Kentech Instruments Ltd.

Instruction Manual

for

PDG2-50

Precision Programmable

Delay Generator

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PLEASE READ THIS MANUAL CAREFULLY

BEFORE USING THE DELAY GENERATOR

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1 SPECIFICATION

- Maximum delay adjustment — 50ns
- Incremental delay step — 25ps
- Intrinsic delay at zero setting — 7.7ns
- Interstep error — <± 0.5 steps, but reproducible.
- Jitter — effectively zero, mechanical device.
- Characteristic impedance — 50Ω.
- Voltage handling — D.C. 30 volts.

  With pulsed signals up to 30 volts the delay may be changed whilst the signal is propagating through the device.

  If the delay setting is not changed whilst the pulse is propagating, the pulse is limited to 1.8μA coulombs. e.g. 1.5kV for 2ns.

  1.5kV is the maximum recommended voltage even for very short pulses.
- Fully functional controls via front panel keys and serial port.
- LCD display of status and functions.
- USB port — VCP driver 115,200 baud, requires simple text commands from a terminal or emulator.
- Ethernet port — Web page control compatible with Firefox, Safari.

  Requires DHCP server for IP address allocation
- Delay — Relative to intrinsic delay.
- Memory — Nonvolatile memory of last manual delay setting.
- Size — 270 x 210 x 87 mm^3•
- Power requirements — Universal mains voltage at approximately 20 watts.

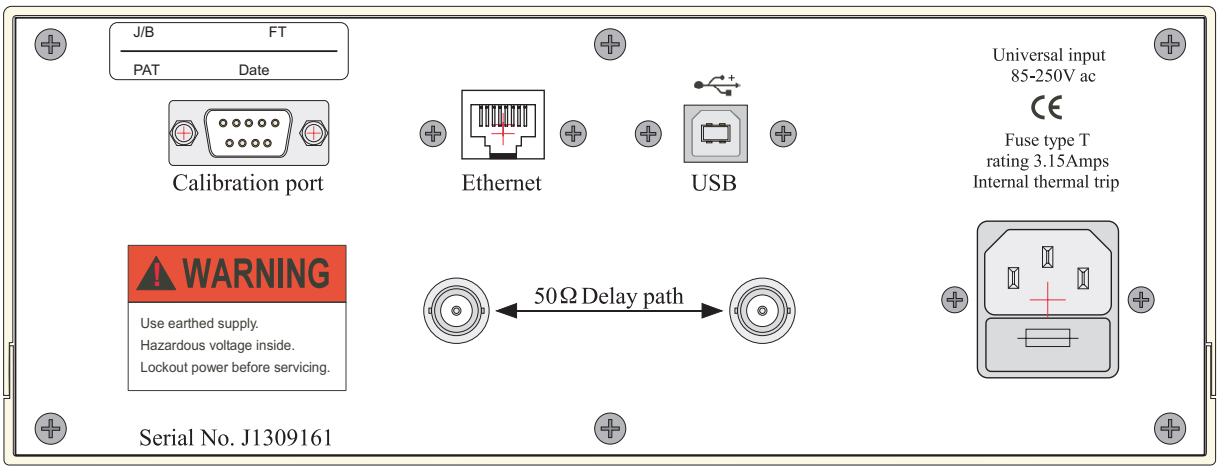

Figure 1 The rear panel showing the input and delayed output.

2 INTRODUCTION

The Kentech Programmable Delay Generator uses a passive delay line to form a compact unit designed for the critical timing adjustment of fast camera systems and other fast instrumentation. It will delay an arbitrary input signal over an adjustment range of 50ns in 25ps steps. The unit consists of a set of switched 50Ω calibrated delay lines together with a controlling microcomputer. The device has no inherent jitter, a rise time of better than 1ns and a high voltage capability for short pulses. The delay is set manually from the front panel or remotely from a USB remote control interface or from a web browser using the Ethernet port. The current delay setting and the IP address can be displayed on the LCD display.

The delay is achieved by the switching in and out of various sections of delay line by a set of matched relays. Care has been taken to give a reproducible rise time over the entire adjustment range and the through rise time is better than 0.8ns for all delay settings. The unit may be used to delay short, relatively high voltage trigger signals. Many Kentech high voltage pulsers are able to use this feature to provide highly stable relative timing between two or more output pulse channels. This will find such applications as the adjustment of inter frame timing in fast framing cameras and triggering or pulse shaping in laser systems.

2.1 USING THE PROGRAMMABLE PRECISION DELAY GENERATOR

In manual mode all that is required to operate the unit is to route the signal to be delayed via the two BNC connectors on the rear panel of the delay generator. The front panel controls may then be used to adjust the delay added by the unit over a relative delay range of 0 to 50ns in 25ps steps.

The unit provides various special functions which are available via the USB or web browser interface for which a computer or a terminal will be required.

The relays used in the PDG2 are a latching design. When power is removed they will tend to stay in their exisiting position, though this is not guaranteed.

2.2 DELAYING A TRIGGER SIGNAL

Although care has been taken to maintain a constant rise time, the shape of a fast rising signal will change slightly as different delay line sections are switched in and out. In order that the triggering of some piece of equipment is most accurately delayed the trigger threshold of the equipment to be triggered should be set at around half the trigger amplitude.

2.3 LOCAL/REMOTE MODES

The unit always powers up in Local control mode in which the delay can be modified only with the front panel controls. The delay and status can be monitored remotely by the USB or web browser interfaces but they can not modify the delay in Local mode.

The PDG2 can be changed to Remote mode by the USB and web browser interfaces. In remote mode the LCD on the front panel displays delay and status information but the delay can not be changed locally from the front panel.

2.4 PICOSECOND/RELAY MODES

The PDG2 can be controlled by setting the delay in picoseconds. This is picosecond mode and is the only setting mode available in local control mode.

Alternatively in remote control mode, the USB or ethernet interface allows direct writing to the bits that control the 14 relay bits. This is relay mode.

2.5 MANUAL OPERATION FROM THE FRONT PANEL

On power up, the LCD will briefly display the start up banner, then will show the menu page:-

```
Run...            >
Setup...          >
```

The cursor is under R of Run.

Press the “right” to go to the Run page.

Press “down” then right to go to the Setup page.

Run page:-

```
<Delay =       125 ps
 Save = NO
Control : Local
```

On entering the run page, the cursor will be under the D of Delay.

Press “right” to put the cursor under the most significant digit of the delay setting.

Other digits can be selected with “left” and “right” and they can be incremented and decremented using up and down.

With the cursor under the most significant digit, press “left” to exit the delay editor.

The edited value of the delay is written immediately to the delay relays, but this value will be lost at power off unless it is explicitly saved.

To do this, with the cursor under D of Delay, press “down” to get cursor under S of Save, “right” to get it under “NO”. The save parameter can be toggled between “NO” and YES” using “up” and “down”. Set it to “YES” then exit by pressing “left” and the data will be saved to eeprom.

Note that the saved delay setting is loaded from eeprom at power up and used as the default setting.

Again with the cursor under D of Delay, press “left” to exit the run page and return to the menu page.

The last line of the run page is not editable, it indicates that the PDG2 is in local control mode.

Setup page:-

```
<UseEther? = Y
 IP: 0.0.0.0
```

On line 1 of setup page you can toggle the UseEther? flag.

This is used at power up. If it is set the ethernet interface routine is started up, otherwise it is left disabled. Note that this setting has to be saved to eeprom on the run page in the same way as the delay setting.

Line 2 of the setup page displays the IP address. This is not editable. It is normal for this to display all zeroes initially until the DHCP server allocates an IP address.

When the PDG2 is put in remote mode by the USB interface or web page interface, the LCD displays the remote page:-

```
Delay =       125 ps
Relay =      2118
Mode : ps
Control : Local
```

The remote page is not editable.

The first line displays the current delay setting in ps if the PDG2 is in picosecond mode.

The second line displays the value written to the 14 bit register that controls the relays.

The third line indicates whether picosecond or relay modes is in use.

2.6 USB INTERFACE

The USB interface is implemented with an FTDI FT232RL chip. A virtual COM port driver may be found at:

http://www.ftdichip.com/Drivers/VCP.htm

The virtual COM port should be set to 115200 baud, no parity, no flow control, 1 stop bit.

Note that power cycling will interrupt the USB protocol and the host will need to re-establish the USB link.

The user will require a suitable terminal, computer with terminal emulation or must write a simple program to be able to use the USB interface. Many terminal emulation programmes are available.

Commands are not case sensitive. They must be followed by a carriage return. Unrecognisable commands will result in an error message. The unit will echo all characters sent to it.

The following is a list of all commands and their function.

Commands that are active in local or remote modes:-

`control`	return 1 if remote control, 0 if remote control
`HELP {cr}`	print command list
`PS {cr}`	read delay in picoseconds, only valid if PSMODE set
`RELS {cr}`	read relay state
`PSMODE {cr}`	return 1 if in picosecond mode, 0 if relay mode
`CALIBRATION {cr}`	returns a list of delay cable lengths in ps
`SWversion {cr}`	returns software version (currently 0)
`HWversion {cr}`	returns hardware version (currently 0)
`Snumber {cr}`	returns serial number

Commands that are active in local mode only:-

`+control {cr}` put instrument into remote control

Commands that are active in remote mode only:-

-control return instrument to local control

`xxxx !PS {cr}` set delay in picoseconds and set PSMODE
`xxxx !RELS {cr}` set delay relays directly and reset PSMODE
`TESTRELAYS {cr}` clicks each relay 5 times in turn

`CYCLE {cr}` cycles through all ps delays in 25ps steps

2.7 ETHERNET INTERFACE

The ethernet interface is configured to get an IP address from a DHCP server. Logically it consists of a web page which can be manipulated with a web browser. The page was tested with Firefox 21.0 and Safari 5.0.5.

The control page is divided vertically into two areas. The lower or instrument monitor area shows information that is read back from the PDG2. The current delay setting, and the relay setting is displayed and there are two virtual leds to indicate if the instrument is in picosecond or relay mode. The monitor area reflects the current state of the PDG2 whether it is in local or remote control.

There are two virtual leds that indicate the control state, if local the Instrument Monitor led is on, if remote the Instrument Control led is on. You can select the control state by clicking on the control or monitor buttons in the centre of the page. The monitor button selects local control, the control button selects remote control.

When the Instrument Control led is on, i.e the PDG2 is in remote control, you can adjust the delay setting by changing the requested delay value in ps in the upper section of the page and clicking apply. Setting a delay in picoseconds like this will also select Picosecond mode. In picosecond mode, the PDG2 looks up the correct relay setting in a look up table and writes it to the relay register to change the delay, so if you change the delay in picoseconds you will see both the picosecond and relay values change in the lower monitor section.

If you change the relay setting in the upper section and click apply, this will cause the PDG2 to change to relay mode and it will write the value directly to the relay register. The relay value in the lower section should reflect this, i.e. after a short the delay the two number should be equal. In relay mode the delay setting in picoseconds is not used.

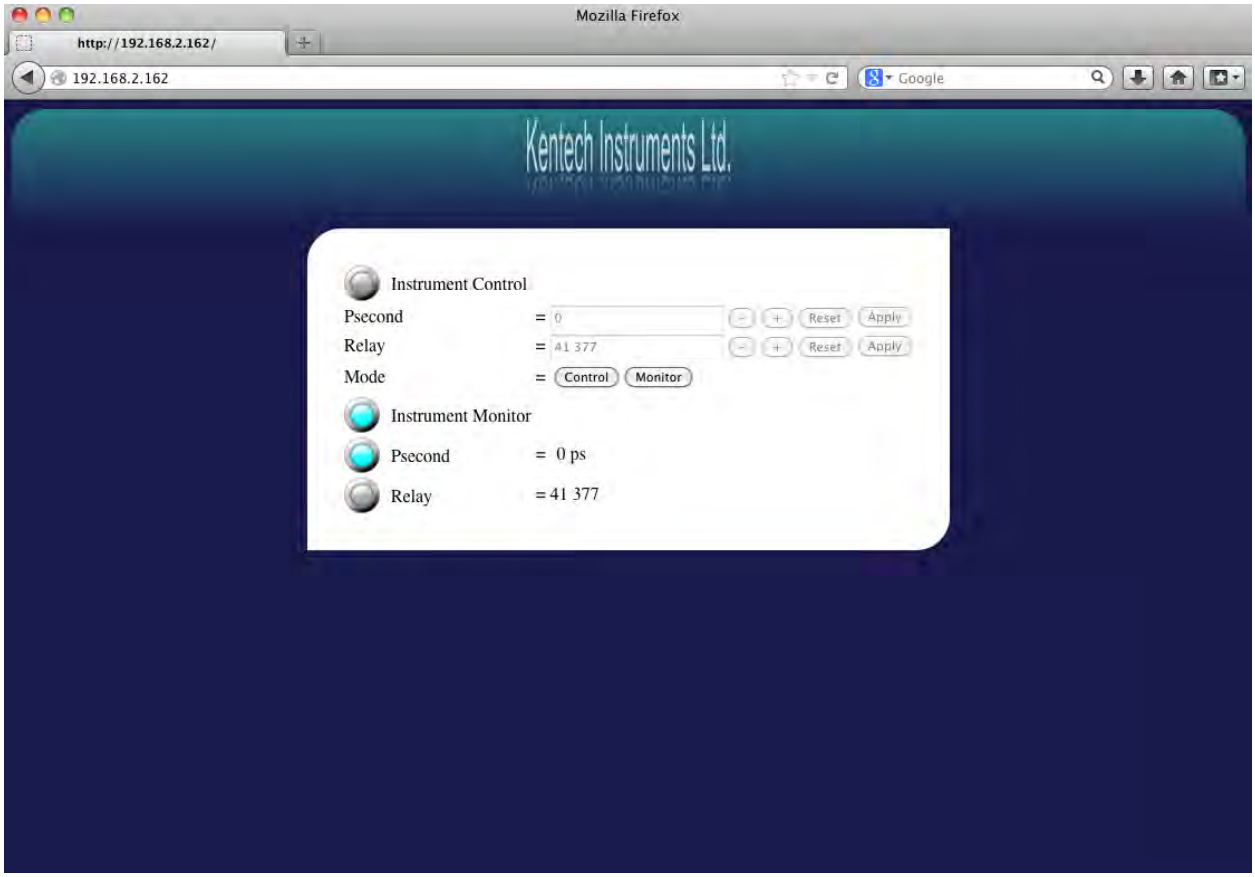

Figure 2 The web interface.

3 TEST DATA

The unit was tested at low voltage with the auxiliary output of an Agilent 80804B oscilloscope. Data was taken with the same instrument.

Figure 3 Delay with 1ns increments.

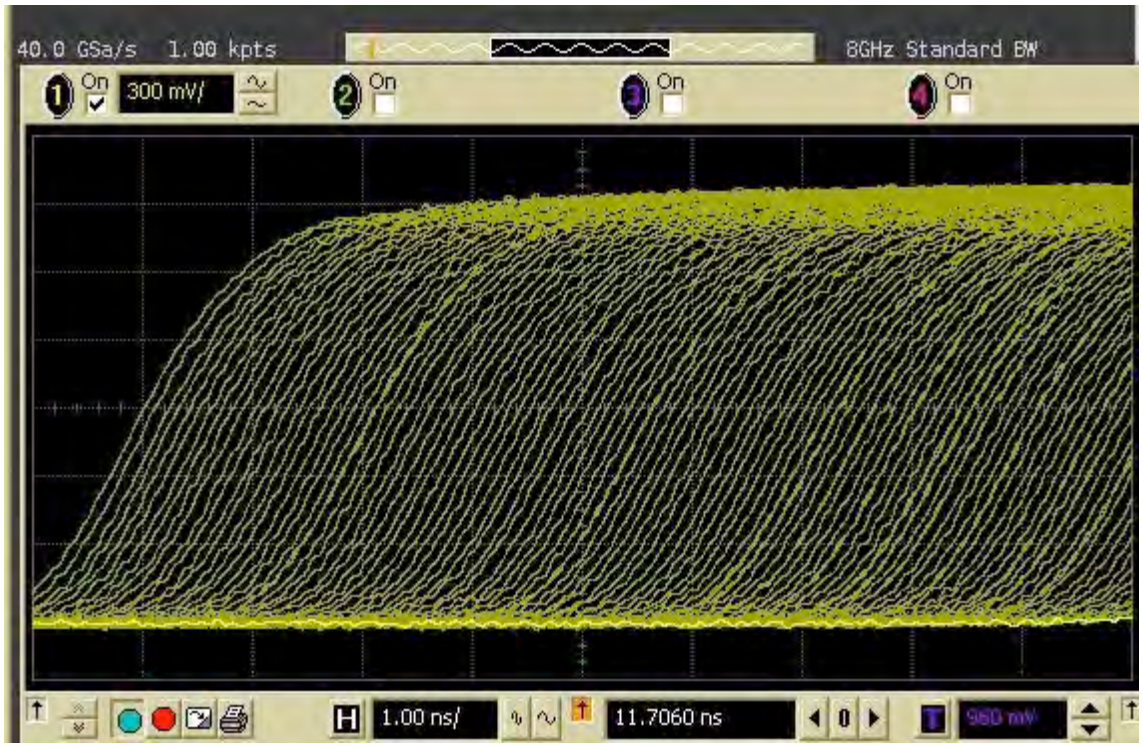

Figure 4 100ps delay increments from zero.

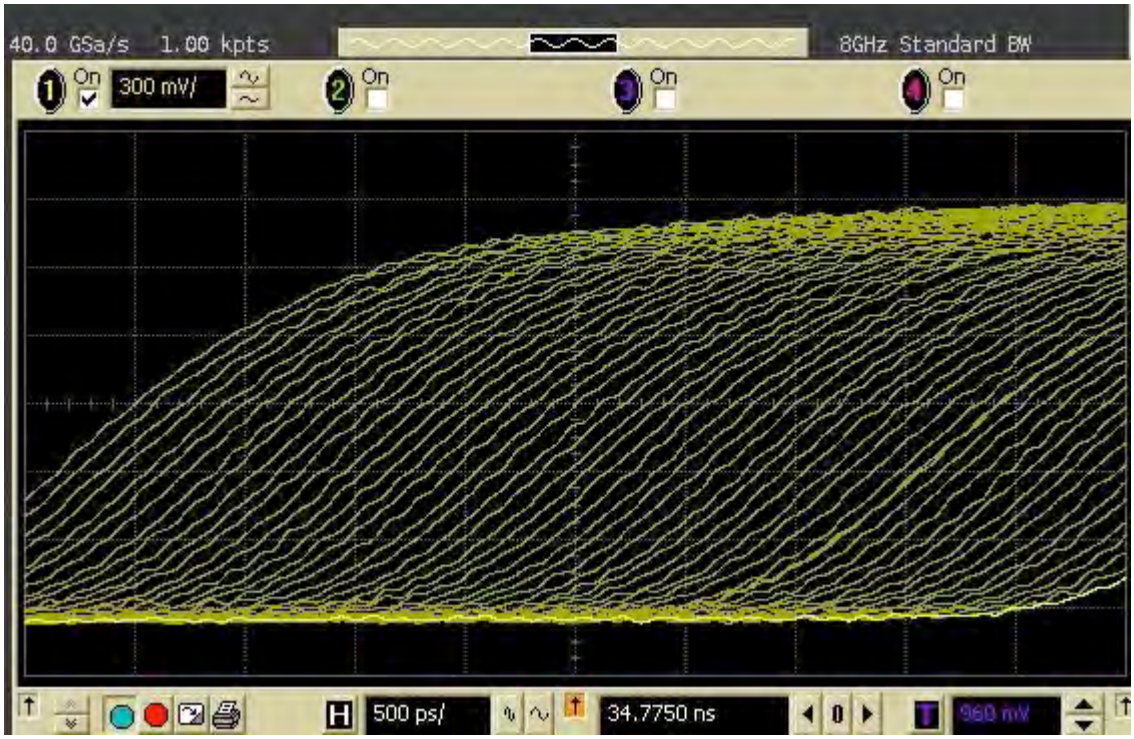

Figure 5 100ps delay increments from 25ns.

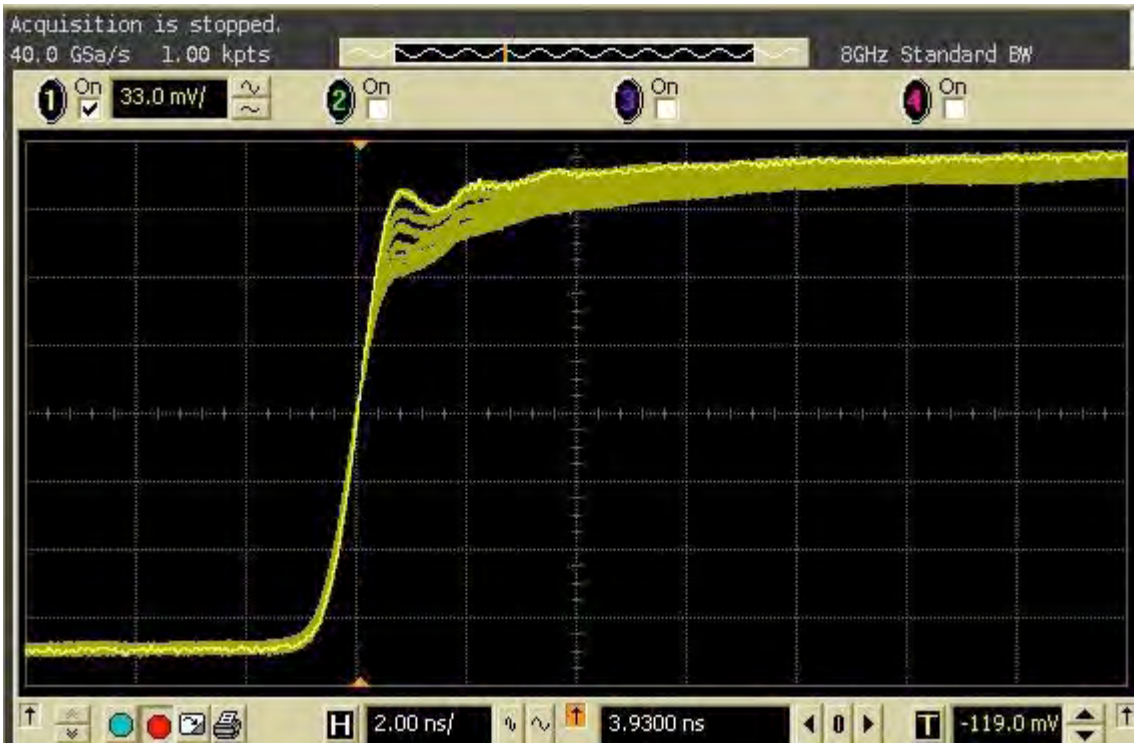

Figure 6 Degredation of rise tim eof a pulse as the delay is increased.

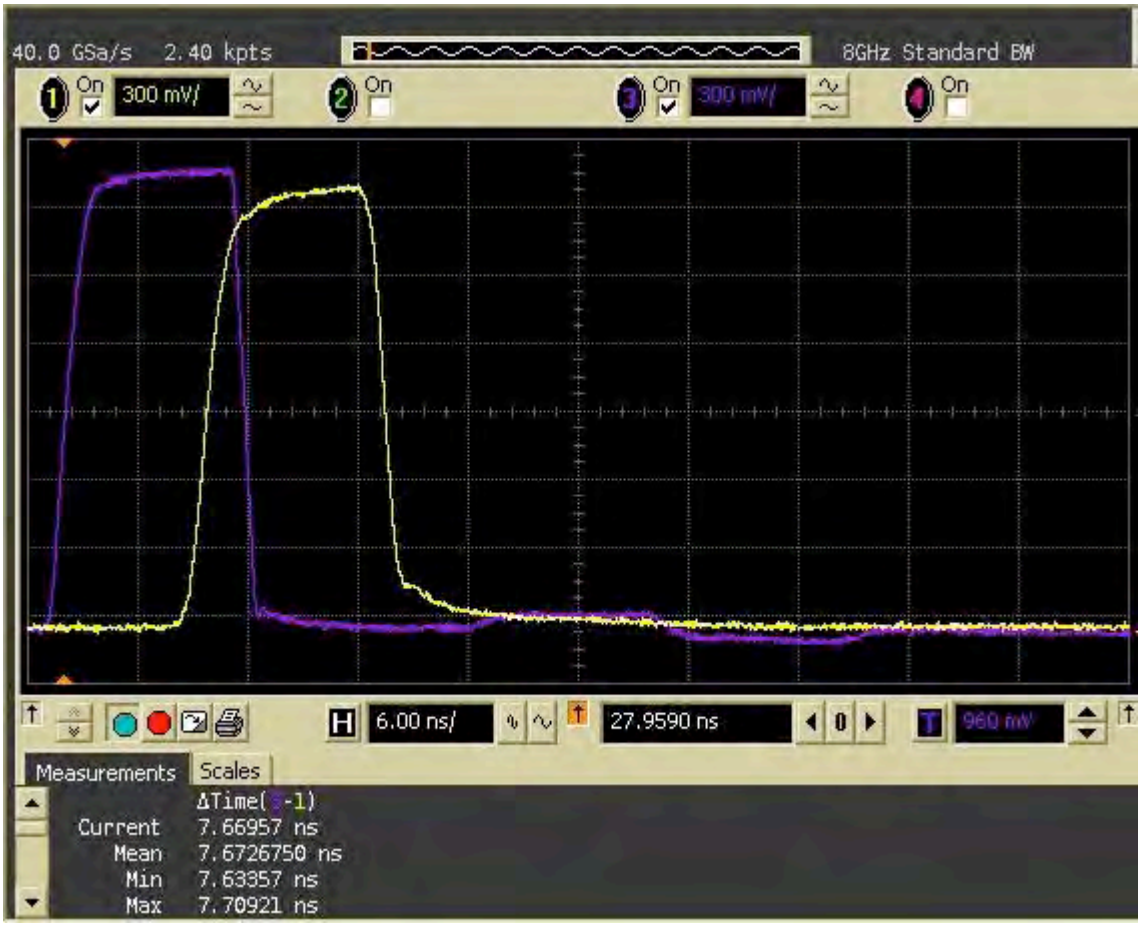

Figure 7 The intrinsic delay.