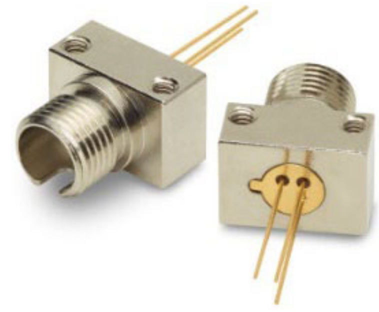
Data Sheet

AFBR-POC205A2

Optical Power Converter



Description

The AFBR-POC205A2 belongs to the Broadcom® Power Components product family. The device converts optical power to electrical power for applications that require complete electrical isolation in highly demanding industrial environments. It is an excellent choice for powering electronic circuitry where electrical wired solutions are not feasible due to high voltage, electromagnetic interference, or strong magnetic fields.

The AFBR-POC205A2 is based on the patented Vertically Integrated VEHSA Monolithic GaAs Power Converter. The AFBR-POC205A2 uses a multi-junction compound semiconductor design. It is a versatile 5V source with superior performance for a wide range of wavelengths and temperatures. It can be used in the spectral range between 790 nm and 860 nm for the standard –40°C to +85°C operating temperature range.[1]

The AFBR-POC205A2 can supply output voltage levels > 5 VDC for various applications. In typical cases, these devices can provide > 0.75W of electrical power by converting 1.5W of optical input power from a high-power laser diode. It is a flexible isolated power source with superior performance for a wide range of wavelengths and temperatures and is optimized for optical input wavelengths in the range from 840 nm to 860 nm for room-temperature operations.

The optical power converter shows a nearly linear current response to the optical input power.

Smart thermal design simplifies system integration, and with a 3-pin configuration, it allows isolated anode and/or cathode connections.

The AFBR-POC205A2 is optimized for integration with efficient coupling of multi-mode (MM) fibers with various numerical apertures (for example, NA ~ 0.22) and with core diameters (for example, 40 µm to 400 µm).

Features

- RoHS compliant.
- Fully isolated power over fiber (PoF) solution that efficiently converts optical power to electrical power with a ~5V output.
- Qualified for an operating temperature range of –40°C to +85°C.
- The device is configured with an FC optical port for use with MM fibers with an NA ~ 0.22 and for any fiber core diameters (for example, from 40 µm to >400 µm).
- Easy heat-sink mounting for thermal management.
- Ideal output power range for regular-power applications, complementing Broadcom’s medium-power power converters (for example, AFBR-POC306xx).

1. The AFBR-POC205A2 has also been successfully operated for cryogenic applications (for example, 75K to 150K) using an optical input wavelength of ~ 808 nm, but no formal qualification testing has been performed for such cryogenic conditions. See the AFBR-POC205A2 application note, *Optical Power Converter Operation at Cryogenic Temperatures*.

Applications

The following are typical fields of application for the optical power converter:

- Sensor applications: Provides isolated power for various sensors.
- Electric power utilities: Provides fully isolated power to protect sensor devices.
- Lightning: Protects key circuits.
- Biomedical and neuro-stimulation: Provides safe and tailored voltage and current sources.
- RF power electronic circuits: Reduces interference and ringing.
- Chemical plants: Uses power over fiber in corrosive areas where metal wires can be attacked.
- Avionics: Uses power over fiber instead of metal wires to reduce weight and EMI and to eliminate the risk of fire from sparks.
- Security: Triggers and powers sources unaffected by EMI-RFI.

Package

The 3-pin AFBR-POC205A2 is provided in a solid brass housing with nickel plating. It is designed 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-terminated optical fibers.

For traceability, an individual serial number is laser-engraved on one side of the housing.

Handling Information

CAUTION! These components are susceptible to damage from electrostatic discharge (ESD). Implement advanced static precautions in handling and assembling these components to prevent damage, degradation, or both that can 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.

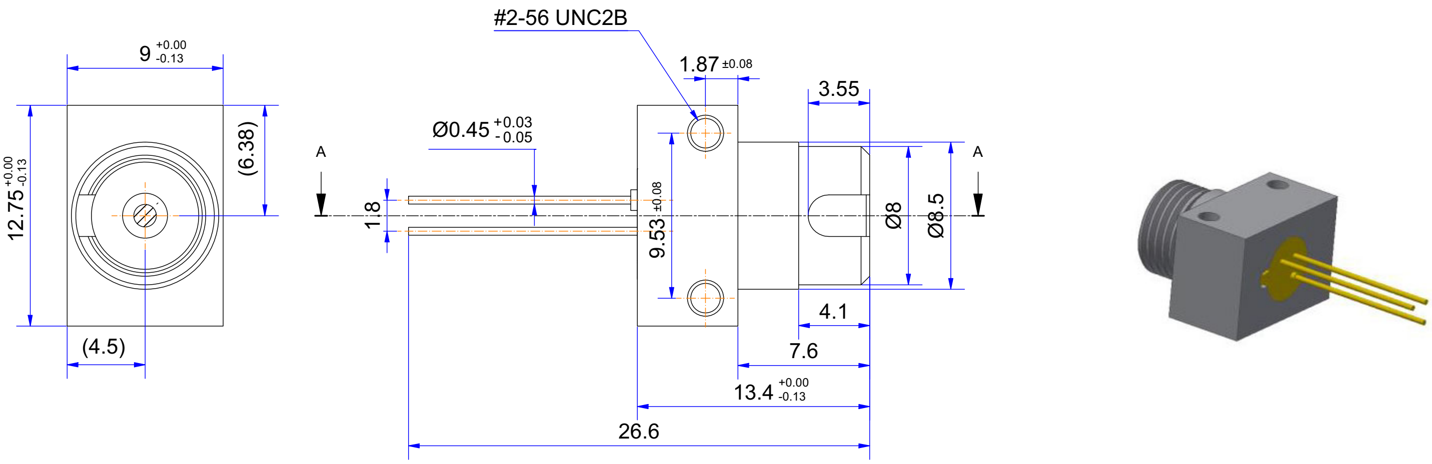
As a general rule, it is recommended to attach the photo-converter units to the board after soldering the other components.

The AFBR-POC205A2 is a photovoltaic device.

Unless for controlled testing purposes, do not apply an external voltage. For testing, make sure that polarities are maintained and do not exceed the value of open circuit voltage in the forward direction. This photovoltaic device should operate in reverse voltage bias.

Mechanical Dimensions – FC Port

Figure 1: AFBR-POC2xxAx (3 Pins)



NOTE: Dimensions are in mm.

Regulatory Compliance

Feature	Test Method	Performance
Electrostatic discharge (ESD) to the electrical pins: human body model	ESDA/JEDEC – JS-001-2017	Minimum ± 500V

Assembly Process and Compatibility

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

a. Maximum temperature refers to peak temperature.

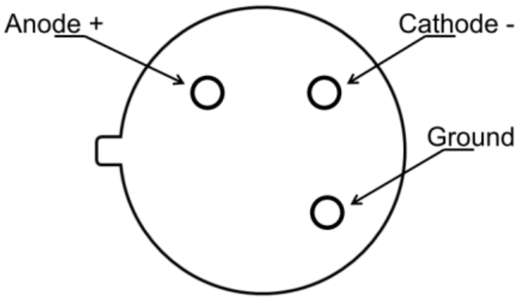
b. Maximum time refers to time spent at peak temperature.

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 1.5W of input power with an external load utilizing one-half of the input power, a heat-sink performance of better than 20°C/W is required to maintain a chip temperature of 15°C above ambient.

Pin Description

Figure 2: Backside View of the AFBR-POC205A2 (3 Pins)



Device Fundamentals

The AFBR-POC205A2 is a photovoltaic device. The device is a multi-junction compound semiconductor, which works as a power source without applying external bias while providing electrical power to a load when illuminated. Unlike a standard photovoltaic device, such as a solar cell, which is a large semiconductor pn-junction, the power converter is small. Typically, the device is illuminated by light emanating from an optical fiber; therefore the light is highly concentrated. The AFBR-POC205A2 devices are uniquely designed to handle these concentrated light levels, which helps to maintain a high output of both voltage and current.

Do not apply external voltage to the device.

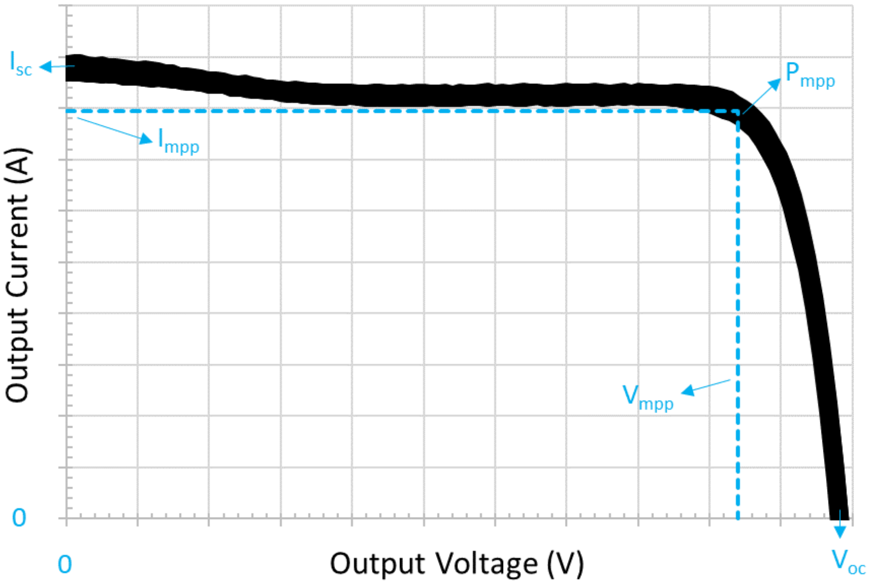
The Anode "+" and Cathode "-" indicate the current flow from positive to negative when a load is connected to the pins and light is coupled into the device.

The AFBR-POC205A2 operates without applying additional external voltage.

Use of voltage regulators is recommended for a stable, efficient, and controlled power extraction from the AFBR-POC205A2. 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 that is coupled into optical fiber, which results in a stabilized output of the AFBR-POC205A2 device. For most applications, combining the device 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: 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 can 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	—	85	°C
Relative Humidity	RH	5	—	85	%
Maximum Optical Input Power [a]	$P_{opt\ IN}$	—	—	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 40 µm and >400 µm	—	µm
Numerical Aperture [b]	NA	0.20	0.22	0.28	—
Fiber Length [c]	—	—	Application-specific	—	meters

a. The device typically performs 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, fibers with a core diameter from 40 µm to 400 µm match the specified NA range (0.20 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 might hit outside the chip aperture inside the device, and the performance might 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 of 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 depending on specific fiber attenuation.
For example, a typical 62.5 µm/125 µm fiber has an attenuation of around 3.5 dB/km at 830 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 [c]	λ_{IN}	840	850 [d]	860	nm
For Optical Power In = 1.0W					
P_{mpp} Defined in Figure 3 vs. Optical Input Power [e]	P_{out}	—	0.57	—	W
Output Voltage at P_{mpp} Defined in Figure 3	V_{OUT}	—	5.2	—	V
Output Current at P_{mpp} Defined in Figure 3	I_{OUT}	—	0.11	—	A
For Optical Power In = 1.5W					
P_{mpp} Defined in Figure 3 vs. Optical Input Power [e]	P_{out}	—	0.88	—	W
Output Voltage at P_{mpp} Defined in Figure 3	V_{OUT}	—	5.2	—	V
Output Current at P_{mpp} Defined in Figure 3	I_{OUT}	—	0.17	—	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-POC205A2 is normally optimized around a spectral input of 850 nm by default.

e. Verified with light emitted by the laser at 850 nm coupled into an MM fiber with an NA of 0.22.
Power measured with a large area detector at the end of the MM fiber.

Figure 4: Example of Current/Voltage Behavior for 0.5W, 1.0W, and 1.5W Optical Input for the AFBR-POC205A2 at 20°C

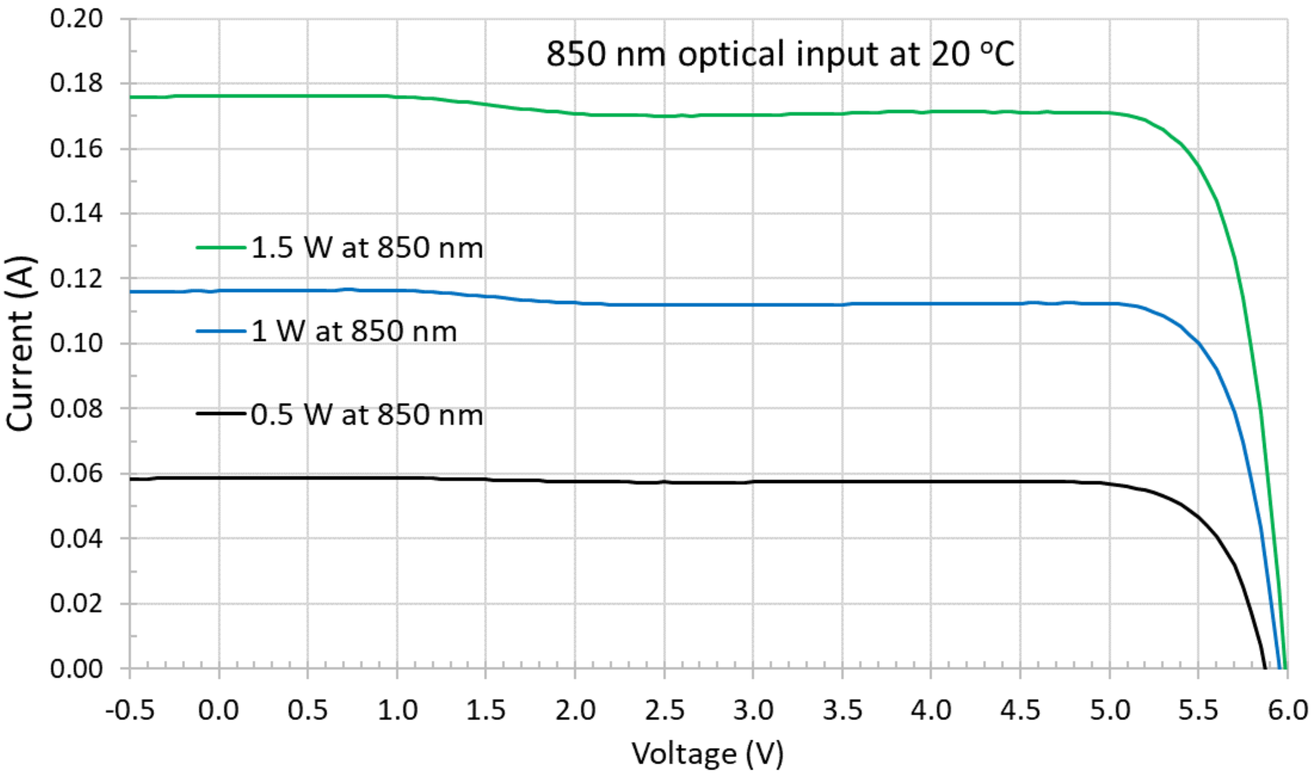


Figure 5: Example of Output Power (P_{mpp}) and Output Voltage (V_{mpp}) vs Optical Input Power for AFBR-POC205A2 at 850 nm at T = 20°C

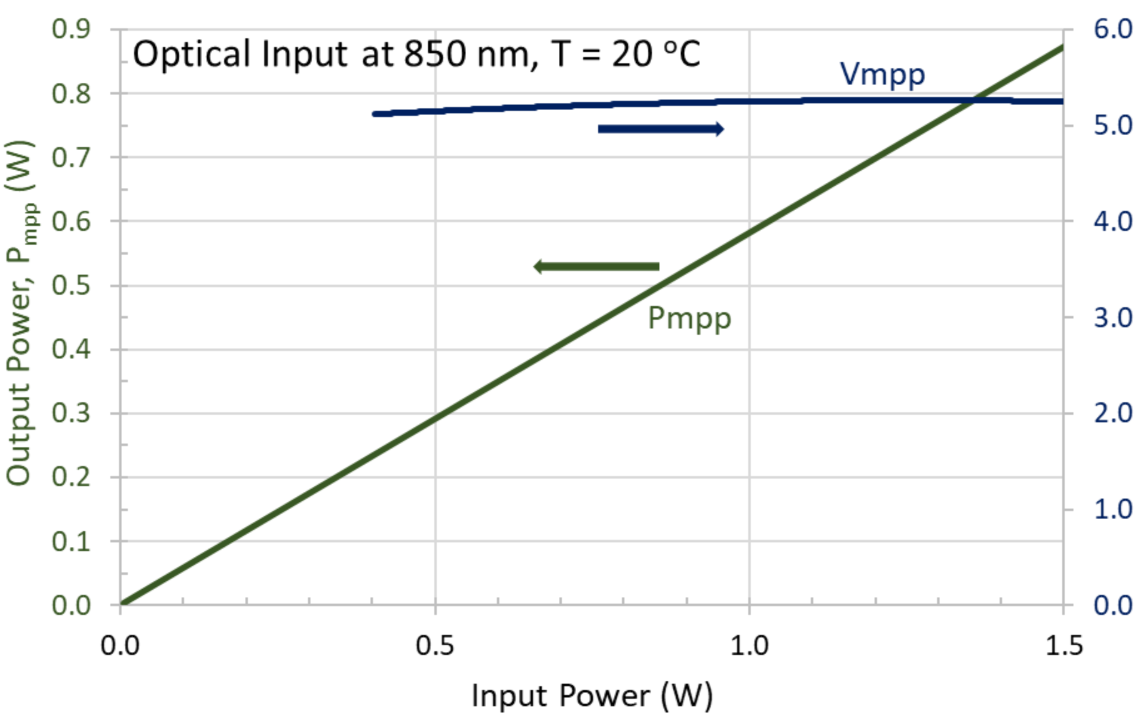


Figure 6: Optimal Load (R_{mpp}) vs Input Power for AFBR-POC205A2 at 850 nm at T = 20°C

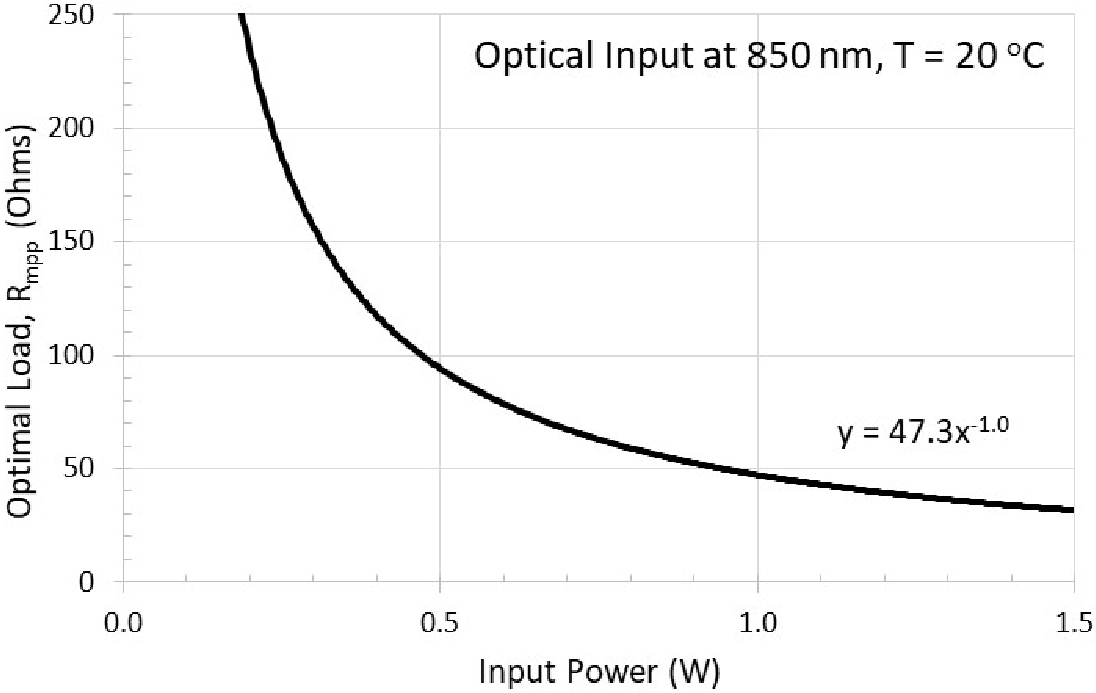
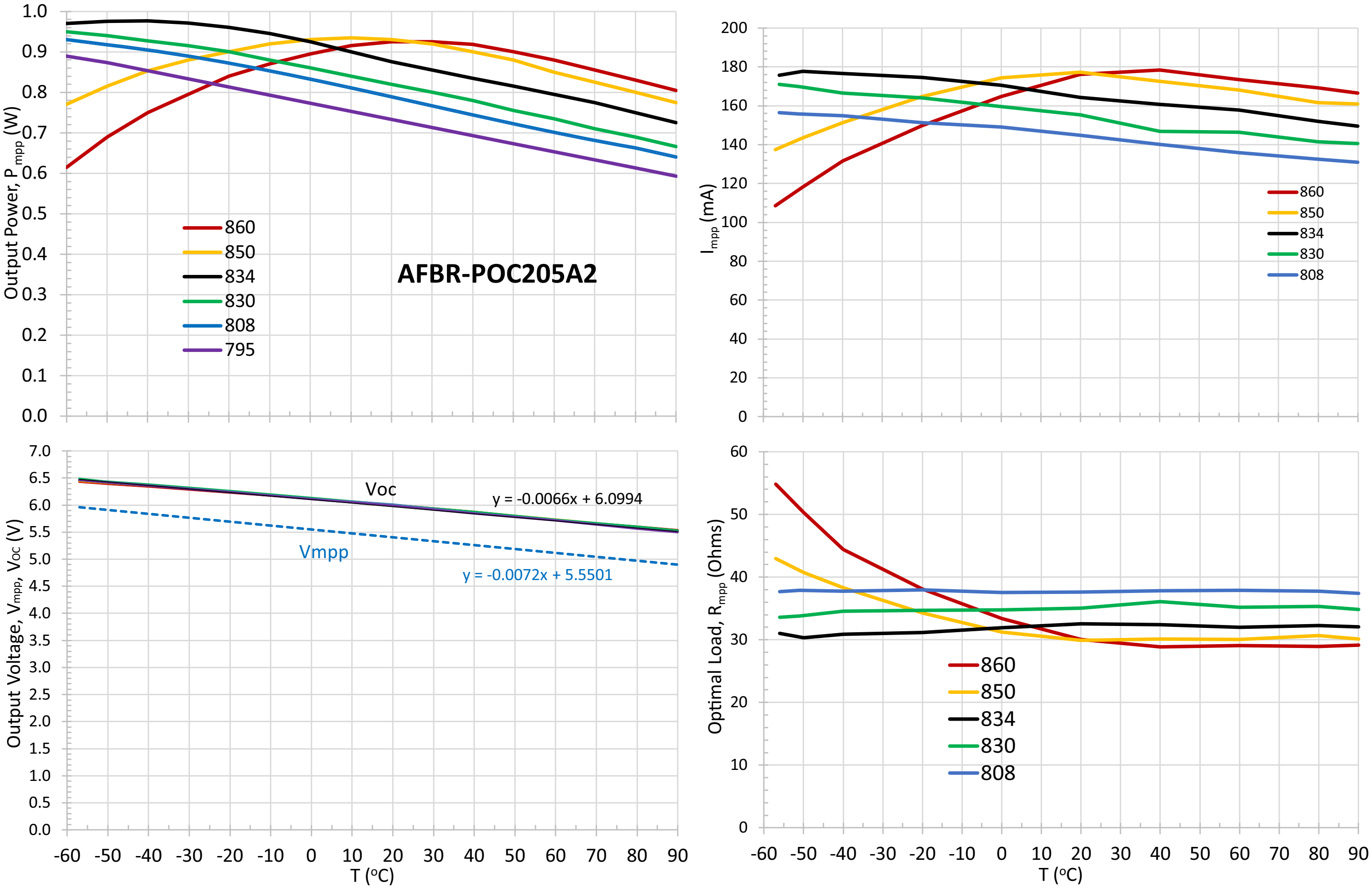


Figure 7: Example of the Temperature Dependence of the Output Power (Upper Left), Output Current (Upper Right), Output Voltage (Lower Left), and Optimal Load (Lower Right) for AFBR-POC205A2 at Various Optical Input Wavelengths for 1.5W of Input Power

The input wavelengths between 795 nm and 860 nm are indicated on the graphs.



Lead (Pb) Free
RoHS 6 fully compliant

RoHS 6 fully compliant options available; -xxxE denotes a lead-free product