licel
lidar computing and electronics

Trigger Timing Controller

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1 Overview

The Trigger Timing controller is designed to meet typical lidar measurement requirements. It will be useful in the following scenarios:

- get a quartz time based delay between laser lamp and Q-switch,
- synchronize the laser with a external trigger source like a chopper wheel,
- generate a pretrigger for the data acquisition
- generate a gate pulse for gated PMTs

2 Getting started

2.1 Mechanical Installation

The Licel Timing Controller is mounted in a standard 3 height unit, 10 widt unith cassette. It can be mounted in a compatible 19” rack system crate.

2.2 Power supply

Connect the power supply connection to a +5V, 0.4A min DC supply.

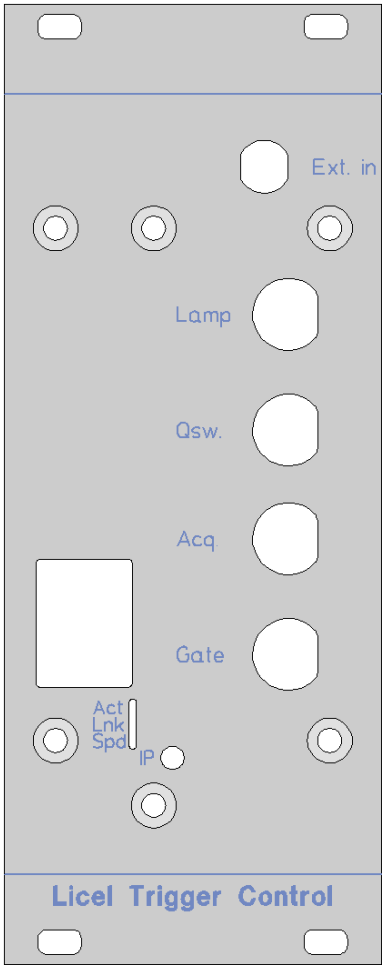
2.3 Ethernet connection

Connect the Ethernet port of the Gating Controller directly to your PC using the red crosslink cable which is supplied with the unit. Follow the steps 6.1, 6.3, 6.4 and 6.5 in the Ethernet Manual to set the IP adress of the controller according to your local network adress range. Once this is done, you can connect the controller to your local Ethernet network hub or switch using a straight Ethernet cable (not supplied).

2.4 Front Panel Connections

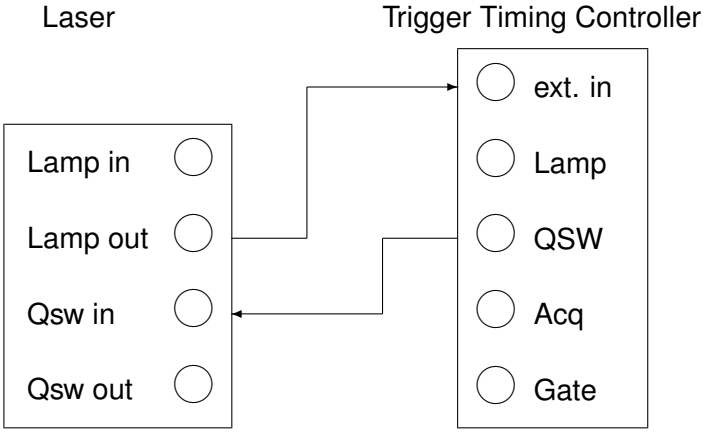
Power up the Gating controller, start the software using the ”Control Timing” program. To get familiar with the controller it’s a good idea to take a look at the pulses by using an oscilloscope. The output signals deliver max. 64mA. This corresponds to 3.2V@50Ohm. The following connectors can be found on the front panel:

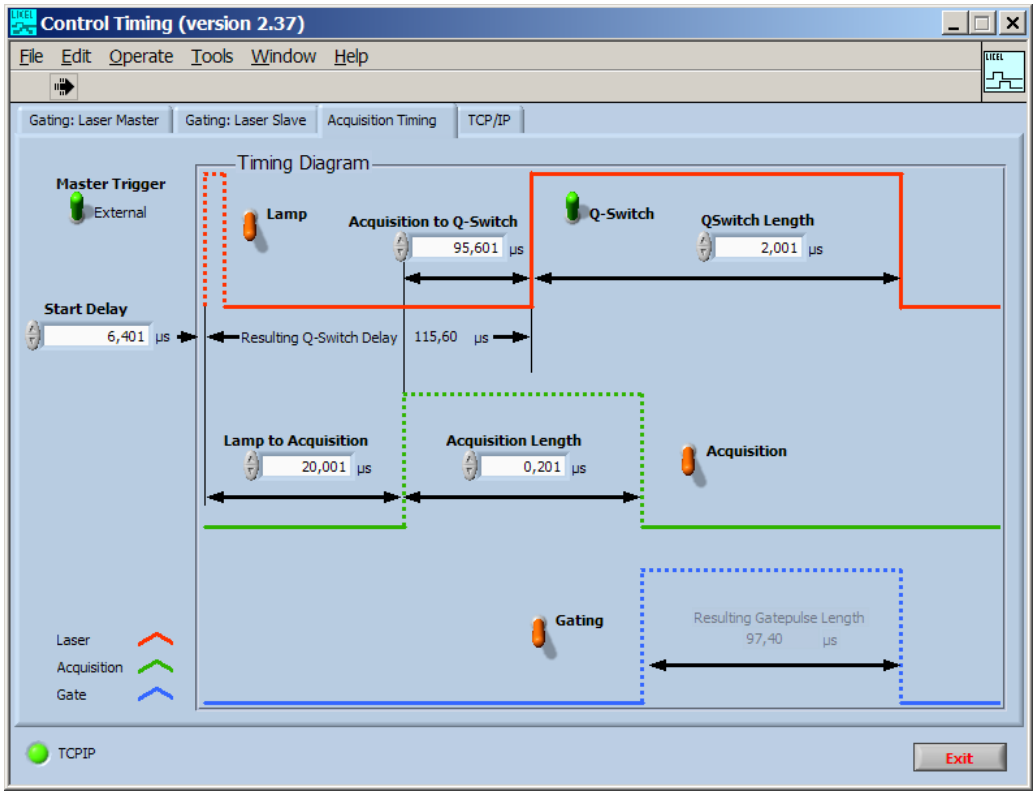
Ext. in	TTL-input, rising slope, start the pulse sequence by an external trigger pulse
Lamp	Output of a positive pulse. Active when ”Master Trigger” switch is set to ”transient” in the software. Fixed duration 6.4μs.
Q-sw	Output of a positive pulse. The total delay of the Q-sw pulse with respect to the Ext. in pulse or the lamp pulse is the sum of Q-Switch - Pretrig Delay + Pretrigger delay.
Acq	Output of a positive pulse. The pulse starts after the Lamp to Pretrigger delay and has the Pretrigger length.
Gate	Output of a positive pulse. The gating pulse starts with the falling edge of the Pretrigger pulse and ends at the falling edge of the Q-sw pulse.



3 Quartz Based Q-Switch Timing

This will be achieved by connecting the laser lamp output to the external trigger and the QSW signal from the trigger generator to the Q-switch input of the laser.





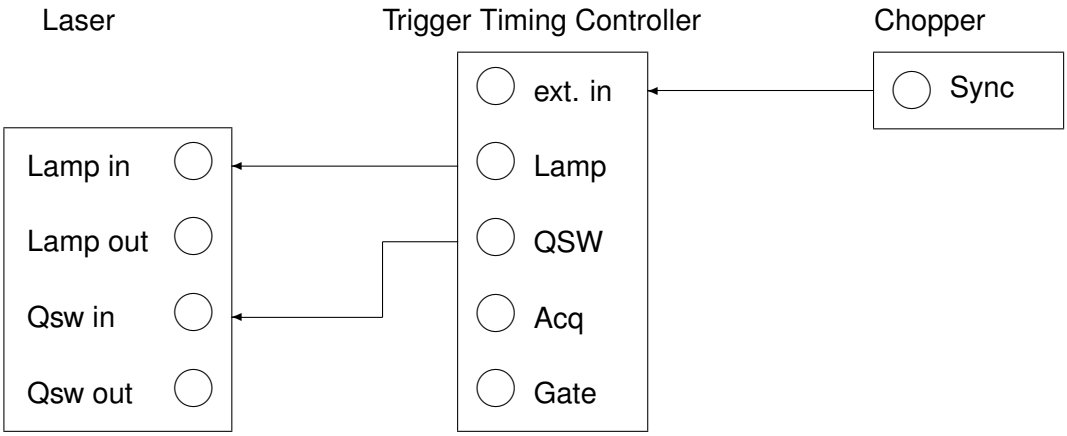
The shown configuration will accept a external trigger. The top left switch needs to be switched to the shown position: `Master Trigger: External`. The switch for the `Q-Switch` output needs to activated. To setup a delay of 121.4 μs One needs to setup three times:

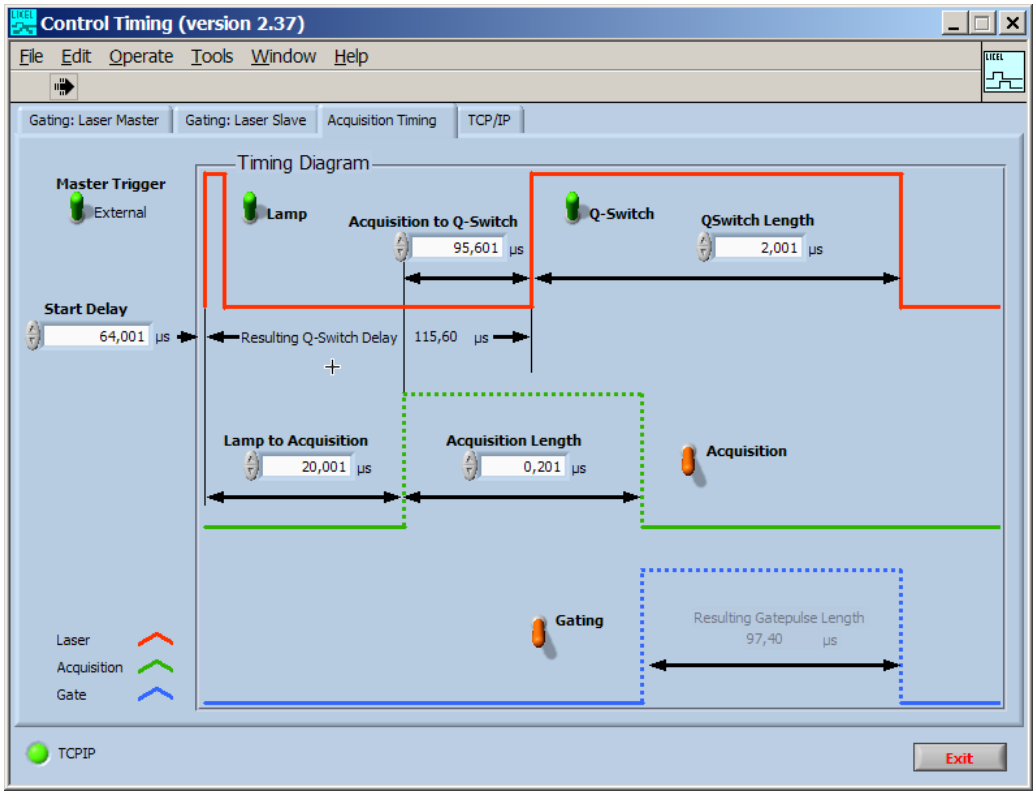
mc

1.	Start Delay	6.40 μs
2.	Lamp to Acquisition	20.00 μs
3.	Aquisition to Q-Switch	95.00 μs
	Overall	121.40 μs

4 External Laser synchronization with a chopper

This will be achieved by connecting chopper sync out to the external trigger. The Lamp and the QSW signal from the trigger generator to the lamp and Q-switch input of the laser.





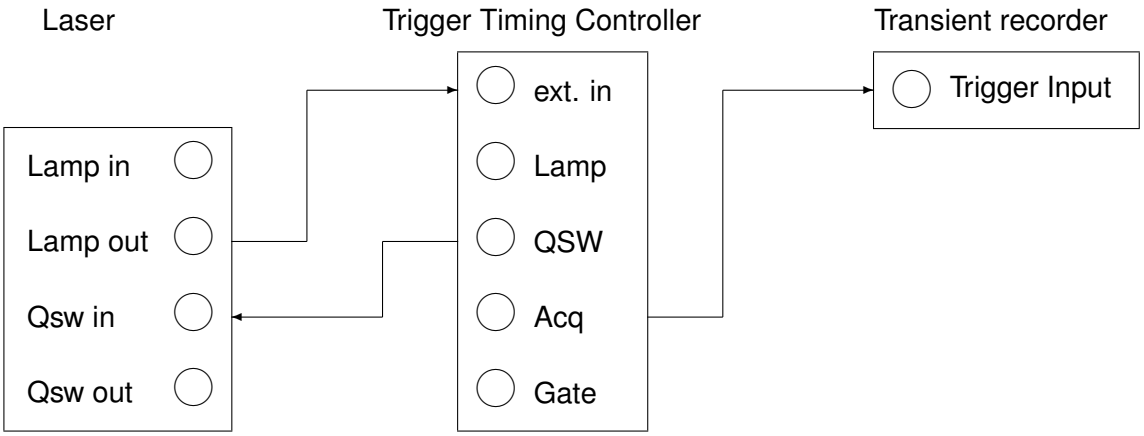
The shown configuration will accept a external trigger from the chopper. The top left switch needs to be switched to the shown position: `Master Trigger: External`. The switches for the `Lamp` and `Q-Switch` output need to activated (green state). The start of the lamp pulse can be adjusted with the Start Delay. The Q-switch pulse needs to adjusted with respect to the laser lamp.

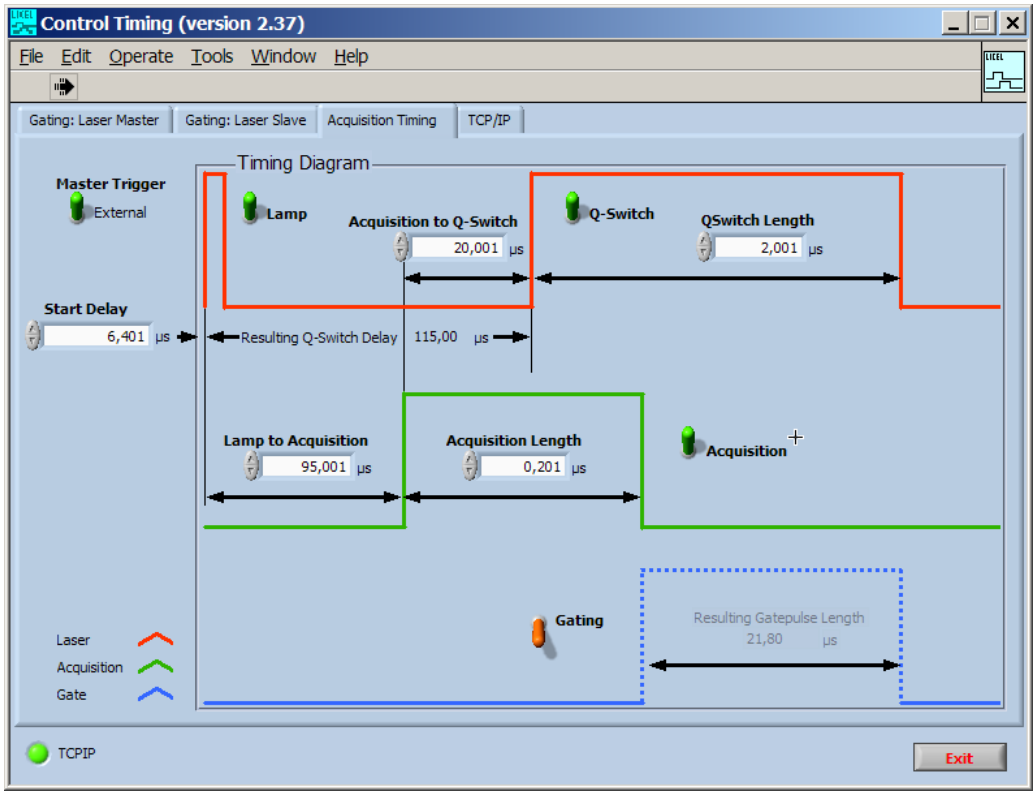
To setup a delay of 64 μs between the shopper and the laser and to have the Q-Switch 115.6 μs after the laser lamp one needs to setup three times:

1.	Start Delay	64.00 μs
2.	Lamp to Acquisition	20.00 μs
3.	Aquisition to Q-Switch	95.00 μs
	Lamp to QSW	115.00 μs
	Chopper to QSW	179.00 μs

5 Pretrigger for the data acquisition

This will be achieved by using the lamp out as the master trigger pulse. The QSW signal from the trigger generator should be connected to the Q-switch input of the laser. The Acq signal should be connected to the trigger input of the rack.





The shown configuration will accept a external trigger from the laser. The top left switch needs to be switched to the shown position: `Master Trigger: External`. The switches for the `Lamp`, `Q-Switch` output and the `Acquisition` need to activated (green state). To setup a delay of 121.4 μs between the laser lamp and the Q-Switch and a 20μs pretrigger for the data acquisition one needs to setup three times:

mc

1.	Start Delay	6.40 μs
2.	Lamp to Acquisition	95.00 μs
3.	Aquisition to Q-Switch	20.00 μs
	Overall	121.40 μs
	Pretrigger	20.00 μs

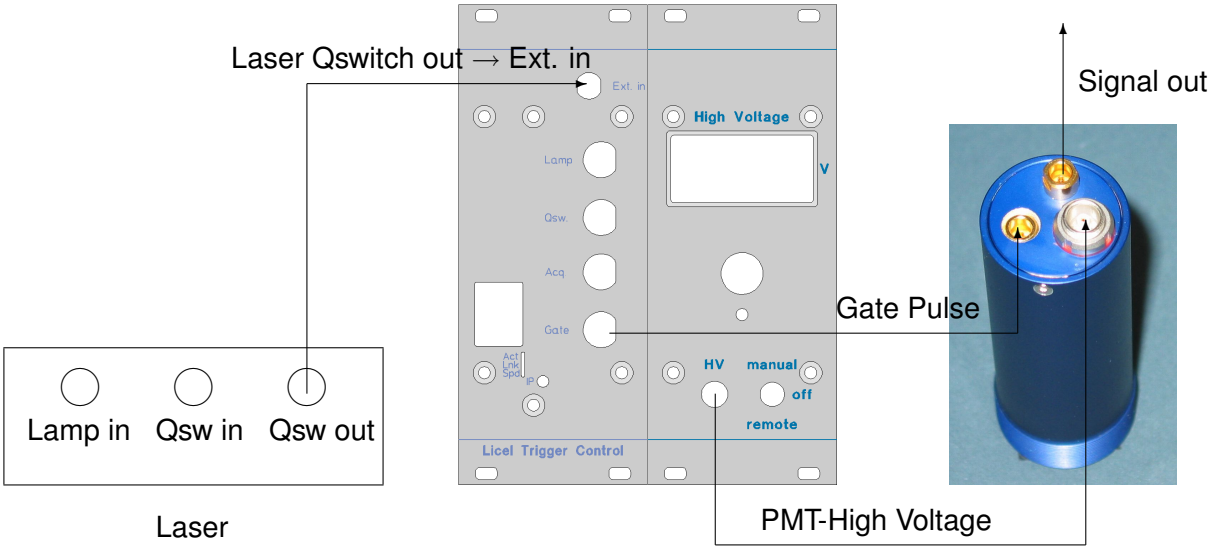
6 Gating

6.1 Selecting the master trigger

There are 2 operational modes for using the Gating controller. The starting pulse of the pulse sequence can be generated by the laser (Laser Master) or by the Gating Controller (Laser Slave Mode).

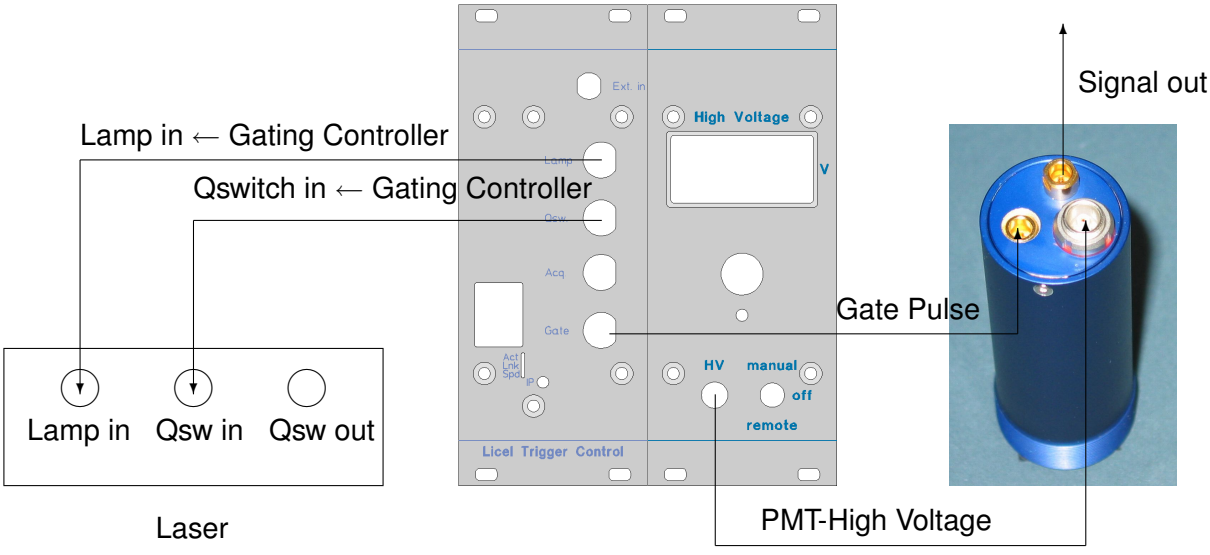
6.1.1 Laser Master mode

In The Laser Master mode,the laser is producing its own lamp trigger and Q-switch trigger pulses and the gating pulse is derived from the Q–Switch out pulse of the laser.



6.1.2 Laser Slave mode

In the Laser Slave mode, the gating controller is producing the lamp trigger and Q-switch trigger pulses as well as the gating pulse.



6.2 Adjusting the Gate Pulse

Since the Gate Pulse is derived from the falling slope of the Pretrigger (Transient Recorder Pulse) and the falling slope of the Q-Switch pulse, changes to the delays and pulse lengths of these pulses change also delay and length of the Gating pulse:

6.3 Parameter changed Effect on Gate Pulse

(Qswitch-Pretrig) Delay	Move rising and falling edge together
Pretrigger length	Move rising edge, leave falling edge unchanged
Pretrigger delay	Leave rising edge unchanged, move falling edge
Q-switch length	Leave rising edge unchanged, move falling edge

The position of the gate pulse can be computed by using:

$$(Qswitch - Pretrig)Delay + Pretriggerlength = risingedge \quad (1)$$

$$(Qswitch - Pretrig)Delay + Pretriggerdelay + Q - switchlength = fallingedge \quad (2)$$

The resulting Gate pulse length is displayed on the control panel. By using a Pretrigger length which exceeds the Pretrigger length + Q-switch length, negati- ve values for the Gate pulse width can be achieved. In this condition the gate pulse will be inverted. The LabVIEW `ControlTiming.vi` prevents this scenario.

7 Min/Max timing parameters

The following table lists the minimum and maximum timing parameters:

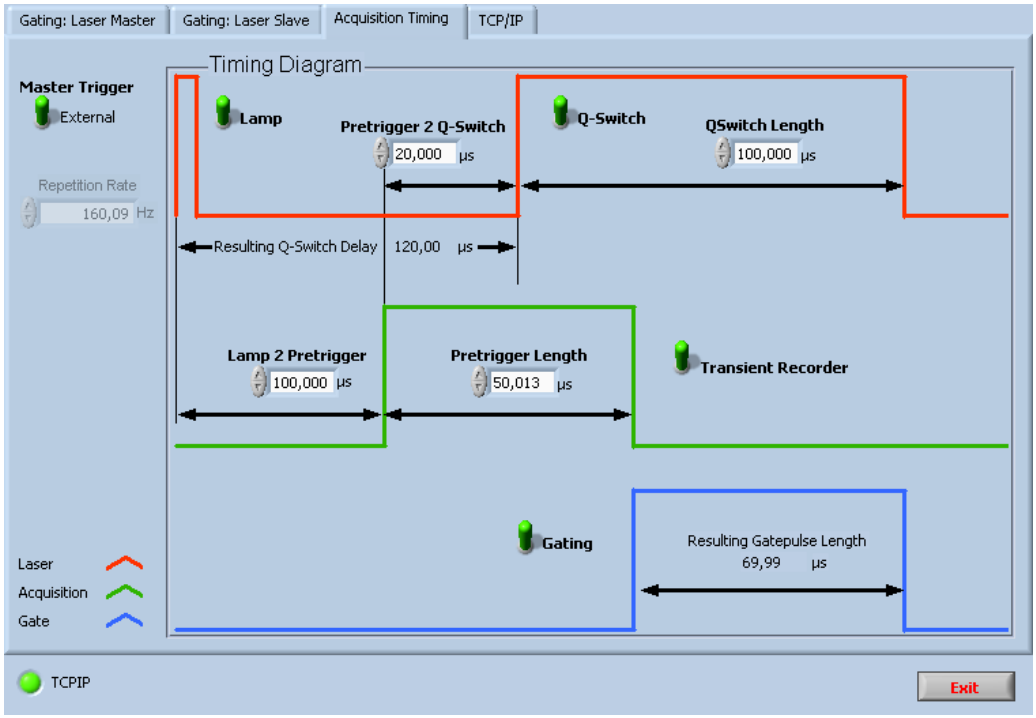
Parameter	min.	time step	max.
Repetition Rate	2.38 Hz	1/6.4μs	78.125kHz
Ext. Trigger to Lamp	6.48μs	6.4 μs	419ms
Lamp to Acquis.	100ns	12.5 ns	0.819ms
Acquis. to Qswitch	62.5ns	12.5 ns	0.819ms
Lamp pulse length	12.88 μs	fixed	12.88 μs
Acquis. Pulse Length	25ns	12.5 ns	0.819ms
Qsw. pulse length 25ns	12.5 ns	0.819ms	
Extern Trigger to Gating rising edge	6.57 μs	12.5 ns	420.147 ms
Extern Trigger to Gating falling edge	323 ns	12.5 ns	420.966 ms[1]

[1]Gate ON must trigger after lamp trigger

Please make sure that you do not exceed the max. duty cycle: Gate ON/Gate OFF$<$100. Exceeding this value will lead to a lower suppression when Gate=OFF

8 Software Interface

The LabVIEW `ControlTiming.vi` provides access to the various delays and enable switches for the trigger lines.



The usage is described in detail in the *Detector and Timing Control Utilities* chapter of the Licel Ethernet Controller Installation and Reference Manual

The parameters to achieve the maximum length for the gating pulse is shown below: