Ossila USB Test Board
User Guide and Specifications

Contents

Safety

The Ossila USB test board is designed for low-voltage low-current applications and should not be used with high-voltage or high-current sources. It is also designed for use only with equipment featuring current or voltage compliance limiting to avoid either damaging the device under test or board electronics.

Warning

To avoid safety hazards obey the following:

- **Only connect to low-voltage (<12 V) low current (<1 A continuous) power supplies.**
- **Do not leave devices with applied bias or current, unattended as a power failure may result in board damage or device damage and potentially hazardous situations.**

Caution

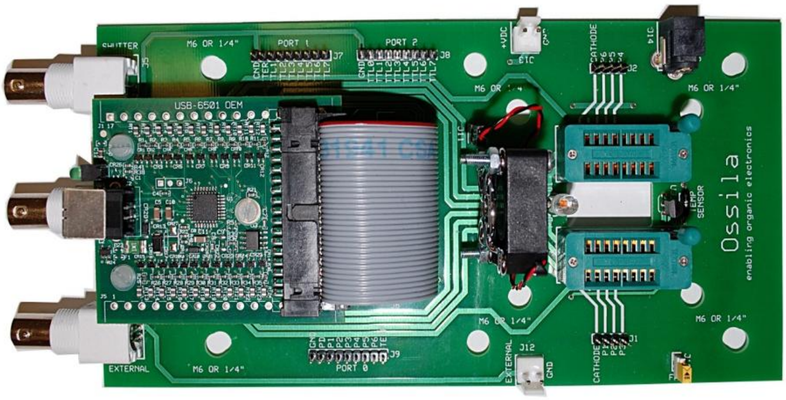
To avoid damaging devices or equipment obey the following:

- Avoid electrostatic discharge (ESD) as this may damage the device. The Ossila USB test board uses high performance MOSFETs which are static sensitive. To avoid damage use static discharge and prevention equipment where necessary.
- Only use the device for the purposes intended (described in this document)
- Do not expose the device to any cleaning fluids or solvents.
- When a USB lead is first connected to the test board all pixels are switched to off. However, when USB connector is removed devices may be left in either an on or off state. As such, do not apply voltages or currents to the board without the USB power being applied.

Warranty

To the best of our knowledge the technical information provided here is accurate. However, Ossila assume no liability for the accuracy of this information. The values provided here are typical at the time of manufacture and may vary over time and from batch to batch. This manual may also be updated from time to time without warning.

Overview



The Ossila USB test board allows faster testing and measurement of OLEDs and OPVs to help make research and development faster and easier. It combines computer controlled electronic switching of the six individual pixels on a standard Ossila substrate alongside a reference thermometer and photodiode to allow a variety of measurements to be undertaken with increased speed and a greater degree of automation.

At the heart of the board is a network of ultra-high specification transistors that allow the individual pixels to be multiplexed onto a single BNC connector to attach to a variety of test equipment. The transistors are specified to have an extremely low on-state resistance (<0.2Ω) and off state leakage (<1 nA). They are also capable of delivering high continuous currents of up to 800 mA DC and massive pulses of up to 20 amps meaning you are only limited by your devices and test equipment.

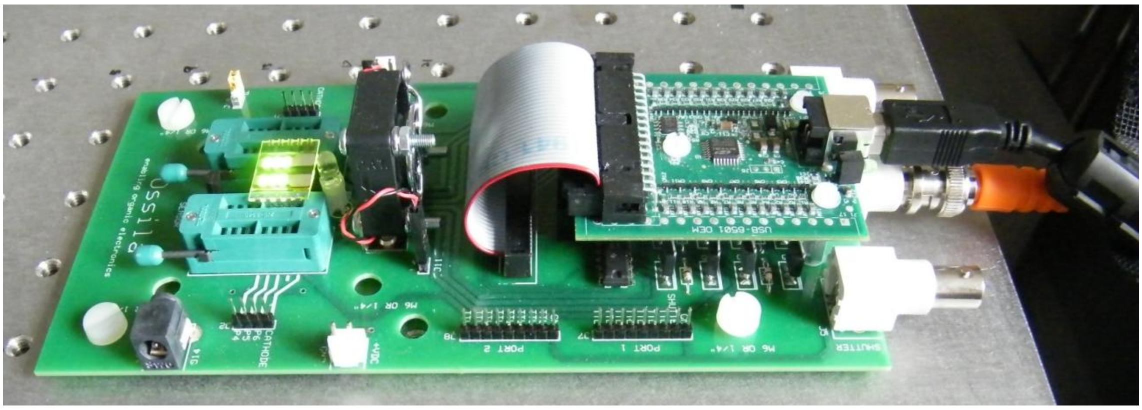
Computer control of the switching is provided by a National Instruments interface card with USB connection to make programming easy in a variety of programs such as LabVIEW and MATLAB.

Additional features include a cooling fan to keep substrate temperatures stable under high illumination and a shutter control for external systems. The versatility of the system makes it ideal for a wide variety of experiments including current-voltage (IV) and current-voltagelight (IVL) sweeps, external quantum efficiency measurements and lifetime testing.

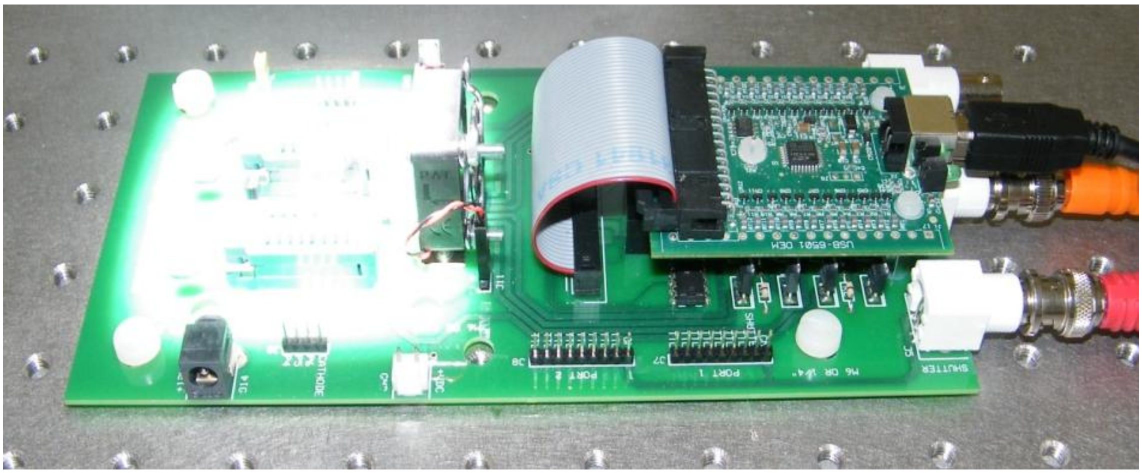
Features:

- Zero Insertion Force (ZIF) sockets for easy attachment and removal of devices
- High performance electronic pixels switches
- USB interface with easy integration to LabVIEW, MATLAB and others
- Compatible with Linux, Mac OS, Pocket PC and Windows
- On board temperature sensor
- On board reference photo-diode (optimised for visible response)
- Shutter control for external instruments
- Onboard cooling fan to keep substrate temperatures constant
- Optical window for experiments where optical access is required from both sides
- Additional access to 15 digital I/O lines for further data acquisition and control.
- M4, M6 and 1/4" mounting holes to make mounting on a variety of optical benches and other equipment quick and simple

Please note that LabVIEW® is a trademark of National Instruments and MATLAB® is a trademark of The Mathworks inc.



An OLED under test



An OPV under test illuminated by a solar simulator

Software Driver

The Ossila USB test board is controlled by a National Instruments USB 6501 OEM system to allow easy interface with a range of languages and is compatible with Linux, Mac OS, Pocket PC and Windows.

Languages that can be used include:

- LabVIEW
- MATLAB (Data Acquisition toolbox required)
- ANSI C
- LabWindows/CVI
- Measurement Studio
- Visual Basic
- Visual Studio
- Visual Studio .NET

In order for the Ossila USB test board to be recognised by your computer, please ensure that the **National Instruments DAQmx driver version 9.3** or above is installed on your system.

Many computers running LabVIEW with other national instruments hardware will already have DAQmx drivers installed and should recognise the board instantly. To check if DAQmx is installed on a PC navigate to Start Menu -> All Programs -> National Instruments and look for NI-DAQ.

If DAQmx is not installed on your system please download and install it from the National Instruments Website (www.ni.com) where it is available free of charge (registration required).

Outputs

The USB 6501 controller has 24 TTL outputs (+5v or 0v) arranged in three groups of eight. Only 9 out of these 24 lines are used to control the switching network for the device under test with the remaining 15 outputs available for expansion.

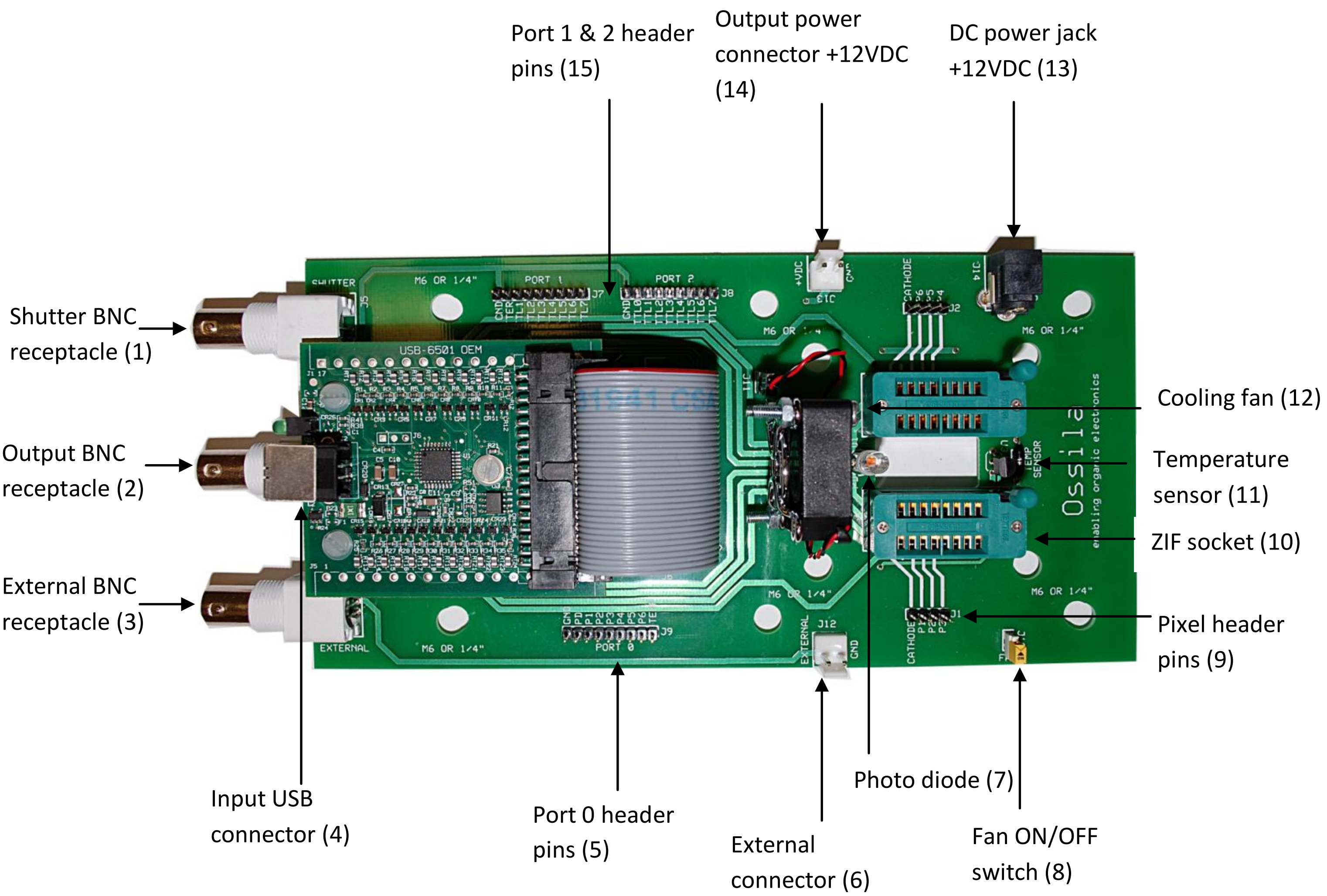
Line	Port 0	Port 1	Port 2
Line 0	Photodiode	Shutter	Unused
Line 1	Pixel 1	Unused	Unused
Line 2	Pixel 2	Unused	Unused
Line 3	Pixle 3	Unused	Unused
Line 4	Pixel 4	Unused	Unused
Line 5	Pixel 5	Unused	Unused
Line 6	Pixel 6	Unused	Unused
Line 7	Temperature sensor	Unused	Unused

Code example

Code examples written in LabVIEW and MATLAB can be found at the following links:

- LabVIEW code example
- MATLAB code example

Layout


Port 1 & 2 header pins (15)
Output power connector +12VDC (14)
DC power jack +12VDC (13)
Shutter BNC receptacle (1)
Output BNC receptacle (2)
External BNC receptacle (3)
Cooling fan (12)
Temperature sensor (11)
ZIF socket (10)
Pixel header pins (9)
Input USB connector (4)
Port 0 header pins (5)
External connector (6)
Photo diode (7)
Fan ON/OFF switch (8)

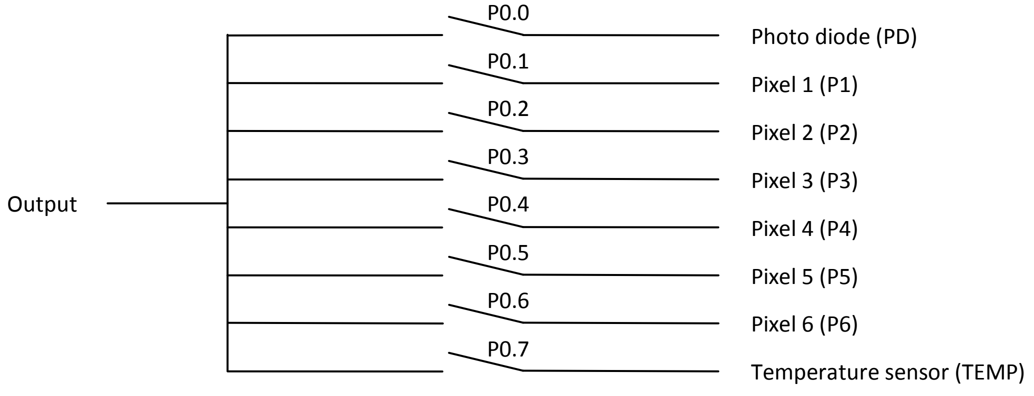
Reference number	Type	Description
1	BNC connector	This output connector can be used to control the shutter of a solar simulator. The control signal is also present on the header pin of PORT 1 named "SHUTTER".
2	BNC connector	Output (or input) connector for the DUT as well as the temperature sensor and photo diode with switching controlled by USB.
3	BNC connector	Linked directly to the 2way EXTERNAL header connector (6). It can be used for further expansion of the test board.
4	USB connector	Type B USB connector that allows for connecting a type A-B USB cable between a PC and the board. Note: the test board (except the cooling fan) takes all power required from the USB connector. Therefore, it is not necessary to use the DC power jack when the cooling fan is not in use.
5	Header pins	Header pins containing the digital signals of PORT 0 allowing easy multimeter access for testing/debugging purposes. (note it is only possible to read the status from these pins).
6	Header	These two header pins are connected directly to the BNC receptacle allowing easy multimeter access for testing/debugging
7	Photo diode	GaP (Gallium Phosphide) photo diode with a peak sensitivity at 470nm. Note: The cathode of the diode is connected to the core of the BNC connector.
8	ON/OFF switch	Used to switch the cooling fan ON and OFF.
9	Header	These pins are connected directly to the active areas and cathode of the DUT allowing easy multimeter access for testing/debugging purposes
10	ZIF socket	Zero insertion force socket to easily connect and remove devices.
11	Tmperature Sensor	A temperature sensor that ourputs a current directly proportional to the temperature in Kelvin allowing easy measurement and calibration.
12	Cooling fan	Detachable cooling fan to ensure a stable substrate temperature.
13	DC power jack	Used to power the cooling fan only. If the fan is not in use, it is not necessary to use the DC power jack. Ø 0.080" (2.0 mm) pin
14	Header	These two header pins are connected directly to the DC power jack. They can be used for further expansion.
15	Header	Header pins containing the digital signals of PORT 1 & 2. Each pin, except pin 0 of PORT 1 (which is used for the external shutter), can be used as digital input or output.

Absolute Maximum Ratings

DC pixel current: 800mA DC per pixel (total of 4.8 A)
Pulsed pixel current: <20 A
Pixel voltage range: -7V to +7V
Shutter output current: 8mA
Digital I/O header pin current: 8mA
Output power (+12VDC connector) current: 5A
External BNC current: 2.5A DC
Digital I/O voltage range: -0.5 to 5.8 V with respect to GND

Controlling the Multiplexer and Shutter

Each port pin can be programmed as a digital input or output. Access to the port pins is given by the header pins for debugging and expansion. To control the switches of the multiplexer, PORT 0 has to be configured as an output port. A connection with the BNC connector named "OUTPUT" can be established by setting the port bits LOW. Similarly, the connection is broken when the port bits are set to HIGH. To have control over the shutter of a solar simulator, pin 0 of PORT 1 has to be configured as a digital output pin. This signal is present at the BNC connector named "SHUTTER".



Equivalent circuit of the multiplexer

At system startup and reset, the hardware sets all DIO (digital I/O) lines to high-impedance inputs. As each line has a weak pull-up resistor of 4.7kOhm connected to it, all pins are set to HIGH.
The default output configuration of the port pins is open-drain. This configuration allows the digital output signal to swing to 5V.

Digital I/O

Signal Name	Direction (software selectable)	Output driver type (software selectable)	Description
P0.<0..7>	Output	Push-pull or open-drain	Photo diode (PD) , Pixel 1-6, Temperature sensor (TEMP)
P1.0	Output	Push-pull or open-drain	Shutter control. This port pin, connected to a BNC receptacle, can be used to control the shutter of a solar simulator.
P1.<1..7>	Input or Output	Push-pull or open-drain	Digital I/O — Each port pin can be configured as an input or output.
P2.<0..6>	Input or Output	Push-pull or open-drain	Digital I/O — Each port pin can be configured as an input or output.
P2.7/PFI 0	Input or Output	Push-pull or open-drain	Can be configured as either a digital I/O or as an event counter. The counter can be used to count events on the port pin.

When P2.7 is configured as a 32-bit counter, it is possible to count high to low transitions. The count can be read or reset through software. For more information about counter programming techniques, please refer to your software documentation.

Digital Logic Levels

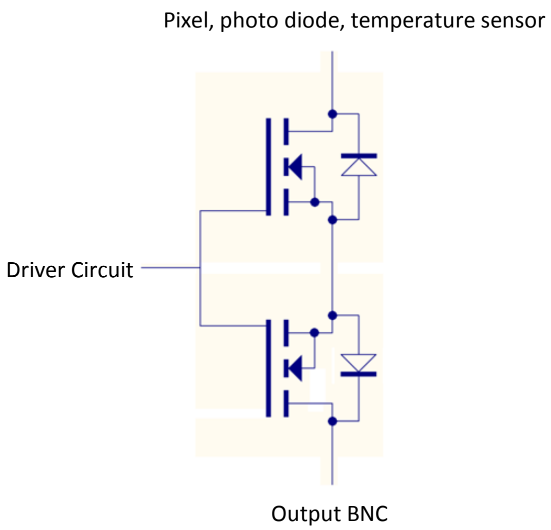
Level	Min	Max	Units
Input			
Input low voltage	–0.3	0.8	V
Input high voltage	2.0	5.8	V
Input leakage current	—	50.0	μA
Output			
Output low voltage			
Open collector (open-drain) or active drive (push pull)			
I_{OL} = 2 mA	—	0.4	V
I_{OL} = 8.5 mA	—	0.8	V
Output high voltage			
Active drive (push-pull[1])			
I_{OH} = –2 mA	2.8	3.6	V
I_{OH} = –8.5 mA	2.0	3.5	V
Open collector (open-drain), I_{OH} = –0.4 mA, nominal	2.0	5.0	V
Open collector (open-drain), I_{OH} = –7.5 mA, with external pull-up resistor	2.0	—	V
[1] The total current sourced by all DO lines simultaneously should not exceed 65 mA.			

Counter

Number of counters: 1 (P2.7 can be configured as a counter)
Resolution: 32 bits
Counter measurements: Falling edge counting
Maximum input frequency: 5 MHz
Minimum high pulse width: 100 ns
Minimum low pulse width: 100 ns

Electronic Switch Specifications

Each indvidual pixel as well as the photodiode and temperature sensor can be turned on/off electronically through a network of high performance transistors. Each pixel/device is connected to the output BNC through the following transistor arrangement:



Schematic diagram of an electronic switch

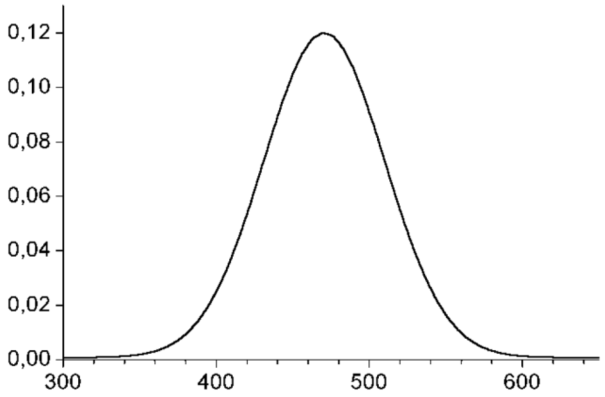
DC pixel current: 800mA DC
Pulsed pixel current: 800mA DC
Pixel voltage range: -7V to +7V
On-state resistance: <0.4 Ω
Leakage current when the switch is off: < 1nA

The multiplexer comprises eight single channels. It is capable of switching one or multiple inputs to the common BNC output. A switch is turned ON by setting the corresponding PORT bit into the LOW state.

Similarly, the switch is turned OFF by setting the PORT bit into the HIGH state. The schematic diagram and specifications of a single switch from the multiplexer are shown below.

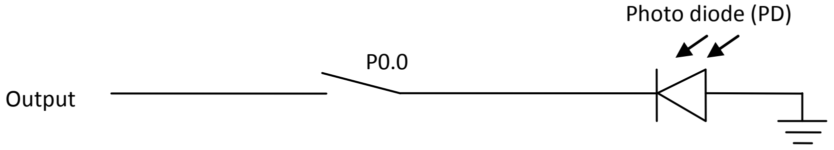
Photo Diode Specifications

The on board GaP (Gallium Phosphide) photo diode has been chosen to give a response in the visible spectrum with a peak sensitivity at 470 nm.



Typical spectral responsitivity (A/W)

Parameter	Type	Unit
Active area	0.2	mm^2
Peak sensitivity, typ.	470	nm
Spectral bandwidth (Sλ) at 50%	100	nm
Acceptance angle at 50% Sλ	20	deg.
Responsivity at 470 nm	0.2	A/W



Equivalent circuit

Temperature Sensor Specifications

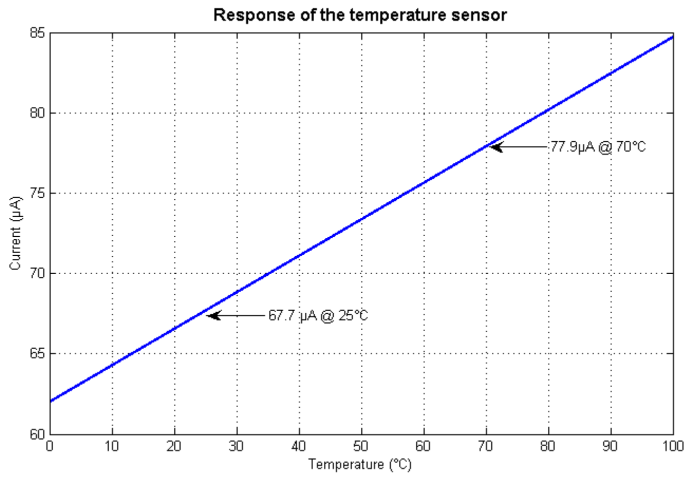
The temperature sensor acts as a current source with an absolute accuracy of ±3°C with an output current directly proportional to temperature in Kelvin.

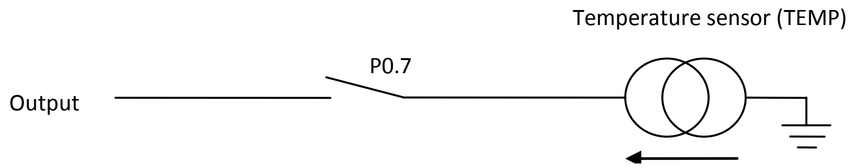
The temperature can be calculated according to the following formula:

$$Temperature\ in\ Kelvin = \frac{10^9 \times Output\ current}{227}$$

Therefore, the temperature in degree Celcius is equal to:

$$Temperature\ in\ degree\ Celcius = \frac{10^9 \times Output\ current}{227} - 273.15$$





Equivalent circuit

Cooling fan Specifications

The cooling fan is provided to keep devices at a constant temperature when illuminated under solar simulators but is also detachable. Power for the fan is not provided by the USB connection and so the external power suppy must be used for the fan to operate.

Rated voltage: 12VDC
Rated power: 0.5W
Air delivery: 4.6 CFM
Operating voltage range: 4.5~13.8 VDC
Fully detachable.

Physical Characteristics

-Dimensions: 223 mm (L) x 100 mm (W) x 40 mm (H)
(8.78 in. (L) x 3.94 in. (W) x 1.57 in. (H))

-I/O connectors: 1 x USB series B receptacle (cable included)
3 x BNC receptacle
3 x 9way header pins giving access to the digital I/O ports
2 x 4way header pins giving access to the pixels of the DUT

-Weight: 188 g
(6.63 oz)

-Insulating M6 bolts & washers, USB cable are included.

- Cooling fan and +12VDC power supply.