neoplas control

solutions for your operations in gases and plasmas

High-Precision Gas and Plasma Analysis in Real-Time

Product catalog

neoplas control

solutions for your operations in gases and plasmas

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Contents

High Precision Plasma and Gas Analysis – In-line, On-line in real-time

Why spectroscopy in the mid infrared region?

Environmental and safety requirements are becoming stricter. The demands on quality and efficiency of industrial production are rising not only for economical reasons in many industries. Scientific research is going into new dimensions of measurable parameters. Optical spectrometers can help to meet new regulatory demands, optimize processes and support basic research, where a high degree of reliability, security and readiness is required as well as high accuracy and reproducebility.

neoplas control uses the property of molecules to absorb electromagnetic radiation at certain wavelengths. The laser light is sent through the medium to be analyzed, which is not disturbed. By detecting the strength and position of absorptions the type and concentration of the present substances can be determined very fast (up to ns scale) and with very high precision (down to ppt level). We utilize quantum cascade lasers (QCL) as favourable radiation sources in the mid-infrared spectral range (3-20 µm), since they operate at room temperature and allow the design of compact and robust instruments for industrial applications. The mid-infrared spectral range is of great advantage, since many molecules have much stronger absorption here. Furthermore, several chemical species absorb exclusively in this range. Our core competence lies in the optical and electronic design combined with broad experience in application of QCL-based spectroscopy in complex research environments or industrial production.

Company

neoplas control GmbH is a competence center for gas and plasma diagnostics and environmental analysis. It was founded in 2006 as a spin-off company of the INP Greifswald (Leibniz Institute for Plasma Science and Technology e. V.). As the first company worldwide, we provide QCL systems in particular for plasma diagnostics. By working in close collaboration with the INP, neoplas control holds access to a network that features promising and future-oriented technologies from world-wide leading experts. Our mission is to provide pioneering work for your operations in gases and plasmas.

For our customers we provide sophisticated solutions and services, ranging from problem definitions, over prototype development to specific individual applications. Based on our long experience and internationally proved expertise, we are the very forefront of infrared spectroscopy, plasma diagnostics and able to meet specific process requirements and individual requests.

Our customers are our benchmark. In times of growing global competition, it is not only our ambition to be faster and more proficient but also to offer more sophisticated and innovative products. This does spur us on working even harder on new developments but it also leads us to achieve ongoing advancements in terms of technical improvements in our current product portfolio. As a result, we take a pioneering role by implementing innovative methods for developing high-tech products.

Concept

Until recently, the on-line control of plasma processes was not really feasible. The idea to design Q-MACS is based on the recent development and commercial availability of a new laser class, the Quantum Cascade Laser. This new option has made it possible to bring a system to the market that is compact and user friendly for measurement and control of industrial processes in particular for on-line process monitoring. The Q-MACS products need almost no maintenance and can be individually adapted to customer requirements inside industrial processes due to its modular design. The systems can be configurated according to both in-situ and extractive measurement, depending on target gases and measurement range.

Benefits

- Extreme high selectivity
- Very high detection sensitivity up to parts per trillion
- Response time down to nanoseconds with up to a million measurements in a second
- no consumables
- Easy and operation handling at room temperature
- Extractive or in-situ measurements without interference with measured medium
- Self-calibrating devices with low maintenance level
- Simultaneous detection of up to eight gases
- Compact, modular, expandable and user-friendly

Applications

- Scientific research utilizing absorption spectrometry in the mid infrared (3 - 20 µm),
  e. g. atmospheric chemistry, trace gas or radical analyses or plasma physics (e. g. radicals)
- Exhaust and emissions monitoring (chemical or power plants, engines, incinerators etc.)
- On-line process control of surface treatments and coatings
  (e.g. semiconductor, automotive, photovoltaics, glass industry)
- On-line control of sintering processes (e. g. end point detection) gas purity and concentration control
  (e. g. medical gases, petrochemistry, metallurgical production)
- Clean rooms and hazardous environments: leak detection and monitoring of toxic industrial chemicals
- In-situ leak testing
- Improvement of utilisation rates in ALD-processes
- Screening of objects and infrastructures for toxic agents, explosives, or narcotics

Process Monitoring & Control

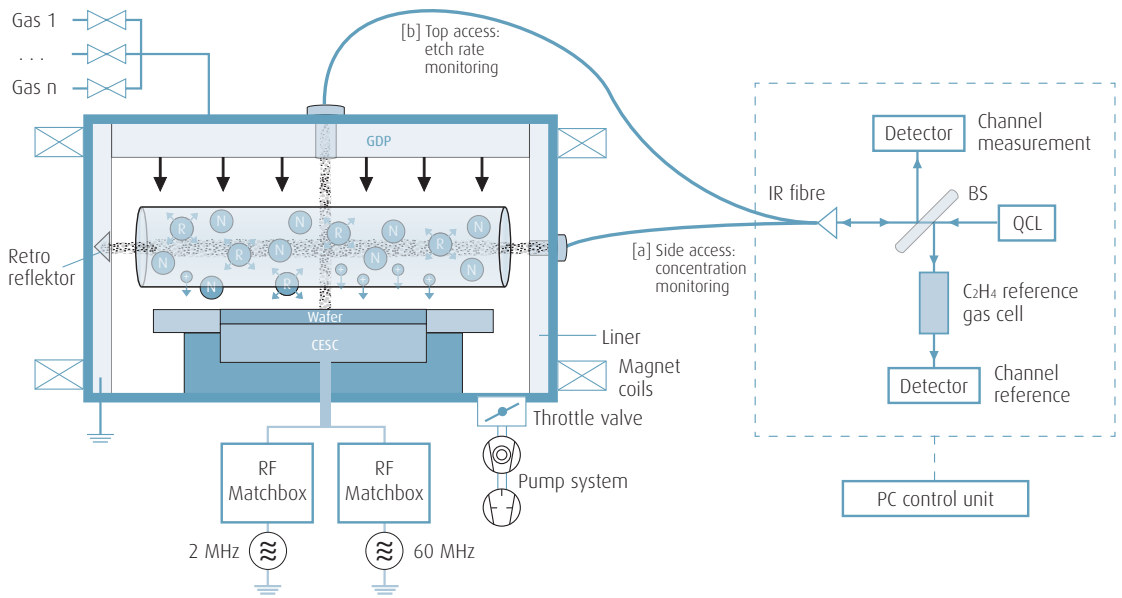
The systems of the Q-MACS Process family are designed for in situ monitoring and to control industrial processes. Directly adapted to your production system Q-MACS will enable you to ensure an effective process control. Being dependent on the exact concentrations of different chemical species in plasma or gaseous states up to the range of parts per billion, Q-MACS has been developed to meet these highest precision standards. Furthermore, an in situ process control by a Q-MAC system makes it possible to observe production processes on the one hand and allows you an active control for quality purposes on the other hand.

Features

- observation and active control of industrial processes
- quality control during the production instead of downstream acceptance sampling
- in-situ and on-line monitoring with high sensitivity in real-time
- coupling of laser light into measuring site via open path optics or mid infrared fibre
- significant improvements in process stability and reproducibility
- efficiency improvements combined with cost reduction

Applications

- process monitoring and controlling in surface treatment
- chamber matching in photovoltaic and semiconductor industry
- monitoring of the etch progress via online depth control measurements
- controlling of gas injection and mixture in chemical and metallurgical production
- in-situ leak test



Q-MACS Process fibre concept drawing

technical specification

The Q-MACS Process is a portable monitoring system for on line measurements of industrial processes. It is based on the Q-MACS Basic and features a three channel setup to improve the signal-to-noise ratio and to achieve long-term stability. This open path system uses infrared absorption spectroscopy to measure absolute molecular concentrations. The optical coupling to the measurement's region can also be provided by an optical fibre.

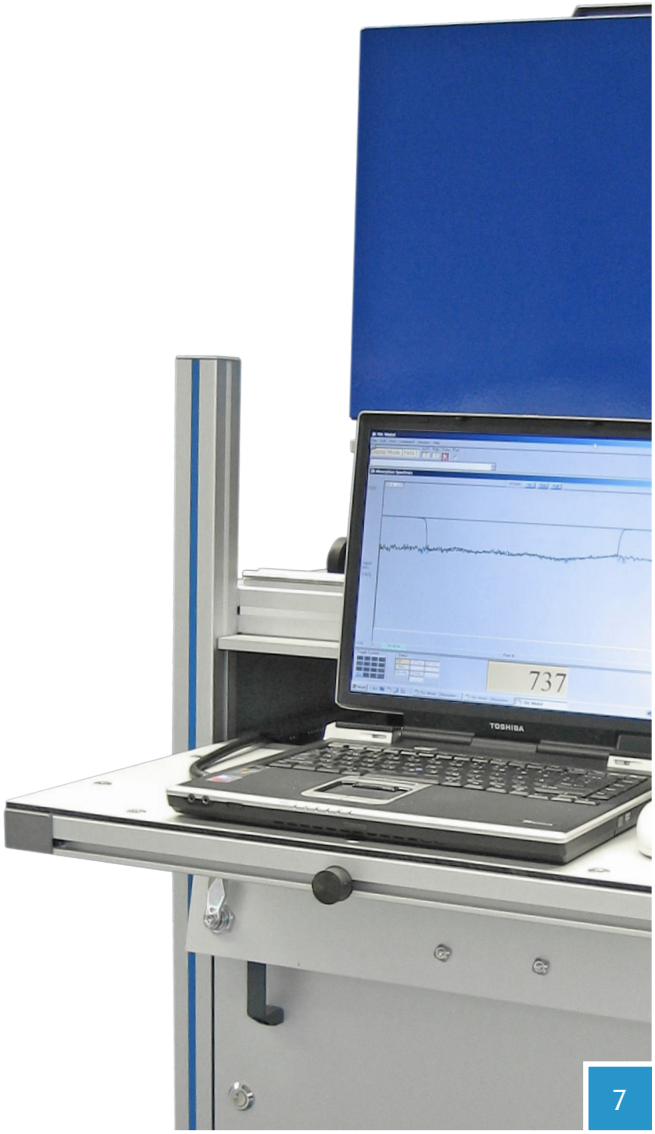
general	
description	three path infrared spectrometer with IR-light source
sensitivity	down to ppb range [1]
time resolution	down to milliseconds
size	710 mm x 1375 mm x 440 mm
weight	137 kg

components	
parts	▪ optical board ▪ light guide cable coupling (on request) ▪ industrial PC with acquisition hardware ▪ electronic supply system ▪ water cooling system

parameter	
power	▪ 230 V, max. 2 A (switch-on current 6 A) ▪ 115 V, max. 4 A (switch-on current 12 A)
working range	+5 °C to +40°C

QCL	
tuning method	▪ inter pulse mode (laser sweep mode) ▪ intra pulse mode (single pulse mode)
pulse width	8 ns* ... 256 ns** * depends on the QCL and QCL-voltage used ** longer pulses on request
pulse frequency	up to 1 MHz
QCL temperature range	-35 °C to +40 °C
QCL	tested and installed

[1] depends on species, temperature and pressure



Q-MACS Process DC

technical specification

The Q-MACS Process DC is a portable monitoring system for on-line measurements of industrial processes, where the measurement equipment's installation in the process room is not possible. This open path system uses mid-infrared absorption spectroscopic methods to determine absolute molecular concentrations. It is based on the Q-MACS Basic and features a dual channel setup, which allows the simultaneous measurement of multiple species. The long-term stability for broad absorption features was improved by adapting normalization concepts.

general	
description	dual path infrared spectrometer with two IR-light sources
sensitivity	down to ppb range [1]
response time	down to milliseconds
time resolution	down to milliseconds, sub-microsecond time resolution on request
size	554 mm x 1229 mm x 600 mm
weight	160 kg

components	
parts	▪ optical board ▪ industrial PC with acquisition hardware ▪ electronic supply system ▪ water cooling system

parameter	
power	▪ 230 V, max. 2 A (switch-on current 6 A) ▪ 115 V, max. 4 A (switch-on current 12 A)
working range	+5 °C to +40°C

QCL	
tuning method	▪ inter pulse mode (laser sweep mode) ▪ intra pulse mode (single pulse mode)
pulse width	8 ns* ... 256 ns** * depends on the QCL and QCL-voltage used ** longer pulses on request
pulse frequency	up to 1 MHz
QCL temperature range	-35 °C to +40 °C
QCL	tested and installed

[1] depends on species, temperature and pressure

Q-MACS Process fibre

technical specification

The Q-MACS Process fibre is a portable monitoring system for on-line measurements of industrial processes. It is bases on the Q-MACS Basic and features a two channel setup to achieve long-term stability and can be directly coupled to the measuring path via an IR-fibre. The system uses infrared absorption spectroscopy to measure absolute molecular concentrations.

general	
description	two path infrared spectrometer with IR-light source, IR-fibre coupling
sensitivity	down to ppb range [1]
response time	down to milliseconds
time resolution	down to milliseconds, sub-microsecond time resolution on request
size	554 mm x 962 mm x 600 mm
weight	125 kg

components	
parts	▪ optical board ▪ light guide cable coupling ▪ industrial PC with acquisition hardware ▪ electronic supply system ▪ water cooling system

parameter	
power	▪ 230 V, max. 2 A (switch-on current 6 A) ▪ 115 V, max. 4 A (switch-on current 12 A)
working range	+5 °C to +40°C

QCL	
tuning method	▪ inter pulse mode (laser sweep mode) ▪ intra pulse mode (single pulse mode)
pulse width	8 ns* ... 256 ns** * depends on the QCL and QCL-voltage used ** longer pulses on request
pulse frequency	up to 1 MHz
QCL temperature range	-35 °C to +40 °C
QCL	tested and installed

[1] depends on species, temperature and pressure

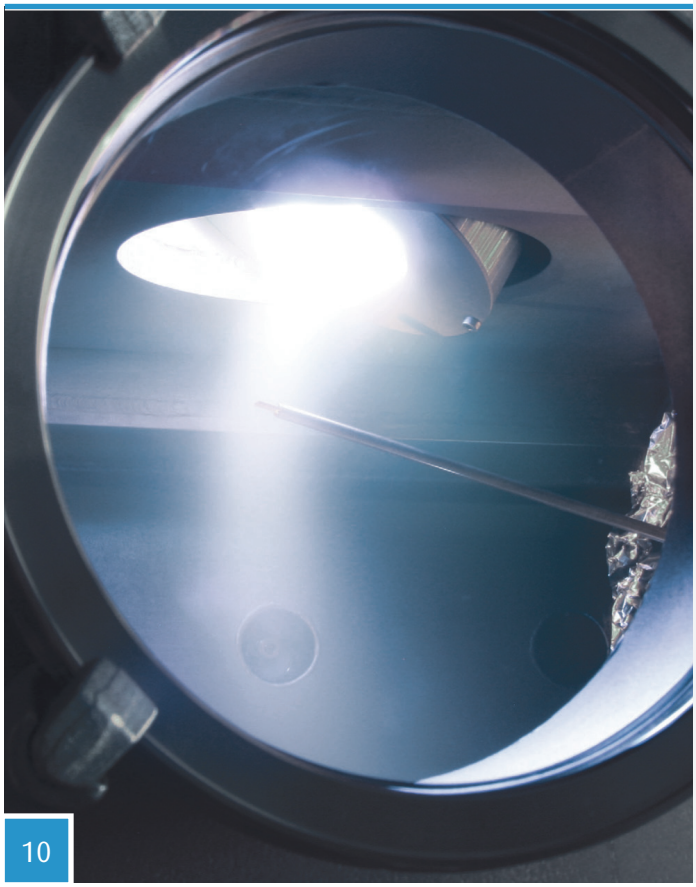
Active Thermal Probe

technical specification

The characterization, control and monitoring of plasma processes is crucial for the production of high quality coatings and material properties. A parameter of paramount importance is the actual and total energy influx to the substrate – the active thermal probe is the single tool to measure this decisive quantity.

Incoming particles influence surface processes and reactions at the substrate. This energy along with other components like thermal radiation or chemical energy comprises the total energy influx. The active thermal probe measures continuously and directionally this influx and correlates well with layer and surface properties.

Due to the probe's very high sensitivity it is especially suitable for costeffective quality control in industrial processes or for research purposes. A special version with a bigger selection of adjustable parameters is available to address R&D of plasma processes.



general
suitable for vacuum
temperature resistant up to 450°C
energy influx up to (2 ± 0,001) W/cm2 measurable
variable length and geometry
includes software package for system control and evaluation
installation service and consulting on process optimization is possible

Trace Gas Analyses and Emmissions Monitoring

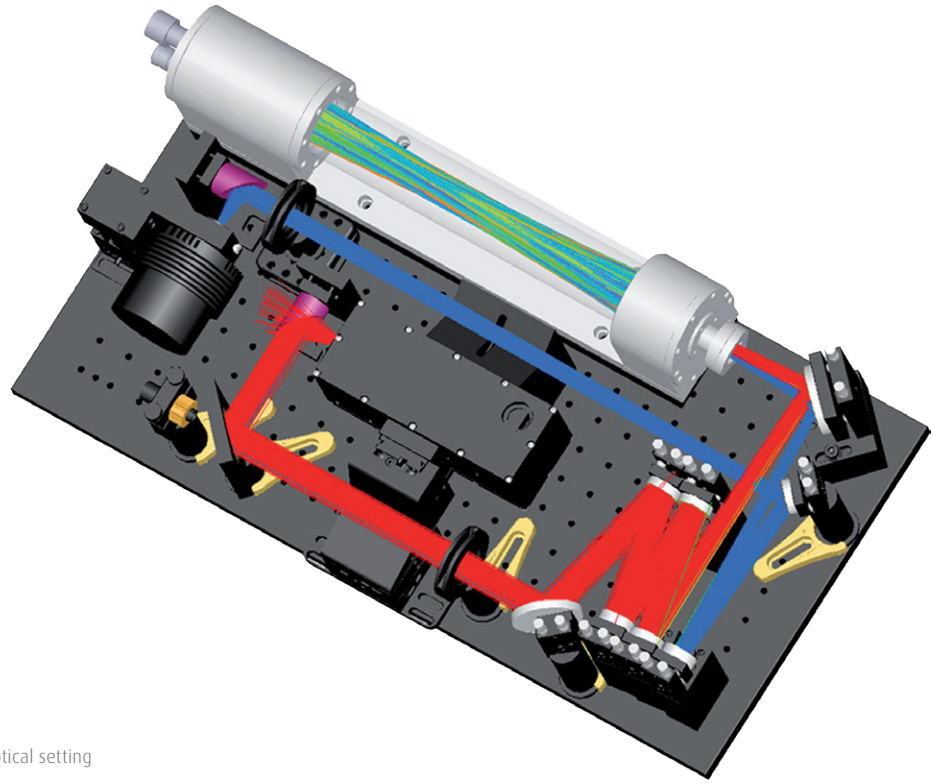
Q-MACS Trace systems allow a highly selective and sensitive gas analysis up to concentration rates of parts per trillion (ppt). They are in an adaptable steady or portable state and have been developed for trace gas measurements in scientific research, to monitor environmental or security regulations and to meet industrial demands for fast, reliable determination of gaseous species. A long path cell further increases the measuring accuracy.

Features

- trace gas measurement by using a long path cell
- adaptable stationary or mobile system
- detection and identification of molecules in concentrations up to ppt

Applications

- scientific research (analytical chemistry, atmospheric chemistry, plasma physics, vacuum science)
- environmental studies
- emissions and immission monitoring (engines, clean rooms etc.)
- detection of explosives and toxic industrial chemicals
- breath gas analysis in medical diagnostics
- determination of gas purity (gas manufacturing, hospitals etc.)



Q-MACS Trace optical setting

Q-MACS Trace

technical specification

The Q-MACS Trace is a portable system for high sensitive trace gas measurements using different optical long path cells which depend on the sensitivity required. It is based on the Q-MACS Basic and uses infrared absorption spectroscopy to measure absolute molecular concentrations.

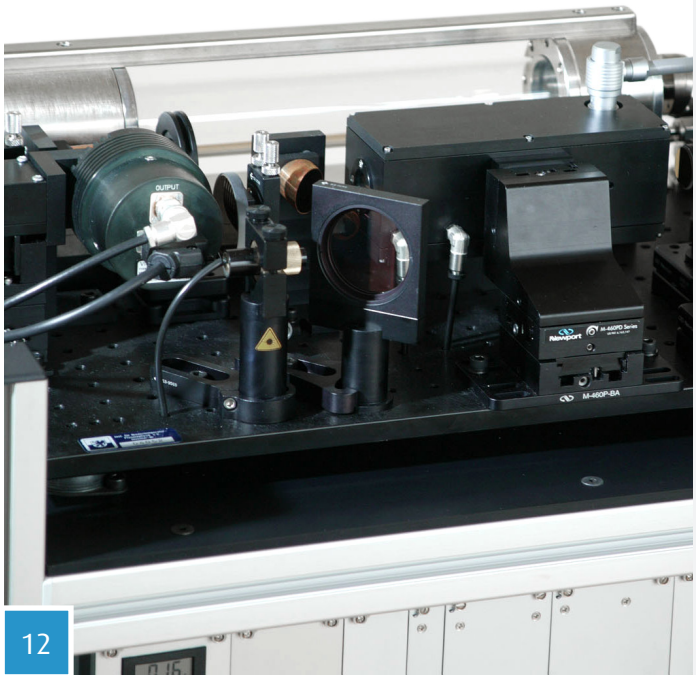
general	
description	single path infrared spectrometer with IR-light source and long path cell
sensitivity	down to ppb range [1]
time resolution	down to milliseconds
size	700 mm x 1240 mm x 450 mm
weight	125 kg
system versions	▪ Q-MACS Trace 3.6 - 36 m Long Path Cell ▪ Q-MACS Trace 5.4 - 54 m Long Path Cell ▪ Q-MACS Trace 7.6 - 76 m Long Path Cell ▪ Q-MACS Trace 10.0 - 100 m Long Path Cell

components	
parts	▪ optical board ▪ laptop with external PCI-card box ▪ Herriot cell ▪ vacuum pump system ▪ water cooling system

parameter	
power	▪ 230 V, max. 2 A (switch-on current 6 A) ▪ 115 V, max. 4 A (switch-on current 12 A)
working range	+5 °C to +40°C

QCL	
tuning method	▪ inter pulse mode (laser sweep mode) ▪ intra pulse mode (single pulse mode)
pulse width	8 ns* ... 256 ns** * depends on the QCL and QCL-voltage used ** longer pulses on request
pulse frequency	up to 1 MHz
QCL temperature range	-35 °C to +40 °C
QCL	tested and installed

[1] depends on species, temperature and pressure



Q-MACS Trace compact

technical specification

The Q-MACS Trace compact is a newly developed compact, easy portable system for high sensitive trace gas measurements using a 36 m optical long path cell. It is based on the Q-MACS Basic and uses infrared absorption spectroscopy to measure absolute molecular concentrations.

general	
description	single path infrared spectrometer with IR-light source and 36 m long path cell
sensitivity	down to ppb range [1]
time resolution	down to milliseconds
size	520 mm x 600 mm x 370 mm
weight	40 kg
system version	Q-MACS Trace 3.6 - 36 m Long Path Cell

components	
parts	▪ optical board ▪ laptop with PCMCIA-card ▪ 36 m Herriot cell ▪ vacuum pump system ▪ water cooling system

parameter	
power	▪ 230 V, max. 2 A (switch-on current 6 A) ▪ 115 V, max. 4 A (switch-on current 12 A)
working range	+5 °C to +40°C

QCL	
tuning method	▪ inter pulse mode (laser sweep mode) ▪ intra pulse mode (single pulse mode)
pulse width	8 ns* ... 256 ns** * depends on the QCL and QCL-voltage used ** longer pulses on request
pulse frequency	up to 1 MHz
QCL temperature range	-35 °C to +40 °C
QCL	tested and installed

[1] depends on species, temperature and pressure

Tailored Systems for Research and Industry

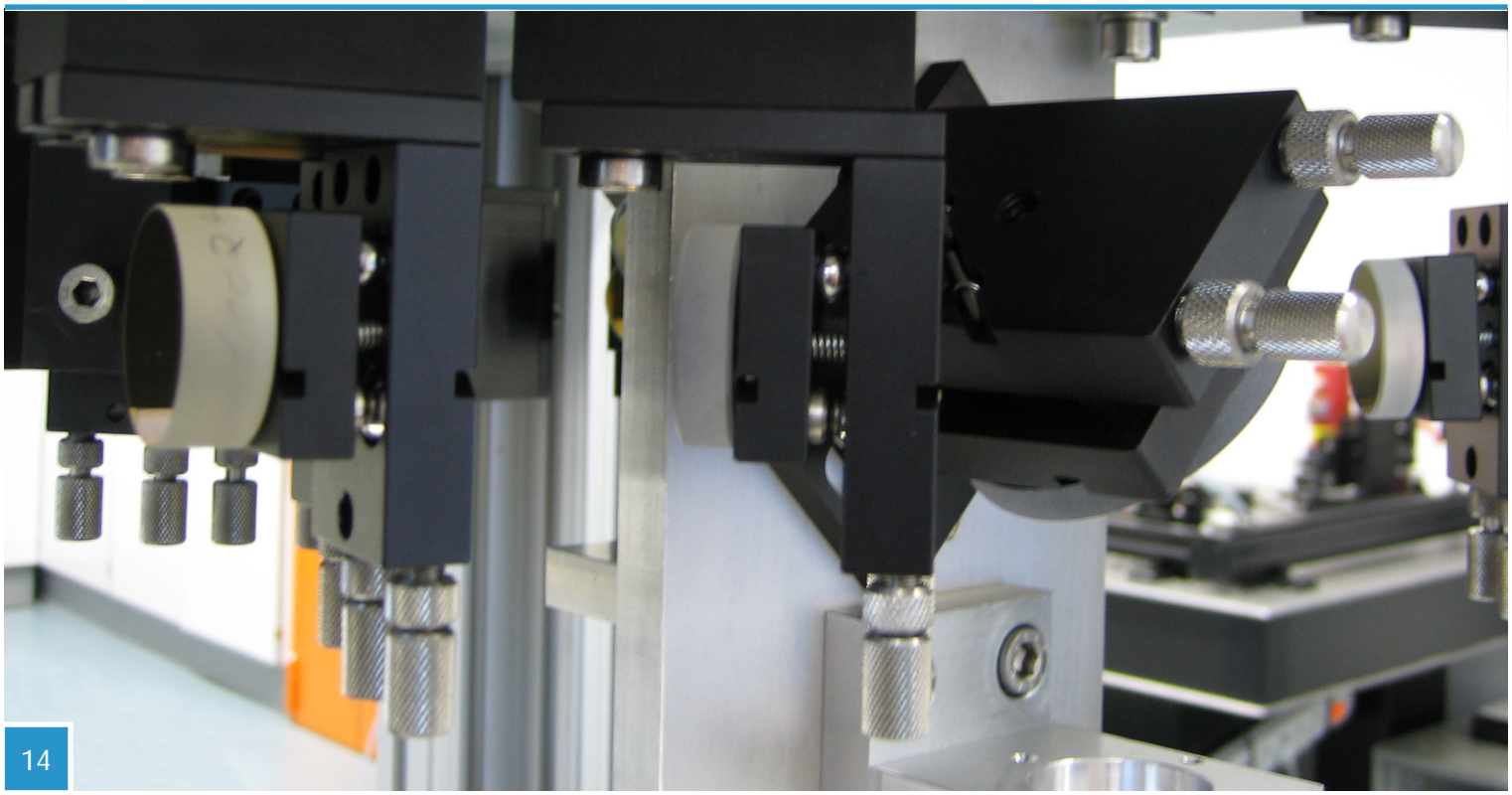
The greatest advantage of the Q-MACS family of spectroscopic systems is their flexibility and adaptability. Based on the modular approach to combine proven system components to fit the customers requirements almost every problem in molecular absorption spectroscopy can be tackled. Using Q-MACS highly selective and sensitive gas measurement solutions for the monitoring of mixing ratios from the percentage range even down to some parts per trillion (ppt) can be achieved. While some applications require only measurements every seconds to avoid data overflow after monitoring for days and weeks other applications require temporal resolutions in the sub-microsecond range. Q-MACS tailored systems for Research and Industry can be adapted to such special specifications and customers need. Please don't hesitate to contact us for further information and discussion of availability.

Available Features

- trace gas measurement by using a long path cell
- fast (sub-microsecond) burst mode acquisition mode
- adaptable stationary or mobile system
- detection and identification of molecules in concentrations from percent to ppt

Possible Applications

- scientific research (analytical chemistry, atmospheric chemistry, plasma physics, vacuum science)
- environmental studies
- emissions and immission monitoring (engines, clean rooms etc.)
- detection of explosives and toxic industrial chemicals
- breath analysis in medical diagnostics
- determination of gas purity (gas manufacturing, hospitals etc.)



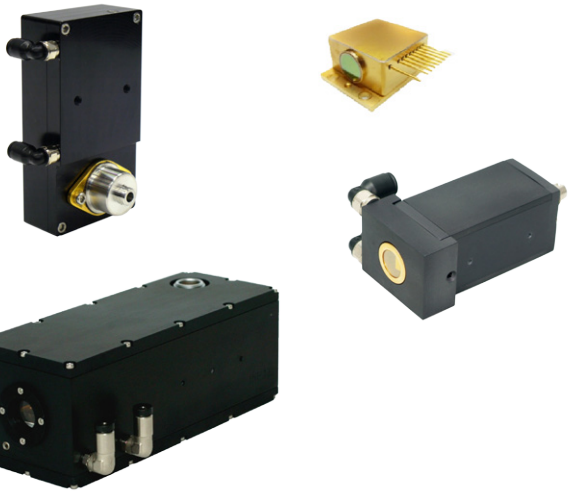
technical specification

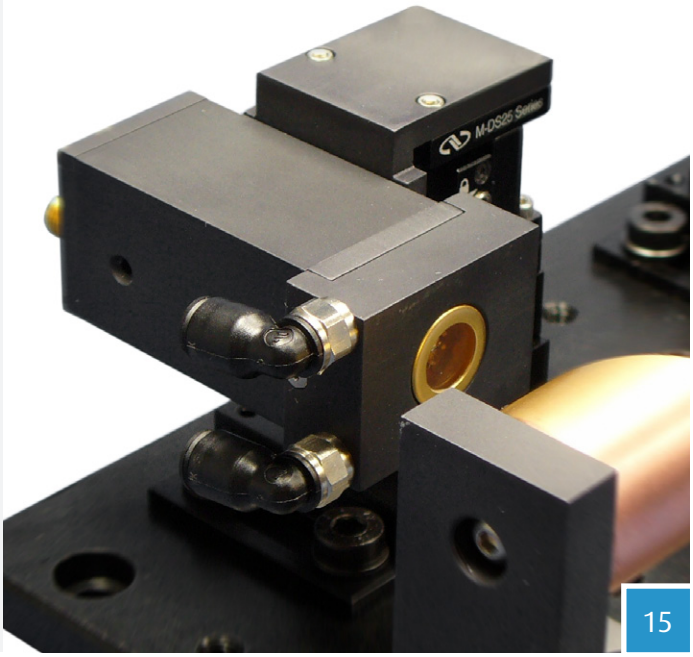
The Q-MACS Basic series provide highly developed equipment for operating pulsed and continuous wave distributed-feedback- or Fabry-Perot-Laser. The driver solution consists of a single supply unit and an external laser head incorporating the temperature controller and the current driver for an efficient work with QCL light sources. The laser is easily installed into the thermally stabilized laser head, which has to be connected to the supply unit afterwards, and the laser will be ready to use. Therewith the first steps, when investigating new innovative ideas based on the usage of QCLs, could be implemented very fast and highly effective by applying our Q MACS Starter Kits.

There are multiple alternative laser heads for mounting NS-/ST-, C mount, TO3 and TO8 packaged QCL available. This allows a very flexible configuration of our Q-MACS Starter Kits to perfectly fit the particular application specific requirements.

With its outstanding performance combined with our design and integration services, the Starter Kits based on the Q MACS Basic laser driver system is a versatile and reliable solution for various optical applications.

general	
description	Highly flexible QCL driver supporting various packages of continuous wave and pulsed lasers.
components	supply unit with control features laser head ▪ laser mount ▪ temperature controller ▪ cw and pulse current driver ▪ connector cable
laser head	
Q-MACS Basic	robust laser head for QCL on NS-, ST- or C-Mounts
Q-MACS LH3	robust laser head for pulsed and continuous wave QCL in TO3 packages
Q-MACS LH3 II	very compact laser head for pulsed and continuous wave QCL in TO3 packages
Q-MACS LH8	very compact laser head for pulsed QCL in TO8 packages
HHL Packages	direct connection of HHL packaged continuous wave QCL
QCL current driver	
smallest pulse widths	8 to 512 ns* with up to 10 A peak current * longer pulse widths on request
pulse frequency	up to 5 MHz
cw modulation current	up to 900 mA with customized shapes
temperature controller	
temperature range	-35* to 45 °C * heat removal via water cooler needed
supported Peltier specifications	up to 15 V / 5 A* * higher specs available on request
security features	overheat protection circuit
monitoring features	output for actual temperature





Q-MACS Spectral Calibration Source

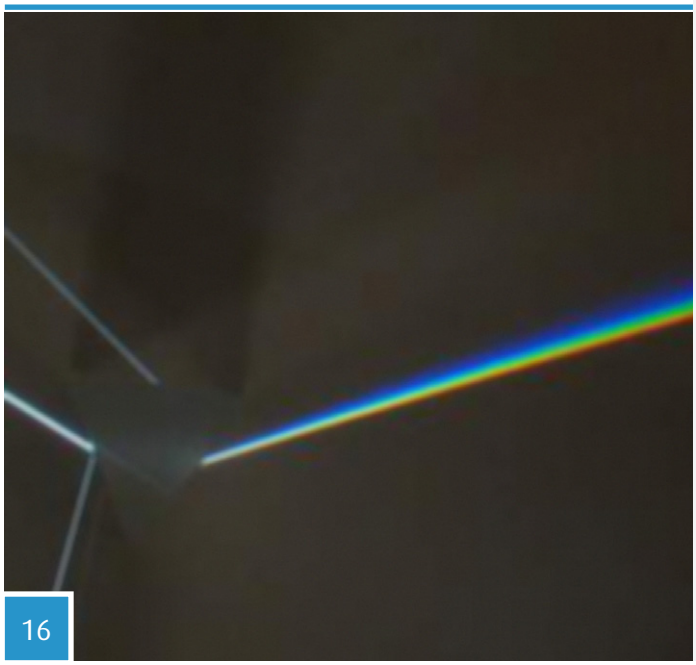
technical specification

The absolute wave length accuracy of the Q-MACS Spectral Calibration Source is guaranteed by using specific absorptions lines. Furthermore, these narrow band light sources allow an ultra-fine resolution of infrared spectra and guarantee a reliable determination and stabilization of the spectral position. A visual wave length control is available, which can be elaborated into an optional closed active wave length stabilization loop. Extremely high spectral power density as a result of narrow laser line width and average power levels up to a couple of mW ensure excellent signal to noise ratios.

The controller electronics were initially designed to deliver ultra stable pulses in high end laser spectrometer for trace gas analysis. Together with fast and high sensitive mid-infrared detection system of neoplas control, the optical pulses could be analysed with maximum sensitivity at the technical limit to reasonable prices.

Q-MACS Spectral calibration source can control up to 8 lasers, which are individually configurable including synchronized emission based on an internal clock signal. The driver is applicable for tuneable dye lasers as well. The compact, robust and easy to use driver solution allows setting up highly stable and accurate emission sources at different wavelengths in various applications like FTIR-spectrometer / monochromator calibration, refractive index measurements, laser spectrometer and optical test systems.

Beam shaping optics to adapt the emission to your application can be efficiently tailored based on our broad experiences in research and industrial applications of QCL systems.

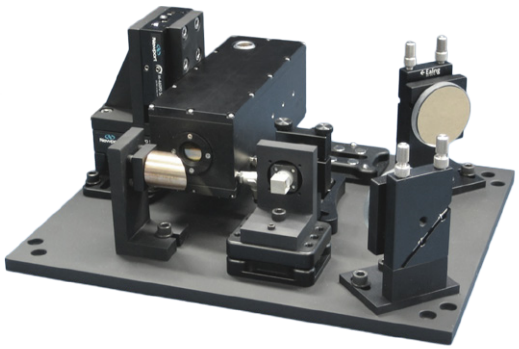


general
covering mid-infrared range from 2280 cm^{-1} to 920 cm^{-1} (4.4 µm - 10.9 µm) *
absolute wave length referenced to absorption lines (<0,1 cm^{-1}) *
pulsed and quasi-CW operation(repetition rate up to 5 MHz)
extremely high spectral power density (line width <0,03 cm^{-1})
high stability of the driving pulses (< 0,01% I_{max})
optional active wavelength control and active stabilization
pulse jitter / timing reproducibility <2 ns
up to 8 wavelengths independently configurable

* depending on the individual Quantum Cascade Laser (QCL)

technical specification

The Q-MACS Basic plus comes additionally with collimating and alignment optics: base plate, XYZ stage, alignment laser, removable beam splitter, off axis parabolic mirror (OAP) and 2 gold coated mirrors on adjustable mirror mounts.



general	
dimensions	64 mm x 64 mm x 170 mm
weight	1050 g
pulse width	8 ns*... 256 ns** * depends on the used QCL and the QCL-voltage; ** longer pulses on request
pulse frequency	up to 1 MHz
cw current	to 900 mA
QCL temperature range	-35 °C to +40 °C
QCL	tested and installed (on request)

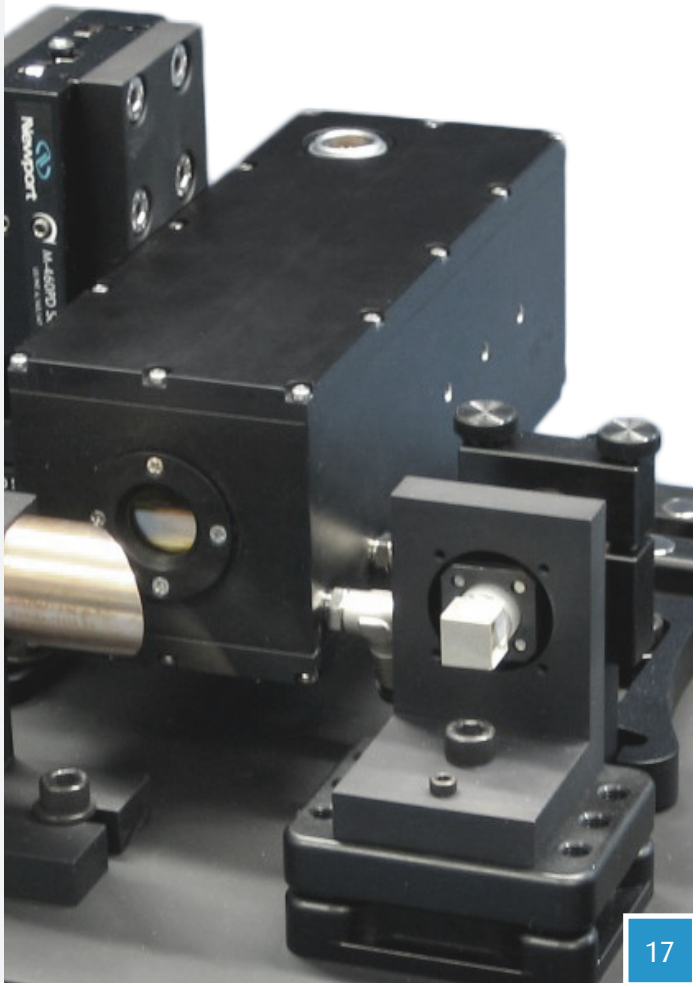
cable	
length and weight	2 m (other lengths on request), 500 g
connector	straight or rectangular

supply	
dimensions	42 TE/3HE x 235 mm = 236 mm x 139 mm x 256 mm
weight	5.4 kg
power	230 V / 1 A / 50 Hz; 115 V / 2 A / 60 Hz (switchable)
working range	+5 °C to +40 °C

signals on BNC	
input	▪ trigger (external / internal) (TTL); gate (TTL) ▪ set temperature: -4 V (= -40 °C) to +4 V (= +40 °C) ▪ set QCL-voltage: 0 ... 10 V programmable voltage
output	actual temperature: -400 mV (-40 °C) to +400 mV (+40 °C) actual QCL-voltage

collimation and allignment board	
dimension	320 mm x 260 mm x 110 mm
weight	7.6 kg (without head)
output	▪ collimated infrared laser beam, diameter ca. 25 mm ▪ co-alligned visible red trace laser beam, diameter ca. 3 mm

RS 232 interface	
parameter control	using Q-MACSoft 2.0



Q-MACS MidIR Point Source

OPTICAL TESTING

technical specification

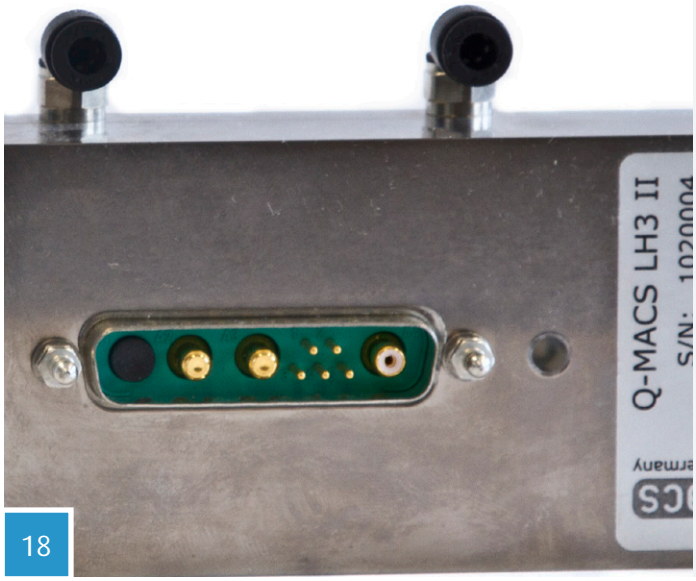
The Q-MACS MidIR point source offers highly brilliant emissive surfaces with approximately the same order of magnitude size as the wave length are regarded as a true point source, which is ideal for testing infrared lenses, microscope objectives and ir-cameras. The emissive surface of about 3* (6 to 20 µm) works as a true point source without any additional slits or pin holes. No misalignment in respect to slits or pin holes can occur. The power level can be easily adapted to any sensitivity of the camera by computer control in order to achieve bet signal to noise ratios (SNR).

The small line width, the high spectral power density and the wide range of available wave lengths allow quantifying the chromatic aberration of the lens, which limits the image quality especially in broad band applications like thermal imaging.

Former pin hole based approaches struggles with the contradicting restrictions using small apertures to fulfil the approximation of being a point source and getting enough energy through an infinitely small diameter.

The high wave length precision of the high resolution source would even allow measuring the refractive index of the optical material as long as the geometry is known. The high resolution version of Q-MACS MidIR point source is guarantees this by using specific absorptions lines. A visual wave length control is available, which can be elaborated into an optional closed active wave length stabilization loop. Extremely high spectral power density as a result of narrow laser line width and average power levels up to a couple of mW ensure excellent signal to noise ratios, which is the basement of high precision measurements.

Q-MACS MidIR point source can control up to 8 lasers, which are individually configurable including synchronized emission based on an internal clock signal. The compact, robust and easy to use driver solution allows remote control via PC.



general
True point source with emissive apertures down to 3 * 6µm² *
More than 100 discrete wave lengths available in the mid-infrared range 3 to 11µm
Extremely brilliant IR-Source with unmatched spectral and spatial power density
Enables precise chromatic aberration measurements due to low wavelengths uncertainty
Precise absolute wave length reference based on absorption lines (uncertainty <0,1 nm)* (High Resolution version)
pulsed and quasi-CW operation (repetition rate up to 5 MHz)
high stability of optical emission
up to 8 wavelengths independently configurable
Emission angle >90° (full angle) for lenses with high NA (e. g. microscopes)

* depending on the individual Quantum Cascade Laser (QCL)

technical specification

The Q-MACS Industrial is a robust and compact solution for problems in industry requiring sensitive concentration monitoring of molecular gases. The Q-MACS Industrial combines a Q-MACS laser light source with a long-path cell. Both are fitted with a gas extraction system into a standard 19" rack unit. Using the Q-MACS Industrial hazardous trace gases in the exhaust of industrial process can be detected as well as the purity of source gases can be checked to achieve maximum reliability, efficiency and reproducibility as well as minimum impact on the environment. The Q-MACS Industrial is adaptable to customers requirements.

general	
description	single path infrared spectrometer with IR-light source and long path cell
sensitivity	down to ppb range [1]
time resolution	down to milliseconds
size	554 mm x 695 mm x 600 mm

components	
parts	▪ optical board ▪ integrated controll electronics ▪ electronic supply system ▪ Integrated water cooling system

parameter	
power	▪ 230 V, max. 2 A ▪ 115 V, max. 4 A
working range	+5 °C to +40°C

[1] depends on species, temperature and pressure

Subsystems & Components

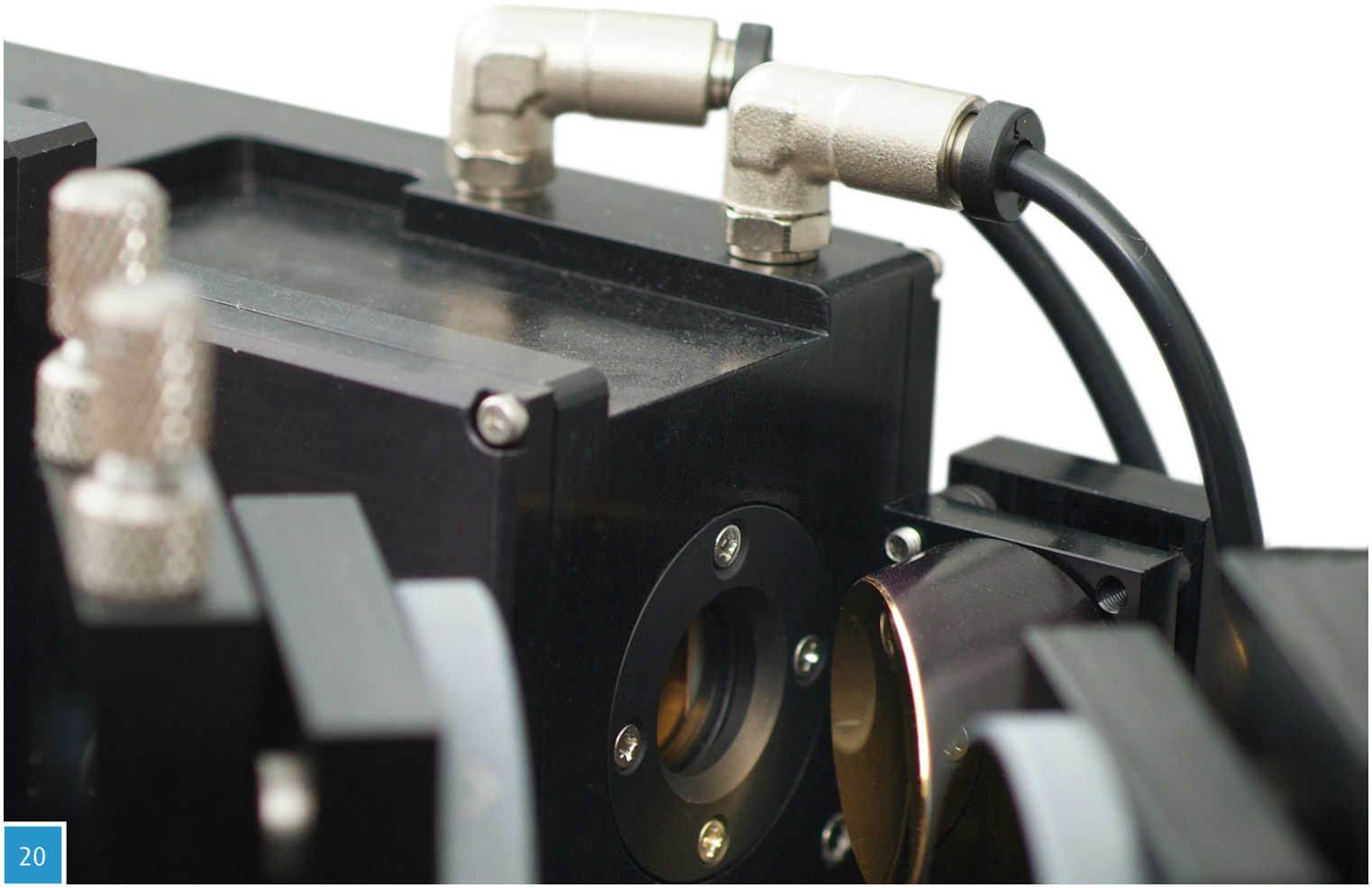
Many components of the Q-MACS Process and Q-MACS Trace systems are separately available. Q-MACS Basic represents the key component within our product range to access the field of mid infrared absorption spectroscopy. As a stand alone laser head with its control and supply unit it can be utilized for spectroscopic research purposes. The additional software package Q-MACSoft enables you to enhance scientific results in many ways. The components can be assembled to lab systems that meet the specific needs of the respective experimental setting or to enhance your existing laboratory measuring equipment.

Features

- customizable and compact lab systems
- Q-MACS Basic for operation with pulsed and continuous wave QCL
- complementary equipment and software
- expansion of Q-MAC systems

Applications

- research of gas and plasma phenomena
- calibration of spectroscopic equipment
- tuning of mid infrared radiation sources
- OEM parts for manufacturer and reseller



technical specification

The Q-MACS Basic is the fundamental component of Q-MAC Systems' entire line up. It is a robust and versatile QC Laser driver system, pulsed and continuous wave, for various infrared absorption spectroscopic applications. It can be utilized for fundamental and industrial research purposes. The Q-MACS Basic is a QC Laser head containing all necessary electronics, a power supply and a cable connection. It comes with special control software (Q-MACSoft 2.0) to drive the QCL.

general

dimensions	64 mm x 64 mm x 170 mm
weight	1050 g
pulse width	8 ns*... 256 ns** * depends on the used QCL and the QCL-voltage; ** longer pulses on request
pulse frequency	up to 1 MHz
cw current	to 900 mA
QCL temperature range	-35 °C to +40 °C
QCL	tested and installed

cable

length and weight	2 m (other lengths on request), 500 g
connector	straight or rectangular

supply

dimensions	▪ 42 TE / 3HE x 235 mm (without cooling) = BTH: 23.6/13.9/ 25.6 cm ▪ 42 TE / 4HE x 235 mm (with cooling) = BTH: 23.6/.../25.6 cm
weight	5.4 kg (without cooling)
power	230 V / 1 A / 50 Hz; 115 V / 2 A / 60 Hz (switchable)
working range	+5 °C to +40 °C

signals on BNC

input	▪ trigger (external / internal) (TTL); gate (TTL) ▪ set temperature: -4 V (= -40 °C) to +4 V (= +40 °C) ▪ set QCL-voltage: 0 ... 10 V programmable voltage ▪ set ramp: 0 ... 10 V, for ramp and cw current control
output	▪ actual temperature: -400 mV (-40 °C) to +400 mV (+40 °C) ▪ actual QCL-voltage ▪ trigger
optional connections	2 x 68 pin AMP connector for using National Instruments DACs and TDLWintel

RS 232 interface

parameter control	using Q-MACSoft 2.0

Q-MACS Basic embedded

technical specification

The Q-MACS Basic is the fundamental component of Q-MAC Systems' entire line up. It is a robust and versatile QC Laser driver system, pulsed and continuous wave, for various infrared absorption spectroscopic applications. It can be utilized for fundamental and industrial research purposes. The Q-MACS Basic is a QC Laser head containing all necessary electronics, a power supply and a cable connection. It comes with special control software (Q-MACSoft 2.0) to drive the QCL.

general	
dimensions	58 mm x 58 mm x 127 mm
weight	850 g
pulse width	8 ns* ... 256 ns** * depends on the used QCL and QCL-voltage
pulse frequency	up to 1 MHz
cw current	to 600 mA
QCL temperature range	-35 °C to +40 °C
QCL	tested and installed

cable	
length and weight	2 m (other lengths on request), 500 g
connector	straight or rectangular

supply	
dimensions	160 mm x 106 mm x 195 mm
weight	3,5 kg
power	230 V / 1 A / 50 Hz; 115 V / 2 A / 60 Hz (switchable)
working range	+5 °C to +40 °C

signals on BNC	
input	▪ clock source (external/internal); TTL on mixed D-Sub ▪ gate; TTL on mixed D-Sub ▪ set temperature; analog ±4 V on mixed D-Sub ▪ set QCL-voltage; analog 0 .. 10 V on mixed D-Sub ▪ set ramp*; analog 0 .. 10 V on mixed D-Sub (* for pre-heating ramp and cw current control)
output	▪ monitor trigger or gate (pre-selected); TTL on SMA ▪ read temperature; analog voltage on 15 pol. D-Sub ▪ read QCL voltage; analog voltage on 15 pol. D-Sub ▪ QCL current; analog voltage on 15 pol. D-Sub ▪ TEC current; analog voltage on 15 pol. D-Sub

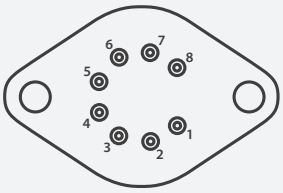
RS 232 interface	
parameter control	using Q-MACSoft 2.0 and Terminal applications

technical specification

The Q-MACS basic TO3 is an advanced QC laser driver. It consists of a newly developed laser head, which is compatible to the Q-MACS basic supply. This enables the extension of existing Q-MACS setups by the possibility to drive TO3 packaged QCL devices. This head is a robust and versatile laser driver for currently available pulsed QC laser based on the TO3 package. Within the laser head a high performance temperature controller as well as a thermoelectric cooler and the pulse driver are installed. Because of its sturdy design, the system can be utilized for spectroscopic applications at industrial facilities. The Q-MACS basic is a QC laser head containing all necessary electronics, a power supply and a connecting cable. Furthermore special software (Q-MACSoft 2.0) to control the basic features of the Q-MAC System is included.

head

dimensions	58 mm x 58 mm x127 mm
weight	850 g
connector	compatible with Q-MACS Basic



1 TEC +
2 thermistor
3 thermistor
4 negative contact of the laser
5 positive contact of the laser
6 not connected
7 not connected
8 TEC -

pulse driver

QCL voltage	0...17V [1]
QCL current	up to 9A
frequency	up to 1MHz
pulse width	8 ns ... 256 ns

temperature controller

max. TEC voltage	3V [2]
max. TEC current	2A [2]
QCL temperature range	min. -10 °C [3] max. +40 °C [3]
heat sink	water cooling

[1] depends on the Supply, QCL voltage on the supply can be changed to max. 27V
[2] different TEC voltage (max. 15V) and current (max. 5A) on request
[3] different ranges are possible: -10 °C...+17 °C or -3 °C...+40 °C

Q-MACS Basic MC

technical specification

The Q-MACS Basic MC is a newly developed Multi-Channel system for parallel measurement of up to 8 gas species at different wave numbers. The Q-MACS Basic MC is able to drive up to 8 QCL in pulsed or cw mode.

general	
description	64 mm x 64 mm x 170 mm
each channel contains	
a controller for	▪ monitoring of all parameters ▪ control of all settings ▪ communication with other channels and the PC
a programmable unit for	▪ adjustment of various operational modes ▪ free configuration of the ramp ▪ providing the QCL-pulses ▪ providing a detector gate pulse
an electricity supply for	▪ QCL-laser head ▪ stable supply voltage ▪ electricity and voltage controllable QCL-feed-in
a controller for	▪ ramp ▪ TEC-temperature

Q-MACS Basic SC Supply

technical specification

The Q-MACS Basic Single Channel (SC) supply is part of a new generation QCL driver tailored for OEM application. It combines highest reliability in pulse generation with a compact and robust design and provides outstanding flexibility for driving QCL in pulsed or continuous wave mode respectively. It is a robust and versatile laser driver system for various infrared absorption spectroscopic applications and can be utilized for fundamental and industrial research purposes. The system is capable to deal with laser heads of different characteristics containing all electronics necessary to support diverse packages. It comes with special control software to configure the device via its USB interface.

general	
description	single channel QCL driver utilizes compact laser heads very flexible pulse regimes various operational modes (pulsed, continuous wave) USB-interface
dimensions	160 mm x 240 mm x 140 mm* *dimensions might change slightly depending on the model
weight	2 kg
working range	+5 °C to +40 °C
power	230 V / 1 A / 50 Hz; 115 V / 2 A / 60 Hz (switchable)
pulse frequency	up to 5 MHz
pulse width	6 ns ... 510 ns* *resulting optical pulse width depends on the used QCL, the electronic pulse width is determined by the FPGA load
cw or bias current	up to 800 mA per channel* *not available, when using Q-MACS LH8 laser head
temperature range	-25 °C to +40 °C
head	
supported devices	Q-MACS LH8 Q-MACS LH3 II
USB interface	
parameter control	using related driver and control Software

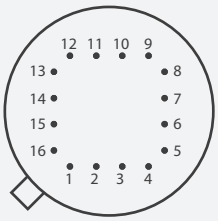
Q-MACS Basic LH8

technical specification

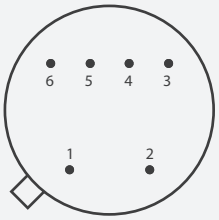
The Q-MACS Basic LH8 is an advanced QC Laser driver system for absorption spectroscopic applications. The Q-MACS Basic 1.5 TO8 has nearly the same functionality as the Q-MACS Basic but comes equipped with a very small laser head. It can be utilized for research and industrial purposes. The QMACS Basic 1.5 consists of the compact QC laser head, a power supply and a cable connection. It comes with special control software (Q-MACSoft 2.0) to drive the QCL and monitor your processes.

head	
dimensions	25 mm x 25 mm x 50 mm [1]
weight	62 g [1]
connector	▪ Binder RD08 Serie 711 ▪ SMA

1 TEC (-)	9 Thermistor
2 n.c.	10 Thermistor
3 n.c.	11 n.c.
4 TEC (+)	12 n.c.
5 LD (+)	13 LD (-)
6 LD (+)	14 LD (-)
7 LD (+)	15 LD (-)
8 LD (+)	16 LD (-)



1 TEC (-)
2 TEC (+)
3 Thermistor
4 Thermistor
5 LD (+)
6 LD (-)



tested TO-8 QCL	Laser Components, nanoplus

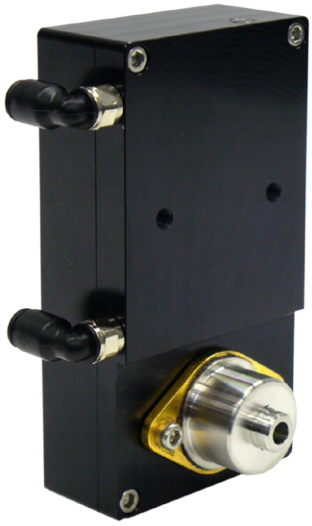
pulse driver	
supply voltage	+9 V
QCL voltage	0 – 15 V
QCL current	max. 2 A
frequency	1 Hz – 1 MHz
pulse width	10 ns – 1000 ns

temperature controller	
max. TEC voltage	1.8 V
max. TEC current	±1.5 A
QCL temperature range	20 °C to +30 °C
heat sink	air or water cooling

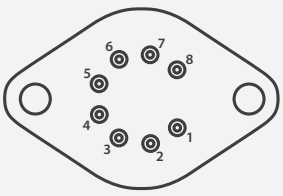
[1] without additional heat sink

technical specification

The Q-MACS Basic LH3 II is a laser head, which enables to drive TO-3 packaged QCL by the Q-MACS Basic MC Supply. It provides all necessary power signals to control pulsed and continuous wave QC laser in a compact and robust laser driver system.



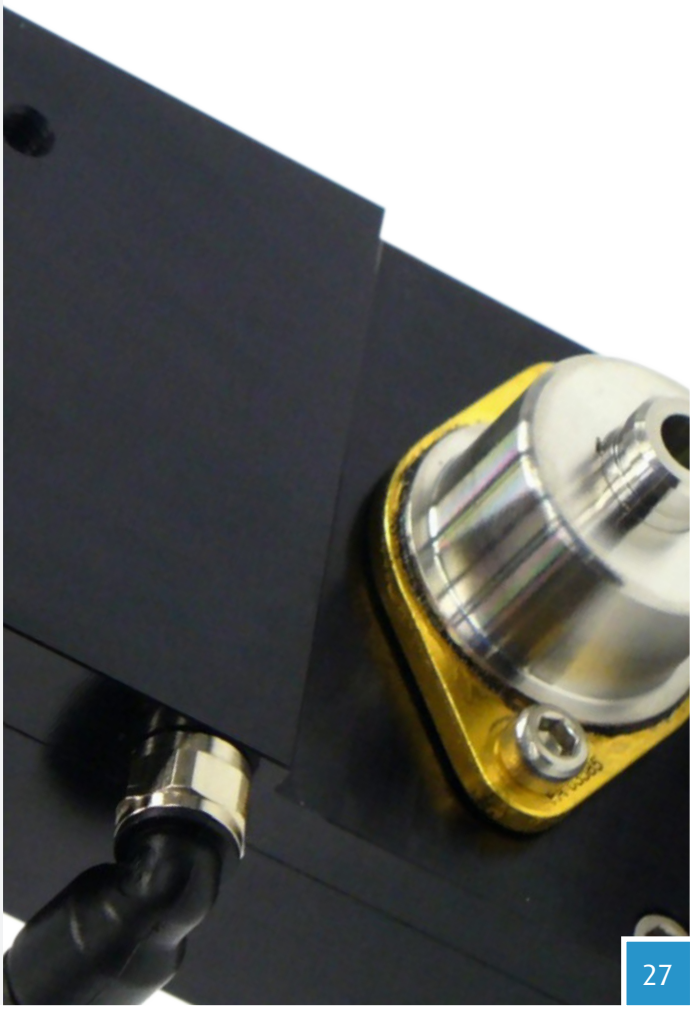
head	
dimensions	80 mm x 40 mm x 25 mm* *without fittings, TO3 and connector
weight	150 g
cw current	up to 800 mA
QCL	TO-3 package* * supported TO3 pinout



1 TEC +
2 thermistor
3 thermistor
4 negative contact of the laser
5 positive contact of the laser
6 not connected
7 not connected
8 TEC -

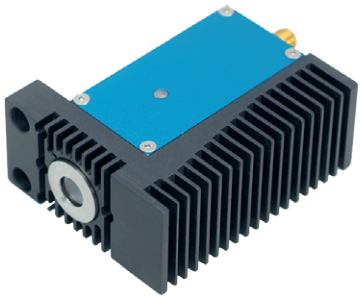
pulse driver	
supply voltage	+10 V
QCL voltage	Max. 16 V
QCL pulse current	max. 8 A
Pulse frequency	defined by external signal* up to 5 MHz * recommended hardware: Q-MACS MC/SC supply
pulse width	defined by external signal* usually max. 256ns * recommended hardware: Q-MACS MC/SC supply

temperature controller	
TEC voltage	max. 4.3 V
TEC current	max. ±3 A
QCL temperature range	-25 °C to +40 °C
heat sink	air or water cooling



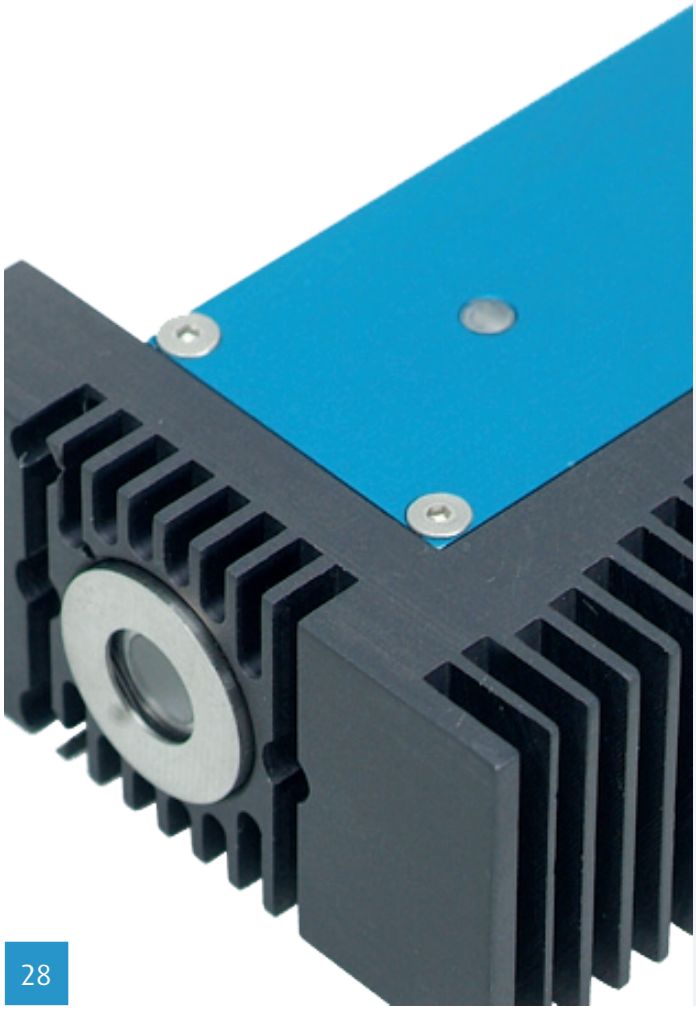
Q-MACS IR Detector

MID-INFRARED DETECTOR



technical specification

The Q-MACS Infrared Detector module is a compact detector device for infrared absorption spectroscopic purposes. It includes an ultra-low-noise pre-amplifier, which is available in two bandwidth versions for detection of fast and continuous wave signals respectively. The temperature controller, for driving the thermo electric cooling elements, is available in digital and analogue implementation. The analogue temperature controller provides lowest noise behaviour, but requires the use of water cooling for long term runs. The detector's exterior dimensions are similar to the small-sized Q-MACS Basic 1.5 QC laser head. The Q-MACS Infrared Detector Module allows on-line measurements and can be utilized for research and industrial applications.



general	
dimensions	25 mm x 25 mm x 50 mm [1]
weight	62 g [1]
supply voltage	+5 V/ 2 A on Binder RD04 Serie 707
detectors	e.g. Vigo PVI-2TE/3TE, PCI-2TE/3TE

pre-amplifier IRDM-600	
input voltage	±2 mV
output voltage	±0.2 Vp-p @ 50 Ω, SMA connector
gain	38 dB
bandwidth	10 kHz – 600 MHz
bias	adjustable up to 10 mA

pre-amplifier IRDM-5	
input voltage	±4 mV
output voltage	±2 Vp-p @ 1 MΩ, SMA connector
gain	60 dB
bandwidth	10 Hz – 5 MHz
bias	adjustable up to 10 mA

temperature controller	
max. TEC voltage	1.8 V
max. TEC current	±1.5 A
temperature range	200 K to 240 K, 235 K typ.
heat sink	air or water cooling [2]

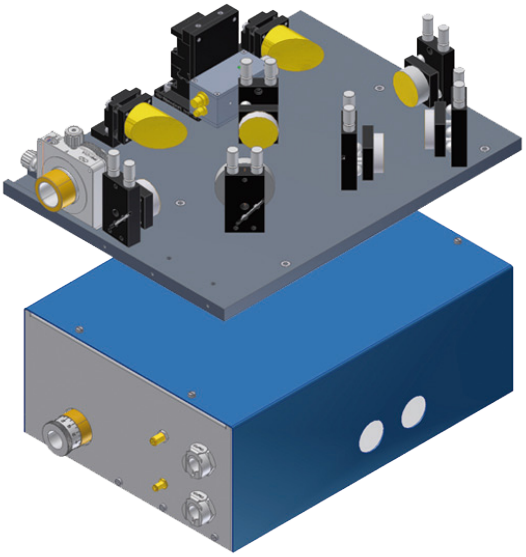
[1] without additional heat sink

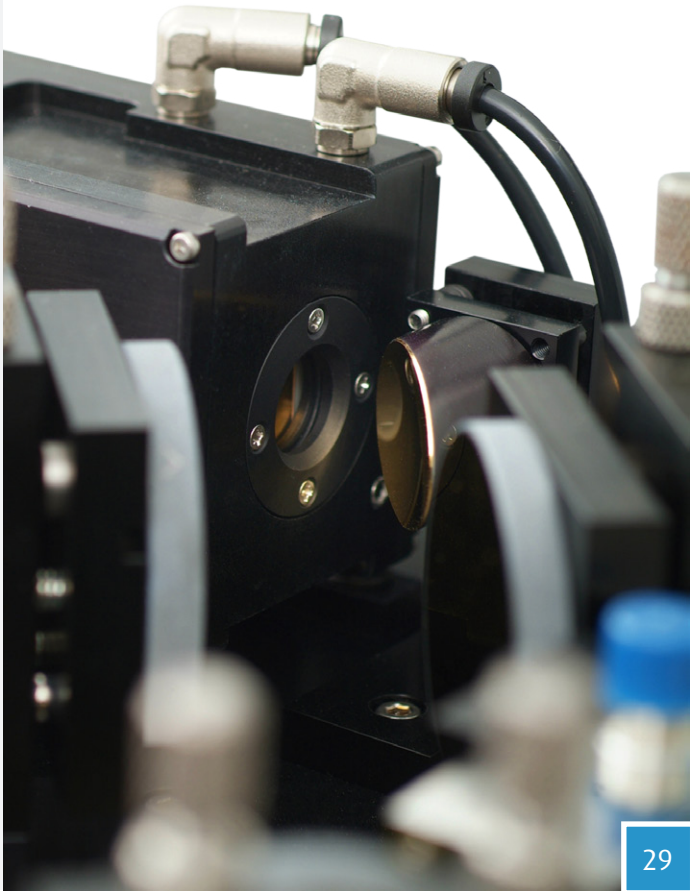
[2] air cooling might not be applicable due to specific TEC configurations

Q-MACS Detector board

technical specification

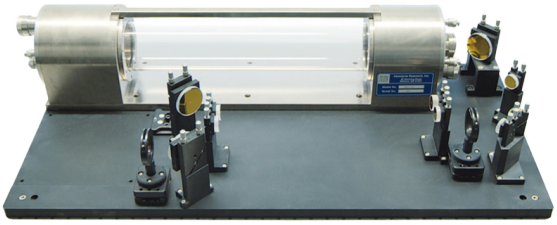
The Q-MACS Detector board implements the beam path for ideal in-coupling to the Q-MACS Detector module. The high reflective gold coated mirrors are installed on adjustable holders to simplify the alignment procedure. Furthermore, water inlets for optimum heat exchange are available. Alternative setups allow the handling of open path beam guidance and IR fibre respectively. With these options the Q-MACS Detector board allows flexible beam coupling at plasma chambers in industrial applications as well as efficient configuration for scientific experiments in the laboratory.





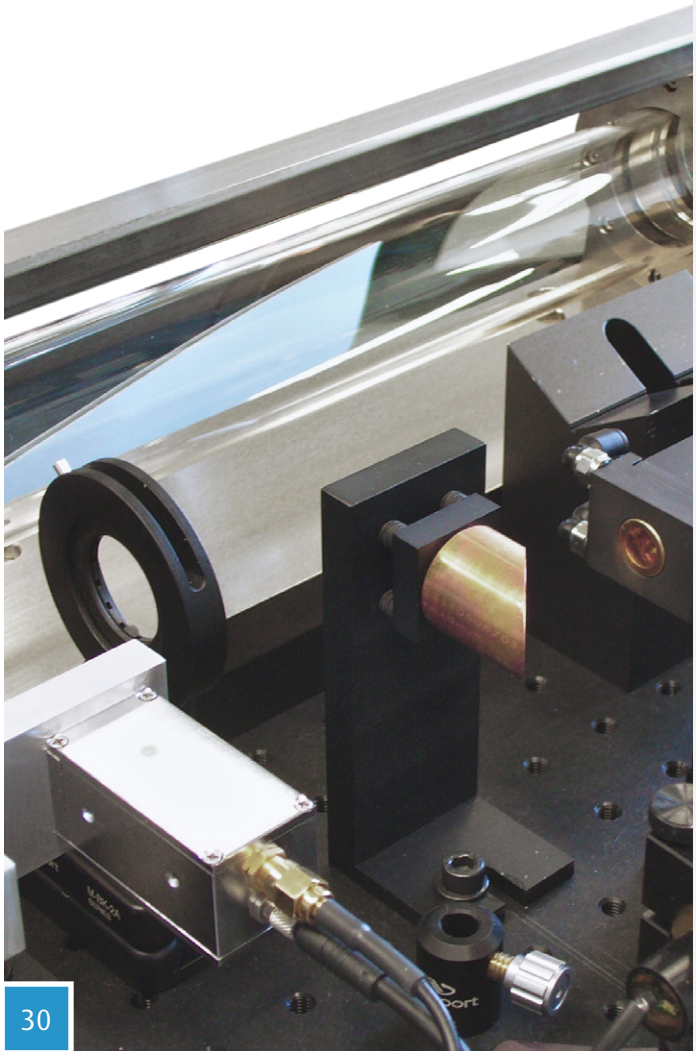
general	
description	flexible optical setup for ideal beam coupling on Q-MACS Detector modules
board versions	▪ fibre based IRDM-600 or IRDM-5 ▪ open path IRDM-600 or IRDM-5
dimension	250 mm x 200 mm x 170 mm

Q-MACS Long path cell board



technical specification

The Q-MACS Long path cell board is a custom-made product to increase the effective absorption length for infrared absorption spectroscopic applications by using different types of Herriot cells. The optical board is especially designed to be used with systems of the Q-MACS family. It provides an effective and easy adjustable in- and out-coupling of infrared radiation to the Herriott cell. A detector board with the Q-MACS infrared detector module can be included additionally.

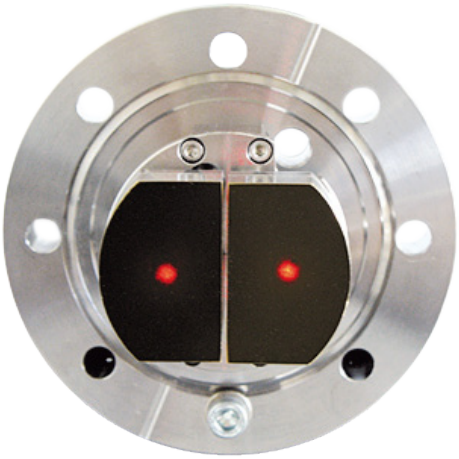


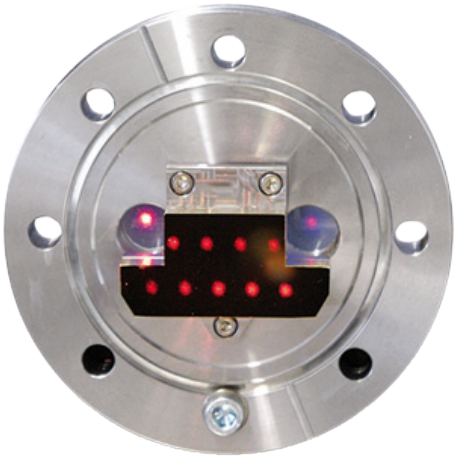
general	
description	robust optical board for effective and easy adjustable in- and out-coupling of infrared radiation to Herriott cells, detector board with IRDM-600 can be included
board versions	▪ Q-MACS Long Path Cell Board 3.6 – 36 m Herriott cell ▪ Q-MACS Long Path Cell Board 7.6 – 76 m Herriott cell ▪ Q-MACS Long Path Cell Board 10.0 – 100 m Herriott cell ▪ Q-MACS Long Path Cell Board 20.0 – 200 m Herriott cell
cell physical length	▪ 30 cm, 36 m Herriott cell ▪ 42 cm, 76 m Herriott cell ▪ 70 cm, 100 m Herriott cell ▪ 104 cm, 200 m Herriott cell
cell interior volume	▪ 0.3 liters, 36 m Herriott cell ▪ 0.5 liters, 76 m Herriott cell ▪ 3.2 liters, 100 m Herriott cell ▪ 5.1 liters, 200 m Herriott cell
wavelength range	3 µm – 11 µm
window material	BaF_2
extras	heating mantle, available for special versions of the 36 m and the 76 m version

Q-MACS Multipass optics

technical specification

The Q-MACS Multipass optics are custom-made innovative products to increase the effective absorption length for infrared absorption spectroscopic applications. It is especially designed to be used with systems of the Q-MACS family. The Multipass optics include a robust and compact set of gold coated mirrors optimized for usage in the mid-infrared and allow a wide range of possible absorption lengths.

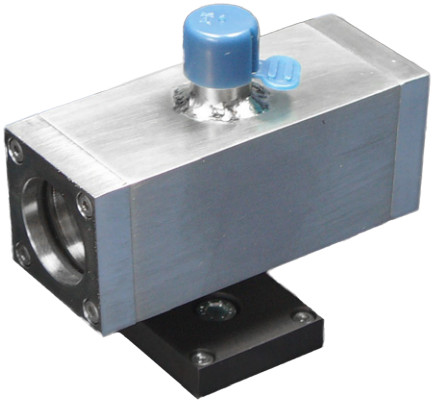




general	
dimension	depending on customer's requirements
mirror spacing / absorption length	depending on customer's setup
mirror mounting	typically ISO-K DN 63 and ISO-K DN 100 flanges customized mountings on request
passes	4 to 32 (typically)
maximum beam diameter	15 mm (typically)

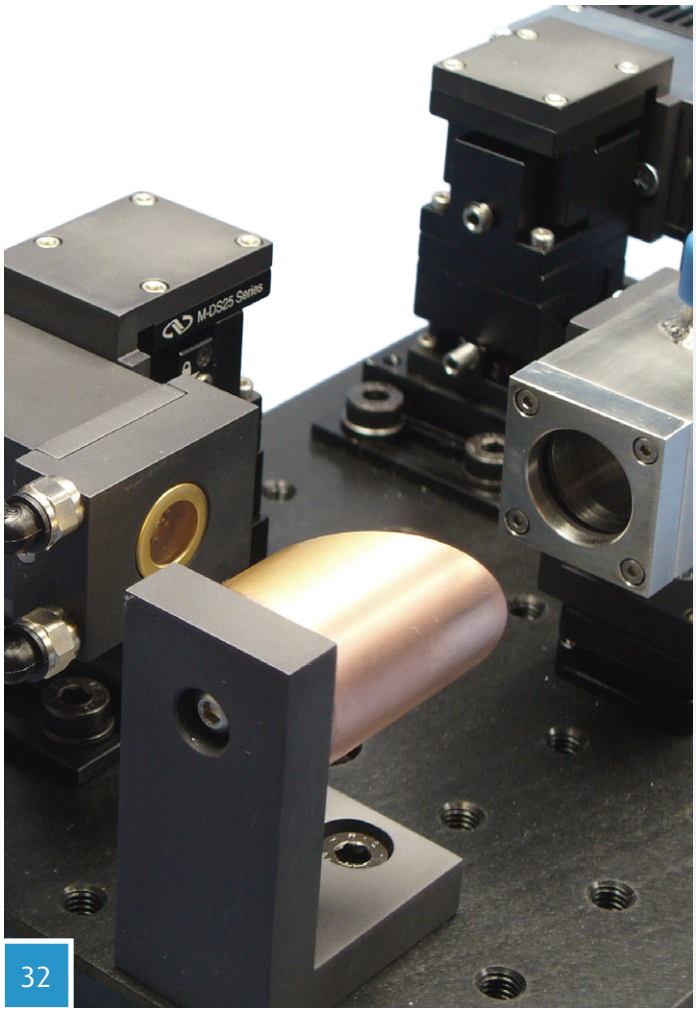
Q-MACS Reference gas cell

MINI REFERENCE GAS CELL RGC 50



technical specification

The Q-MACS Reference gas cell is a compact and robust solution for placing sealed reference gas probes in absorption spectroscopic setups. Its dimensions are similar to the small-sized Q-MACS Basic 1.5 QC Laser head and can be used for laboratory and industrial applications. A large variety of molecular gases can be filled with high purity into this cell.



features	
dimensions	25 mm x 25 mm x 63 mm
weight	156 g
absorption length	50 mm
beam diameter	17 mm
window material	BaF_2
gas volume	15.2 cm^3
leakage	10^{-10} mbar l/s

Q-MACS GE etalon

GERMANIUM ETALON

technical specification

The Q-MACS Ge etalon is a solid Germanium crystal for the determination of laser tuning rates in the mid infrared spectral range. It is especially designed to be used with systems of the Q-MACS family. Different lengths of the etalon are available to achieve various accuracies in tuning rate measurements.

general	
crystal material	single crystal of Germanium
crystal length	1, 3, 5 or 6 inch; tolerance ±0.05 mm
dimensions	▪ 34.8 mm diameter ▪ 38 mm (1 inch) ▪ 89 mm (3 inch) ▪ 140 mm (5 inch) ▪ 169 mm (6 inch)
Free spectral range*	0.049 cm-1, 0.016 cm-1, 0.0098 cm-1 or 0.0082 cm-1 * depending on wavelength and crystal temperature
clear diameter	25.4 mm ± 0.1 mm
wavelength range	2 µm – 20 µm
parallelism	deviation less than 3 arcsec

Q-MACS TCU

Thermo Control Unit

technical specification

The Q-MACS Thermo Control Unit (TCU) is designed to chill lasers and detectors for high sophisticated spectroscopic and industrial applications. The high control accuracy is achieved by a PID element and the vibration-free water cycle. This enables best measuring results without unwanted artefacts.

general	
description	▪ high-precision water cooler ▪ stand alone operation ▪ PID-controlled ▪ vibration-free closed water cycle ▪ communication and control software TCU-Control
dimensions	▪ 88,9 mm x 448,9 mm x 435,5 mm ▪ 19″ case with 2 RU height suitable for rack mount
control accuracy	+/- 0,01 K
control range	+16 °C to +30 °C
cooling capacity	80 W at 0 K ΔT
flow rate	max. 60 liter per hour
power	85 - 265 VAC
interfaces	▪ LC-display ▪ key panel ▪ power supply ▪ RS232 ▪ CPC water connectors

High Precision Temperature Controller

technical specification

This high precision temperature controller fulfils maximum performance requirements whether you are using heating or Peltier elements. The outstanding and reliable temperature stability for various applications is achieved by the high resolution temperature measurement of 0.001 K and an optimized PID-loop. The controller is set up via a USB interface and comes complete with easy-to-use control software. The PID-parameters, temperature limits and further options can be configured on site by the customer. The controller can be easily integrated in your own lab software using an open ascii-protocol. The HAT Control - B20 owns two different measurement inputs for Pt100 and Pt1000 probes respectively. The second measurement input allows the implementation of additional monitoring- or safety measures and therefore it has separately adjustable temperature limits. For calibration or matching of multiple sensors the temperature offsets can be dynamically programmed. Furthermore, a controllable analog output provides the option to integrate a further device, like a fan unit for heat dissipation when implementing Peltier cooling. The HAT Control – B20 temperature controllers are also available as OEM-Version for integration in your own setups. These outstanding features allow the controller to fulfil challenging requirements in various sophisticated applications such as microscopy or laser spectroscopy.

HAT Control – B20

HAT Control – B20--OEM

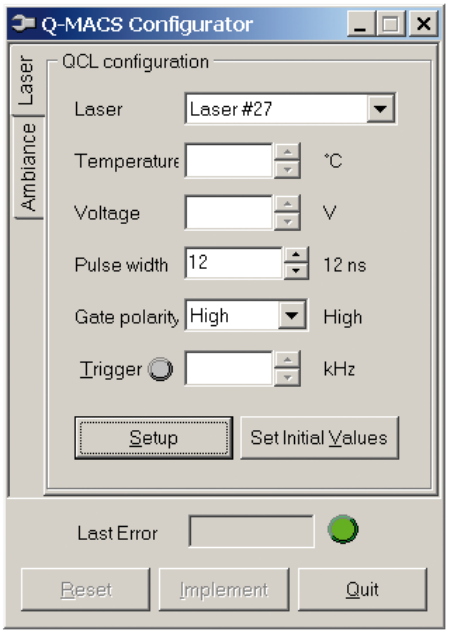
general	
description	high precision temperature controller
atmospheric moisture	0 ... 80 %
working temperature	10 ... 45 °C
weight	2.2 kg
dimensions	185 x 250 x 100 mm³ (B20), 80 x 100 x 35 mm³ (B20-OEM)

controller	
temperature resolution	0.001°C
metering range	-200...400 °C (Pt1000) -200...550 °C (Pt100)
measurement uncertainty	± 0,05 K* (* absolute, plus uncertainty of temperature sensors attached)
temperature coefficient	0.05 mK / K
control output	PWM with 300Hz max. 10 A
output voltages	customer configuration available* 12V 100W, max 8A 15V 150W, max 10A (standard) 24V 150W, max 6A * power supply not included in B20-OEM
control accuracy	down to ±0.002 K
interface	USB 2.0
auxiliary output	with PWM functionality, 12 V @ 0.3 A e.g. fan unit

scope of delivery	
	temperature controller
	line cord (B20 only)
	Interface cable
	mating connectors (B20 only)
	heat transfer paste
	application software for WinXP/Vista/7
	manual

Q-MACSoft 2.0-Driver & SDK

TRIGGER SOFTWARE



technical specification

The Q-MACSoft 2.0 control application enables you to determine and configure the Q-MACS Basic devices' parameters. In addition, this software can be used to generate a trigger signal or set the actual laser temperature and pulse voltage, respectively. Therefore, data acquisition hardware is adjusted using Q-MACSoft 2.0. The control application provides all features to adopt the intrapulse- mode with Q-MACS Basic devices. Furthermore, a SDK is part of the Q-MACS 2.0 package which allows the user to control Q-MACS Basic devices through software solutions.

features

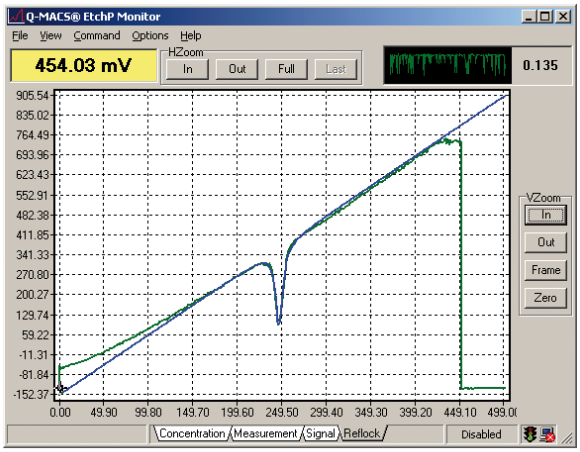
- support of MS Windows 9x, NT, 2k, XP systems and Vista
- management of Q-MACS devices controlled by a PC
- test and configuration of Q-MACS devices
- easy manual configuration of all device parameter
- experiment control using Q-MACS devices and additional DAQ hardware
- predefined DAQ configurations, for a quick start
- SDK, providing all features of the control software, to use Q-MACS devices in customers applications
- supported programming languages MS® VC++, MS® Visual Basic, Borland ® C++, Borland ® Delphi

Q-MACSoft 2.0-Monitor

CONTROL AND ANALYSIS SOFTWARE

technical specification

The Q-MACSoft 2.0-Monitor software package is a flexible control and analysis application. This software allows its users to generate specific extensions to achieve special hardware support for the particular application . The software package's focus is the control of Q-MACS based setups and the determination of concentration values using absorption spectroscopic methods. A basic feature of the Q-MACSoft 2.0-Monitor is the user's environment integration by extending its features with specific network types and protocols. It is also possible to generate analogue or digital control signals as a result of the measurement process, which allows direct control of laboratory and industrial equipment.

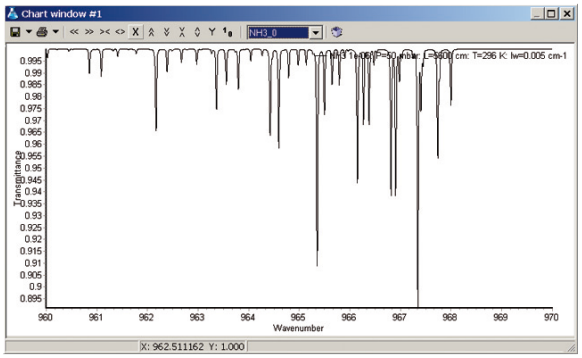


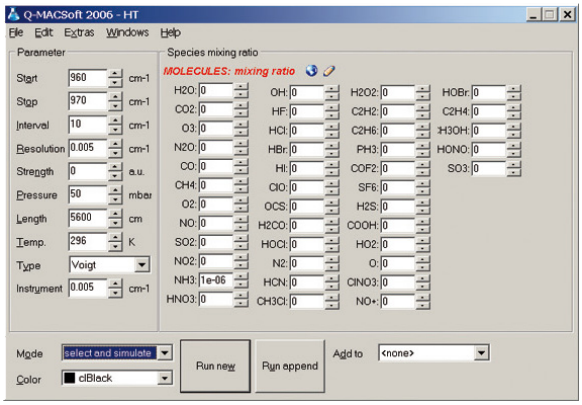
features

- support of MS Windows 9x, NT, 2k, XP and Vista operating systems
- support of National Instruments data acquisition boards
- support of Q-MACS Driver & SDK devices
- absorption spectroscopic methods for on-line concentration measurements
- synchronisation with external devices for automatic calibration
- ethernet support to synchronisation and distribution of measurement results
- automatic control of complete measuring tasks
- simultaneously monitoring and control of auxiliary equipment
- repetitive system check for secure operation
- user extendable hardware, analysis method and communication standards

Q-MACSoft 2.0-HT

SPECTRA SIMULATION SOFTWARE





technical specification

Spectroscopic applications require information about the absorptivity of molecules at specific spectral positions. The Q-MACSoft 2.0-HT gives an easy access to the spectroscopic parameters of the HITRAN [1] database. Therewith it provides an effective way to perform identification and sensitivity estimation tasks. The latest features of isotope specific selection and abundance increases the simulation results' accuracy.

features

- extraction of user selected parts of the HITRAN database
- support of HITRAN file formats version `96 and above
- display of spectral line strengths simulated using the selection and user defined parameters
- isotope specific selection and adaptable abundances
- easy to handle graph windows assist when aligning an absorption spectrometer by identifying
- storage of selected parts of the HITRAN database for use in a variety of spectroscopic applications
- storage of simulated spectral curves as text or bitmap files or using in reports and documentations

[1] Journal of Quantitative Spectroscopy and Radiative Transfer, vol 96, 139-204 (2005)

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