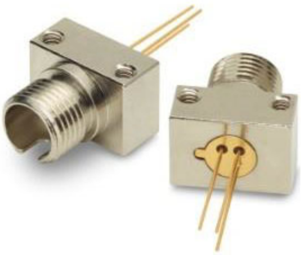
Data Sheet

AFBR-POC205A8, AFBR-POC205A9

Optical Power Converter



Description

The AFBR-POC205A8/A9 belong to the Broadcom® Power Components product family. These devices are designed to operate in the low-loss wavelength range of optical fibers. They convert optical power to electrical power for applications that require complete electrical isolation in highly demanding industrial environments. They are an excellent choice for powering electronic circuitry where electrical wired solutions are not feasible due to high voltage, electromagnetic interference, capacitive coupling, or strong magnetic fields.

The AFBR-POC205A8/A9 are based on the patented Vertically Integrated VEHSA Monolithic GaAs Power Converter. They use multi-junction compound semiconductor devices to cover an optical input wavelength range from 1450 nm to 1550 nm. The multi-junction technology allows manageable external loads, whereas other single-junction devices often require optimal loads with R << 1 ohm. And the AFBR-POC205A8/A9 provide output voltage levels up to 5 VDC for a range of applications.

In typical applications, these devices can provide close to 1 watt of electrical power by converting optical input power from a high-power laser diode with an output wavelength near 1500 nm. The optical power converter shows a nearly linear response to high optical input powers over a wide temperature range.

Smart thermal design simplifies system integration.

The AFBR-POC205A8/A9 are optimized for integration with efficient coupling of multi-mode (MM) or single-mode (SM) fibers with various numerical apertures (for example, NA ~ 0.22). The AFBR-POC205A8/A9 are typically used between 1450 nm and 1550 nm: The AFBR-POC205A8 has an optimal response peaking between 1450 nm and 1500 nm. The AFBR-POC205A9 is best between 1500 nm and 1550 nm.

Features

- RoHS-compliant.
- Fully isolated power over fiber (PoF) solution that efficiently converts optical power to electrical power.
- Optical energy conversion efficiencies over 40%.
- Operating temperature range: –40°C to +85°C.
- The devices are configured with an FC optical port for use with MM or SM fibers with an NA of ~ 0.22 or smaller and for any fiber core diameters.
- Easy heat-sink mounting for thermal management.

Applications

- Power source: Optical power transmission in optical fiber over long distances.
- Sensors: Powering over distances that are impractical using copper wires.
- Utility grid monitoring: Powering using existing infrastructure single-mode fiber.
- Power electronics: Complete galvanic isolation and elimination of parasitic capacitance.
- Oil and gas industry: Power over fiber eliminates the risk of sparks.
- Chemical plants: Power over fiber in corrosive areas where metal wires can be compromised.
- Avionics: Power over fiber reduces weight, ensures EMI immunity, and eliminates the risk of fire from sparks.
- Medical instrumentation: Magnetic resonance imaging (MRI).
- Security: Power over fiber enhances protection against frequency jamming, EMI, and RFI.

Package

The AFBR-POC205A8/A9 are packaged in a standard-power, brass, 3-pin package for board mounting with standard heat-sink technology for thermal management.

The RoHS-compliant package can be integrated with various solutions.

The package allows easy board mount integration with flexible geometries for fast and secure connection to standard FC optical connector strategies.

Handling Information

CAUTION! The pn junctions in the design of these components increase the components' susceptibility to damage from electrostatic discharge (ESD). Take appropriate static precautions in handling and assembling of these components to prevent damage, degradation, or both that may be induced by ESD.

Good system performance requires clean port optics and cable ferrules to avoid obstructing the optical path. The optic components are hermetically sealed in a TO header with a glass window.

Any particles of dirt in the optical path can reduce the conversion efficiency.

Do not attempt to focus the input light onto the device surface. This focused light can burn and irreversibly damage the device.

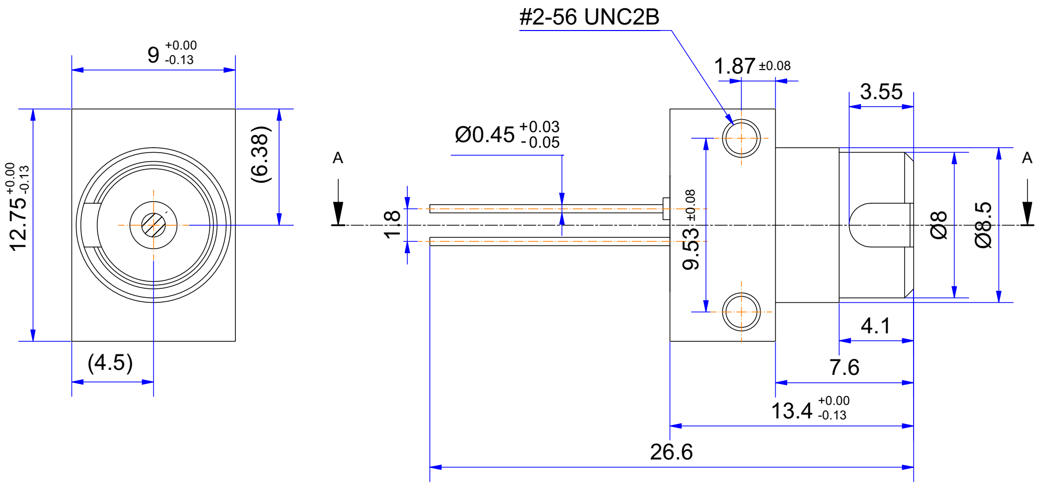
As a general rule, it is recommended to attach the photo-converter units to the board after soldering the other components.

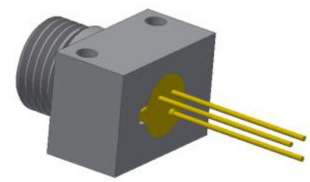
The AFBR-POC205A8/A9 are photovoltaic devices.

Do not apply external voltage to the device.

Mechanical Dimensions – FC Port

Figure 1: AFBR-POC2xxAx (3 Pins)





Dimensions are in mm.

Regulatory Compliance

Feature	Test Method	Performance
Electrostatic Discharge (ESD) to the Electrical Pins Human Body Model	ESDA/JEDEC – JS-001-2012	± 500V

CAUTION! The pn junctions in the design of these components are susceptible to damage from electrostatic discharge (ESD). It is advised that precautions be taken in handling these components to prevent damage and/or degradation that can be induced by ESD.

Assembly Process and Compatibility

Parameter	Symbol	Min.	Typical	Max.	Unit
Solder Environment	T_{SOLD}	—	—	260 [a]	°C
	t_{SOLD}	—	—	10 [b]	sec

a. Maximum temperature refers to peak temperature.

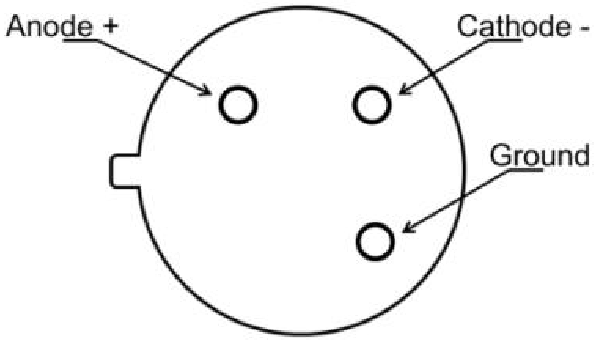
b. Maximum time refers to time spent at peak temperature.

The device can be secured with 2-56 screws for easy integration with the power board and the chosen heat-sink design.

Sufficient heat-sink performance is highly recommended to avoid high operating temperatures and to maintain good performance. It is also recommended to select a good-performing thermal interface material (TIM) to mount the device on the heat sink. For example, at 2W of input power with an external load utilizing one-half of the input power, a heat-sink performance of better than 10°C/W is required to maintain a chip temperature of 10°C above ambient.

Pin Description

Figure 2: Backside View of the AFBR-POC2xxAy (3 Pins)



Device Fundamentals

The AFBR-POC205A8/A9 are photovoltaic devices.

The devices are multi-junction compound semiconductors, which work as a power source without applying external bias while providing electrical power to a load when illuminated. Unlike standard photovoltaic devices, such as a solar cell, which is a large semiconductor pn junction, the power converter is small. Typically, the devices are illuminated by light emanating from an optical fiber; therefore the light is highly concentrated. The AFBR-POC205A8/A9 devices are uniquely designed to handle these concentrated light levels, which helps to maintain high output of both voltage and current.

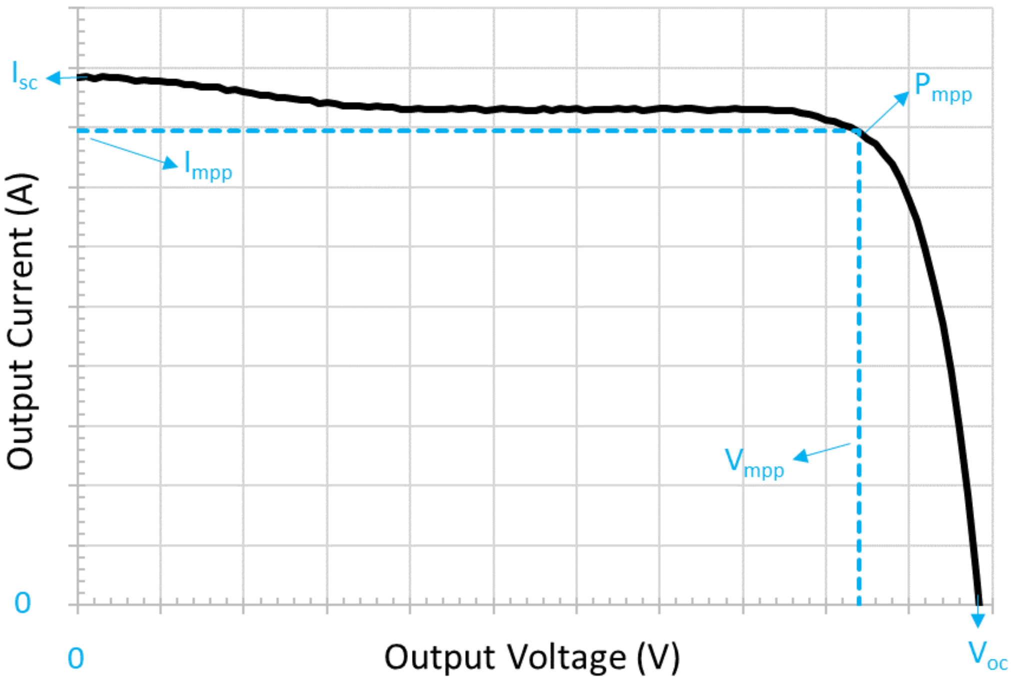
No external voltage is required in normal operation.

The Anode "+" and Cathode "-" indicate the current flow from positive to negative, when a load is connected to the pins and light is coupled into the devices.

Use of voltage regulators is recommended for a stable, efficient, and controlled power extraction from the AFBR-POC205A8/A9. Typically, photovoltaic devices, such as solar cells, do not have a continuous operating point. To reach the highest conversion performance, the load must be adapted accordingly. This adjustment is primarily due to the influence of the optical input power to the device output. Therefore, a fixed load power extraction is not an optimum method for power harvesting with solar cells.

Conversely, the Broadcom optical power converters operate with controllable laser light coupled into optical fiber, which results in stabilized output of the AFBR-POC205A8/A9 devices. For most applications, combining the devices with a voltage regulator, such as a DC/DC converter, is sufficient. Integration of ICs that provide automatic maximum power point tracking (MPPT) can be done but is typically not needed.

Figure 3: Illustration of an I-V Curve of Optical Power Converters



The output current versus output voltage characteristics of a typical optical power converter is illustrated in the preceding figure. At short circuit, the current output (I_{sc}) is at its maximum, but no power is delivered. At open circuit (V_{oc}), the voltage is at its maximum; however, no power can be extracted. In between, a maximum power point exists (P_{mpp}), which is the product of the current (I_{mpp}) and the voltage (V_{mpp}) at that specific point. Ideally, the external load should be tailored to allow the device to operate near V_{mpp} and I_{mpp}, that is, for a load $R_{mpp} \sim V_{mpp}/I_{mpp}$. Note that R_{mpp} will vary with the input power (P_{in}).

Absolute Maximum Ratings

Absolute maximum ratings are those values beyond which damage to the device may occur if these limits are exceeded other than for a short period of time.

Parameter	Symbol	Min.	Typical	Max.	Unit
Storage Temperature	T_S	−40	25	85	°C
Operating Case Temperature	T_C	−40	—	90	°C
Relative Humidity	RH	5	—	95	%
Maximum Optical Input Power [a] AFBR-POC205A9	$P_{opt\ IN}$	—	—	1.5	W

a. Proper heat sinking is highly recommended. Lower-performance heat sinking can affect the maximum optical input power value because the operating case temperature can be exceeded at higher powers if the heat-sink design does not properly extract the excess heat.

Fiber Specifications

The input fiber should be protected by a sleeve or ceramic ferrule during handling.

Parameter	Symbol	Min.	Typical	Max.	Unit
Core Diameter [a]	D	—	Typically insignificant impact between 9 µm and 400 µm	—	µm
Numerical Aperture [b]	NA	0.1	0.22	0.28	—
Fiber Length [c]	—	—	Application-specific	—	meter

a. The devices typically perform well with most types of fiber; that is, there is a lot of flexibility on the choice of the input fiber minimum and maximum fiber core diameter that can be used with AFBR-POCxxx products. The device performance is more specifically linked to the fiber's numerical aperture value rather than the core diameter choice. Typically, SM and MM fibers with a core diameter from 40 µm to 400 µm match the specified NA range (0.1 to 0.28).

b. NA values smaller than 0.22 can result in lower than optimal output power for the higher input power conditions near the specified maximum optical input power. Conversely, if the NA is too large, part of the beam can hit outside the chip aperture inside the device and the performance can decrease due to lower currents (wasted input optical power ending up outside the clear aperture). Note that the actual NA of the fiber laser might be less than the nominal fiber NA if the laser fiber pigtail is relatively short (for example, laser diodes with a nominal fiber NA = 0.22 are sometimes observed to actually have an NA closer to 0.1x for relatively short pigtails of only a few meters or less).

c. Fiber length depends on application requirements, mainly on the specific fiber attenuation.
For example, a typical single-mode fiber has an attenuation of around 0.2 dB/km at 1500 nm.

Operating Characteristics

All specified parameters are valid for operations at a case temperature of 25°C. [a]

Parameter	Symbol	Min.	Typical [b]	Max.	Unit
Recommended Optical Input Spectrum Range (A8) [c]	λ_{IN}	1460	1480 [d]	1500	nm
Recommended Optical Input Spectrum Range (A9) [c]	λ_{IN}	1530	1550 [d]	1570	nm
For Optical Power In = 1.0W					
P_{mpp} defined in Figure 3 vs. Optical Input Power [e]	P_{out}	—	0.45	—	W
Output Voltage at P_{mpp} defined in Figure 3	V_{OUT}	—	4.7	—	V
Output Current at P_{mpp} defined in Figure 3	I_{OUT}	—	0.09	—	A
For Optical Power In = 1.5W					
P_{mpp} defined in Figure 3 vs. Optical Input Power [c]	P_{out}	—	0.69	—	W
Output Voltage at P_{mpp} defined in Figure 3	V_{OUT}	—	4.7	—	V
Output Current at P_{mpp} defined in Figure 3	I_{OUT}	—	0.14	—	A

a. Insufficient heat sinking can result in lower device performance due to increased case and device temperatures. Quick testing at the start of illumination or in pulse mode is typically a good method to confirm that the heat sinking is adequate.

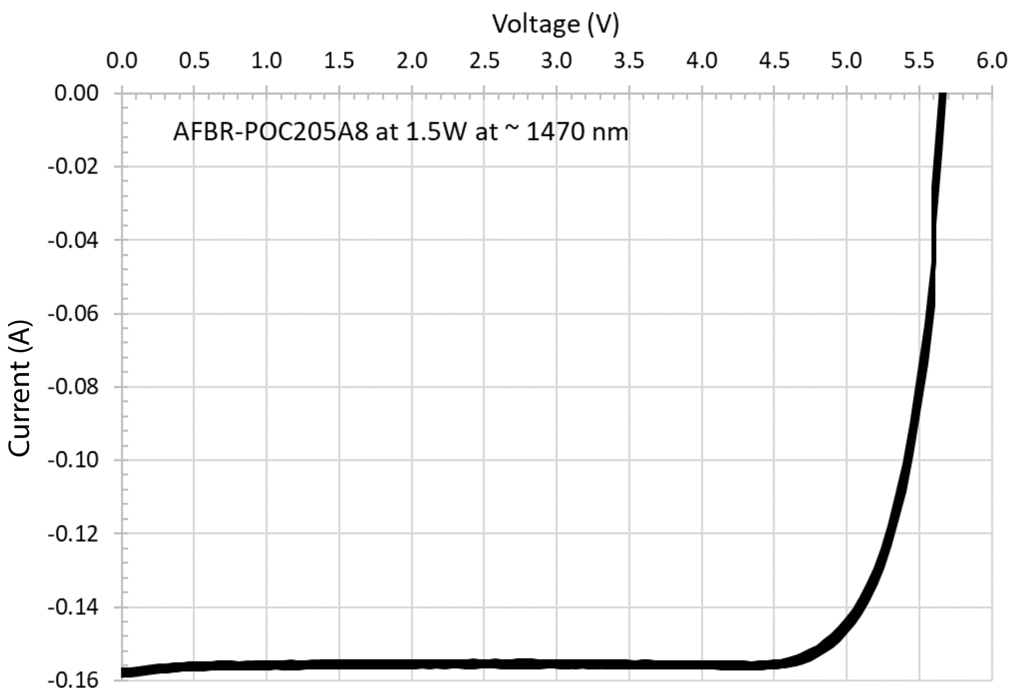
b. Typical values are average values *measured at a case temperature of 20°C*.

c. The product can be safely used outside the recommended range, but the performance will be lower.

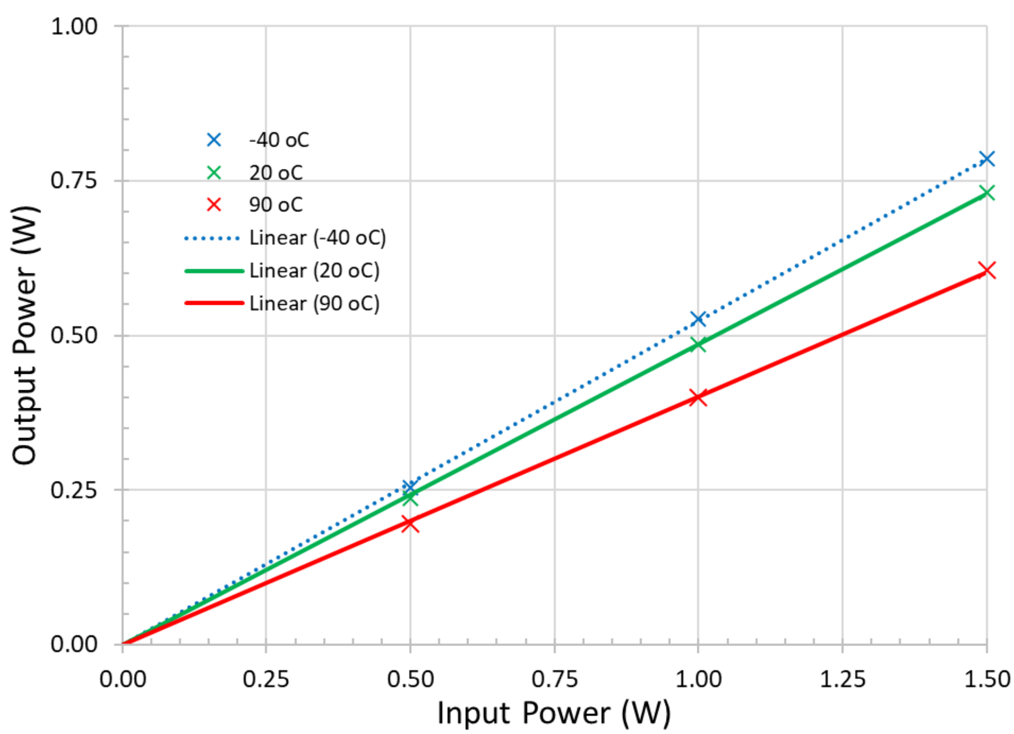
d. The AFBR-POC205A9 is normally optimized around a spectral input of 1550 nm by default. The AFBR-POC205A8 is normally optimized around a spectral input of 1470 nm by default.

e. Verified with light emitted by a laser at ~ 1550 nm coupled into an MM fiber with an NA = 0.22. Power measured with a large area detector.

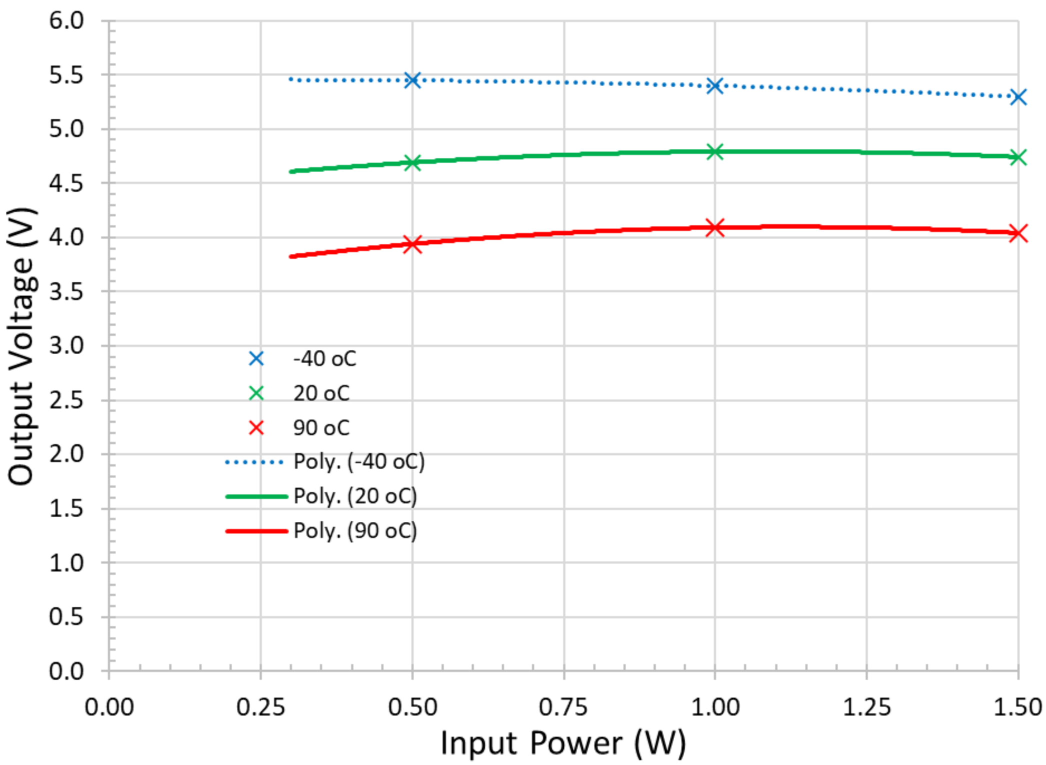
The following figure shows the current/voltage behavior for the AFBR-POC205A8 at 1.5W optical input at ~ 1470 nm with a case temperature of 20°C (similar results are achieved for the AFBR-POC205A9 with an optical input at ~ 1550 nm).



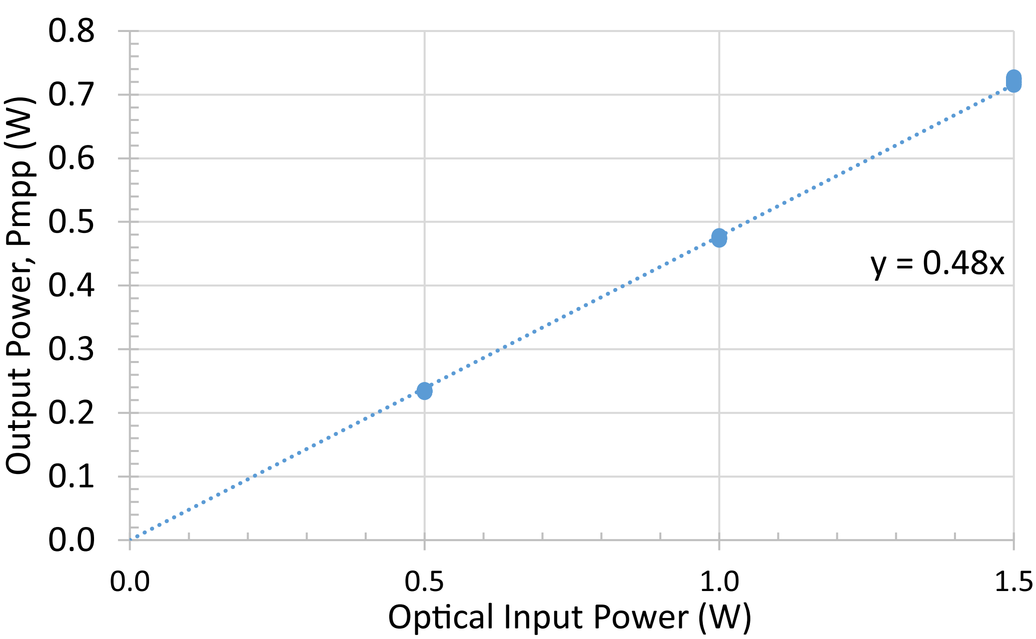
The following figure shows the output power versus input power behavior for the AFBR-POC205A8 with an optical input at ~ 1470 nm with different case temperatures (similar results are achieved for the AFBR-POC205A9 with an optical input at ~ 1550 nm).



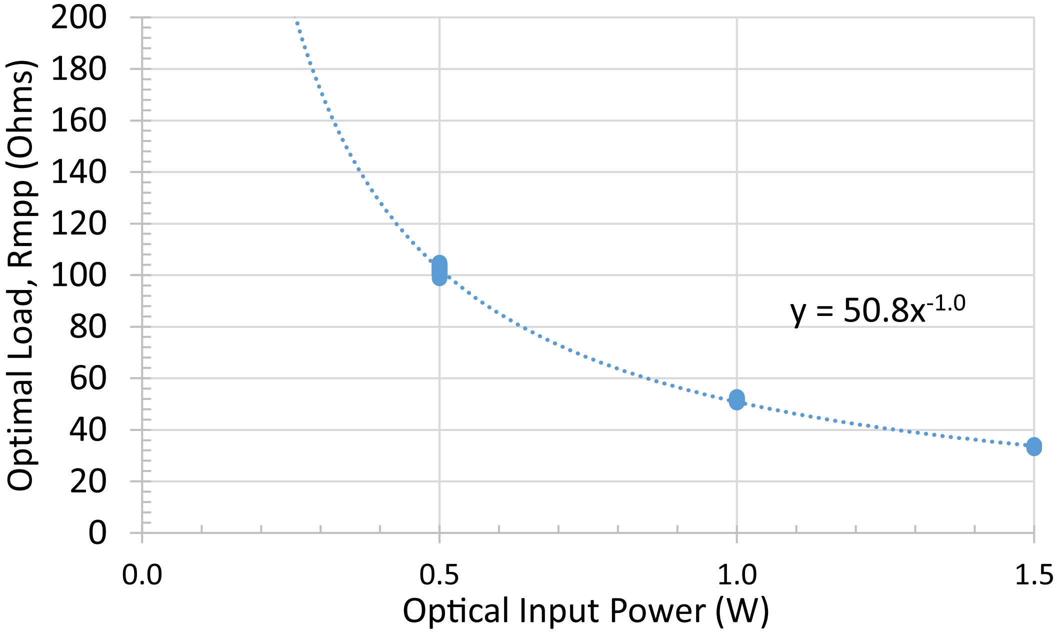
The following figure shows the output voltage (V_{mpp}) versus input power behavior for the AFBR-POC205A8 with an optical input at about 1470 nm with different case temperatures (similar results are achieved for the AFBR-POC205A9 with an optical input at about 1550 nm).



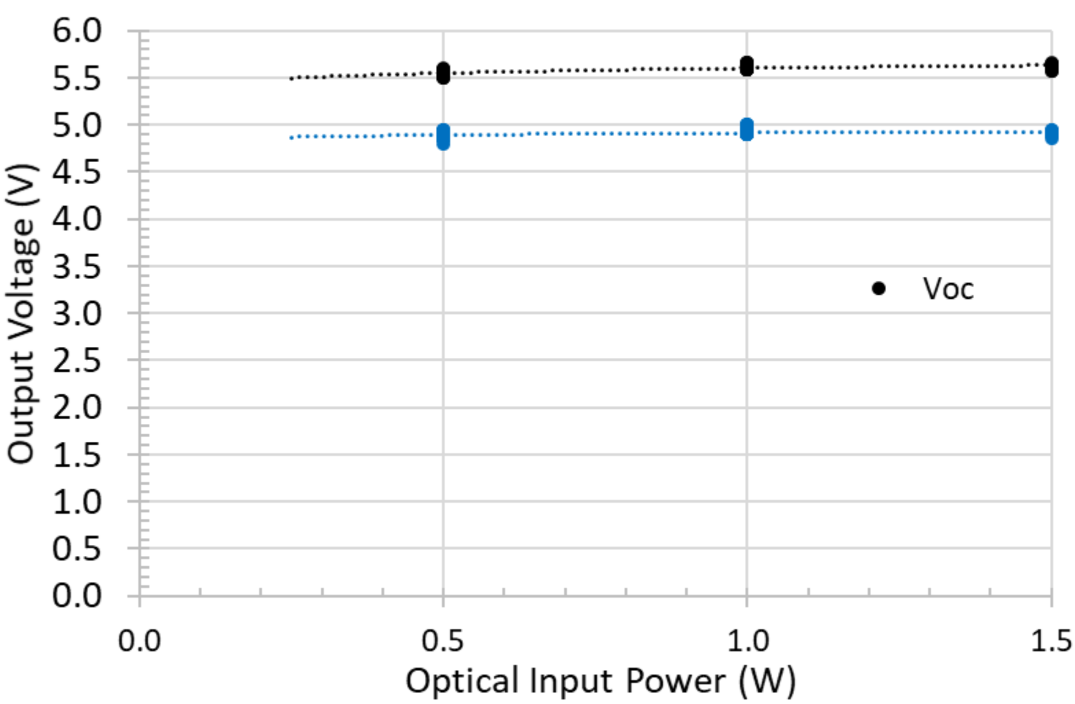
The following figure shows the input power dependence of the maximum power point output power (P_{mpp} or optimal P_{out}) with a case temperature of 20°C for P_{in} at ~ 1550 nm for the AFBR-POC205A9 (similar results are achieved for the AFBR-POC205A8 with an optical input at ~ 1470 nm).



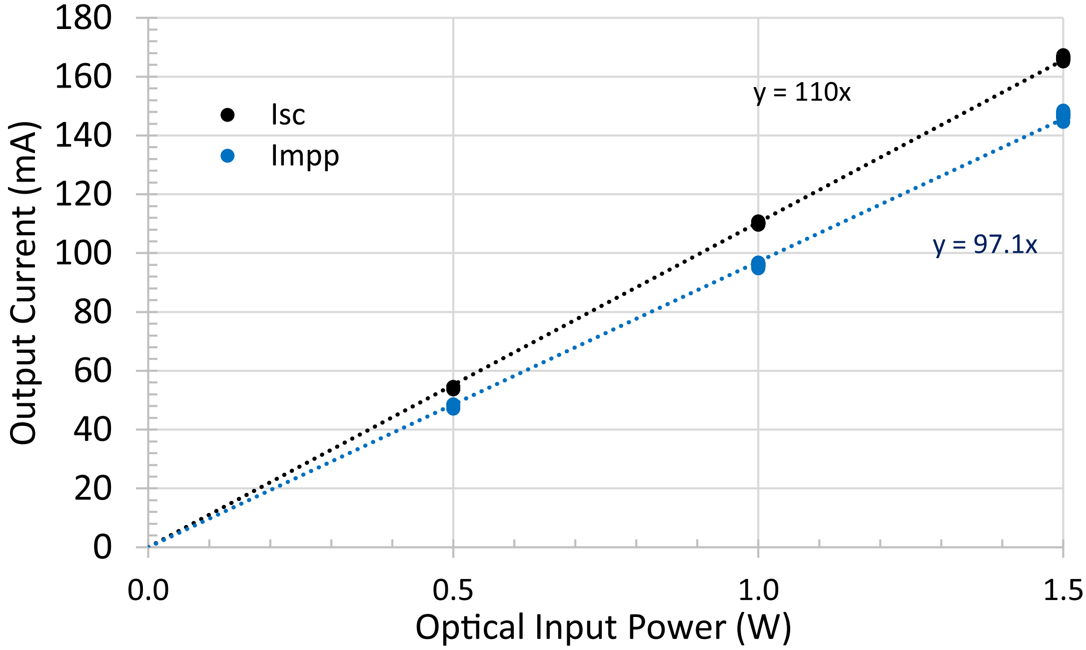
The following figure shows the optimal load value (R_{mpp}) at a case temperature of 20°C for the AFBR-POC205A9 versus the input power at ~ 1550 nm (similar results are achieved for the AFBR-POC205A8 with optical input at ~ 1480 nm).



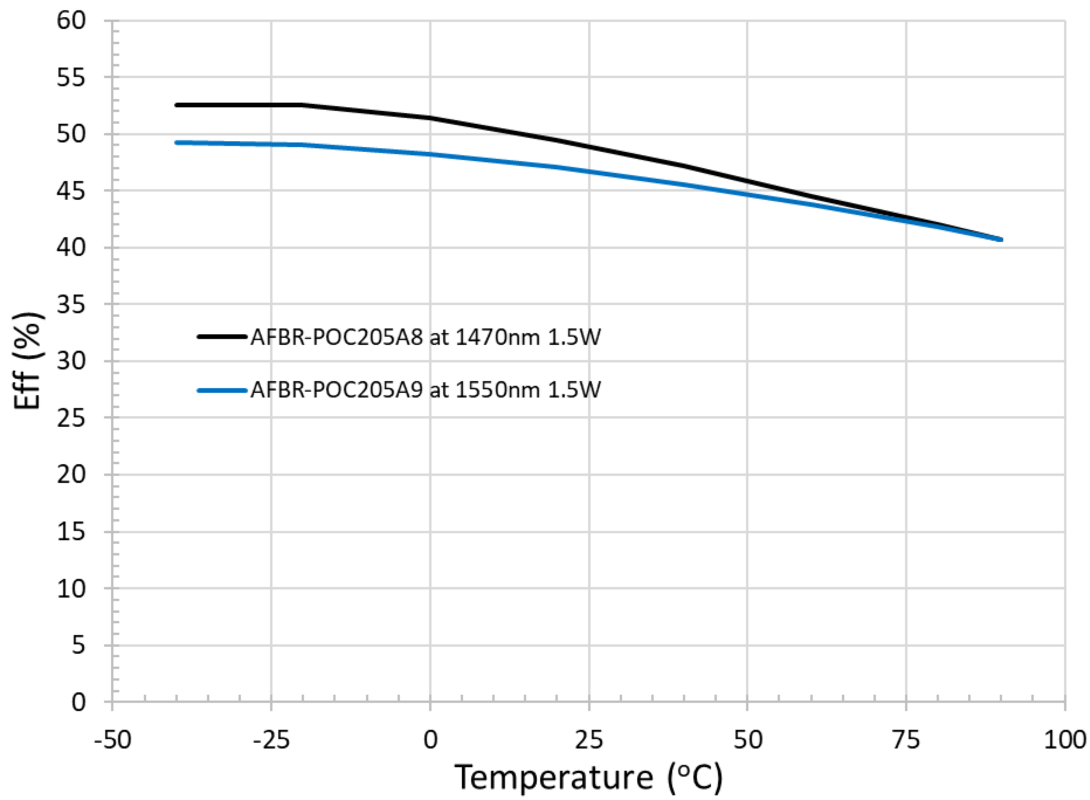
The following figure shows the output voltage (V_{oc} and V_{mpp}) at a case temperature of 20°C for the AFBR-POC205A9 versus the input power at ~ 1550 nm (similar results are achieved for the AFBR-POC205A8 with an optical input at ~ 1470 nm).



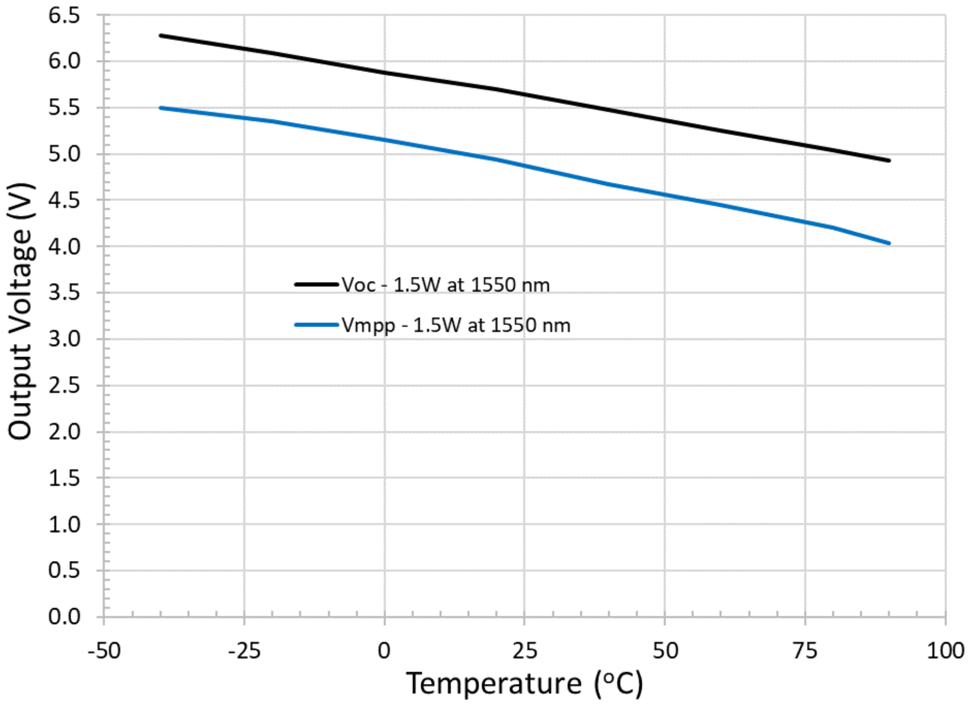
The following figure shows the output current (I_{sc} and I_{mpp}) at a case temperature of 20°C for the AFBR-POC205A9 versus the input power at ~ 1550 nm (similar results are achieved for the AFBR-POC205A8 with an optical input at ~ 1470 nm).



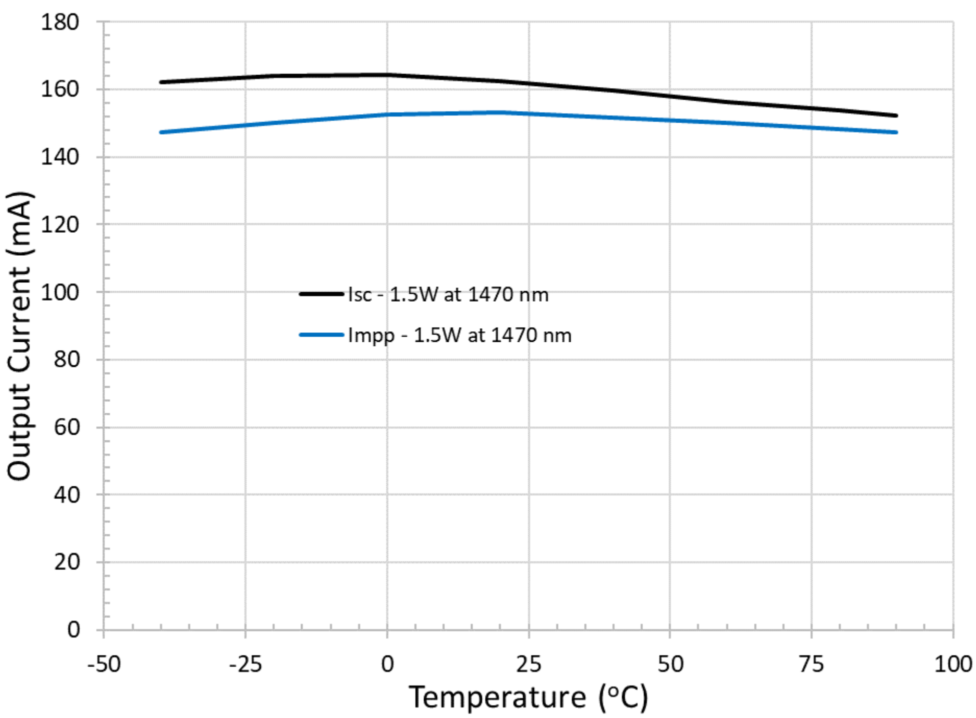
The following figure shows the efficiency (Eff) versus the case temperature for the AFBR-POC205A8 at ~ 1470 nm and for the AFBR-POC205A9 at ~ 1550 nm.



The following figure shows the output voltage (V_{oc} and V_{mpp}) versus the case temperature for the AFBR-POC205A9 at ~ 1550 nm (similar results are achieved for the AFBR-POC205A8 with an optical input at ~ 1470 nm).



The following figure shows the output current (I_{sc} and I_{mpp}) versus the case temperature for the AFBR-POC205A8 at ~ 1470 nm (similar results are achieved for the AFBR-POC205A9 with an optical input at ~ 1550 nm).



Lead (Pb) Free
RoHS 6 fully compliant
RoHS 6 fully compliant options available;
-xxxE denotes a lead-free product