

Kentech Instruments Ltd.

PBG5

With remote control over Fibre Link

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1. Specifications

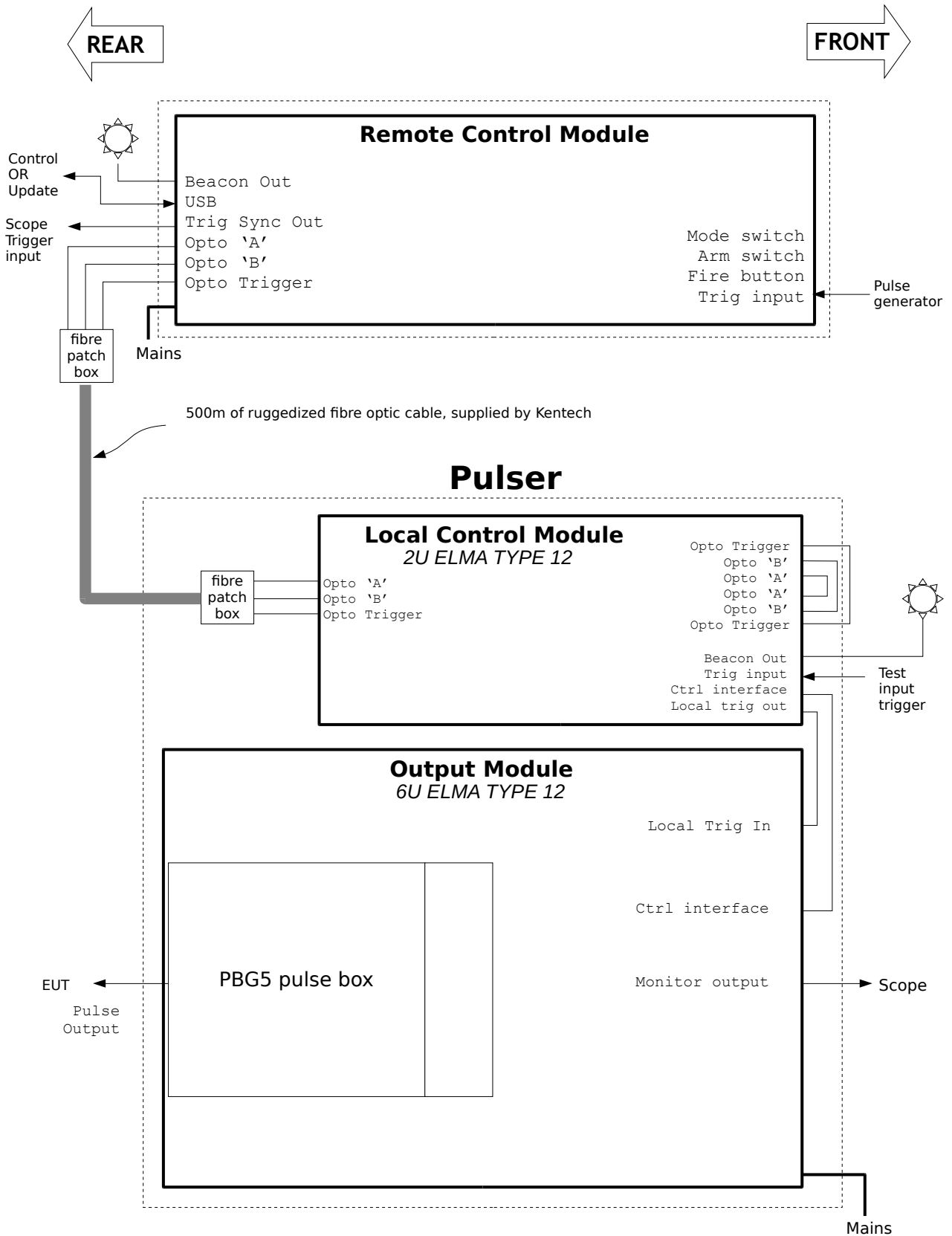
Pulser output

Output amplitude	24kV 17kV 12kV 8.5kV 6kV
Output polarity	Positive
Rise time	< 0.16 ns
Duration, FWHM	2.0 ns
Load	50 Ω
PRF	1 kHz
Proportional monitor	1/1000

Remote Control Internal Trigger

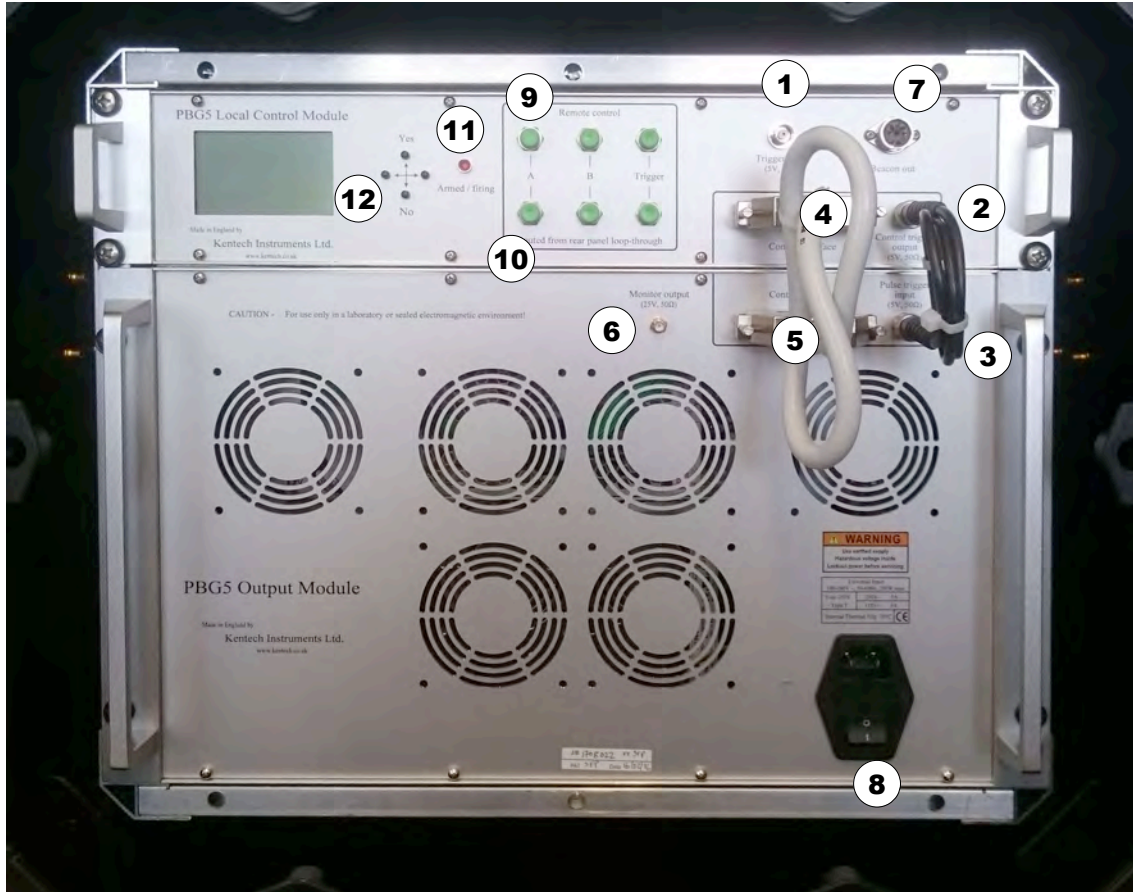
Frequency range	1Hz to 1000Hz
Frequency resolution	1Hz
Burst duration	0.1s to 60s
Burst resolution	0.1s

2. System Overview



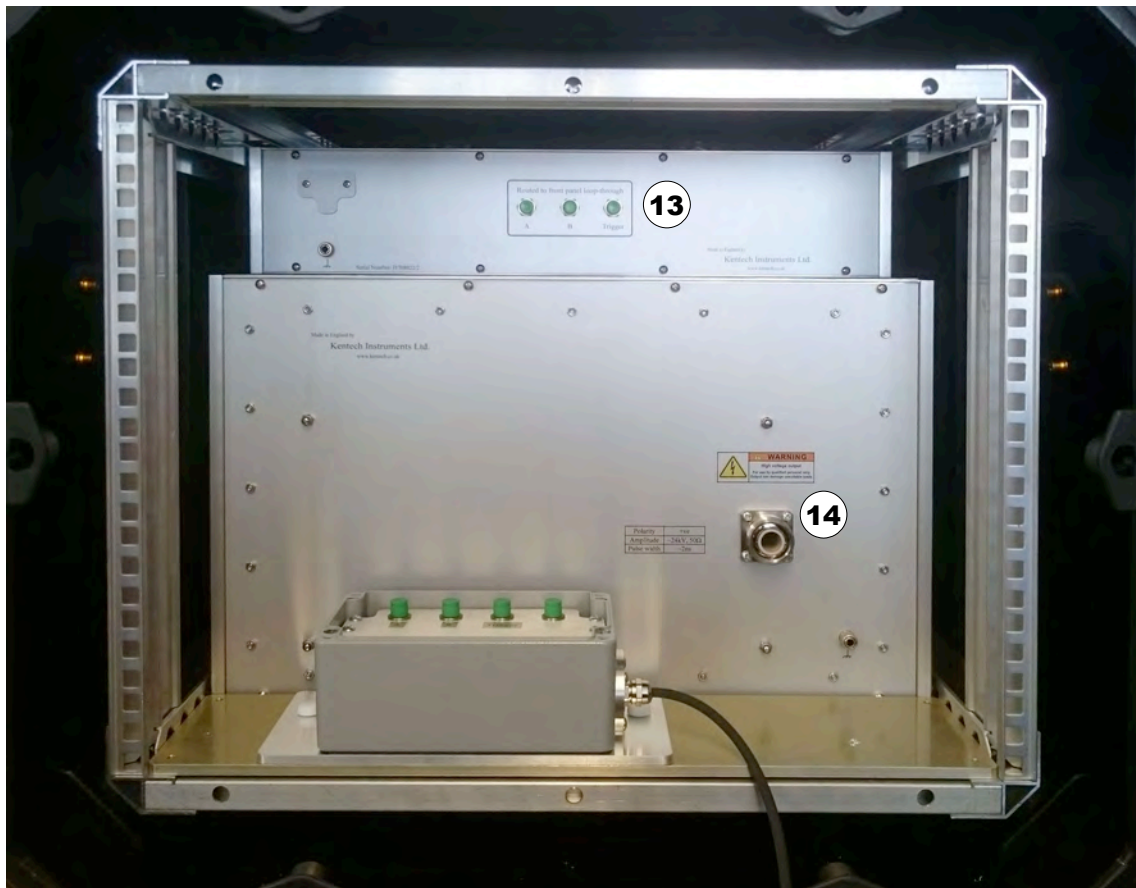
3. PBG5 Connectors & Interface

Pulser (Local Control and Output Module) Connectors & Interface



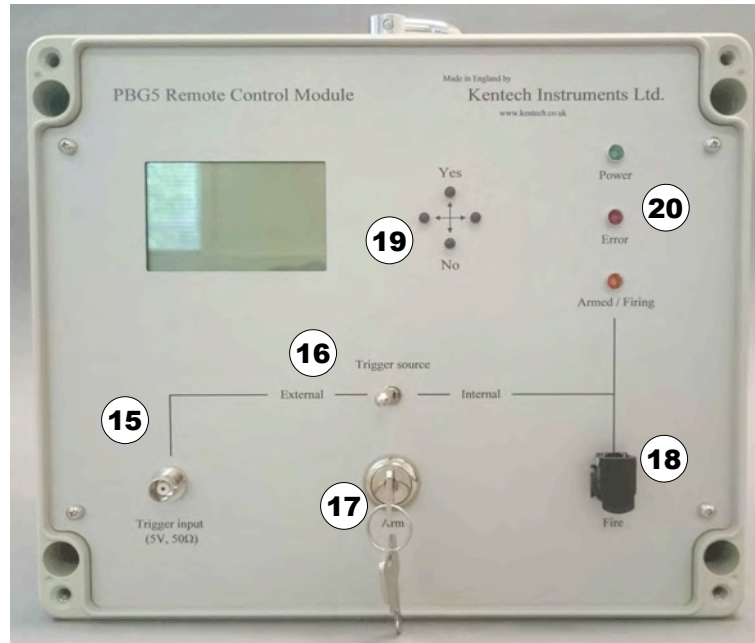
1	Trigger input (5V 50 Ω)	BNC	Front	Local electrical trigger input. The Trigger input on the Local Control Module is used for testing the Pulser without using the Remote Control Module. When the optical link to the Remote Control Module is not connected, the Pulser can be programmed locally and triggered with an external pulse generator via this electrical input. This input is not used in normal operation.
2	Control trigger output (5V 50 Ω)	BNC	Front	Trigger output to the PBG5 Output Module's Pulse trigger input. The Control trigger output is used to drive the trigger the PBG5 Output Module. This output is limited to a maximum frequency of 1.1kHz to prevent overdriving the main high voltage power supplies. It should be connected to the Pulse trigger input, of the Pulse Module, with a short BNC patch cable.
3	Pulse trigger input	BNC	Front	Trigger input from the PBG5 Local Control Module's "Control trigger output".

4	Control interface	37 way Dsub	Front	Control and monitor signals to the PBG5 Output Module. The Control Interface must be connected to the adjacent connector on the PBG5 Output Module with the 37 way Dsub shielded patch cable provided. IMPORTANT: Do NOT connect or remove the 37 way Dsub cable when the instrument is powered.
5	Control interface	37 way Dsub	Front	Control and monitor signals to the PBG5 Local Control Module. IMPORTANT: Do NOT connect or remove the 37 way Dsub cable when the instrument is powered.
6	Monitor output (25V, 50 Ω)	SMA	Front	Output pulse monitor signal, from main output divided by 1000.
7	Beacon out	DIN	Front	Connection to LED beacon. Connect the supplied LED beacon here.
8	A.C. Mains inlet	IEC	Front	110V-250V a.c.
9	A	FC/APC	Front	Local Serial comms receiver input.
	B	FC/APC	Front	Local Serial comms transmitter output.
	Trigger	FC/APC	Front	Local optical trigger input.
10	A	FC/APC	Front	Local Serial comms receiver input loop-through.
	B	FC/APC	Front	Local Serial comms transmitter output loop-through.
	Trigger	FC/APC	Front	Local optical trigger input loop-through.
<p>There are six optical connectors on the front panel of the Local Control Module as shown below.</p> <div style="text-align: center;"> </div> <p>The top row of connectors are directly connected to the Local Control Module's optical transmitters and receivers. The bottom row of optical connectors are routed directly through from the rear panel for convenience. This is because the armoured optical cable termination box is normally located at the rear of the instrument. In this situation:</p> <ul style="list-style-type: none"> • use 3x 800mm patch leads from the termination box to the rear panel connectors, and • use 3x 200mm patch leads on the front panel to loop these signals, i.e. A to A, B to B and Trigger to Trigger. 				
11	Armed/Firing LED (yellow)		Front	Armed LED is on when high-voltage enabled, and flashes when Output Module receives a trigger.
12	LCD & menu buttons		Front	For local control of the PBG5 Pulser.



13	A	FC/APC	Rear	Local Serial comms receiver input loop-through.
	B	FC/APC	Rear	Local Serial comms transmitter output loop-through.
	Trigger	FC/APC	Rear	Local optical trigger input loop-through.
14	H.V. Pulse output	Modified 7/16 DIN	Rear	Main 24kV Pulse output.

Remote Control Module Connectors & Interface



15	Trigger input (5V, 50 Ω)	BNC	Front	Remote electrical trigger input. When operated in <i>External</i> mode, the Remote Control Module must be triggered with an external pulse generator via this electrical input.
16	Trigger Source switch		Front	Toggle switch used to select Internal or External trigger source.
17	Arm Key switch		Front	Arm switch to enable/disable high voltage supplies and trigger circuits.

18	Fire button		Front	Button to initiate sending trigger signal to the Pulser. Covered to prevent accidental operation.
19	LCD and menu buttons		Front	For remote control of the PBG5 Pulser.
20	Power LED (green)		Front	Power LED is on when mains A.C. power is applied.
	Error LED (red)		Front	Error LED is on when a system error is detected.
	Armed/Firing LED (yellow)		Front	Armed LED is on when high-voltage enabled, and flashes when Output Module receives a trigger.
21	Trigger output (5V, 50 Ω)	BNC	Rear	Remote electrical TTL trigger (sync) output.
22	Trigger output (20V, 50 Ω)	BNC	Rear	Remote electrical 20V trigger (sync) output.
23	Beacon out	DIN	Rear	Connection to LED beacon. Connect the supplied LED beacon here.
24	A	FC/APC	Rear	Remote Serial comms transmitter output.
	B	FC/APC	Rear	Remote Serial comms receiver input.
	Trigger	FC/APC	Rear	Remote optical trigger output.
25	USB	USB Socket Type B	Rear	For future use.
26	A.C. Mains inlet	IEC	Rear	110V-250V a.c.

4. Local Operation

```

■Amplitude: 6.0kV
 Test Stacks... >
 Run... >

```

The PBG5 Pulser may be operated without the Remote Control Module. When the optical link to the Remote Control Module is not connected, the Pulser can be programmed locally and triggered with an external pulse generator via its electrical input. Following power-up, the Local Control Module will display its top-level menu (shown above) giving the option to set the output pulse amplitude, test the high-voltage stacks, or run the pulser.

Setting the Pulse Amplitude

Position the cursor on the left side, adjacent to the **Amplitude:** option, as shown above. Press the Right (→) button.

Adjust the amplitude up with the Up/Yes (↑) or down with the Down/No (↓) buttons. Having set the correct amplitude, return to the left side with the Left (←) button.

Local Testing of High Voltage Stacks

Position the cursor on the left side, adjacent to the **Test Stacks** option. Press the Right (→) button. The following menu is displayed.

```

< Test Stacks:
 ■Run FAST test... >
   Run SLOW test... >

```

Select one of the test methods shown by moving the cursor adjacent to it and pressing the Right (→) button. See Description of High Voltage Tests (page 14) for details of the different tests.

To cancel without starting a test, move the cursor up adjacent to the < **Test Stacks:** option and press the Left (←) button.

When the test is completed, the Local Control Module will display a results menu (shown below). The PBG5 avalanche pulser can tolerate a number of transistor failures without significantly affecting performance. This test will generate a warning for each section of avalanche stack which has more than one transistor failure. The total number of warnings detected is displayed and the menu gives options to display the individual measured values.

```

< Test results:
  Warnings: 0
  █ Voltages (%) ... >
  Voltages (V) ... >
  Currents (mA)... >
    
```

If warnings are present, further investigation is recommended. The PBG5 can still be operated, but servicing may be required.

To display all the stack voltages, move the cursor adjacent to the **Voltages (V) ... >** option and press the Right (→) button.

To display the stack voltages as a percentage of the calibrated values, move the cursor adjacent to the **Voltages (%) ... >** option and press the Right (→) button.

To display the High Voltage Power Supply output currents, move the cursor adjacent to the **Currents (mA)... >** option and press the Right (→) button.

When displaying the stack voltages, either in Volts (as shown below), or as a percentage of the calibrated values, press the Up/Yes (↑) or Down/No (↓) buttons to see the results from each pulse card (0 to 5).

```

< █ Card: 0 Voltage (V)
Stk  A      B      C
0    3826  3826  3818
1    3822  3800  3819
2    3817  3823  3815
3    3795  3802  3795
    
```

To return to the previous menu, press the Left (←) button.

Running the Pulser from the Local Module

In the top level menu, move the cursor adjacent to the **Run...** option and press the Right (→) button. The Local Control Module will turn on the high voltage power supplies and, when they have stabilized, it will enable the trigger circuits. The pulser may now be triggered from the Trigger input BNC connector. The PRF is limited to 1.1kHz.

To disable the high voltage power supplies and return to the previous menu, press the Left (←) button.

5. Remote Operation

Under normal operating conditions, the PBG5 will be controlled by the Remote Control Module. To operate the PBG5 with its Remote Control Module, use the following power-up sequence:

1. Ensure the comms fibre link has been properly connected to the Local Control Module;
2. Switch on the PBG5 Pulser and Local Control Module at the AC Inlet on the front panel;
3. Connect the comms fibre link to the Remote Control Module;
4. Ensure the Remote Control Arm Key Switch is in the off position (key removed);
5. Switch on the Remote Control Module at the AC Inlet on the rear panel.

At this point the Local Control Module LCD will indicate that remote control has been established and the Pulser Module will no longer respond to local commands. The Local Control Module will now act as a slave to the Remote Control Module, and will remain in this state until the power is cycled.

The Remote Control Module will show a steady Error LED to indicate that the user must test the optical link before proceeding.

Testing the Optical Link

The operation of the optical link can be verified from the Edit menu on the Remote Control Module. Ensure the cursor is on the left side, adjacent to the **Test Opto link** option, as shown below.

```

Mode: Edit
Trig: Internal

■ Test Opto link >
  Amplitude: 6.0kV
  Burst PRF: 10Hz
  Duration : 1.0s

Temp: 25°C
Please test link.

```

Press the Right (→) button. The test will check the serial comms (A & B) and Trigger signals. A successful test will clear the Error LED.

Press the Left (←) button to return the cursor to the left side.

Edit Mode

The Remote Control Module will power-up in Edit mode. In this mode, the user may select the trigger source and edit the PBG5 pulse parameters.

The PBG5 Trigger Source is selected by the position of the toggle switch on the front panel of the Remote Control Module.

When the switch is in the **Internal** position, the trigger source is generated by the internal logic. The amplitude, frequency and duration of the burst is programmed from the Remote Control Module front panel LCD.

When the switch is in the **External** position, the trigger source is taken from the Trigger input BNC connector on the front panel. In this case, amplitude is programmed from the Remote Control

Module front panel LCD in Edit mode, but frequency and duration is set by an external pulse generator.

While in Edit mode, enter Arm mode:

1. Ensure the optical link is properly connected and a valid comms link is detected,
2. Ensure the optical link has been tested with the **Test Opto link** option, and
3. Enable the Arm key switch.

Arm Mode

In Arm mode, the PBG5 High-Voltage stacks can be enabled, and therefore the Armed/firing LED and the external Warning Beacon will be illuminated.

The user may test the High Voltage stacks in the pulser while in Arm mode. To do this, position the cursor on the left side, adjacent to the **Test Stacks** option. Press the Right (→) button. This will perform a Fast Test on the Pulse cards and return a pass/fail result. If any stack voltage deviates from its calibrated value by more than 4%, the test will fail. Note that the Remote Control Module will not display the voltages.

In Arm mode, the user will still be able to select the trigger source using the toggle switch. However, the pulse settings - amplitude, frequency and burst duration - may not be changed. To make changes to these parameters, return to Edit mode by disabling the Arm key switch.

To enter Run mode with the displayed settings, move the cursor adjacent to the **Run...** option and press the Right (→) button. The Remote Control Module will enable the high voltage power supplies and, when they have stabilized, it will enable the trigger circuits.

Run Mode

In Run mode, triggering is enabled. The Armed/firing LED and the Beacons, if fitted, will flash in response to trigger pulses received by the Pulse Module.

If the Trigger source switch is in the **Internal** position, the Fire button on the Remote Control Module may be used to deliver a burst of pulses as previously programmed in Edit mode. One burst is delivered when the Fire button is depressed, and this may be repeated often as required.

If the Trigger source switch is in the **External** position, the pulser may now be triggered from the Remote Control Module's Trigger input BNC connector. The PRF is limited to 1.1kHz.

In Run mode, the user cannot change the trigger source using the toggle switch. If the toggle switch is changed, the pulser will exit Run mode.

To exit Run mode and return to Arm mode, press the Left (←) button. Alternatively, return directly to Edit mode by disabling the Arm key switch.

Communications Failure

If the optical communication link fails while the pulser is in Arm or Run mode, the pulser will return to Edit mode and enter a safe state. It will remain in this state until a valid comms link is detected.

```
Mode: Edit
Trig: Internal

■ Test Opto link >
  Amplitude: 6.0kV
  Burst PRF: 10Hz
  Duration : 1.0s

Temp: -----
No comms detected.
```

Description of High Voltage Tests

The PBG5 Output Module contains a single CPS3 trigger card and five PBG5 high voltage pulse cards. Each pulse card contains four high voltage power supplies, so there are a total of 20 high voltage power supplies on the pulse cards. Each one of these high voltage power supplies generates a voltage for three avalanche stacks.

The PBG5 Local Control Module can test the high voltage power supplies and compare the stack monitor voltages with the previously calibrated values. If there are any significant differences between the monitor voltages and the original values, there may be a fault in one of the stacks.

Due to the design of the high voltage monitoring circuit, only one power supply can be monitored on each pulse card at any one time - the other power supplies must be disabled. Each power supply takes about 2.5 seconds to stabilize after power-up so that a voltage sample can be taken. When enabling only one of the 20 power supplies at a time, this means a test can take up to 1 minute. We refer to this as a Slow test. If any one of the avalanche stacks has failed, due to a shorted transistor or a self-triggering fault, the voltage on that stack will most likely be a few hundred Volts lower than its normal (calibrated) value.

It is possible to enable one power supply on each of the five pulse cards simultaneously. This test takes a little over ten seconds, and is referred to as a Fast test. The Fast test is used as the default method of testing the stacks as it will quickly indicate that there is a problem. However, since five stacks are enabled at any one time, a self-triggering fault may appear to affect those other stacks that, in reality, are functioning normally. In this case, the Slow test should be used as a diagnostic test to identify the faulty stack.

6. Test Results

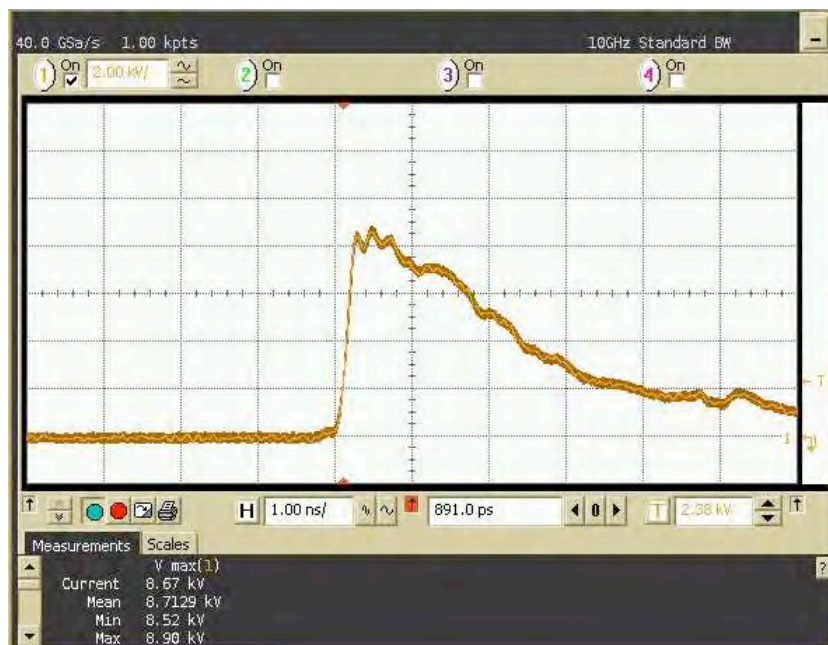
Pulse Amplitude Tests

All pulse amplitude tests carried out at 50Hz PRF.

Pulse Amplitude Test: 6kV



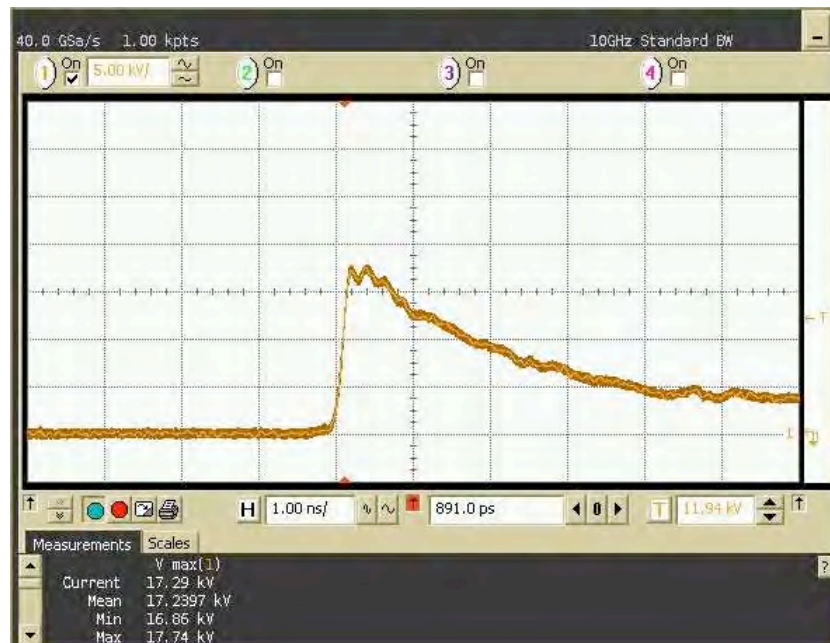
Pulse Amplitude Test: 8.5kV



Pulse Amplitude Test: 12kV



Pulse Amplitude Test: 17kV



Pulse Amplitude Test: 24kV



Pulse Rise-time Tests

All pulse rise-time tests carried out at 50Hz PRF.

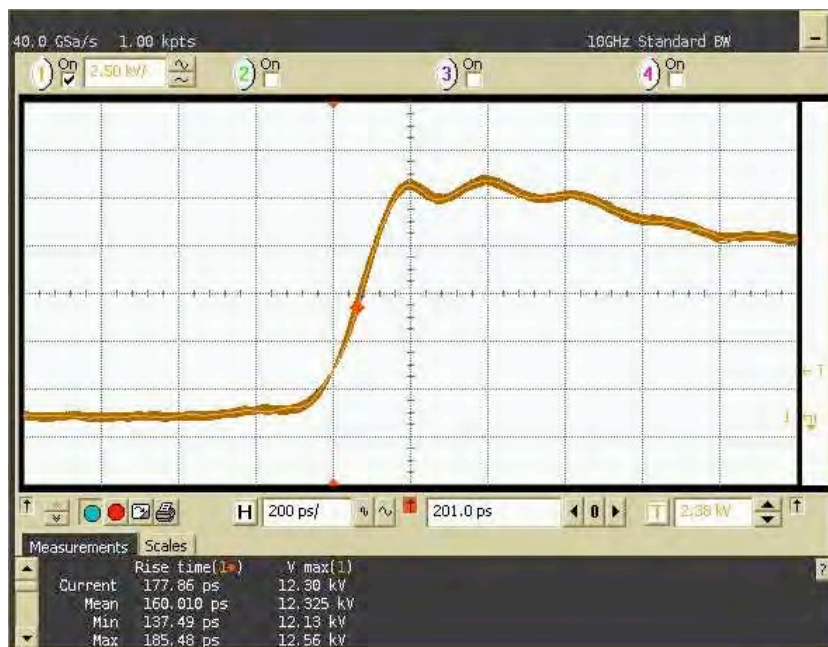
Rise-time Test: 6kV



Rise-time Test: 8.5kV



Rise-time Test: 12kV



Rise-time Test: 17kV



Rise-time Test: 24kV

