



# Operating manual

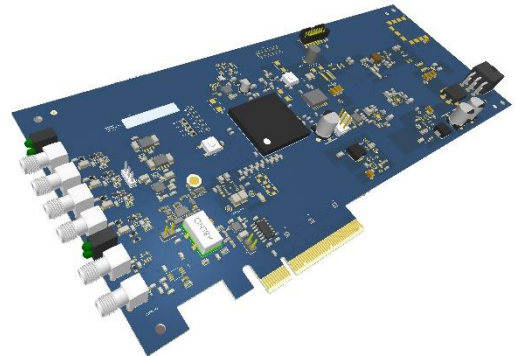
Time Tagger  
Q400

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### Introduction

The Redwave Labs Time Tagger Q400 is a PCIe ¾ length card that works within an x64 Linux computer. It provides four count inputs and a fifth input for a frame or synchronisation input. External clocks can be provided as either a 10MHz single ended or 100MHz differential signal. An additional input is provided to gate the counts. Counts are returned over the PCIe bus to the main system memory and is accessible via an API.



Features	Time Tagger Q400 provides timing resolution to 125ps.	
Applications	Photon Timing, QKD, Quantum computing, single-photon spectroscopy	
Specifications	Parameter	Value
Power	Single	+12 V, 2x 3A from PCIe extension power
Timing Inputs	Voltage Type	3V to 5V TTL type pulse
	Resolution	125 /62/32ps peak to peak
	Number	4 Continuous timing inputs
		1 Slow synchronisation or framing count
Clock Sources	Single-ended	10MHz e.g. from GPS or atomic standard
	Differential	100MHz or custom
	Internal clock	100MHz derived from 25MHz crystal
Gate Input	Type	3V3 CMOS logic
	Connection	0.1 Inch header internal
Connectors	Timing	SMA positive pin. Max 5V 10GHz
	Power	Molex Jnr PCI express power
	Clock	SMA positive pin. 10MHz sinusoidal. Max 13dBm
	Gate	Molex 0.1 inch header
Dimensions (WxHxD)	248 x 111 x 33 mm	
Weight	300 g	
Storage Temp	-20 to 85 C	
Operating Temp	-20 to 60 C	

RedWave Labs Ltd keeps improving its products and therefore some specifications can vary.

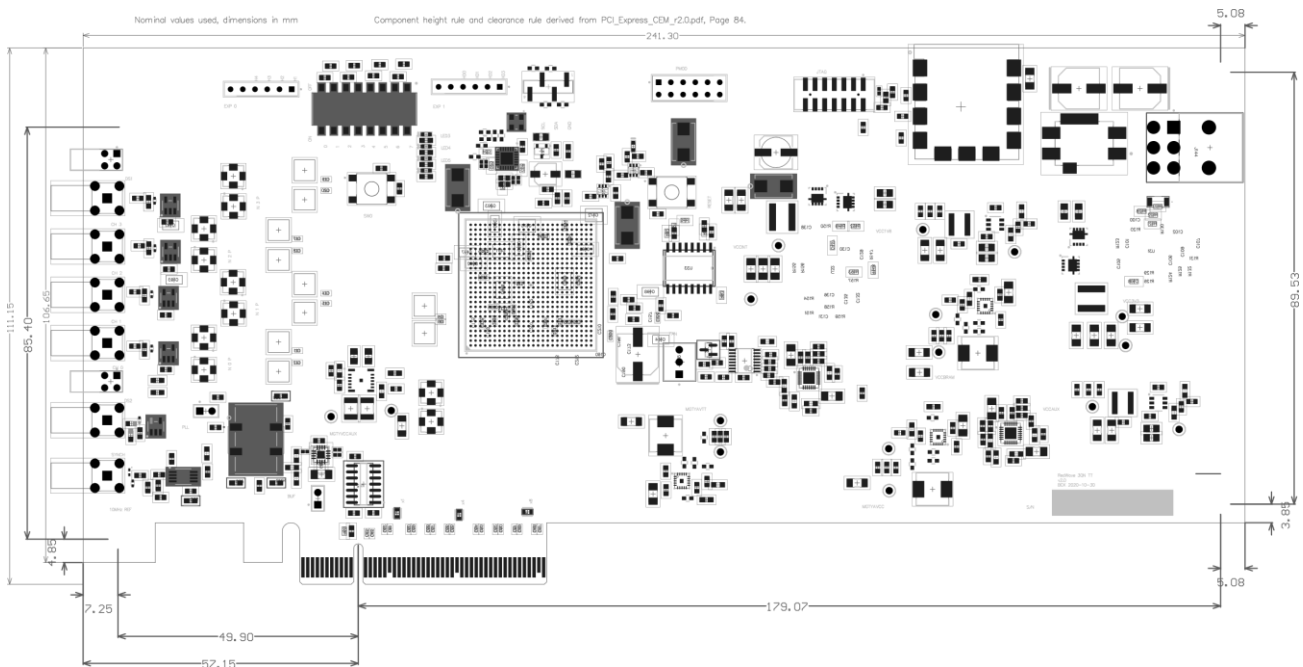
## Setting Up

Important! Before powering on the PC, place on a flat surface, open the chassis lid and check the liquid cooling system inside for leaks. The rack should remain horizontal in normal use. Also ensure the PCIe card is firmly seated and no cables are loose. Any queries, please contact RedWave Labs.

## Absolute Maximum Ratings

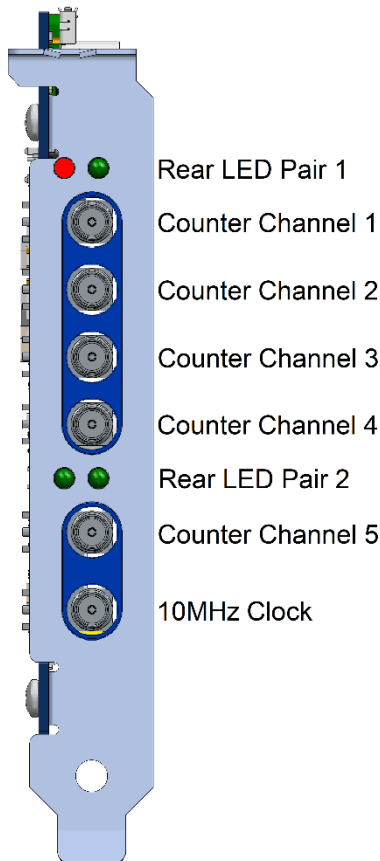
Symbol	Parameter	Ratings	Unit
$V_{dd}$	Supply voltage	+12	Volt
$T_{op}$	Operational Temperature	-40 to 85	C
$T_{st}$	Storage Temperature	-55 to 100	C
$P_t$	Heat dissipation	120	W

## Mechanical Information

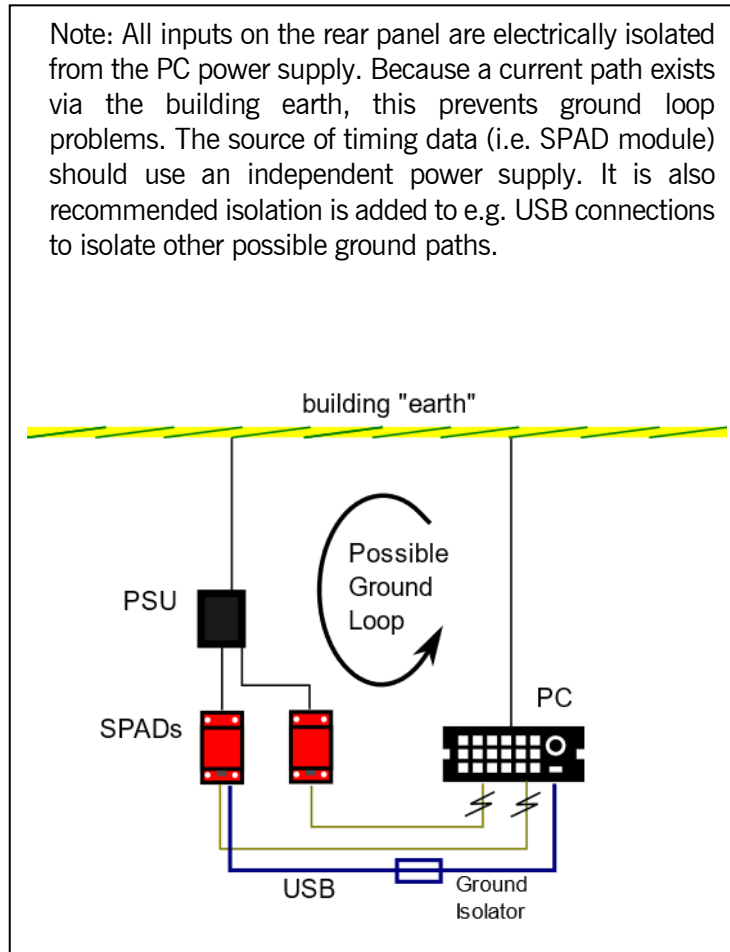


Eight lane PCI Express card as per CEM specification v2.0. Note reverse side of board has MCMX connectors that must have sufficient clearance from other cards and PC case.

## Electrical Characteristics: Rear Panel 1



Note: All inputs on the rear panel are electrically isolated from the PC power supply. Because a current path exists via the building earth, this prevents ground loop problems. The source of timing data (i.e. SPAD module) should use an independent power supply. It is also recommended isolation is added to e.g. USB connections to isolate other possible ground paths.



Parameter	Value	Unit
<b>TIMING INPUTS*</b>		
Type	LVTTTL 3.3	Volts
Threshold Voltage	2.1	Volts
Termination	50	Ohms
Maximum Voltage	5	Volts
ESD Protection	IEC 61000-4-2 Level 4	
Over-voltage	Tolerant to 5	Volts
<b>CLOCK INPUT</b>		
Type	10MHz sine	
Amplitude	0.5 RMS	Volts
Termination	50	Ohms
Maximum Power	13	dBm
ESD Protection	IEC 61000-4-2 Level 4	
Over-voltage	Clamped at 1.8	Volts

## Electrical Characteristics: Rear Panel 2

The gate pulse input is on it's own SMA on the second PCIe expansion slot. This is internally connected to the PMOD header on the PCIe board.

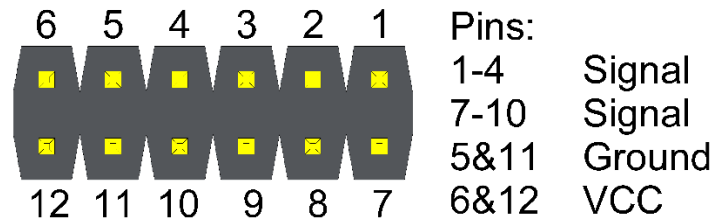


Figure 1: Diagram of PMOD header with board PCIe connector down (pin 1 is front of board, pin 12 is toward rear)

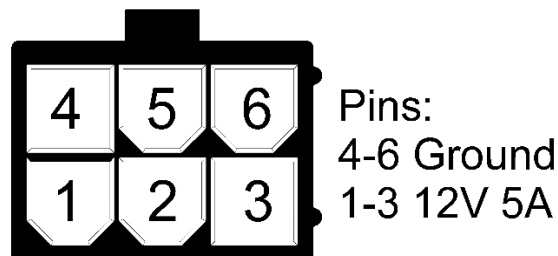
Parameter	Value	Unit
<b>GATE INPUT*</b>		
Type	CMOS 3.3	Volts
Threshold Voltage	2	Volts
Termination	High-Z	Ohms
Maximum Voltage	3.3	Volts
ESD Protection	<b>None**</b>	
Over-voltage	<b>None**</b>	

\*Gate input is H1 (labelled PMOD) pin 1 and Pin 5 or 11 (gnd). See **Error! Reference source not found..** This is for a dvanced use only as the input is not electrically protected.

\*\*Any over-voltage or ESD will permanently damage the FPGA.

## Power Connector Characteristics

Power is supplied via the PC power supply using the PCIe expansion connector or “GPU” connector. This is not available on older PCs.



PIN#	Connection	Name	Description
1	Power	Power	12V 5A per pin
2	Power	Sense/12V	75W PSU: sense pin. 150W PSU: 12V
3	Power	Power	12V 5A per pin
4	Ground	GND	PC system ground
5	Ground	NC/GND	75W PSU: NC. 150W PSU: ground.
6	Ground	GND	PC system ground

This meets both the 75W PSU and 150W PSU PCI express standard. RedWave recommends using a reputable manufacturer for the PC power supply and that it is at least 600W.

## Status LEDs

Status LEDs are used for fast visual assessment of the Q400 status.

LED	Colour	Name	Description
PAIR 1 BOTTOM	RED	INIT	Red while FPGA initialising
PAIR 1 TOP	GREEN	INIT DONE	Green when FPGA ready
PAIR 2 TOP	GREEN	VOLTAGE GOOD	Green steady when Power Good
PAIR 2 BOTTOM	GREEN	STATUS	Off: no error. Flashing: see API manual for details.

## Jumper settings

The two jumpers are shipped closed. This allows the 10MHz clock input to be used. For lower noise operation, these jumpers maybe removed to disable the PLL if the 10MHz clock is not being used.

Name	Selection	Description
PLL	On (closed) Off (open)	Switches on 100MHz PLL. May increase noise
BUF	On (closed) Off (open)	Switches on 100MHz PLL differential buffer. Not needed if PLL is not switched on.

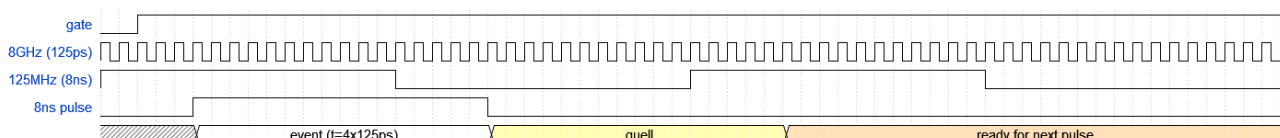
## DIP Switch settings

Name	Selection	Description
DIP 1 (D7)	On (high)  Off (low)	Clock: PLL from 10MHz reference (assuming it is enabled with Jumpers above) Clock: 100MHz in-built oscillator
DIP 2-8 (D6-D0)	On (high) Off (low)	RESERVED

Before changing the PLL Jumpers or Clock selection DIP, ensure PC is powered down. Take normal ESD precautions before handling the board.

## Timing Characteristics

Timing starts on the rising edge of the gate pulse. Each event is timed from this edge, until the next positive edge.



There is a quell period that is set in software that rejects second pulses for one complete period (8ns) or more. This is for photon detectors that suffer from “after-pulsing”

Parameter	Value	Unit
<b>Channel Pulse Characteristics</b>		
Minimum Pulse Width	8	ns
Quell period (rejection of pulses)	8 - 120	ns

The time returned is a count of the 8GHz clock edges since the gate edge. This is in steps of 125ps (8GHz).

## Installation

The time-tagger is normally supplied in a 3U rack mount PC. However, if the card needs to be removed from the PC, first ensure the PC is powered down and isolated from the mains supply. Then remove the 12V connector. Taking normal static precautions, the card can then be removed. Upon reinstallation, ensure there is sufficient space and air-flow in the PC before installing the card. The card needs a PCIe with at least 8 active lanes (some motherboards do not have all lanes active, please check the motherboard specs). The motherboard and CPU must be capable of reaching Gen 3.0 DMA speeds to main system memory. Make sure a suitable 12V connection is made from the PC power supply before powering the PC. We recommend a minimum PSU of 600W from a reputable manufacturer and a CPU of at least 3.0GHz with 64GB DDR RAM.

## Certification

RedWave Labs Ltd certifies that: i) the parts and/or materials were produced in conformance with all contractually applicable Government and/or Buyer’s specification as referenced in, or furnished with, the above purchase order and ii) all processes required in the production of these parts and/or materials are listed and were performed by a facility or by personnel specifically approved or certified by the seller’s cognizant government quality control agency when such approval or certification is required by an applicable specification. RedWave Labs products are not authorized for use in safety-critical applications (such as life support) where a failure of the product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use of the products.

## Warranty and returns

### Return procedure

Customer must obtain a valid RMA number by contacting RedWave Labs prior to the return. In all cases the customer is responsible for duty fees incurred on all received shipments and on all international returns for both warranty and non-warranty items; the customer is responsible for any duties, brokers fees or freight charges deemed chargeable to RedWave Labs Ltd.