axetris®
Company of the Leister Group

MICRO-OPTICS INFRARED SOURCES MASS FLOW DEVICES LASER GAS DETECTION

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EMIRS50 AT06V

Thermal MEMS based infrared source

For direct electrical fast modulation

Base version, chip on TO46 header

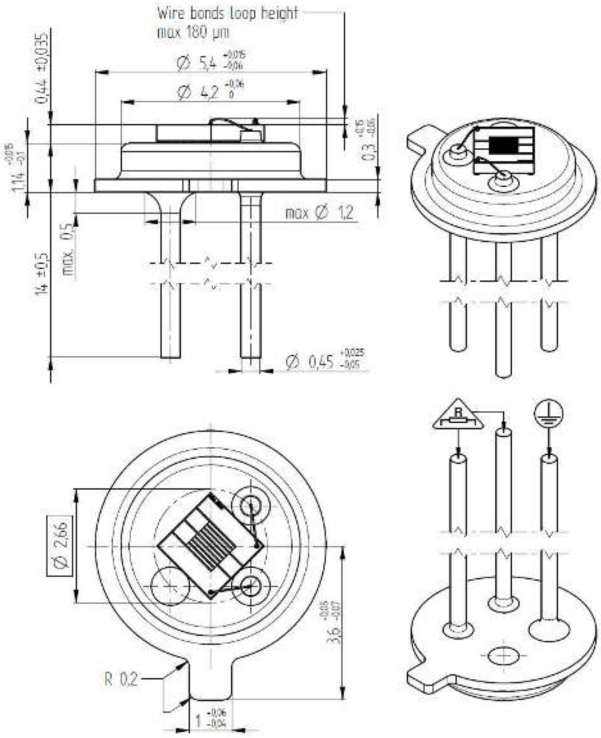
■ Infrared Source

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 patented 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

■ 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}	5.8	mW
Optical output power between 4 µm and 5 µm (T_M = 500°C)	P_{s4-5}	0.85	mW
Optical output power between 6 µm and 8 µm (T_M = 500°C)	P_{s6-8}	1.1	mW
Optical output power between 8 µm and 10 µm (T_M = 500°C)	P_{s8-10}	0.67	mW
Optical output power between 10 µm and 13 µm (T_M = 500°C)	P_{s10-13}	0.55	mW
Electrical cold resistance (at T_M = T_A = 22°C)	R_{C22}	22 to 36	Ω
Electrical operating (hot) resistance[2] (at T_M = 500°C with f = ≥ 10 Hz and t_{on} ≥ 3 ms)	R_{H500C}	1.555 * RC22 - 3.618	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	0.8 x 0.8	mm^2
Frequency[4]	f	10 to 100	Hz

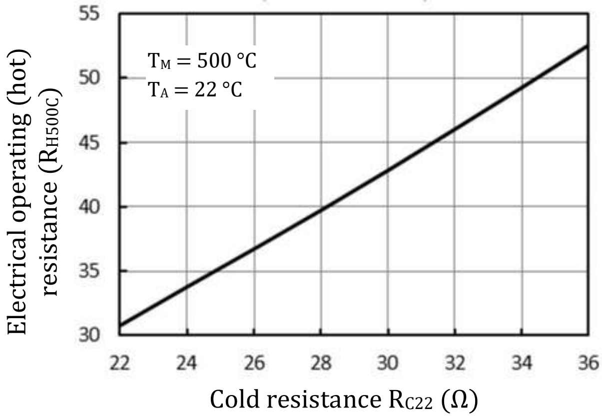
Note: Emission power in this table is defined by hemispherical radiation. Stress beyond those listed under "absolute maximum ratings" may cause permanent damage to the device.

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 ≥ 10 Hz
    b. on-time (pulse duration) ≥ 3 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

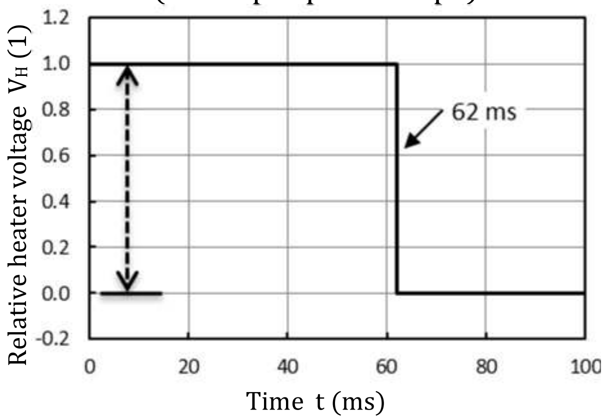
[1] Temperatures above 500°C will impact drift and lifetime of the devices.
[2] See Diagram R_H — R_C | (T_M = 500°C)
[3] The environmental and package temperature might impact the lifetime and characteristic of the devices.
[4] Lower cut-off frequency of 10 Hz for designed thermodynamic state. DC drive is also possible but recommended with "soft-off" switch.

■ 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}	10	Hz
On time constant of integral emissive power P_{OO}	τ_{on}	10	ms
Off time constant of integral emissive power P_{OO}	τ_{off}	5	ms
Package temperature at T_A = 22°C	T_P	40 to 50	°C

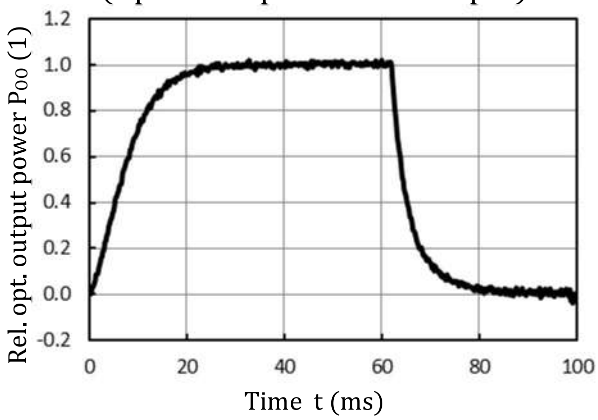
Note: First order on-time model using τ_{on}: First order off-time model using τ_{off}:

V_H — t
(RO[1] input pulse shape)



Relative rectangular heater voltage (V_H) pulse with a relative pulse width of 62 ms at 10 Hz
(time description of reference operation RO[1])

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

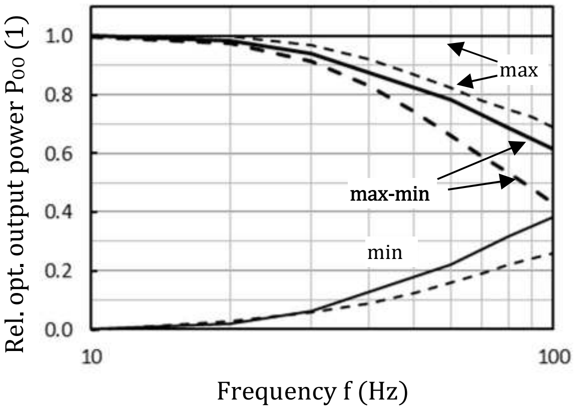


Optical response time (relative optical output power P_{OO}) of a rectangular voltage pulse
(RO[1] conditions)

[1] Reference Operation: combines lower cut-off frequency of 10 Hz and maximum modulation depth (max-min signal)
[2] Recommended frequencies from 10 Hz to 100 Hz

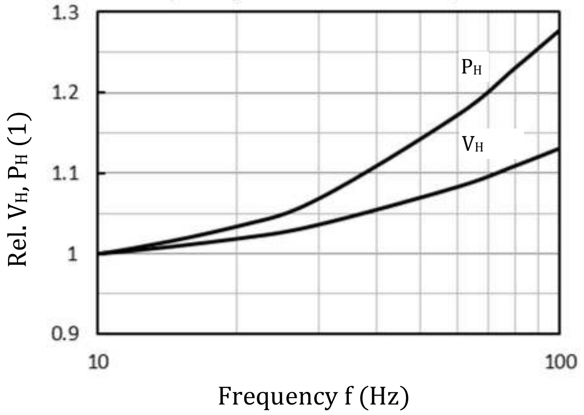
■ Typical Timing Characteristics Frequency (D = 62%)

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



Relative (to RO) max, min, max-min values of optical output power (P_{OO}) versus frequency f with fixed and compensated V_H

V_H, P_H — f
(compensation factor)



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=10 Hz, rect. pulse D=62%

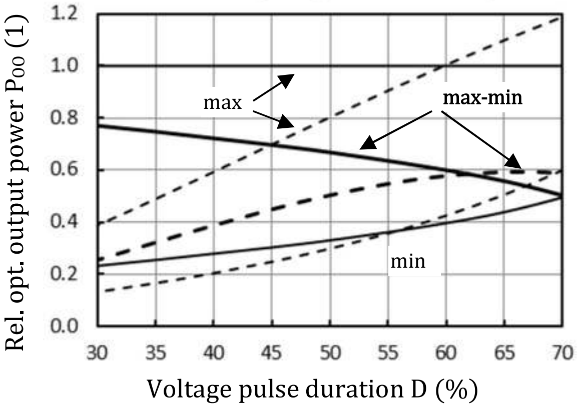
max: maximum value of P_{OO} response shape
min: minimum value of P_{OO} response shape
max-min: amplitude calculation of P_{OO} resp. shape

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 10 Hz.

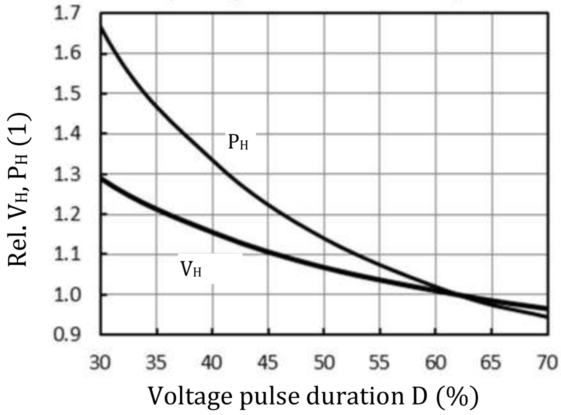
■ Typical Timing Characteristics Pulse Duration D[1] (f = 100 Hz)

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, 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=100 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.

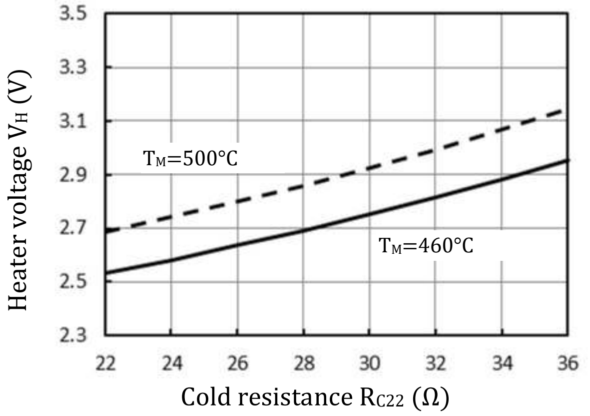
Compensated V_H: for every frequency value, the voltage is adjusted to achieve the same maximum of P_{OO} response shape as for D=62%.

[1] Effective D shorter than 30% and voltage or power compensation at high frequencies (e.g. 20% @ 100 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)

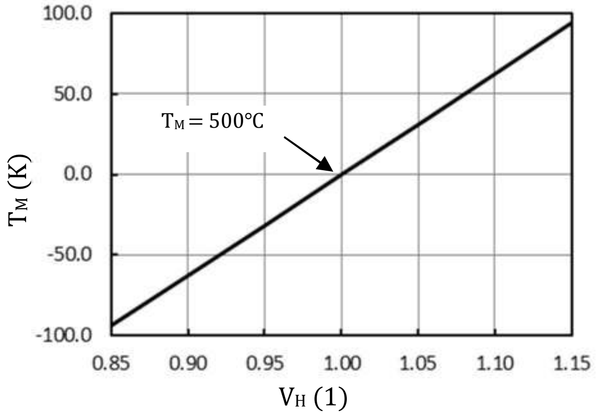
Parameter	Symbol	Rating	Unit
Peak chip membrane temperature	T_M	460	°C
Heater voltage	V_H	2.69	V
Heater power	P_H	187	mW

U_{460} — R_{C22}
U_{500} - - R_{C22}



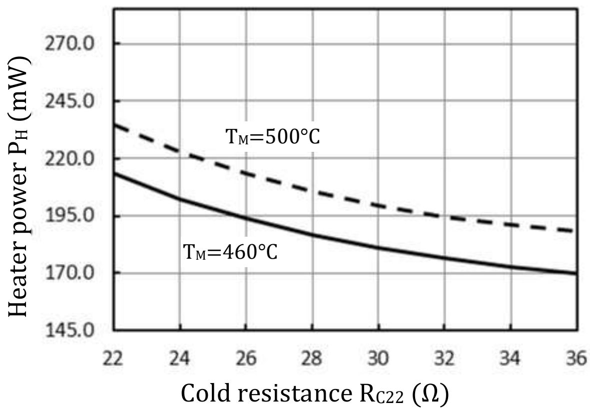
Mean[1] and upper bound of heater voltage V_H vs. cold resistance RC_{22}

T_M — V_H



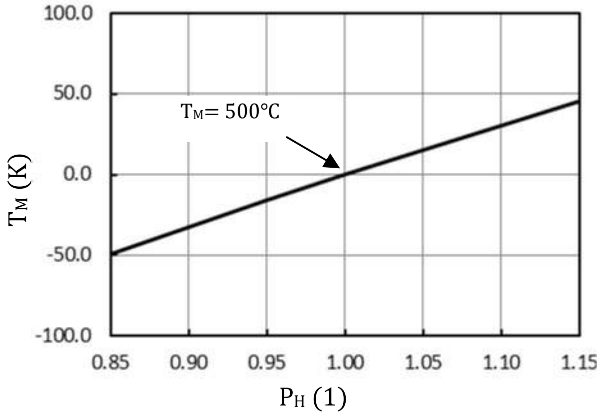
Relative change of membrane temperature (T_M) by changing heater voltage (V_H)

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

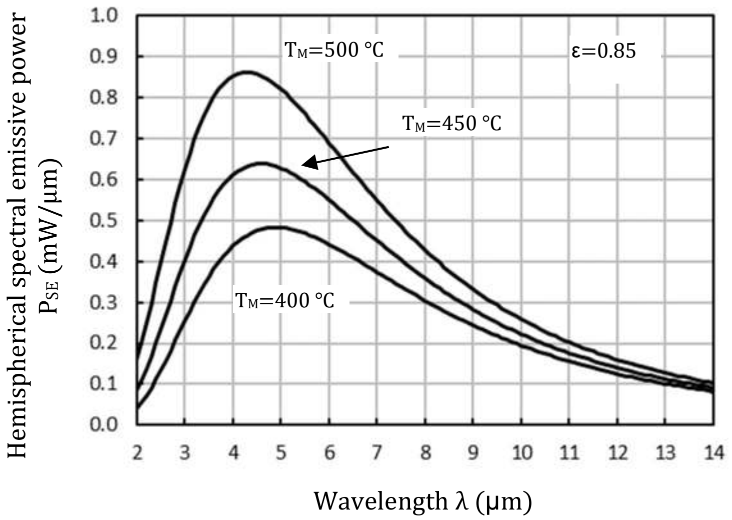


Relative change membrane temperature (T_M) by changing heater power (P_H)

[1] Recommended operation mode T_M =460°C, which ensures 95% confidence that the maximum temperature T_M = 500°C is not exceeded.

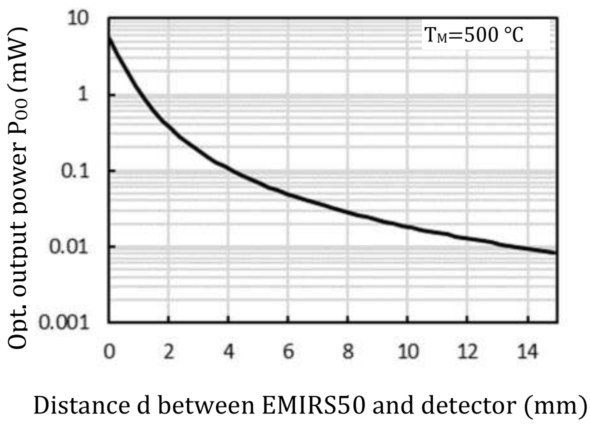
■ Typical Optical Characteristics (RO, T_A = 22°C)

P_{SE} — λ



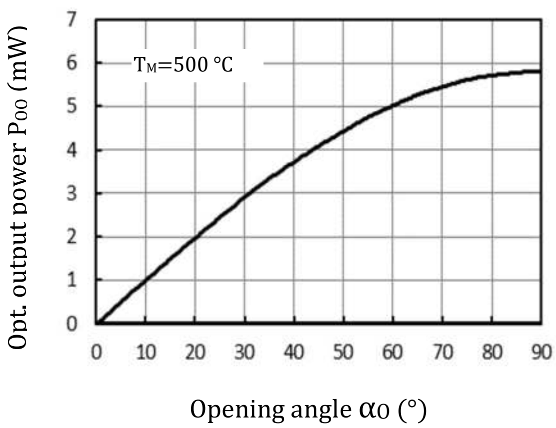
Hemispherical spectral emissive power of EMIRS50 chip surface with a typical emissivity (mean from 2 to 14 µm) of ε=0.85

P_{OO} — d



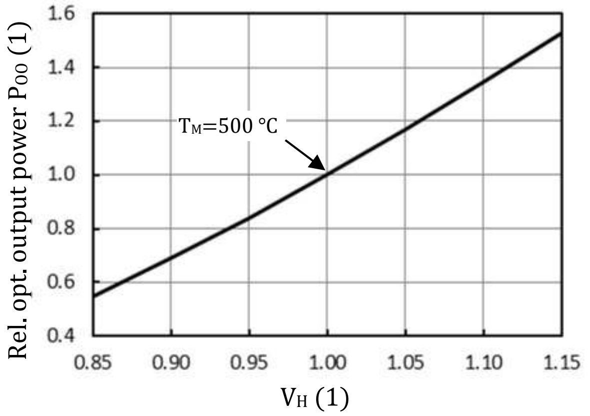
Optical output power (P_{OO}) versus distance d of a 1 mm² detection surface at 500°C T_M

P_{OO} — α_O



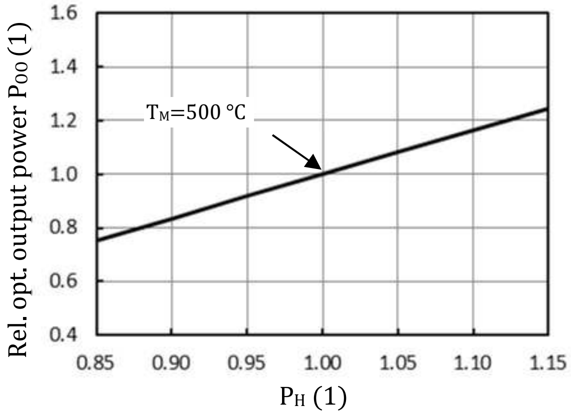
Optical output power (P_{OO}) versus opening angle α_O (integral rotation of a cone) at 500°C T_M

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)

■ Specified Ratings at Test Voltage V_T (on-time ≥ 20 ms, $T_H = T_A$ = 22°C)

Parameter	Symbol	Condition	Typical value	Unit
Test voltage (for $T_M \approx$ 500°C)	V_T	$T_H = T_A$ = 22°C	0.0295 * RC22 + 2.1271	V
Optical output power (after 20 ms on)	P_{OO}	after ≥ 20 ms V_T on time, $T_P = T_A$ = 22°C	0.35	mW

Note: Other optical output specifications are possible by customer specific requirements (e.g. spectral ranges).

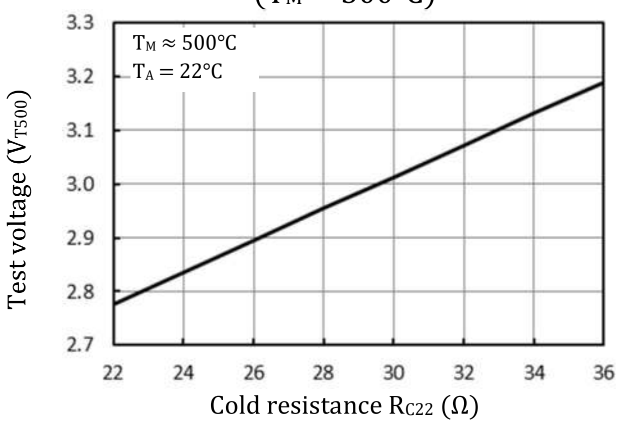
Note: Diagram V_{T500C} — R_{C22} | ($T_M \approx$ 500°C)

Defined test voltage V_T for specified ratings:

1. Determine electrical cold resistance R_{C22} of the EMIRS device at T_A=22°C
2. Drive the device with V_T for each R_C as shown in this diagram.
3. Ratings are only valid for $T_P = T_A$ = 22°C and after 20 ms on-time.

V_{T500} — R_{C22}

($T_M \approx$ 500°C)



Test voltage V_T versus electrical cold resistance R_{C22} at T_A = 22°C