

**a:etris**<sup>®</sup>  
Company of the Leister Group

# Infrared Sources

## for Gas Detection and Monitoring



## Infrared Source Product Range Overview

Axetris 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 integrated onto a thin dielectric membrane which is suspended on a micro-machined silicon structure.

The sources are packaged in compact TO-39 cans and are available with protective cap or with reflector. They can be fitted either with Sapphire, CaF<sub>2</sub> or BaF<sub>2</sub> or Germanium broadband filters.

Axetris IR sources are ideally suited for compact IR gas detection modules where a high emissivity, high reliability and low power consumption are key requirements.

### Benefits

- True blackbody radiation (2 to 16 μm)
- High emissivity
- Fast electrical modulation (no chopper wheel needed)
- High modulation depth
- High electrical input to optical output efficiency
- Low power consumption
- Long lifetime
- Rugged MEMS design (passed the requirements of IEC 60721-3-7 Class 7M3, except for BaF<sub>2</sub> and CaF<sub>2</sub> broadband filters)


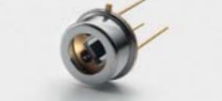





### Infrared Gas Detection Applications

- **Measurement principles:** non-dispersive infrared spectroscopy (NDIR), photoacoustic infrared spectroscopy (PAS) or attenuated-total-reflectance FTIR spectroscopy (ATR)
- **Target gases:** CO, CO<sub>2</sub>, VOC, NO<sub>x</sub>, NH<sub>3</sub>, SO<sub>x</sub>, SF<sub>6</sub>, hydrocarbons, humidity, anesthetic agents, refrigerants, breath alcohols
- **Medical:** Capnography, anesthesia gas monitoring, respiration monitoring, pulmonary function monitoring, breath alcohol measurement
- **Automotive / Transportation:** Exhaust gas monitoring, breath alcohol testing (Interlock/Alcolock), demand controlled ventilation
- **HVAC:** Demand controlled ventilation, refrigerant monitoring
- **Safety & Industry:** Combustion gas analyzers, gas detection in fluids, incubators



Every single IR source undergoes a final burn-in and test.

## IR Source Product Range

Type	Focal length / Power in < 20° angle	Broadband filter	Cap / Reflector	Measurement principles/ Typical application	Product photo
TO-39 Chip on Header	no collimation / 12 %	no	no	NDIR, PAS / custom specific absorption cells	
TO-39 Standard TO-Cap	no collimation / 12 %	no	CAP 0-53/40-0	NDIR, PAS / STD absorption cells	
TO-39 Low Profile TO-Cap	no collimation / 12.3 %	no	CAP 0-45/28-0	NDIR, PAS / STD absorption cells	
TO-39 Alu-Pkg	no collimation / 15.7 %	yes	CAP W-36/12-0	NDIR, PAS / STD absorption cells	
TO-39 Standard Reflector 1	5 – 15 mm / 60 %	yes	REF W-55/40-0	NDIR, ATR / STD absorption cells	
TO-39 Standard Reflector 2	0 – 7 mm / 54 %	no	REF W-40/43-0	NDIR, ATR / short absorption cells	
TO-39 Standard Reflector 3	10 – 30 mm / 82 %	yes	REF W-90/151-0	NDIR / long absorption cells Ø 10 mm	
Customized Products	custom	custom	custom	NDIR, PAS, ATR / custom specific absorption cells	see page 6

The IR source is available with a range of broadband filters shown on page 6.  
Please contact your sales responsible for more information.

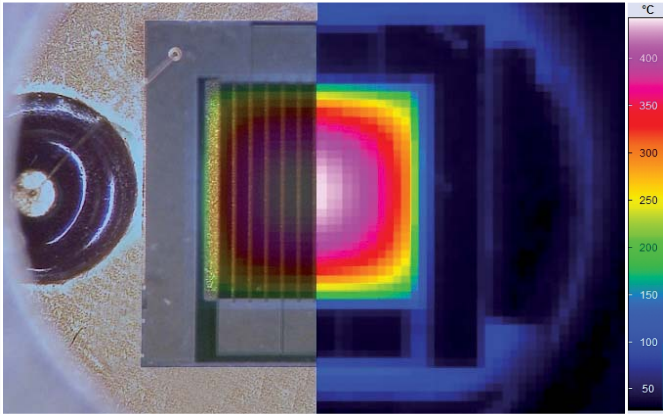
## Electrical / Optical characteristics (Tc = 25°C)

Parameter	Unit	Value	Conditions / Remarks
Cold Resistance	Ω	35 – 55	average cold resistance 45 Ω
Hot Resistance	Ω	54 – 89	at 450 mW / average hot resistance 72 Ω
Electrical input power	mW	450	on-time state
Operating voltage	V	5.7 5.2 6.5	for IRS with R <sub>cold</sub> =45 Ω / to achieve 450 mW for IRS with R <sub>cold</sub> =35 Ω / to achieve 450 mW for IRS with R <sub>cold</sub> =55 Ω / to achieve 450 mW
Operating current	mA	79 86 68	for IRS with R <sub>cold</sub> =45 Ω / to achieve 450 mW for IRS with R <sub>cold</sub> =35 Ω / to achieve 450 mW for IRS with R <sub>cold</sub> =55 Ω / to achieve 450 mW
Heating time constant	ms	11	measurement of the resistance rise time 10 % to 90 %
Cooling time constant	ms	17	measurement of the resistance cooling time 90 % to 10 %
Working temperature	°C	456	at 450 mW
Emissivity		0.95	2 μm to 16 μm
Lifetime	years	> 10	for recommended power of 450 mW
Heating area	mm <sup>2</sup>	2.1 x 1.8	
Case Temperature	°C	55 85	50 % duty cycle, 10 Hz, 450 mW, w/o filter DC, 450 mW, w/o broadband filter

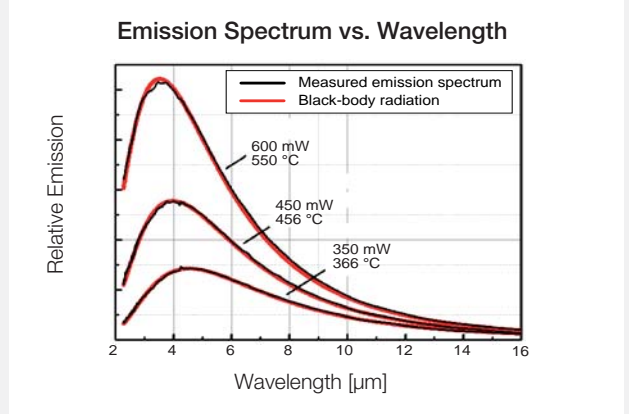
The electrical power limitation for DC and pulsed mode is 500mW. The on-time state defines the power limitation not the average power.  
The real values can slightly deflect from the shown numbers.

### Benefits

True black body radiation (wavelength from 2  $\mu\text{m}$  to 16  $\mu\text{m}$ )

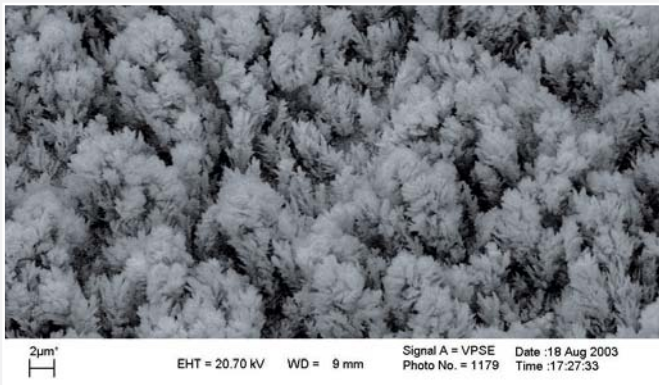


Microscopic image of the MEMS chip packaged on a TO39 header (left). Temperature distribution of the heated membrane (right side)

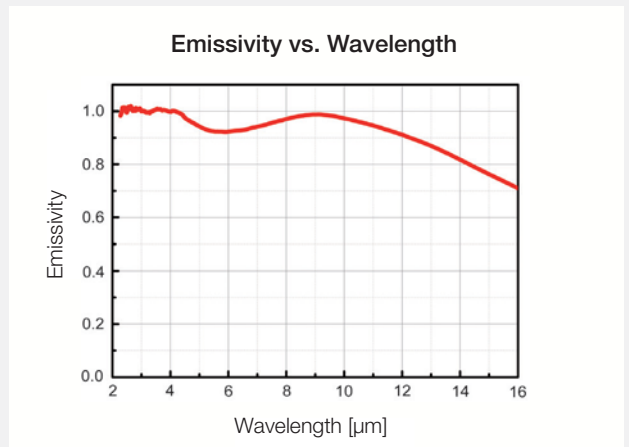


### High emissivity

A unique thin film process creates a pure blackbody structure with emissivity close to 1

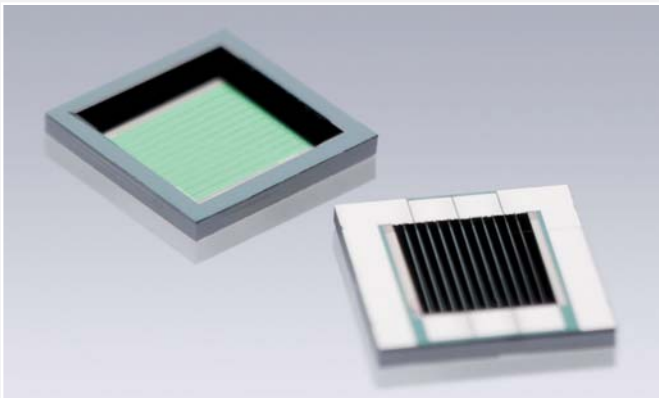


Black dendritic surface structure

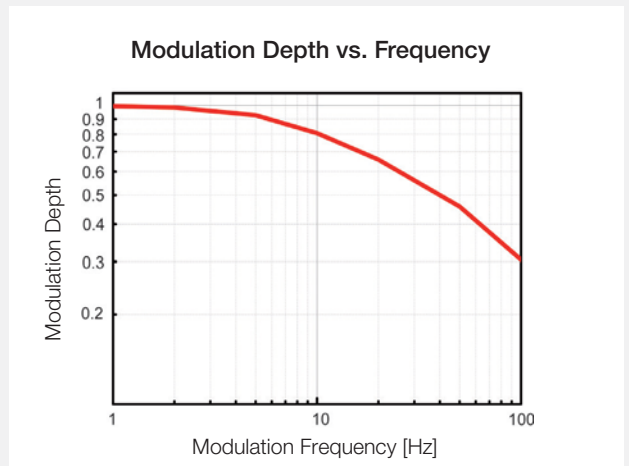


### Fast electrical modulation and high modulation depth

The thin and low mass membrane, only achievable by MEMS technology, makes the IR source fast and dynamic.



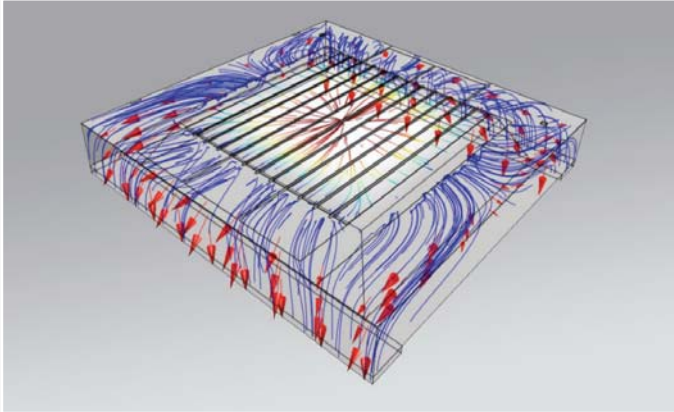
Front and backside of the IR Source MEMS chip. (overall size: 3.2 x 3.2 mm<sup>2</sup>, membrane size: 2.1 x 1.8 mm<sup>2</sup>)



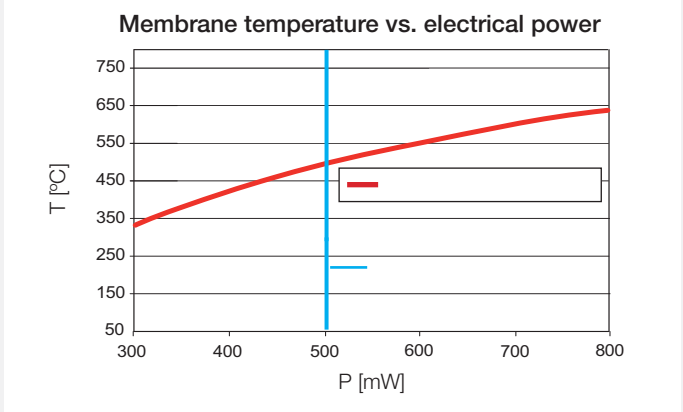
Driven with constant voltage square-wave drive and measured with high speed broadband detector

### High electrical input power to optical output efficiency

The IR source has excellent electrical to optical conversion efficiency. Reasons are on one hand the black surface which guarantees maximized emissivity and on the other hand optimized heat flux.

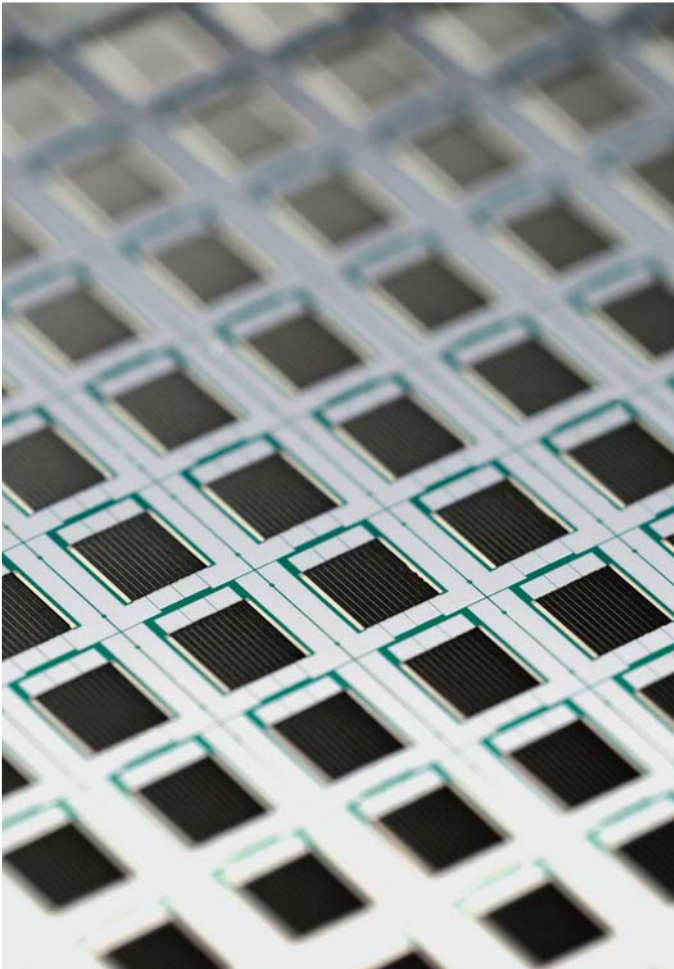


Efficiency optimization by heat flux simulation

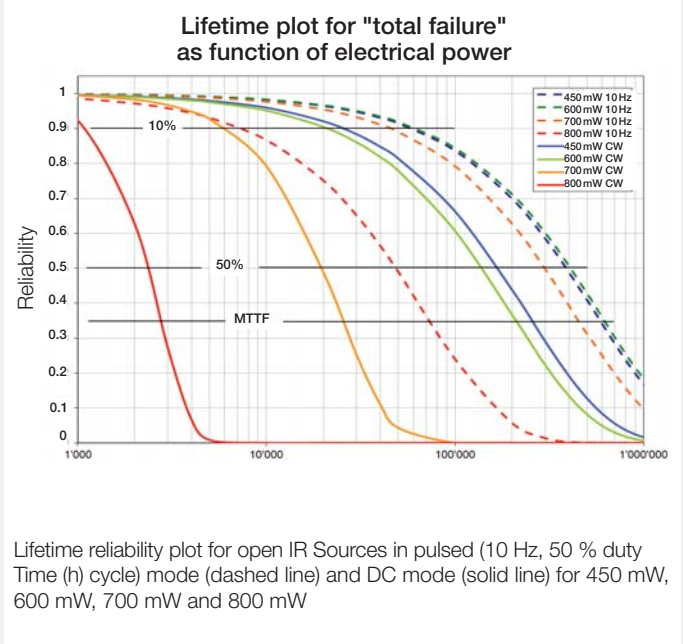


### Reliability of the MEMS structure

The semiconductor MEMS manufacturing technology guarantees highly reliable quality of the IR sources. Adding to the elaborate quality control system during wafer level manufacturing every single IR source is subject to a final burn-in test.



Processed wafer of IRS MEMS based chips before dicing



Lifetime reliability plot for open IR Sources in pulsed (10 Hz, 50 % duty Time (h) cycle) mode (dashed line) and DC mode (solid line) for 450 mW, 600 mW, 700 mW and 800 mW

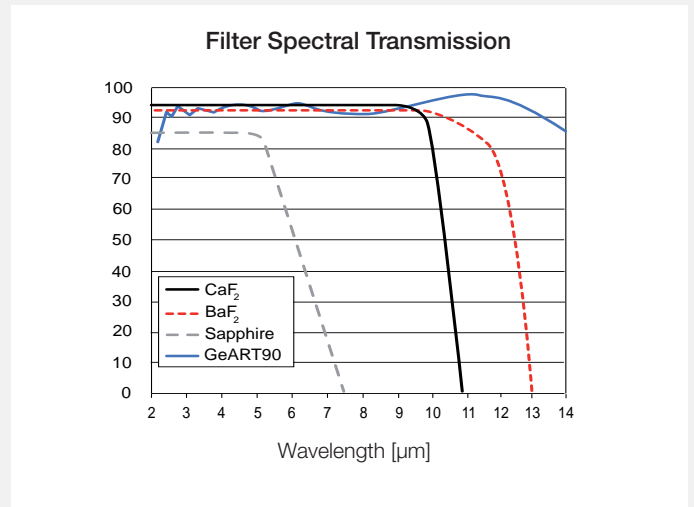
The Mean Time To Failure (MTTF) for membrane breakage of the IR source is based on a statistical analysis of lifetime data collected from several years of reliability testing. Reliability of the membrane breakage depends strongly **on the type of packaging**, the electrical input power and the operating mode.

For example running an IR source (Article no.: 600.347) at 450 mW pulse (10 Hz, 50 % duty cycle) results in a MTTF for membrane breakage of 600 000 operating hours.

- Spectral low pass filter complements detector filter
- Eliminates background signal and improves S/N ratio
- Protection of the IR source in harsh environments
- No parasitic influence of the sample gas (for tightly sealed broadband filter installation)



IR source with broadband filter



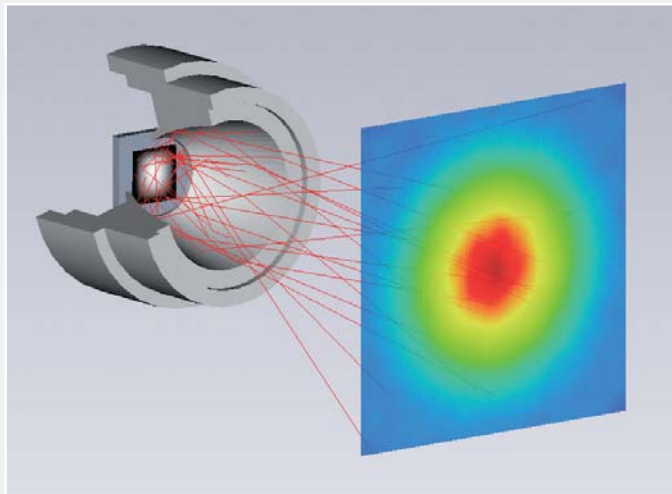
Transmission curves for the different filter types \* Germanium anti-reflective coated with an average transmission above 90 %

### Application Specific Design Options

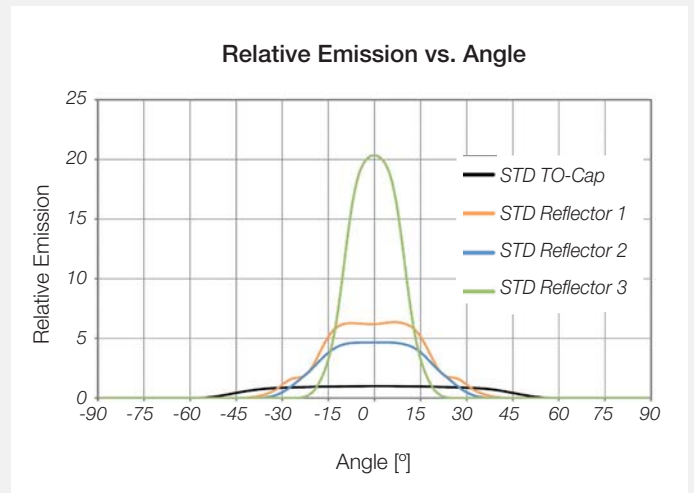
Axetris offers custom IR sources having custom packaging, reflector designs and filter types for OEM customers to meet their specific product needs. The reflector for example optimizes the angular distribution of radiation and therefore the optical signal. A Sapphire, CaF<sub>2</sub>, BaF<sub>2</sub> or Germanium broadband filter improves the signal to noise ratio, protects the IR source from environmental effects and acts as a spectral lowpass filter.

#### Custom Reflector

- Optimization of the emission



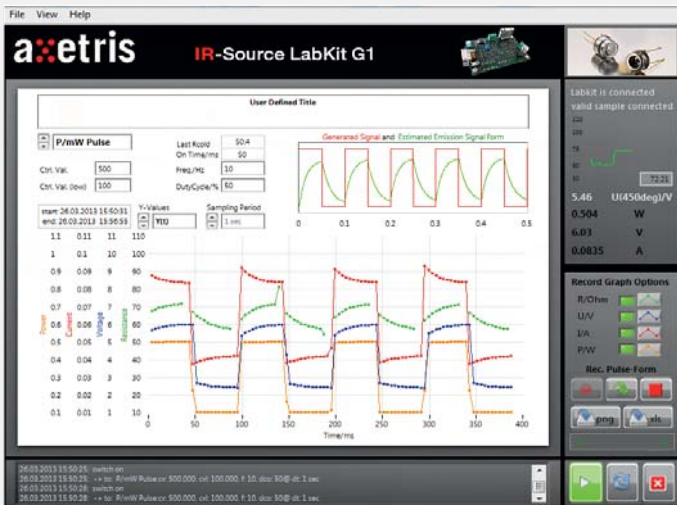
Reflector collimates IR radiation on axis. (red: high emission density per area; blue: low emission density per area)



Angular radiation distribution with standard cap and reflectors

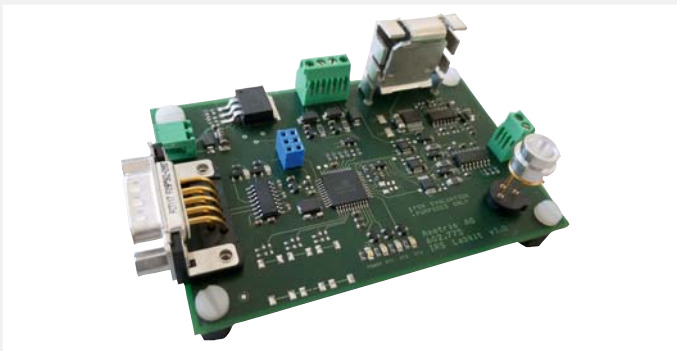
## IRS LabKit

- Faster and easier design-In of Axetris IR-Source
- Very efficient tool evaluating ideal drive mode for the best signal/noise ratio
- Quick and easy start-up and measurement within minutes
- Includes everything you need



Graphical User Interface GUI

- Simple Graphical User Interface (GUI) based on LabVIEW software
- Set and update all drive parameters live from GUI
- Live diagram plots for data display and record
- Visualized drive mode limitations (recommendations)
- Export of bitmap and Excel data



IRS LabKit driver board

- Direct connection to a PC with RS232 protocol and USB
- TO socket and connector for external IR source connection
- I/O analog interface for detector synchronization and signal evaluation

Parameter	Unit	Value	Conditions / Remarks
Drive Moded		P / V / I	DC / Wave signal
Power control P	mW	50 – 800	Power regulated
Voltage control V	V	0.5 – 10	Voltage regulated
Current control I	mA	5 – 100	Current regulated
Wave form signal		DC / SQ Wave Signal	
Frequency	Hz	0 (DC), 4 – 50	
Duty cycle	%	5 – 90	
Analog I/O	V	0 – 5	Synchronisation of detector circuit, detector signal recording



Corporate Headquarters of the Leister Group, Switzerland

## About Axetris AG

Axetris AG, a company of the Leister group, is serving OEM customers with micro technology based (MEMS) infrared light sources, laser gas sensors, mass flow sensors and controllers and micro-optical components used in industrial, process control, environmental, medical automotive and telecom applications.

Axetris supports its customers in many industries with in-depth application know-how. Our engineering and manufacturing teams combine broad experience in simulation, design, manufacturing and metrology from microchip level to advanced electronic and electro-optic

modules. Customers benefit from excellent product value, consistent high product quality and outstanding customer support. OEMs rely on Axetris as a competent and sub-system partner for a wide range of high-quality off-the shelf products as well as customer specific solutions from concept to volume production.

Axetris is ISO 9001 certified and ISO TS 16949 compliant and operates its own 6" to 8" wafer MEMS foundry in Central Switzerland for its own products and external customers.

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