
SiEPIC-PoWx Optical Proof of Work Hardware Summary

Abstract: This document summarizes the SiEPIC Kits built package for PoWx Photonics optical proof-of-work (oPoW) silicon photonics chip. The purpose of the package is to enable remote interface with the chip's electrical+optical inputs and outputs. The document will describe the main building blocks, and present an application of how a remote user can communicate with the chip.

Design by SiEPIC Kits Ltd.

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Disclaimer: The document here is the public release version of the design which abstracts the confidentiality information about the silicon chip fabrication process and manufacturing partners. Some references to documents made on this document may not be available since they contain confidential information. Please contact SiEPIC Kits for further information.

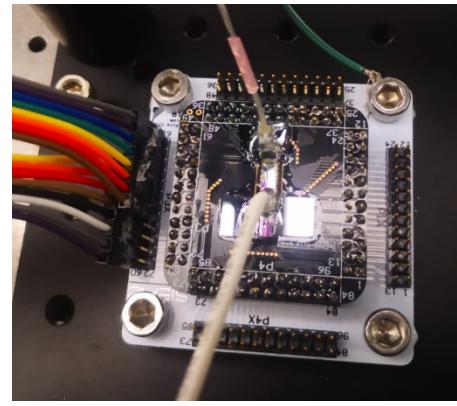
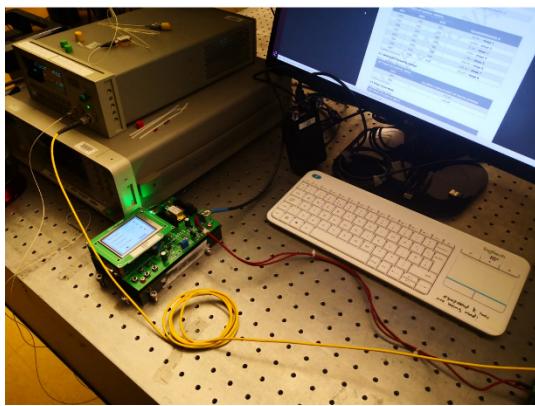
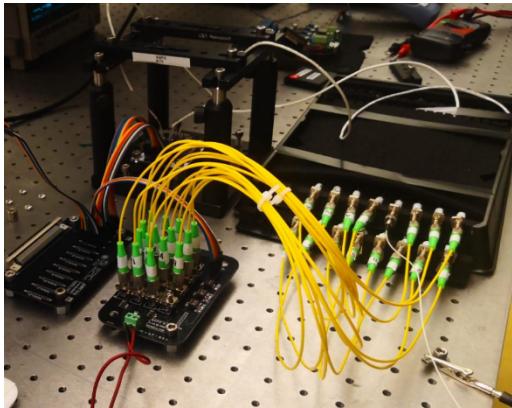
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● Hardware summary

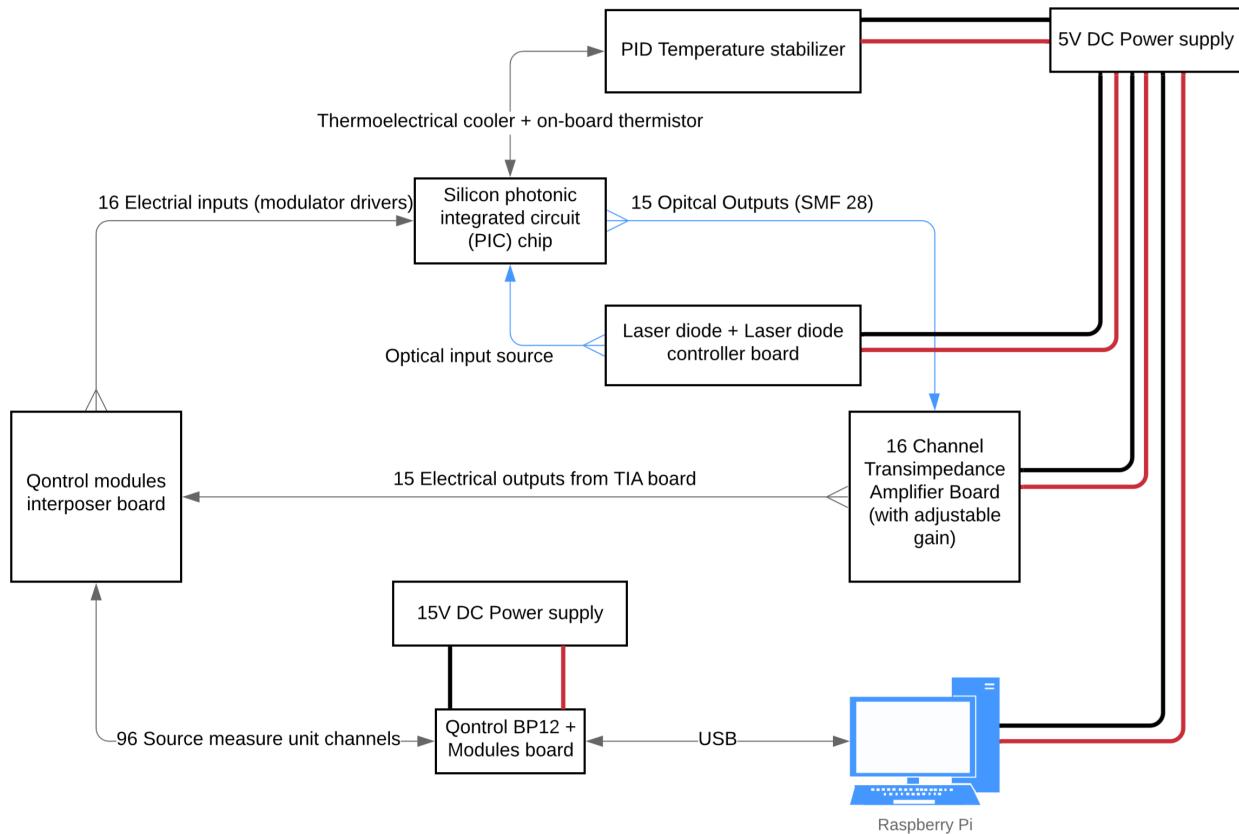
The package consists of the following main components:

1. SiEPIC/PoWx Silicon photonics integrated circuit (PIC) chip.
2. SiEPIC PIC chip's carrier
3. SiEPIC PIC chip carrier's interposer
4. SiEPIC Transimpedance amplifier (TIA) 16 channel board
5. SiEPIC Qontrol modules transposer board
6. Qontrol BP12 board + Q8iv + Q8b driver modules
7. SiEPIC PID temperature controller and stabilizer
8. SiEPIC Laser diode controller (LDC)
9. Raspberry Pi server

The images below are of the real setup, to give an intuition to the reader before describing the system.



The following block diagram summarizes the package's connectivity

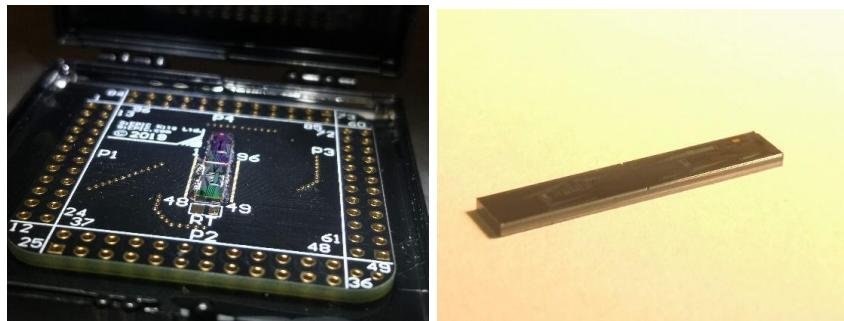


The following section will describe each individual hardware building block:

1. SiEPIC/PoWx Silicon photonics integrated circuit (PIC) chip.

The PIC is made on a silicon-on-insulator substrate. The device under test on this chip is a 16-by-16 unitary multiplication matrix. The device has 16 optical IOs for the laser input and 15 optical outputs. The device has 16 electrical modulators drivers inputs, and 48 electrical inputs to adjust the matrix.

Please refer to [reference/layout_review_v1_2.pdf](#) for complete description of the chip functionality, along with its design.

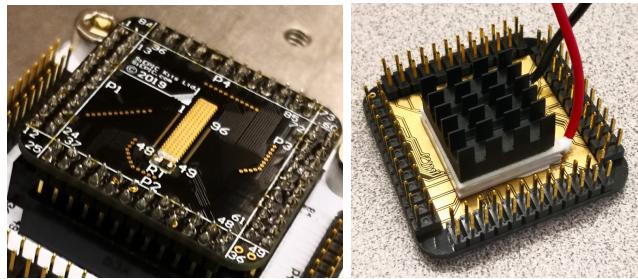


2. SiEPIC PIC chip's carrier:

The SiEPIC Kits PIC chip's carrier can be used to interface with the DC electrical contacts of a PIC using external PCB pin headers. The design uses two boards, a carrier board (Carrier PCB) interposer, mounted on top of an interposer (Interposer PCB). The motivation for having two boards is to create a modular testing design, one can customize the carrier PCB pin layouts as per the PIC requirements.

The chip carrier allows up to 96 DC channel IOs. The chip carrier is fitted with an on-board thermistor and designed to have a thermoelectric peltier cooler fitted at the rear for temperature control and feedback.

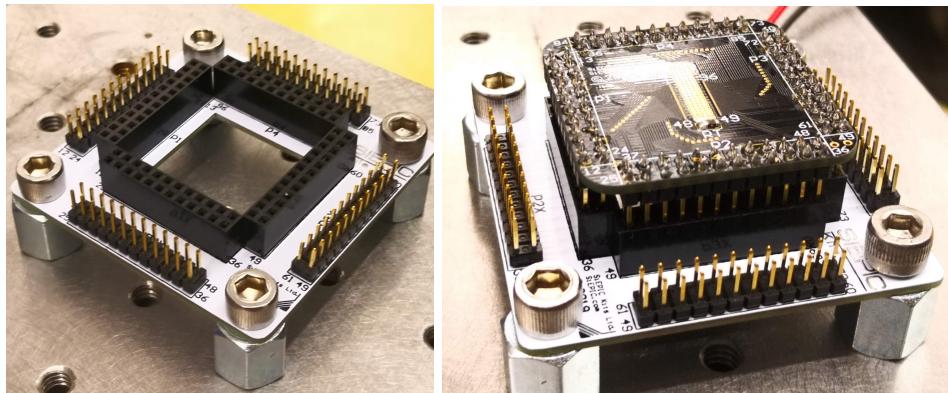
Please refer to [reference/SiEPIC_Kits_interposers.pdf](#) for complete description of the SiEPIC PIC chip carrier design.



3. SiEPIC PIC chip carrier's interposer:

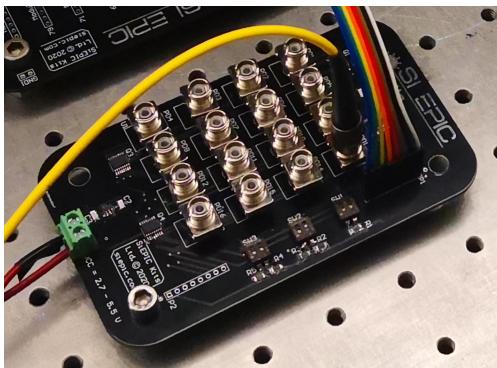
The chip carrier's interposer board is the PCB onto which the chip carrier is plugged into. It simply acts as a modular stage for different pluggable chips.

Please refer to [reference/SiEPIC_Kits_interposers.pdf](#) for complete description of the SiEPIC PIC chip carrier design.



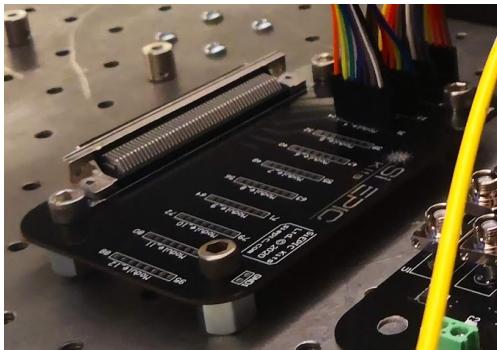
4. SiEPIC Transimpedance amplifier (TIA) 16 channel board

The SiEPIC Kits TIA board is a custom 16 channel TIA with adjustable gain. The board contains 16 InGaAs photodiodes with 0.95 A/W responsivity with a bandwidth of 2.5 GHz. The board has 16 DC outputs. The board must be powered by a DC source of 2.7 V min to 5.5 V max. The switches are used to adjust the gain of the TIA board and adjust its power settings. Refer to [Appendix A](#) for details.



5. SiEPIC Qontrol modules transposer board

The Qontrol modules transposer board takes in the output of a Qontrol BP12 board via the HD-100 shielded cable connector, to a generic DC header pins for easy access via ribbon cables.



6. Qontrol BP12 board + Q8iv + Q8b driver modules

The Qontrol BP12 board along with its modules can act as an (up-to) 96 channel source-measure unit. The specifications of this device can be found at:

<https://qontrol.co.uk/product/bp12/>

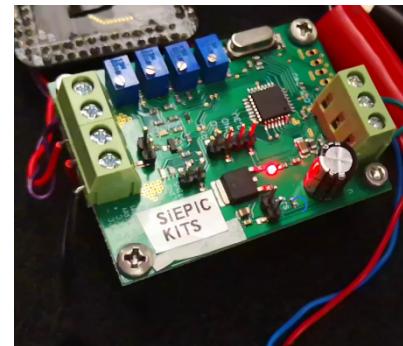
<https://qontrol.co.uk/product/q8iv/>

<https://qontrol.co.uk/product/q8b/>



7. SiEPIC PID temperature controller and stabilizer

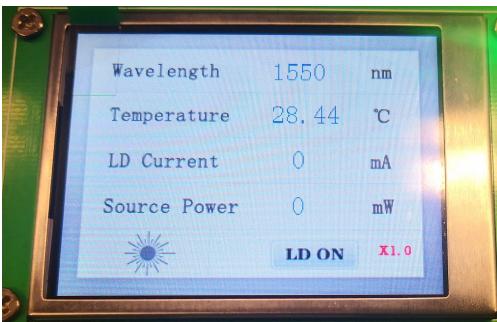
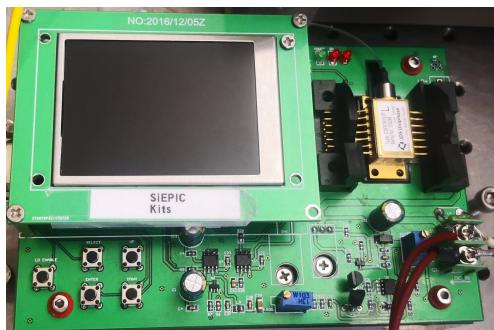
The SiEPIC/LaserOpto PID temperature controller is a board that takes the thermistor readings as an input and outputs current to the thermoelectric peltier cooler. The output is determined via a PID control loop implemented via an on-board microcontroller unit. The values for the PID controller can be adjusted via on-board potentiometers. The set temperature value can be adjusted via on-board potentiometer. The board must be supplied by a voltage of 5 V minimum and 25 V maximum.



8. SiEPIC Laser diode controller (LDC)

The LDC is a simple device that stabilizes a laser diode and ensures a constant output optical power from the laser diode. The board accepts a typical butterfly laser diode package. The board must be powered by a 5V DC source ONLY, higher/lower values will risk damaging the laser diode package permanently.

The LCD display allows the user to adjust the optical output power and maximum limit settings of the mounted laser diode, as per recommended by the laser diode supplier.



9. Raspberry Pi server

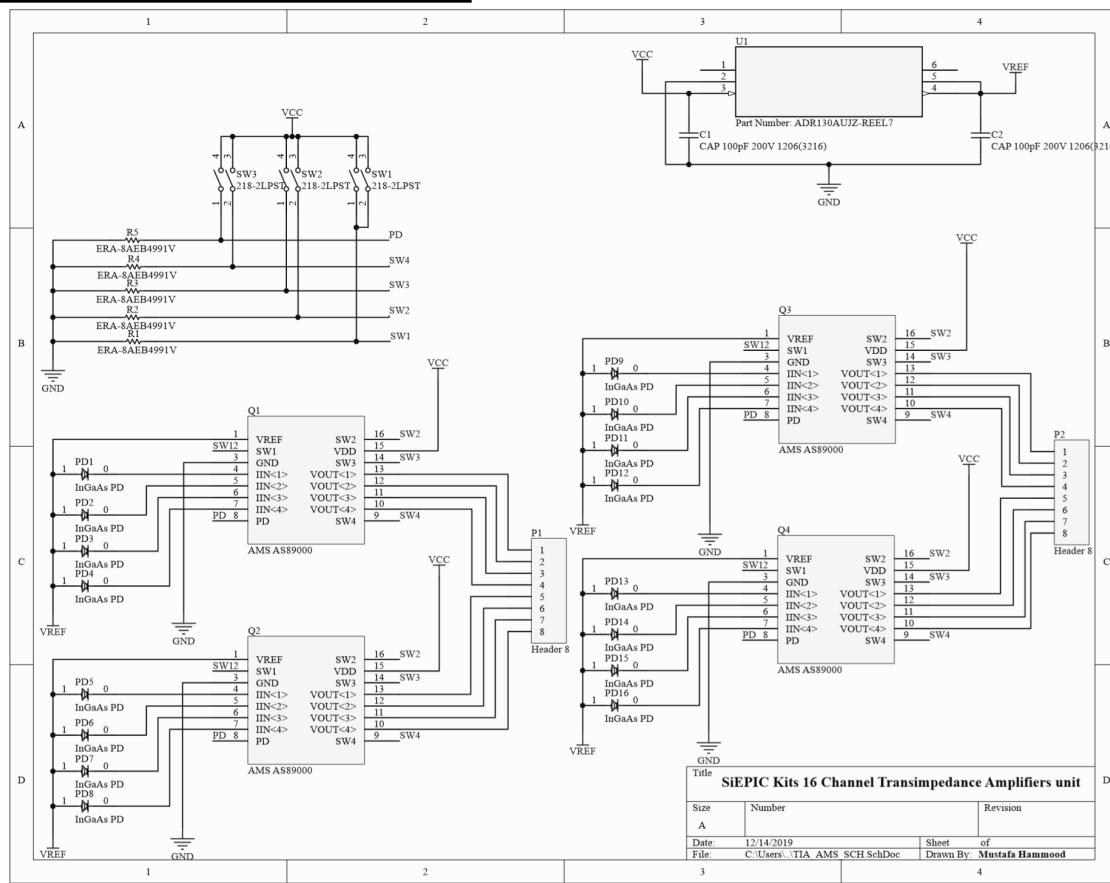
A Raspberry Pi 4 is used as a machine to interface with all the device's peripherals and to allow outside access to the chip via an online hosted server! The following section will describe how one can communicate with the server.

[public]

● Appendix A: Transimpedance Amplifier Board

The schematic of the board is shown below:

SW1	SW2-1	SW2-2	Gain (V/A)
OFF	OFF	OFF	25k
ON	ON	OFF	100k
ON	OFF	OFF	500k
OFF	OFF	ON	1M
ON	OFF	ON	2M
OFF	ON	OFF	5M
OFF	ON	ON	10M
ON	ON	ON	20M



SW3-1: switchable frequency range depended on input capacitance of the photo-sensor. Capacitance is ~80 pF when OFF and ~5 pF when ON.

SW3-2: triggers the power down mode for low power consumption. IC bias current is ~8 uA when this switch is active.

Refer to [reference/AS89000.pdf](#) for further details on the chip being used here.