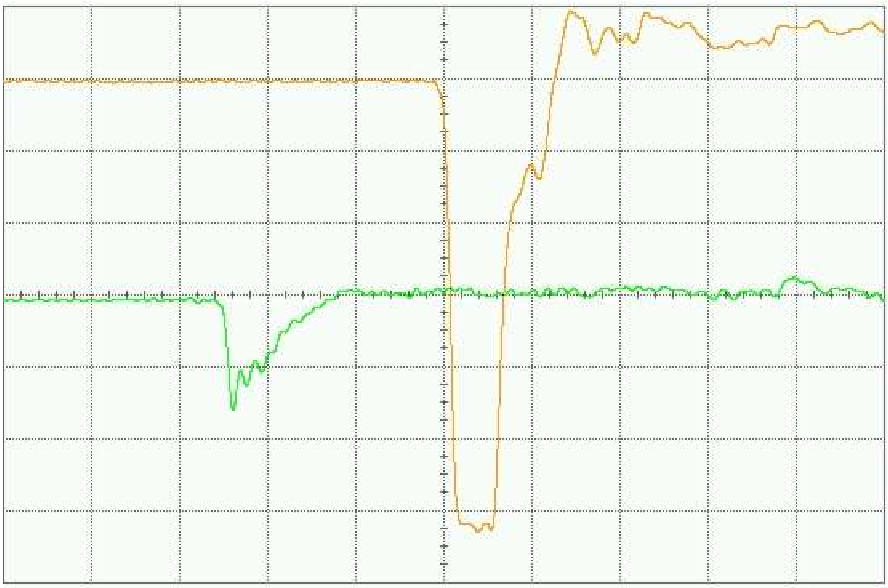

*Figure 8 J0*****/CPS3/2*

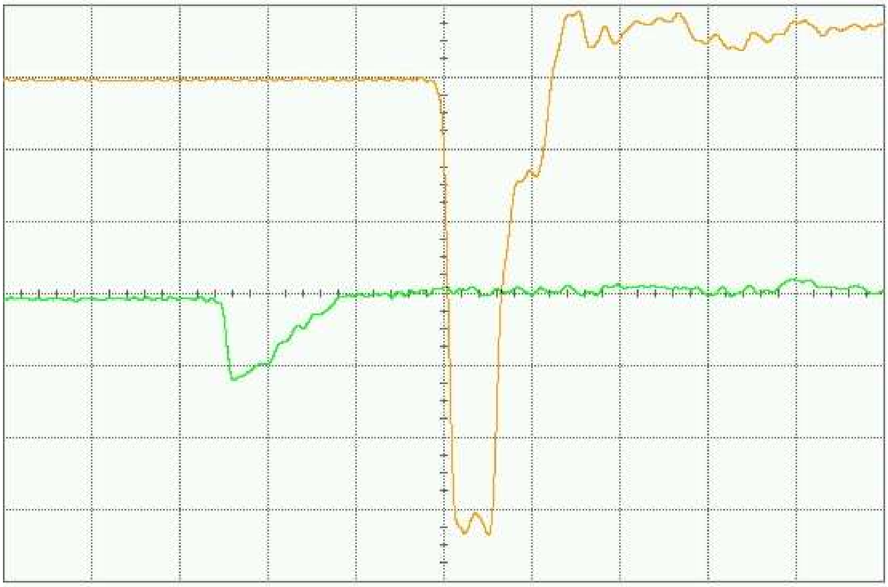

*Figure 9 J05*****/CPS3/3*

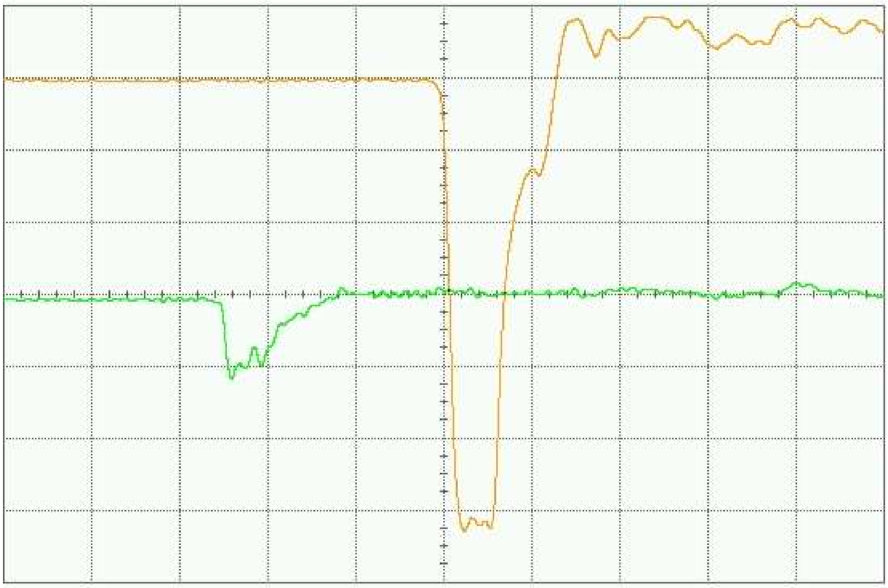

*Figure 10 J05*****/CPS3/4*

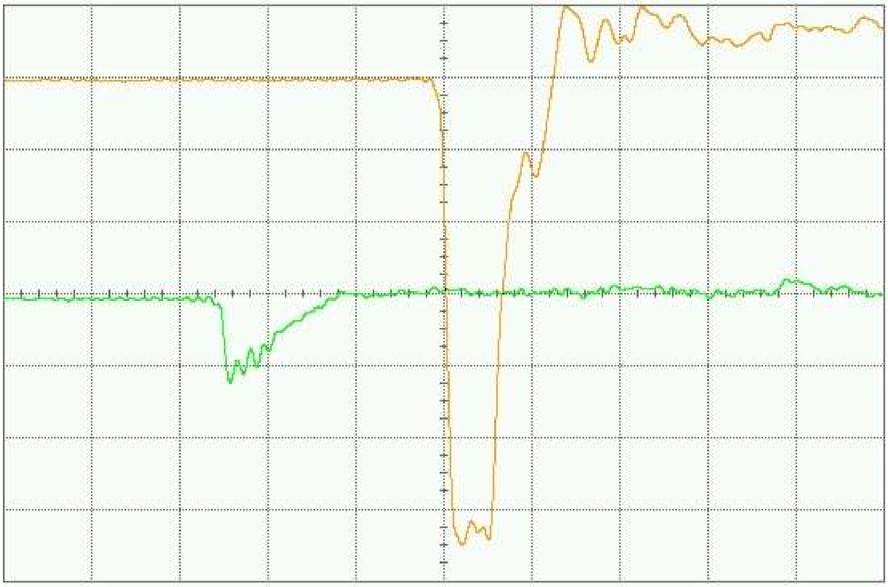

*Figure 11 J05*****/CPS3/5*

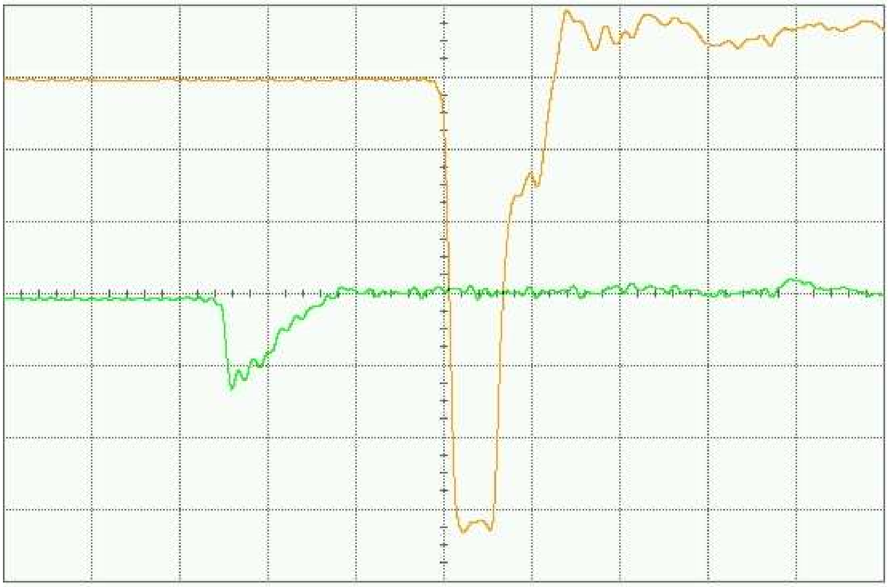

*Figure 12 J05*****/CPS3/6*

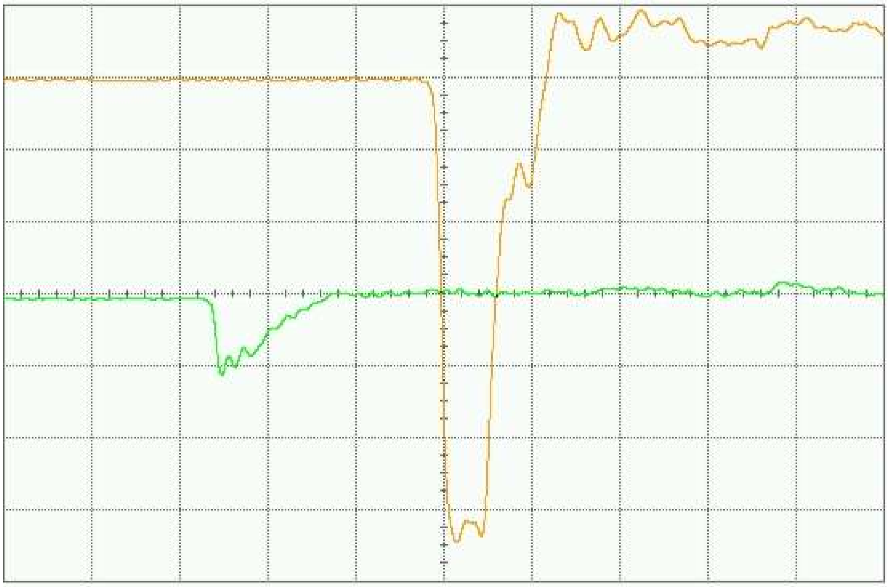

*Figure 13 J05*****/CPS3/7*

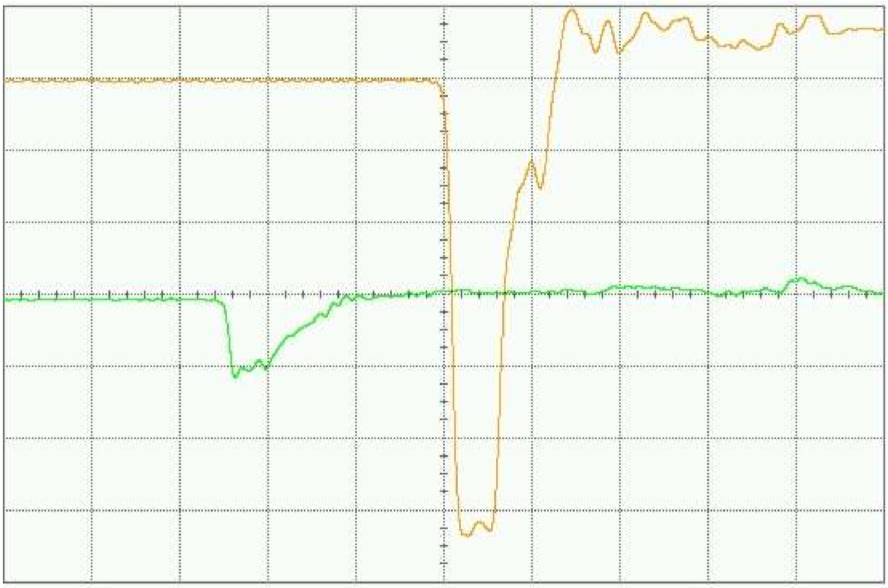

*Figure 14 J05*****/CPS3/8*

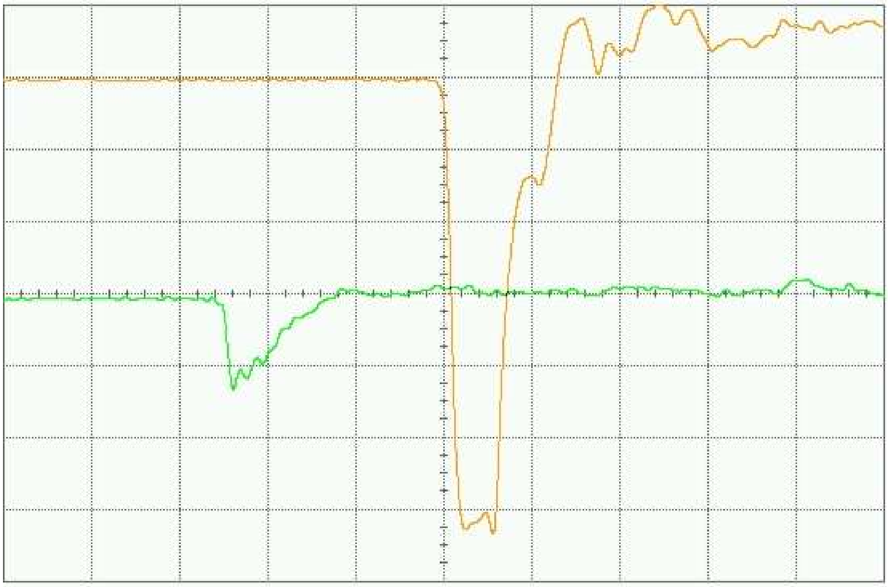

*Figure 15 J05*****/CPS3/9*

7. Test Results

Test results recorded on 22 July 2005.

7.1. Absolute Channel Delays

The absolute delay, measured from system trigger input to pulse output on channel 1, is approximately 44.6ns. The following table shows the delays of the other channels relative to channel 1.

Channel	delay / ps
1	0
2	59
3	34
4	51
5	20
6	47
7	-45
8	76
9	71

7.2. Relative Channel Delays

The following table shows the delay observed in each channel when programmed with a range of nominal values from 0 to 50ns. The delays are measured relative to zero delay for that channel.

	Delay / ns					
Channel	0	10	20	30	40	50
1	0.00	10.01	20.03	30.02	40.06	50.09
2	0.00	9.99	20.00	30.02	40.05	50.09
3	0.00	10.01	20.01	30.03	40.08	50.14
4	0.00	10.00	20.02	30.03	40.09	50.12
5	0.00	10.01	20.04	30.06	40.07	50.13
6	0.00	10.01	20.02	30.04	40.08	50.11
7	0.00	10.03	20.04	30.07	40.09	50.15
8	0.00	10.00	20.01	30.02	40.09	50.12
9	0.00	10.03	20.04	30.07	40.11	50.15

7.3. Bias Supplies

Bias Supply voltages into 1GΩ.

		Programmed Voltage /V										
Channel	**Source**	**-500**	**-400**	**-300**	**-200**	**-100**	**0**	**100**	**200**	**300**	**400**	**500**
1	Actual	-500	-401	-302	-203	-103	25	103	204	299	400	499
	Monitor	-499	-399	-299	-199	-98	24	98	199	301	399	499
2	Actual	-500	-401	-303	-203	-103	23	103	204	299	401	500
	Monitor	-500	-400	-300	-199	-99	22	99	199	301	399	499
3	Actual	-499	-400	-302	-202	-103	24	103	204	299	401	501
	Monitor	-499	-399	-299	-199	-98	23	98	198	300	399	500
4	Actual	-502	-402	-303	-201	-102	22	102	202	300	398	498
	Monitor	-499	-399	-299	-198	-98	22	97	198	299	399	499
5	Actual	-500	-401	-302	-202	-102	24	103	204	299	400	500
	Monitor	-500	-399	-299	-198	-98	23	98	198	300	399	500
6	Actual	-500	-401	-302	-202	-102	27	102	204	301	399	499
	Monitor	-500	-400	-300	-198	-98	26	97	198	300	399	499
7	Actual	-502	-402	-303	-202	-103	24	103	204	301	400	500
	Monitor	-500	-399	-299	-198	-98	23	98	199	299	399	500
8	Actual	-499	-400	-302	-201	-102	25	103	204	301	400	500
	Monitor	-500	-400	-299	-198	-99	24	98	199	300	399	500
9	Actual	-501	-402	-302	-202	-102	19	102	202	298	399	498
	Monitor	-500	-399	-299	-198	-98	19	97	197	300	399	499

Bias Supply voltages into 10MΩ.

	Programmed Voltage /V											
	-500			-100			100			500		
Channel	**Actual V**	**Monitor V**	**I Monitor uA**	**Actual V**	**Monitor V**	**I Monitor uA**	**Actual V**	**Monitor V**	**I Monitor uA**	**Actual V**	**Monitor V**	**I Monitor uA**
1	-491	-499	-49	-99.9	-98	-9	99.8	97	10	487	499	49
2	-492	-500	-49	-100	-98	-10	100	98	10	487	499	48
3	-490	-500	-49	-100	-98	-10	100	100	9	488	500	49
4	-493	-499	-50	-99	-97	-10	98	97	9	485	499	49
5	-492	-499	-49	-100	-97	-9	99	97	10	487	500	49
6	-492	-500	-50	-99	-97	-10	99	97	9	486	500	49
7	-493	-500	-50	-100	-98	-10	100	97	9	487	500	49
8	-491	-500	-49	-99	-97	-10	99	98	9	487	500	49
9	-492	-499	-49	-99	-97	-10	99	97	9	485	500	49

8. CPS3x9 Control Unit RS232 interface 1/07/05

8.1. General Notes

1. If trip or interlock latches are set, the control unit will ignore attempts to enable the bias supplies. Therefore the trip or interlock latches should be reset before attempting to enable supplies.
2. The MCU behaviour on interlock fail is determined by a flag in eeprom called **`safeoninter?`** Interlock fail always causes the bias supplies to be disabled. If **`safeoninter?`** is high, the trigger outputs will also be disabled - equivalent to executing a safe command. If **`safeoninter?`** is low, the trigger outputs are not affected. It is possible to modify the state of this flag but not using the normal protocol.
3. The software refers to channel numbers as 0 thru 8 as opposed to the natural user description 1 thru 9.

8.2. The protocol

The MCU uses a restricted protocol for reliable control. It is not be possible to download code to the MCU or edit flags and calibration data using this protocol. It is possible to change protocol mode and use the full Forth interpreter which allows all flags and calibration data to be edited, or a new version of source code to be downloaded but this is not covered in this document.

The MCU generates responses to valid commands and does not generate any unsolicited output. Invalid commands are ignored. All commands and response are in ASCII characters. Commands are case sensitive.

In the interest of simplicity all commands are parsed by the MCU using the Forth interpreter, so the parameters need to be delimited by spaces and the command line has to be terminated by carriage return and linefeed characters. The Forth interpreter will not recognise any commands other than those defined in the command set.

The MCU will not echo command characters as they are received, no output is generated until a valid command is recognised.

When a valid command is recognised, the MCU outputs a response. Responses are preceeded with a cr and lf, then an ascii **{** character and end with an ascii **}**. The response is delimited into fields by an ascii **;** character. The first field in the response will be a repeat of the command. If the command cannot be completed the MCU will return an error code in the second field. The possible error codes are:-

`?stack` - the command interpreter has detected a wrong stack depth error, ie the wrong number of parameters have been received.
`?param` - the command interpreter has detected an out of range parameter

After any error, the command is not executed, the stack is cleared and no values are returned other than the error code. Following a stack error, the stack is cleared then dummy parameters (generally -1 or 65536) are added for the purpose of formatting the response only.

All status commands expect and deliver data as decimal numbers and all numeric data should be decimal, no decimal points or other punctuation to be used.

For example

1) to set the desired value of coarse delay to 5ns on channel 3, the command would be:-

```
5000  3  !d
```

and the response if the command can be completed would be:-

```
{5000  3  !d}
```

2) as above but with a missing parameter

```
3  !d
```

and the response would be:-

```
{-1  -1  !d;?stack}
```

The command interpreter detects the wrong stack depth, corrects this by clearing the stack and adding some dummy parameters then flags the error. No execution will result.

3) as above with invalid parameter

```
5000  9  !d
```

and the response would be:-

```
{5000  9  !d;?param}
```

Again no execution will result.

4) to read the measure value of bias voltage 2

```
2  @>vb
```

and the response if the command can be completed would be:-

```
{2  @>vb; 100}
```

which implies the voltage is 100V.

5) as above but with a missing parameter

```
@>vb
```

and the response would be

```
{-1  @>vb; ?stack}
```

6) as above but with an invalid parameter

```
9 @>vb
```

and the response would be

```
{9  @>vb; ?param}
```

Bias Trip status bits

Default to zero on reset/power up.
These bits are reset by tripreset command.
This register is intended to allow identification of source channel of trip.

b0	= bias 0 tripped?	ro (1= tripped on this channel)
b1	= bias 1 tripped?	ro (1= tripped on this channel)
b2	= bias 2 tripped?	ro (1= tripped on this channel)
b3	= bias 3 tripped?	ro (1= tripped on this channel)
b4	= bias 4 tripped?	ro (1= tripped on this channel)
b5	= bias 5 tripped?	ro (1= tripped on this channel)
b6	= bias 6 tripped?	ro (1= tripped on this channel)
b7	= bias 7 tripped?	ro (1= tripped on this channel)
b8	= bias 8 tripped?	ro (1= tripped on this channel)
b9	= not used	
b10	= not used	
b11	= not used	
b12	= not used	
b13	= not used	
b14	= not used	

Bias User Enable status bits

Default to zero on reset/power up.
These are all reset by interlock fail or a trip condition.
After reseting interlock or trip you need to reload these.
These bits can only be set if the trip and interlock latches are zero.

b0	= bias 0 enable?	rw (1 = enable)
b1	= bias 1 enable?	rw (1 = enable)
b2	= bias 2 enable?	rw (1 = enable)
b3	= bias 3 enable?	rw (1 = enable)
b4	= bias 4 enable?	rw (1 = enable)
b5	= bias 5 enable?	rw (1 = enable)

b6	= bias 6 enable?	rw (1 = enable)
b7	= bias 7 enable?	rw (1 = enable)
b8	= bias 8 enable?	rw (1 = enable)
b9	= not used	
b10	= not used	
b11	= not used	
b12	= not used	
b13	= not used	
b14	= not used	

Bias Hardware Enable status bits

These reflect the state of the enable outputs to the bias power supplies.

b12 - Trigger latch - is set by a trigger condition, reset by the TriggerReset command
b13 - Interlock fail latch - is set buy the interlock circuit failing, reset by InterlockReset command.

b0	= bias 0 on?	r0 (1/0 = on/off)
b1	= bias 1 on?	r0 (1/0 = on/off)
b2	= bias 2 on?	r0 (1/0 = on/off)
b3	= bias 3 on?	r0 (1/0 = on/off)
b4	= bias 4 on?	r0 (1/0 = on/off)
b5	= bias 5 on?	r0 (1/0 = on/off)
b6	= bias 6 on?	r0 (1/0 = on/off)
b7	= bias 7 on?	r0 (1/0 = on/off)
b8	= bias 8 on?	r0 (1/0 = on/off)
b9	= not used	
b10	= not used	
b11	= not used	
b12	= Trigger latch	(1 = triggered)
b13	= Interlock fail latch	(1 = interlock has failed, 0 = ok)
b14	= hw enable?	ro (1 = interlock is ok, 0 = not ok)

Trigger user enable status bits

Default to zero on reset/power up.
These bits are reset by a trip event
If the SafeOnInter? flag is hi, these bits are also reset by an interlock failure.
After reseting interlock or trip you need to reload these.
These bits can only be set if the trip latch is zero.
If the SafeOnInter? flag is hi, these bits can only be set if the interlock latch is also zero.

b0	= trigger 0 enable?	rw
b1	= trigger 1 enable?	rw
b2	= trigger 2 enable?	rw
b3	= trigger 3 enable?	rw

b4	= trigger 4 enable?	rw
b5	= trigger 5 enable?	rw
b6	= trigger 6 enable?	rw
b7	= trigger 7 enable?	rw
b8	= trigger 8 enable?	rw
b9	= not used	
b10	= not used	
b11	= not used	
b12	= not used	
b13	= not used	
b14	= not used	
b15	= not used	

Trigger hardware enable status bits:-

These reflect the state of the enable outputs to the trigger unit.

b0	= trigger 0 on?	ro
b1	= trigger 1 on?	ro
b2	= trigger 2 on?	ro
b3	= trigger 3 on?	ro
b4	= trigger 4 on?	ro
b5	= trigger 5 on?	ro
b6	= trigger 6 on?	ro
b7	= trigger 7 on?	ro
b8	= trigger 8 on?	ro
b9	= not used	
b10	= not used	
b11	= not used	
b12	= not used	
b13	= not used	
b14	= not used	
b15	= hw enable? ro (read to find state of hw interlock)	

8.3. The Control Commands

a) bias outputs

Name	!vbias
Explanation	write desired value for bias voltage
Format	**`x n !vb`**
parameter 1	x = voltage, range -500 to 500 volts
parameter 2	n = channel number 0 thru 8
returned value	none

Name	@vbias
Explanation	read desired value for bias voltage
Format	**`n @vb`**
parameter 1	n = channel number 0 thru 8
parameter 2	none
returned value	desired value in volts

Name	@>vbias
Explanation	read absolute measured value for bias voltage
Format	**`n @>vb`**
parameter 1	n = channel number 0 thru 8
parameter 2	none
returned value	measured value in volts

Name	@>ibias
Explanation	read absolute measured value for bias current
Format	**`n @>ib`**
parameter 1	n = channel number 0 thru 8
parameter 2	none
returned value	measured value in uA??

Name	!itrip
Explanation	write desired absolute value for bias current trip
Format	**`x n !it`**
parameter 1	x = current in uA, range 0 to 20
parameter 2	n = channel number 0 thru 8
returned value	none

Name	@itrip
Explanation	read desired absolute value for phosphor current trip
Format	**`n @it`**
parameter 1	n = channel number 0 thru 8
parameter 2	none
returned value	current in uA, range 0 to 20

Name	@tripstatus
Explanation	read bias trip status
Format	**`@tp%`**
parameter 1	none
parameter 2	none
returned value	pulser status

Name	@biasstatus
Explanation	read bias user enable status
Format	**`@b%`**
parameter 1	none
parameter 2	none
returned value	pulser status

Name	!biasstatus
Explanation	write bias user enable status
Format	`n  !b%`
parameter 1	bias user enable status
parameter 2	none
returned value	none

Name	@>biastatus
Explanation	read bias hardware enable status
Format	`@>b%`
parameter 1	none
parameter 2	none
returned value	bias hardware enable status

b) trigger outputs

Name	@triggerstatus
Explanation	read trigger user enable status
Format	`@tg%`
parameter 1	none
parameter 2	none
returned value	trigger enable status

Name	!triggerstatus
Explanation	write trigger user enable status
Format	`x  !tg%`
parameter 1	x = trigger enable status
parameter 2	none
returned value	none

Name	@>triggerstatus
Explanation	read trigger hardware enable status
Format	`@>tg%`
parameter 1	none
parameter 2	none
returned value	trigger enable status

c) delays

Name	!delay
Explanation	write desired value for delay
Format	`x  n !d`
parameter 1	x = delay, range 0 to 50,000 ps (rounded down internally to multiples of 25ps)
parameter 2	n = channel number 0 thru 8
returned value	none

Name	@delay
Explanation	read desired value for delay
Format	**`n @d`**
parameter 1	n = channel number 0 thru 8
parameter 2	none
returned value	desired value in picoseconds

Name	safe
Explanation	disable everything, equivalent to:- 0 !triggerstatus 0 !biasstatus
Format	**`safe`**
parameter 1	none
parameter 2	none
returned value	none

Name	@version#
Explanation	read software version number.
Format	**`@v#`**
parameter 1	none
parameter 2	none
returned value	version number

Name	InterlockReset
Explanation	Reset interlock latch
Format	**`0int`**
parameter 1	none
parameter 2	none
returned value	none

Name	TripReset
Explanation	Reset trip latch
Format	**`0trp`**
parameter 1	none
parameter 2	none
returned value	none

Name	TriggerReset
Explanation	Reset trig latch
Format	**`0trg`**
parameter 1	none
parameter 2	none
returned value	none

d) New commands added to facilitate Labview driver

Name	ChannelLook
Eplanation	Read all measure parameters for one channel
Format	**`n chl`**
Parameter 1	channel number 0 thru 8
Parameter 2	none.
Returned value1	channel no.
Returned value2	vbias
Returned value3	ibias
Returned value4	tripped?
Returned value5	biasen?
Returned value6	trigen?

Name	SystemLook
Eplanation	Read all measure parameters for system
Format	**`syl`**
Parameter 1	none
Parameter 2	none.
Returned value1	triplatch
Returned value2	triglatch
Returned value3	interlock latch
Returned value4	interlock cct

Name	Channelset
Eplanation	Set all parameters for one channel
Format	**`p1 p2 p3 p4 p5 chs`**
Parameter 1	vbias
Parameter 2	delay
Parameter 3	1 = EnableBiase
Parameter 4	1 = EnableTrigger
Parameter 5	channel number 0 thru 8
Returned value1	none

Name	Systemset
Eplanation	Set all parameters for system
Format	**`p1 p2 p3 p4 p5 chs`**
Parameter 1	itrip
Parameter 2	1 = TripReset
Parameter 3	1 = TriggerReset
Parameter 4	1 = InterlockReset
Parameter 5	none
Returned value1	none