EMIRS200_AT01T
EMIRS200_AT02V

Thermal MEMS based infrared source

For direct electrical fast modulation

TO39 header

■ Infrared Source

Axetris infrared (IR) sources are micro-machined, electrically modulated thermal infrared emitters featuring true blackbody radiation characteristics, low power consumption, high emissivity and a long lifetime. The appropriate design is based on a resistive heating element deposited onto a thin dielectric membrane which is suspended on a micro-machined silicon structure.

■ Infrared Gas Detection Applications

• **Measurement principles:** non-dispersive infrared spectroscopy (NDIR), photoacoustic infrared spectroscopy (PAS) or attenuated-total-reflectance FTIR spectroscopy (ATR)
• **Target gases:** CO, CO_2, VOC, NO_X, NH_3, SO_X, SF_6, hydrocarbons, humidity, anesthetic agents, refrigerants, breath alcohols
• **Medical:** Capnography, anesthesia gas monitoring, respiration monitoring, pulmonary diagnostics, blood gas analysis
• **Industrial Applications:** Combustible and toxic gas detection, refrigerant monitoring, flame detection, fruit ripening monitoring, SF_6 monitoring, semi-conductor fabrication
• **Automotive:** CO_2 automotive refrigerant monitoring, alcohol detection & interlock, cabin air quality
• **Environmental:** Heating, ventilating and air conditioning (HVAC), indoor air quality and VOC monitoring, air quality monitoring
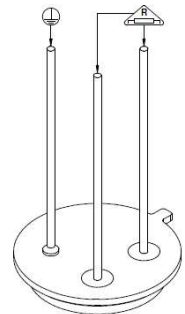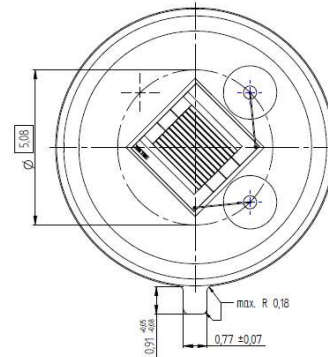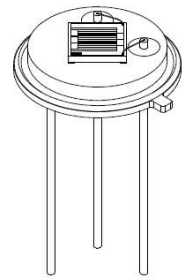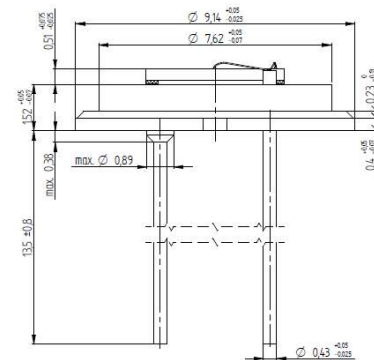
■ Features

• Large modulation depth at high frequencies
• Broad band emission
• Low power consumption
• Long lifetime
• True black body radiation (2 to 14 μm)
• Very fast electrical modulation (no chopper wheel needed)
• Suitable for portable and very small applications
• Rugged MEMS design

Product Datasheet

■ Absolute Maximum Ratings (T_A = 22°C)

Parameter	Symbol	Rating	Unit
Heater membrane temperature[1]	T_M	500	°C
Optical output power (hemispherical spectral) (T_M = 500°C)	P_{OO}	43	mW
Optical output power between 4 μm and 5 μm (T_M = 500°C)	P_{s4-5}	5.6	mW
Optical output power between 6 μm and 8 μm (T_M = 500°C)	P_{s6-8}	7.6	mW
Optical output power between 8 μm and 10 μm (T_M = 500°C)	P_{s8-10}	4.6	mW
Optical output power between 10 μm and 13 μm (T_M = 500°C)	P_{s10-13}	3.9	mW
Electrical cold resistance (at $T_M = T_A$ = 22°C)	R_{C22}	35 to 55	Ω
Electrical operating (hot) resistance[2] (at T_M = 500°C with f = ≥ 5 Hz and t_{on} ≥ 8 ms)	R_{H500C}	1.883 * RC22 – 12.02	Ω
Package temperature	T_P	80	°C
Storage temperature	T_S	-20 to +85	°C
Ambient temperature[3] (operation)	T_A	-40 to +125	°C
Heater area	A_H	2.1 x 1.8	mm²
Frequency[4]	f	5 to 50	Hz

Note: Emission power in this table is defined by hemispherical radiation. Stress beyond those listed under "absolute maximum ratings" may cause permanent damage to the device.

Note: Diagram R_{H500C} — R_{C22} | (T_M = 500°C)

How to ensure that the maximum temperature for T_M is not exceeded:
1. Determine electrical cold resistance R_C of the EMIRS device at TA=22°C
2. Ensure that anytime R_H does not exceed the representative limit as shown in this diagram with respect to these conditions:
    a. f ≥ 5 Hz
    b. on-time (pulse duration) ≥ 8 ms

$$R_{H500C} — R_{C22}$$
$$(T_M = 500°C)$$
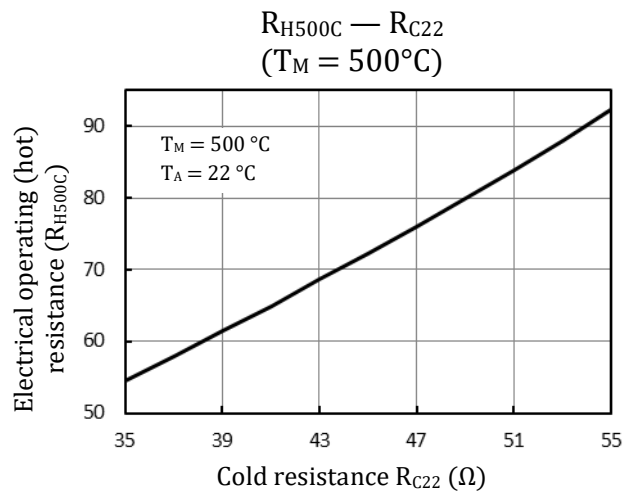
Electrical operating (hot) resistance R_H versus electrical cold resistance R_{C22} at T_A = 22°C

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[1] Temperatures above 500°C will impact drift and lifetime of the devices.
[2] See Diagram R_H — R_C | (T_M = 500°C)
[3] The environmental and package temperature might impact the lifetime and characteristic of the devices.
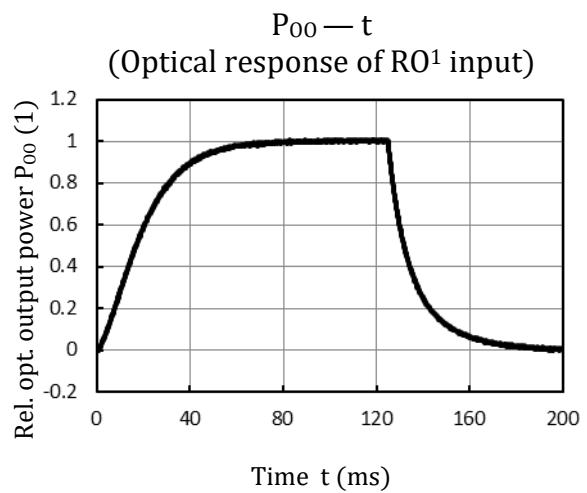[4] Lower cut-off frequency of 5 Hz for designed thermodynamic state.

■ Ratings at Reference Operation (RO[1] T_A = 22°C)

Parameter	Symbol	Rating	Unit
Heater membrane temperature	T_M	< 500	°C
Duty cycle of rectangular V_H pulse	D	62	%
Frequency of rect. pulse shape[2]	f_{ref}	5	Hz
On time constant of integral emissive power P_{OO}	τ_{on}	18	ms
Off time constant of integral emissive power P_{OO}	τ_{off}	8	ms
Package temperature at T_A = 22°C	T_P	40 to 85	°C

Note: First order on-time model using τ_{on}:   First order off-time model using τ_{off}:

V_H — t
(RO[1] input pulse shape)
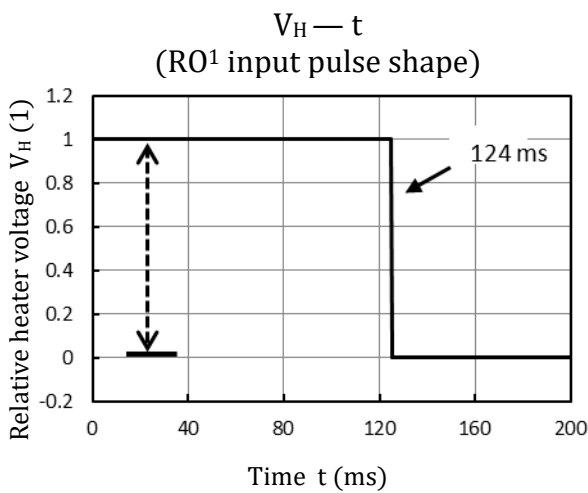
Relative rectangular heater voltage (V_H) pulse with a relative pulse width of 124 ms at 5 Hz
(time description of reference operation RO[1])

P_{OO} — t
(Optical response of RO[1] input)

Optical response time (relative optical output power P_{OO}) of a rectangular voltage pulse
(RO[1] conditions)

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[1] Reference Operation: combines lower cut-off frequency of 5 Hz and maximum modulation depth (max-min signal)
[2] Recommended frequencies from 5 Hz to 50 Hz

■ Typical Timing Characteristics Frequency (D = 62%)

P_{OO} - - - f (fixed V_H)
P_{OO} — f, (comp V_H)

V_H, P_H — f
(compensation factor)
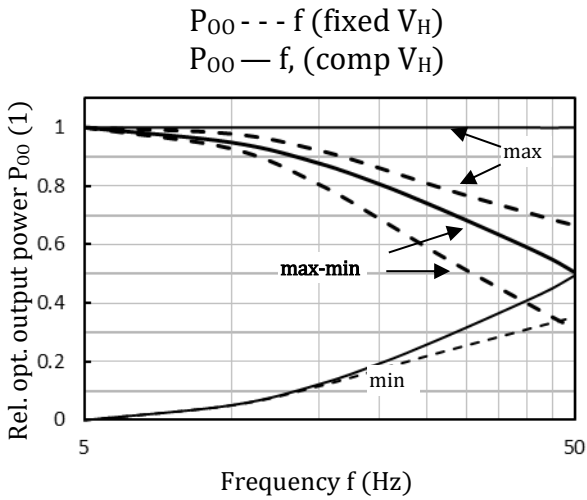
Relative (to RO) max, min, max-min values of optical output power (P_{OO}) versus frequency f with fixed and compensated V_H
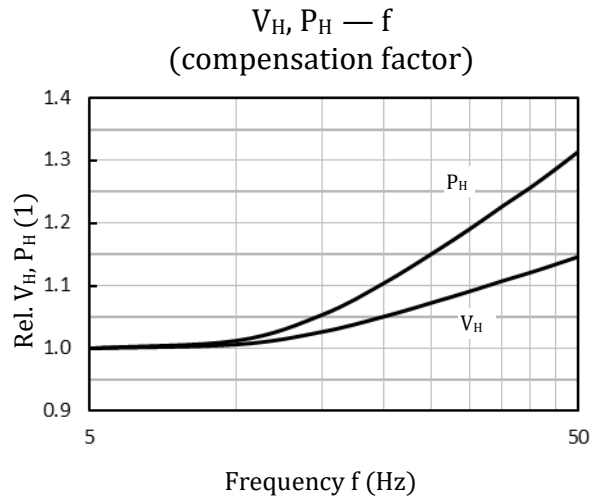
Relative (to RO) electrical drive values heater voltage V_H and power P_H versus frequency f for compensation
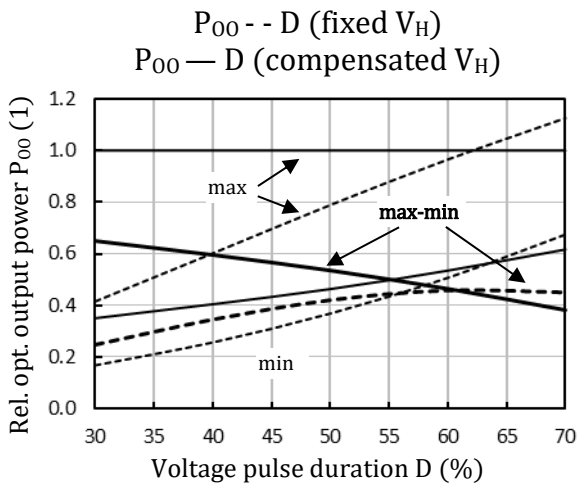
Note: Diagrams a, b
Relative P_{OO}, V_H, P_H to reference operation (RO)
f=5 Hz, rect. pulse D=62%

max: maximum value of P_{OO} response shape
min: minimum value of P_{OO} response shape
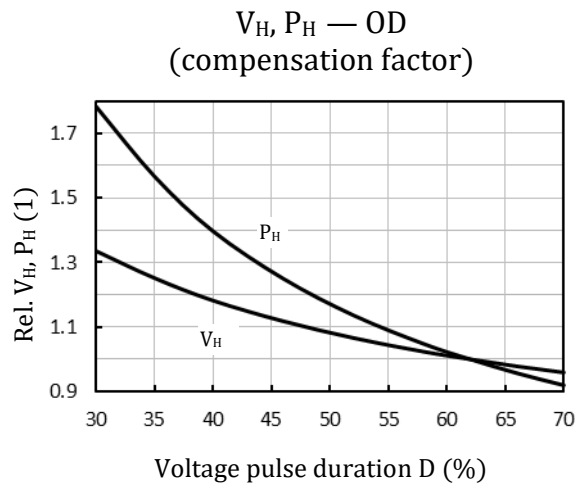max-min: amplitude calculation of P_{OO} resp. shape

Fixed V_H: same voltage for all frequencies.

Compensated V_H: for every frequency value, the voltage is adjusted to achieve the same maximum of P_{OO} response shape as for 5 Hz.

■ Typical Timing Characteristics Pulse Duration D^1 (f = 50 Hz)

P_{OO} - - D (fixed V_H)
P_{OO} — D (compensated V_H)

Relative (to D=62%) max, min, max-min values of optical output power (P_{OO}) versus duty cycle D with fixed and compensated V_H

V_H, P_H — OD
(compensation factor)

Relative (to RO) electrical drive values heater voltage V_H and power P_H versus duty cycle D for compensation

Note: Diagrams a, b
Relative P_{OO}, V_H, P_H to reference operation (RO)
f=50 Hz, rect. voltage pulse

max: maximum value of P_{OO} response shape
min: minimum value of P_{OO} response shape
max-min: amplitude calculation of P_{OO} resp. shape

Fixed V_H: same voltage for all frequencies.

Compensated V_H: for every frequency value, the voltage is adjusted to achieve the same maximum of P_{OO} response shape as for D=62%.

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[1] Effective D shorter than 30% and voltage or power compensation at high frequencies (e.g. 20% @ 50 Hz) might impact the lifetime and characteristic of the devices because of additional stress in material layers.

## ■ Typical electrical/thermal characteristics (RO, $T_A = 22°C$)

Parameter	Symbol	Rating	Unit
Peak chip membrane temperature	T_M	460/500	°C
Heater voltage	V_H	5.23/5.66	V
Heater power	P_H	394/446	mW

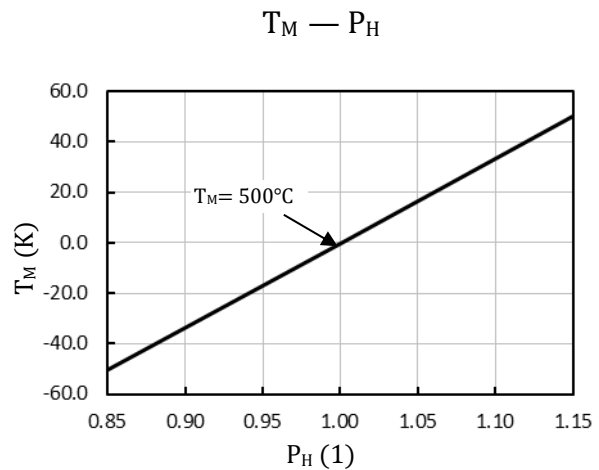U_{460} — R_{C22}
U_{500} - - R_{C22}
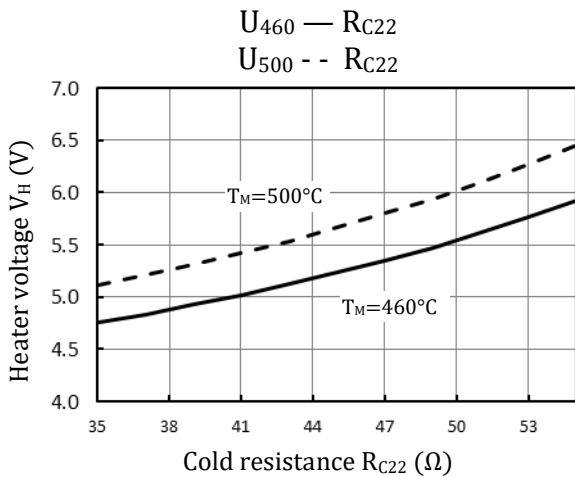
Mean[1] and upper bound of heater voltage V_H vs. cold resistance RC_{22}

T_M — V_H
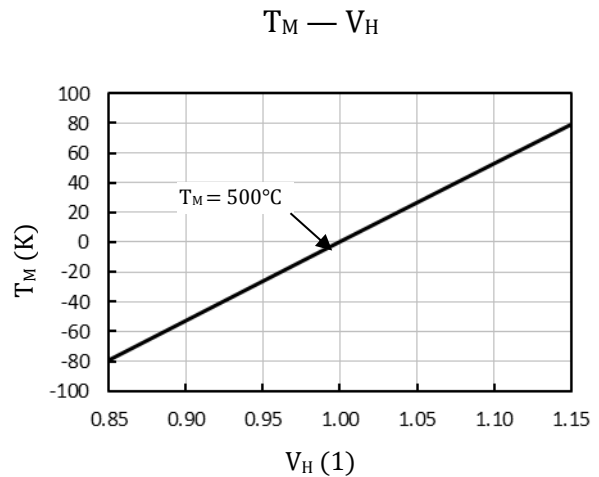
Relative change of membrane temperature (T_M) by changing heater voltage (V_H)

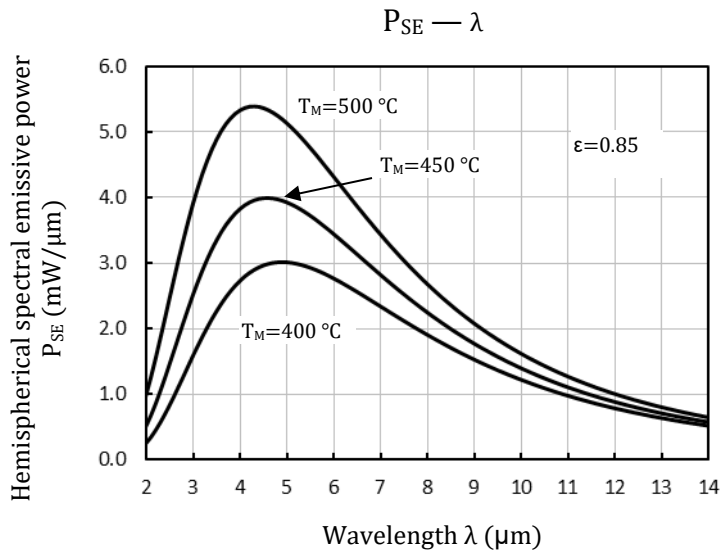P_{460} — R_{C22}
P_{500} - - R_{C22}
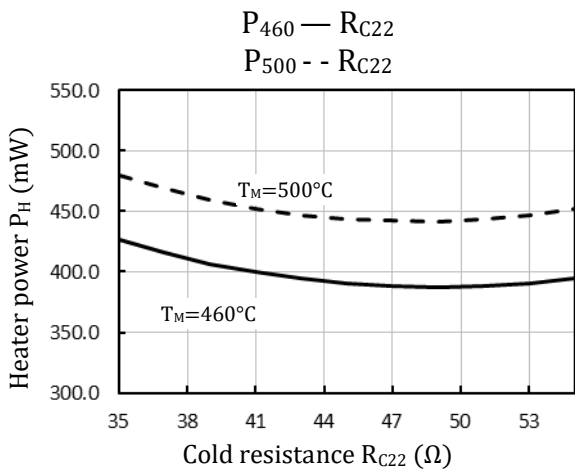
Mean[1] and upper bound of heater power P_H vs. cold resistance RC_{22}

T_M — P_H

Relative change membrane temperature (T_M) by changing heater power (P_H)

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[1] Recommended operation mode $T_M = 460°C$, which ensures 95% confidence that the maximum temperature $T_M = 500°C$ is not exceeded.
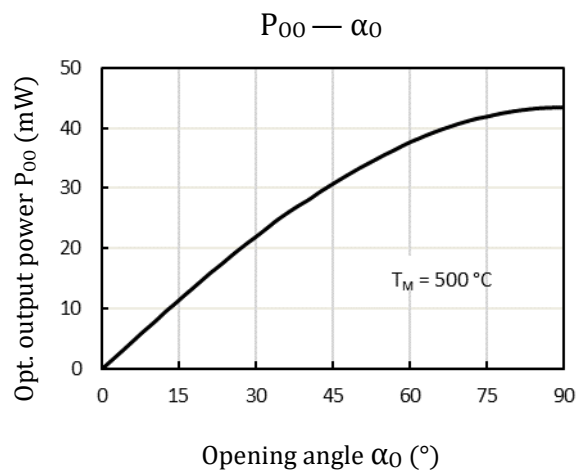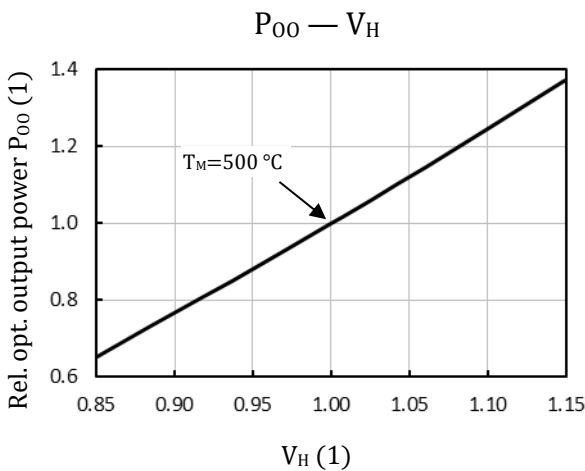
■ Typical Optical Characteristics (RO, $T_A = 22°C$)

$$P_{SE} — \lambda$$

Hemispherical spectral emissive power of EMIRS200 chip surface with a
typical emissivity (mean from 2 to 14 µm) of $\varepsilon=0.85$

$$P_{OO} — d$$
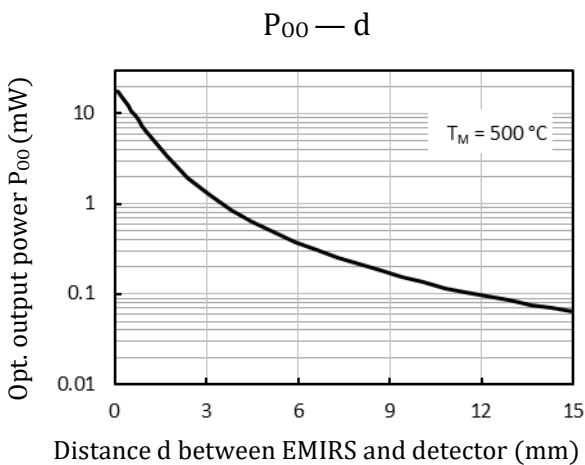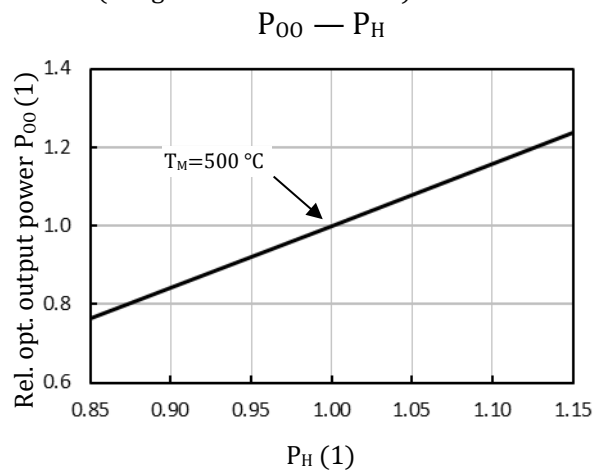

Optical output power (P_{OO}) versus distance d of a
1 mm² detection surface at 500°C T_M

$$P_{OO} — \alpha_O$$

Optical output power (P_{OO}) versus opening angle α_O
(integral rotation of a cone) at 500°C T_M

$$P_{OO} — V_H$$

Relative change of optical output power (P_{OO}) by
changing heater voltage (V_H)

$$P_{OO} — P_H$$

Relative change of optical output power (P_{OO}) by
changing heater power (P_H)