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GFT9404

EIGHT CHANNEL DIGITAL DELAY GENERATOR

USER MANUAL

- Four high resolution delay channels
  - 1 ps delay resolution
  - < 50 ps rms jitter + delay x10^{-7}
  - > 20 second delay range
- Four auxiliary delay channels
  - 5 ns delay resolution
  - < 100 ps rms jitter + delay x10^{-7}
  - > 20 second delay range
  - Available on front panel and PXI TRIG
- Four sources of trigger: external, internal, PXI STAR and software trigger
- Two trigger modes: single shot or repetitive
- One Slot 3U PXI, hybrid compatible



Total sheets: 21

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EDITION

Ed.	Date	Description
1	15/05/2009	Creation
2	30/09/2009	Update the specification
3	27/07/2010	Update the specification
3.1	26/02/2016	Minor correction Board setup section.

1. GENERAL INFORMATION

The GFT9404 module provides four independent delay channels (T0 to T3). The delay resolution is 1 ps, and trigger-to-channel jitter is less than 50 ps. SMB outputs deliver 5 V, 2 ns rise time, under 50 Ω. Amplitude and width are adjustable on each output channel.

The GFT9404 also provides four auxiliary delay channels available on the front panel (AT0 to AT3) and/or on PXI trigger lines (PXI TRIG0 to PXI TRIG3). The delay resolution is 5 ns (one timebase clock), and trigger-to-channel jitter is 100 ps.

One input trigger (TRIG IN), PXI STAR, internal frequency, or software trigger is used to trigger off all output channels.

The module offers two operating trigger modes, repetitive or single shot.

The control panel software for Windows provides a simple method to configure settings for each channel, such as amplitude, width, trigger source, and trigger mode, and to control operation. You can save and recall settings. The software allows you to install and operate multiple GFT9404 boards in the same PXI chassis. The module serial number specifies the module address.

The GFT9404 is the ideal instrument to provide precisely timed pulses, as encountered in picosecond laser system and other accelerator applications.

Package Contents

The box you received should contain the following:

- GFT9404 module,
- CD containing the PDF user manual, LabVIEW driver, and GFT9404 application software,
- Certificate of calibration.

What do you need to get started

To set up and use the GFT9404, you need the following items:

- GFT9404 delay generator,
- GFT9404 user manual,
- GFT9404 CD driver,
- NI-VISA,
- PXI chassis, or PXI Express chassis with hybrid slots,
- PXI embedded controller or a computer connected to the PXI chassis using MXI.

Unpacking

The GFT9404 is shipped in an antistatic package to prevent electrostatic damage to the module. Electrostatic discharge (ESD) can damage several components on the module.

Caution: Never touch the exposed pins of connectors.

To avoid such damage when handling the module, take the following precautions:

- Ground yourself using a grounding strap or by touching a grounded object.
- Touch the antistatic package to a metal part of the computer chassis before removing the module from the package.

Remove the module from the package and inspect the module for loose components or any sign of damage. Notify Greenfield Technology if the module appears damaged in any way. Do *not* install a damaged module into the computer.

Store the GFT9404 in the antistatic package when not in use.

2. INSTALLING AND CONFIGURING

This chapter describes how to install the GFT9404 hardware and software and how to configure the device.

Installing the Software

Refer to the readme.htm file on the GFT9404 CD for software installation directions.

Note : be sure to install the driver software *before* installing the GFT9404 hardware.

The software includes a control application for using the board directly, as well as a library for designing C/C++ applications and LabVIEW VIs.

This release of the GFT9404 control application supports Microsoft Windows XP SP2, Vista, and Windows 7.

For application development, you need either a C/C++ compiler and an IDE such as Visual Studio, or LabVIEW.

Installing the Hardware

The following information provides general installation instructions. Consult the chassis user manual or technical reference manual for specific instructions and warnings about installing new modules.

1. Power off and unplug the chassis.

2. Choose an available PXI or PXI hybrid slot in the chassis.

3. Remove the filler panel for the PXI slot you chose in step 2.

4. Ground yourself using a grounding strap or by touching a grounded object. Follow the ESD protection precautions described in the *Unpacking* section of Chapter 1, *General information*.

5. Insert the GFT9404 into the PXI slot. Use the ejector handle to fully insert the module into the chassis.

6. Screw the front panel of the device to the front panel mounting rail of the chassis.

7. Visually verify the installation. Make sure the module is not touching other modules or components and is fully inserted into the slot.

8. Plug in and power on the chassis.

3. OPERATING INFORMATION

Functional Overview

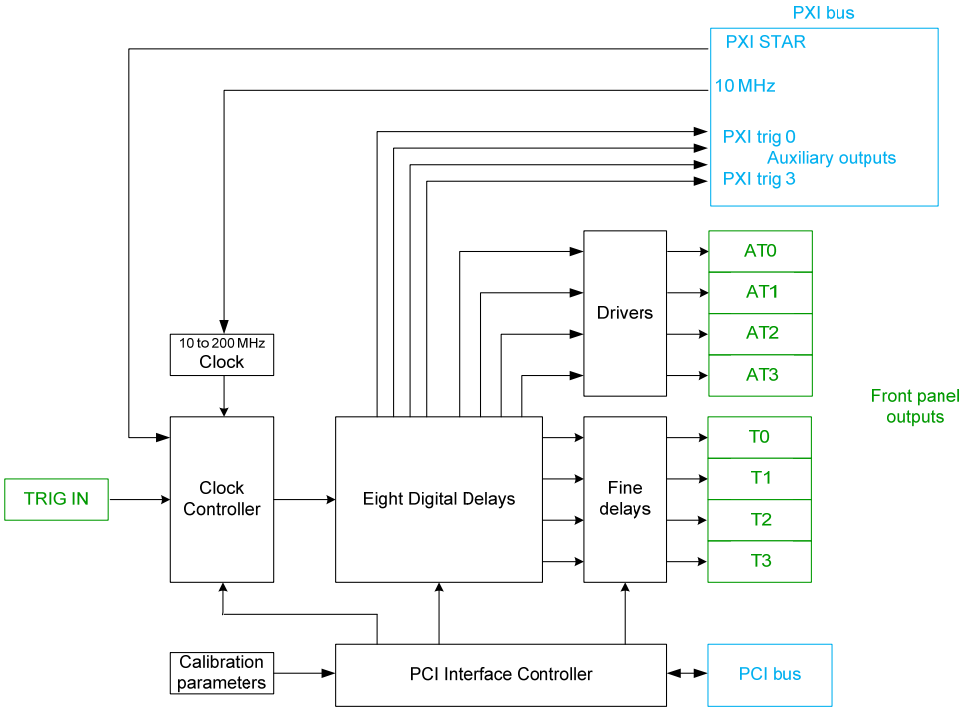


Figure 3-1 Functional Overview

When the module is in the RUN state, a rising edge on a trigger starts a delay sequence. The internal trigger comes from TRIG IN, PXI STAR, or software trigger.

The sequence includes two external trigger phases:

- After an insertion delay, a pulse appears on each channel after a specified delay
- At the end of sequence, after the last delayed pulse, the delay generator is ready for repetitive trigger mode.

When a sequence is in progress, the instrument does not respond to any trigger event.

The GFT9404 must be configured (trigger, delay, etc.) in the STOP state before starting any sequence. In the STOP state, outputs are automatically disabled.

When a delay sequence starts, the green front panel LED turns on for 1 second.

Timing Principle Using External Triggering

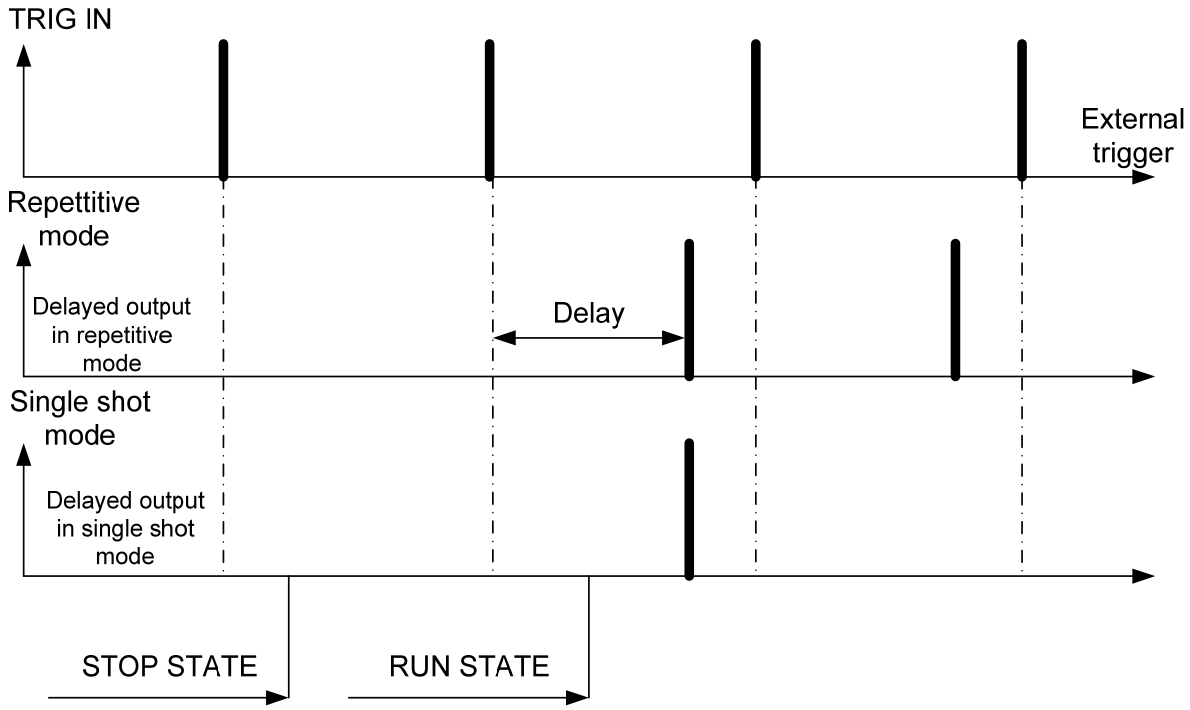


Figure 3-2 Trigger Timing

In response to the input trigger the board can generate a single delayed output (single shot mode) or repetitive delayed outputs (repetitive mode).

Calibration parameters are saved onboard.

Front Panel

The GFT9404 fits into a single slot of a 3U PXI or PXI Express hybrid chassis.

The front panel has two LEDs and 9 connectors.

LEDs		
	TRIG (green)	Lights on when a trigger is detected
	FAULT (red)	Lights on if a fault is detected
Connectors	SMB type	
	TRIG IN	External trigger input
	T0 to T3	Four high resolution outputs
Connectors	MMCX type	
	AT0 to AT3	Four auxiliary outputs
Ejector handle		
	Includes a label with the serial number	

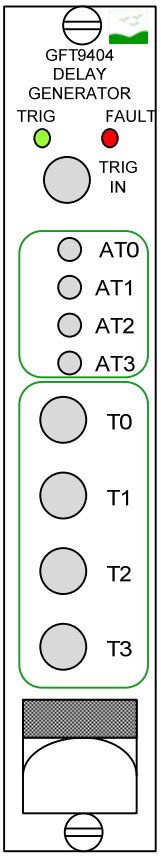


Figure 3-3 Front Panel

Trigger Routing Architecture

The table below lists available connections. If a particular cell is filled in, the connection is possible. If a cell is empty, this connection is not possible.

		Destinations						
		Front Panel			Backplane			Onboard
Front Panel			T<0..3>	AT<0..3>	PXI_CLK10	STAR TRIGGER<0..12>	PXI TRIG<0..7>	Clock
	TRIG IN		X (1)	X (2)			0 .. 3 (2)	
Internal			X (1)	X (2)			0 .. 3 (2)	
Backplane	PXI_CLK10							X
	STAR TRIGGER<0..12>		X (1)	X (2)			0 .. 3 (2)	
	PXI_TRIG<0..7>							
Onboard	Clock							
	Global SW Trigger		X (1)	X (2)			0 .. 3 (2)	

(1) Resolution = 1 ps

(2) Resolution = 5 ns

Triggers available on the PXI_TRIG lines are copies of the auxiliary triggers. Accordingly, to control the delay on a PXI_TRIG line you have to set the appropriate delay for the corresponding auxiliary trigger. The mapping is as follows: AT0 is available on PXI _TRIG0, AT1 on PXI_TRIG1, AT2 on PXI_TRIG2, and AT3 on PXI_TRIG3. Note that, in order to avoid accidental “double driving” of PXI_TRIG lines when using multiple boards in the same chassis, triggers on PXI_TRIG lines are disabled by default. You will have to issue a specific software call to enable the copy of an auxiliary trigger to the corresponding PXI_TRIG line.

Self-Test

The red FAULT LED indicates whether the board has one of the following problems:

- Loss of 10 MHz PXI backplane
- PLL unlock
- Oscillator unlock

Status

For each channel, a status indicator shows if the channel has generated the pulses.

In single shot mode, this status indicator is erased when the RUN state is activated.

In repetitive mode, this status is erased when the STOP state is activated.

Multiple Board Synchronization

External trigger copy:

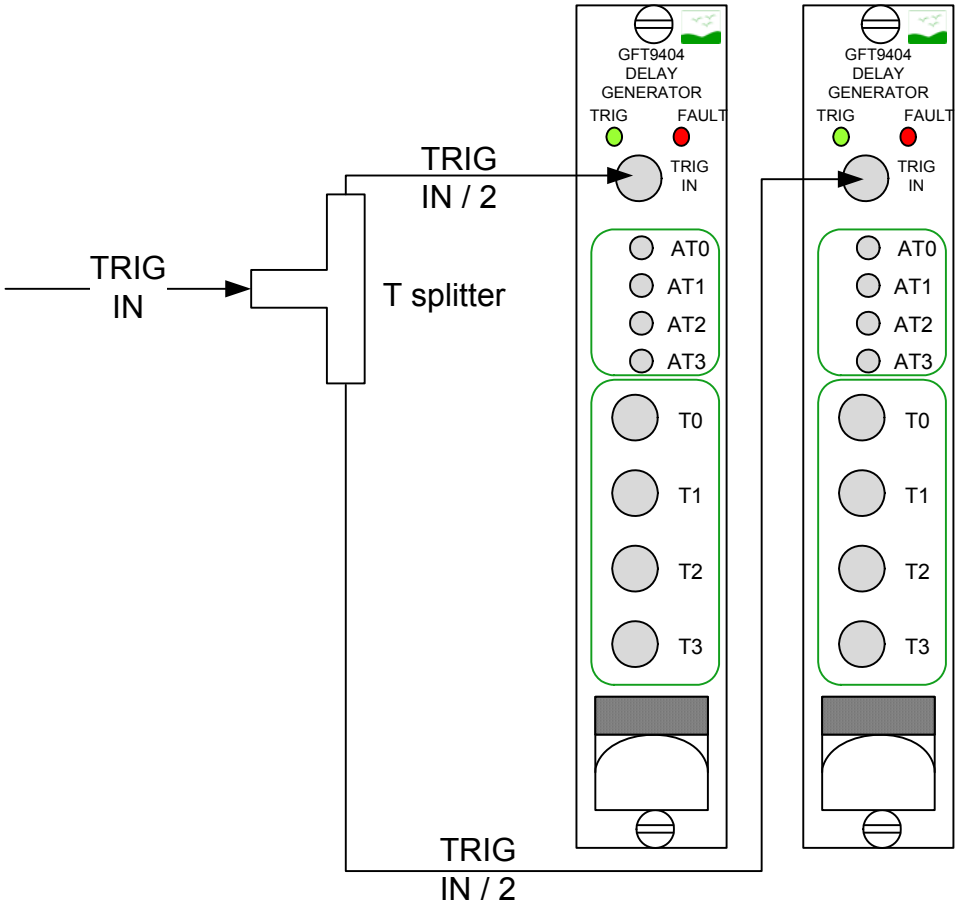


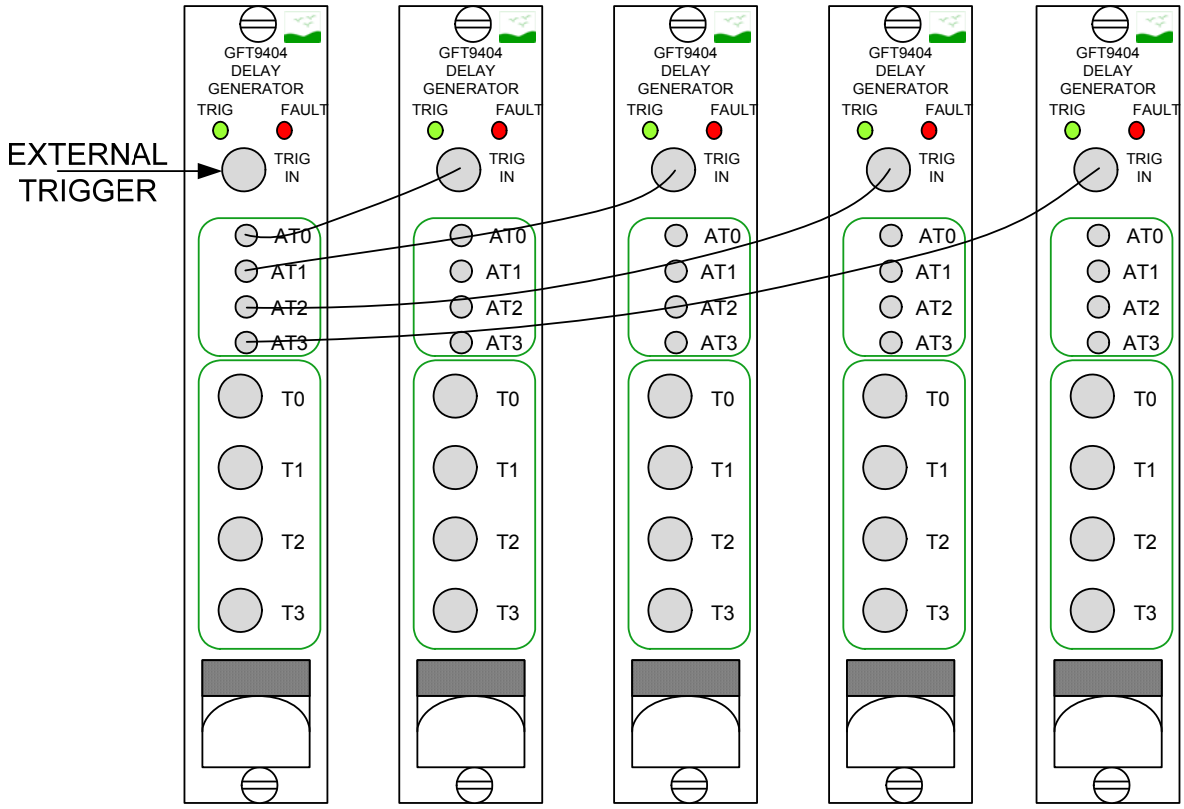
Figure 3-4 Multiple Board Synchronization

With a T splitter (e.g. Radiall reference R114781000), you can synchronize multiple boards (passive solution) as shown above.

With any NI PXI-665X, PXIe-6672, or PXI-6682 board, multiple GFT9404 boards can be synchronized using the PXI STAR lines.

Five modules synchronized:

This configuration provides 36 synchronized delayed outputs from a single trigger source. The use of an external trigger source is shown below. The GFT9404 board on the left is used to control the source of triggers to synchronize the four other GFT9494 boards via the AT0 to AT3 outputs.



4. APPLICATION SOFTWARE

Connecting a Board

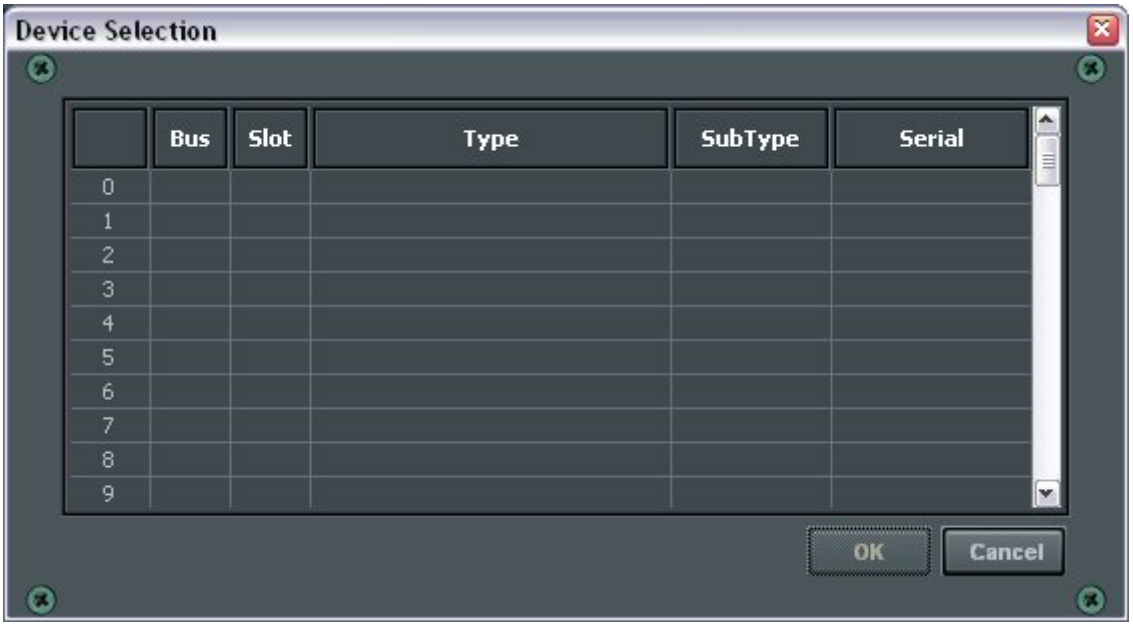
Start the GFT9404 control application by double clicking the gft9404.exe file or by using the menu command <Start> -> Programs -> Gft9404 – PXI delay Generator for VISA -> Gf9404 – PXI delay Generator for VISA.

The main application window is shown below.



For connecting the software to a board, use File->Open a device or use the shortcut Ctrl+O.

This opens a window that shows a list of boards found in the system.



Select the board you want to connect to and click the OK button or double click on the board in the list to connect the board to the control application. The control application reads the registers of the board and shows the delays, amplitude, width and trigger values on the panel.

If the board is in power on state, the control application configures the board with default values.

Board Setup

The front panel includes some buttons and numeric displays to configure and run the board. The elements of the panel can be accessed directly with the mouse or through the keyboard using the TAB or Shift TAB keys. When an element is selected, a thin red line surrounds it.



When selected, the user may change a button state by pressing the space key.

Numeric elements are modified with the arrow keys, by moving the mouse or by the mouse wheel. To modify a number you can place the cursor on the number, press the left mouse button and move the mouse up or down while keeping the left mouse button pressed. The number will be incremented or decremented by a value depending of the weight of the digit in the number. To help selecting the weight of the increment, the digit selected is underlined.

For example, if the number contains the value 1234.56 and you press the mouse button on the digit 2, the number will increment or decrement by a value of 100.

Here is an example when pressing the left mouse button on the digit 2



And, when moving the mouse up while keeping the left button pressed



In the example above, if the user moves the mouse slowly the increment is 100. If the user moves the mouse quickly, the increment will be 1000.

Delay Reference

Delays can be expressed as absolute delays, where the reference is the time of the incoming trigger, or as relative delays, where the reference is the time of the incoming delay plus the minimum insertion delay. As the insertion delay is a small, but non-zero delay (typically of the order of 50 ns), any absolute delay has to be at least as long as the insertion delay. However, when using relative delays, a delay value of zero is possible.



Channel Setup

Channel setup is done simply by choosing the delay, amplitude and width for each channel.

Set the channel enable button to ON to enable trigger output for that channel.



Trigger Setup

The trigger signal can have many sources and characteristics.

Trigger source

Trigger	Description	Level	Frequency
	The trigger signal comes from the front panel connector or from the PXI bus	✓	✗
	The trigger signal comes from the board internal frequency. In this case, the trigger mode is repetitive. Trigger input and polarity are ignored.	✗	✓
	The trigger signal comes from the front panel's trigger connector.	✓	✗
	The trigger signal comes from the PXI STAR trigger line.	✗	✗

Trigger mode

Mode	Description	EXT	INT
	The board is in single shot mode. Enabled channels output only one pulse on the first trigger signal occurrence.	✓	✗
	The board is in repetitive mode. Enabled channels output a pulse for each trigger signal occurrence.	✓	✓

Trigger slope

Mode	Description	EXT	INT
	The delays start on the low to high transition of the trigger signal.	✓	✗
	The delays start on the high to low transition of the trigger signal.	✓	✗

RUN and STOP Delay Sequence

To start a delay sequence, click on the RUN $_{STOP}$ button. When the board is in running mode, the panel elements are disabled (with the exception of the manual trigger button).

When the board is in single shot trigger mode, the board stops after the first trigger.

When the board is in repetitive mode, click on the RUN $_{STOP}$ button to stop the board.

Checking Board Status

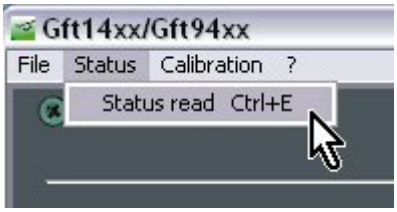
To check the board status, the application panel provides a summary of the error flags and a summary of the trigger flags.



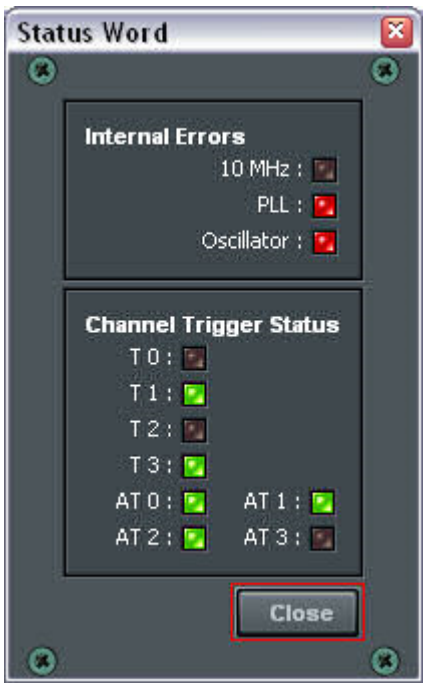
The fault LED is on if one of the board's error flags is on. This LED is on as long as an error is present.

The trigger LED is on for one second when the board is in repetitive mode and at least one channel has triggered. If the board is in single shot trigger mode, the LED is on as soon as a channel has triggered and remains on until the board is started again.

The full status of the board is available by selecting the status menu.



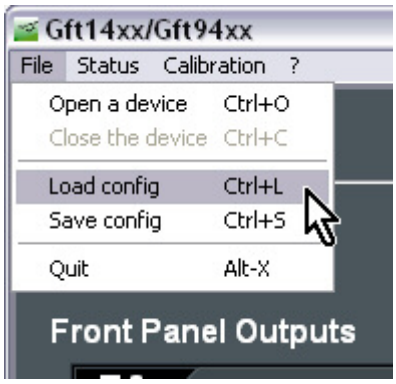
Choosing this menu item opens the status window.



This window shows the three error flags and the eight trigger flags of the board.

Saving and Loading Configuration Files

A complete board configuration can be saved or loaded with the menu items "Save config" or "Load config".



The "Save config" menu item saves the complete board configuration in an XML file that can be later reloaded with the "Load config" menu item.

Appendix A: Specifications

Delays		
	Channels	Four independent delay outputs
	Range	0 to > 20 seconds
	Resolution	< 10 ps
	RMS jitter (External trigger to any	50 ps rms + delay x 10^{-7}
	Accuracy	< 250 ps + delay x 10^{-7}
	Time base	200 MHz, 25 ppm
	Time reference from PXI bus	10 MHz, 25 ppm from PXI bus
Auxiliary Delays		
	Channels	Four independent delay outputs
	Range	0 to > 20 seconds
	Resolution	5 ns
	RMS jitter (External trigger to any	100 ps rms + delay x 10^{-7}
	Accuracy	1 ns + delay x 10^{-7}
Trigger source		
	Internal	
	Frequency	1 Hz to 10 kHz, step = 1 Hz
	External	
	Max repetition rate	< 50 kHz
	Trigger level,	From 0.1 to 5 V
	Trigger slope	Positive or negative
	Minimum trigger Delay	< 50 ns
	PXI bus trigger	PXI STAR
	Soft trigger	
Trigger mode		
	Single shot or repetitive	
Output T0 to T3		
	Amplitude	2 to 5 V
	Width	200 ns to 10 µs
	Load	50 Ω
	Rise time	< 2 ns
	Fall time	< 5 ns
	Connector	SMB

Output AT0 to AT3

Amplitude	5 V
Width	200 ns
Load	50 Ω
Rise time	< 5 ns
Fall time	< 5 ns

Additional PXI TRIG

Amplitude, rise and fall time	PXI standard
Width	25 ns
Connector	PXI connector

General

Size	PXI, 1 slot
Power	15 W (on + 3.3 V / + 5 V / + 12 V)
LEDs	Red : fault; green : trigger on

Environmental

Ambient temperature range	+ 10 to 40 °C
Indoor use only	

Free LabVIEW driver for Windows XP, Vista, and Windows 7, based on NI-VISA

Appendix B: Technical Support and Professional Services

Visit the following sections of the award-winning National Instruments Web site at ni.com for technical support and professional services:

Support—Technical support resources at ni.com/support include the following:

– **Self-Help Technical Resources**—For answers and solutions, visit ni.com/support for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on.
Registered users also receive access to the NI Discussion Forums at ni.com/forums. NI Applications Engineers make sure every question submitted online receives an answer.

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