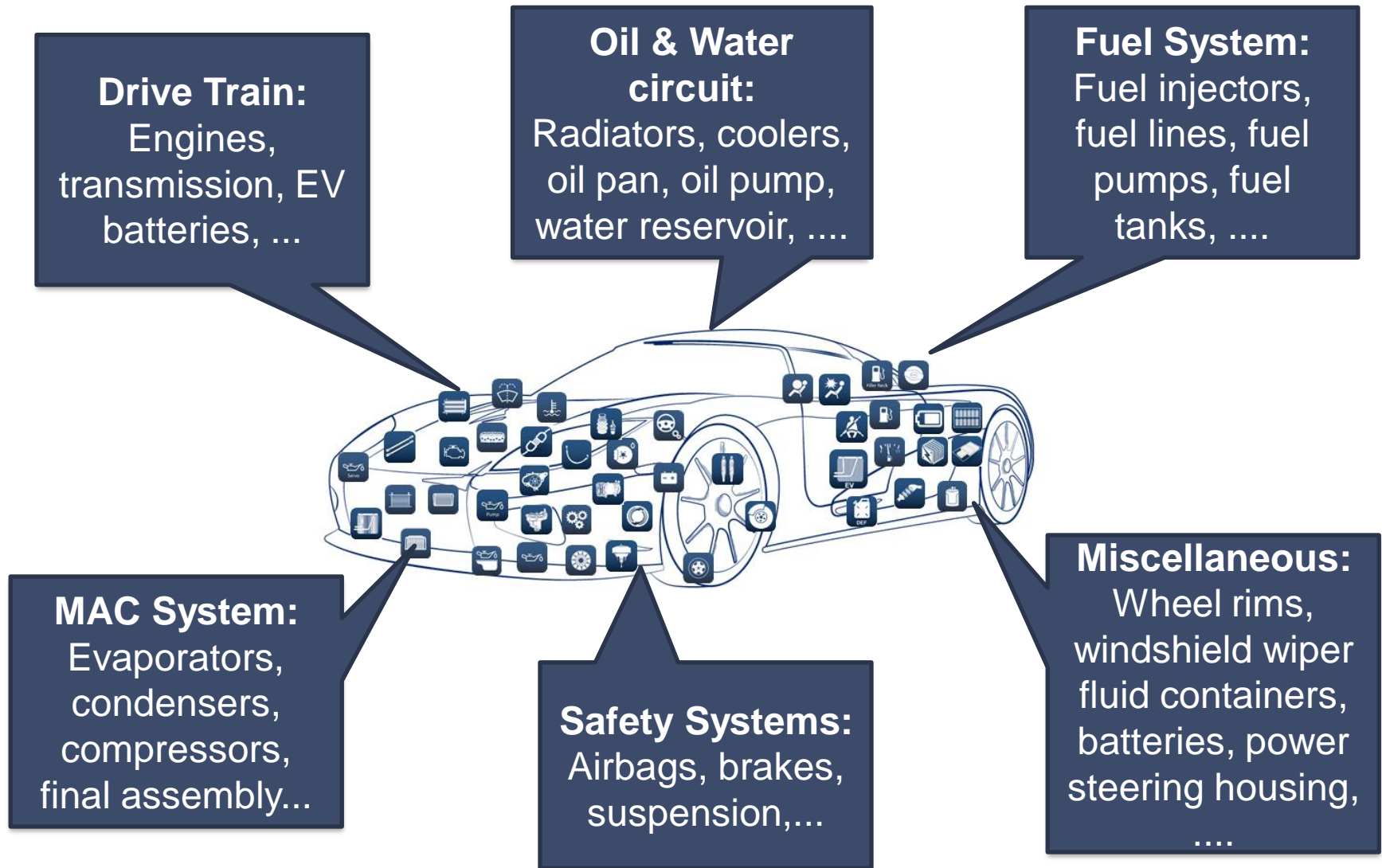




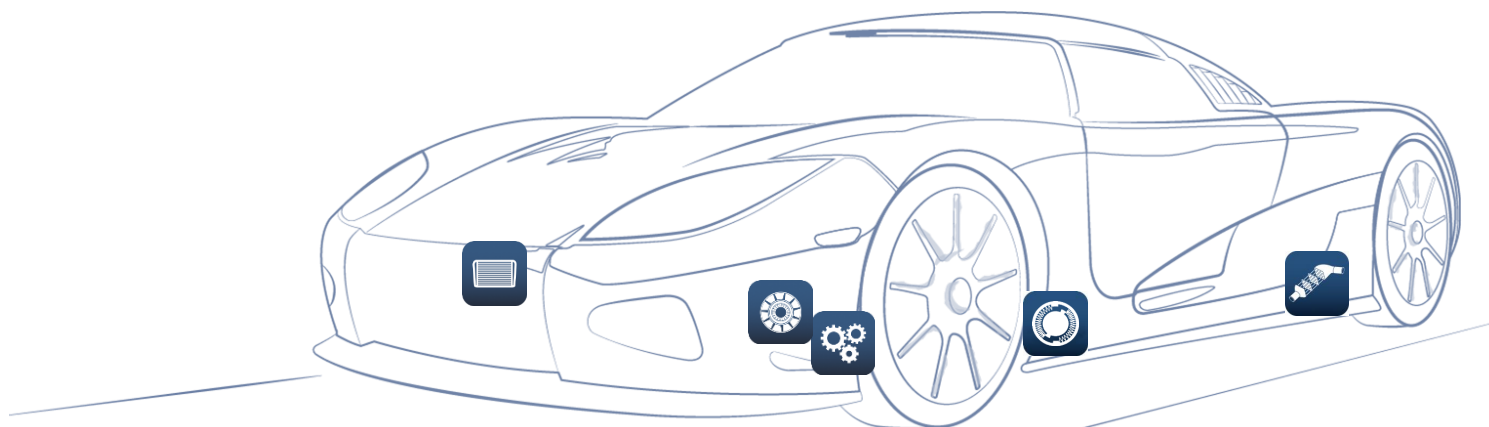
Automotive Leak Testing Applications



Automotive Leak Testing Applications

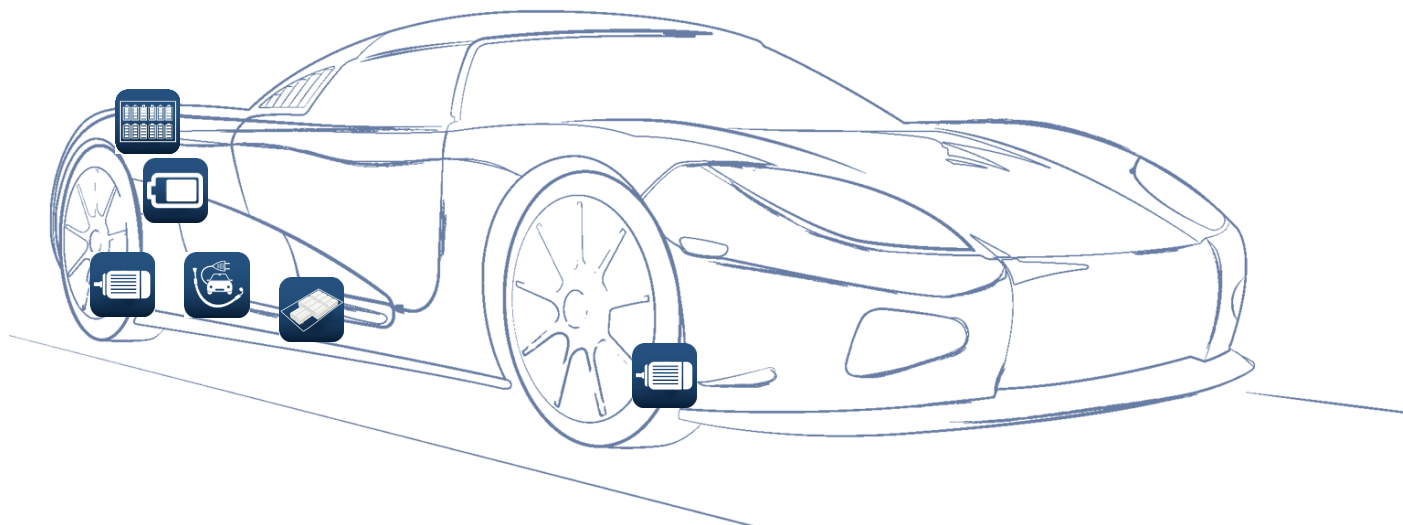


Conventional Drive Train



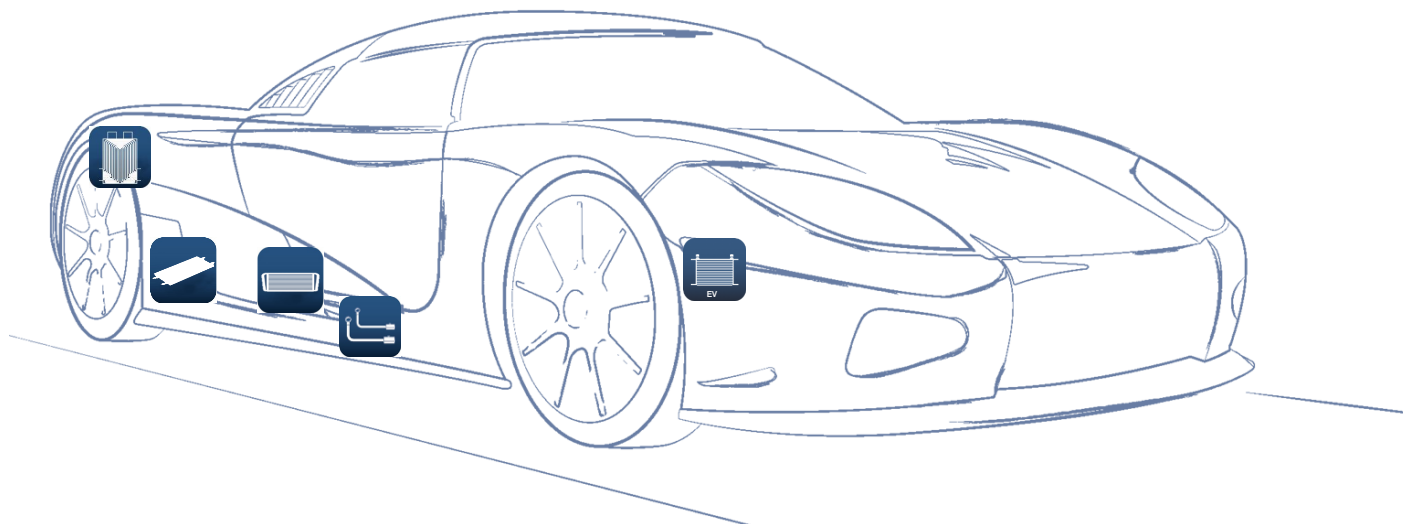
Automotive Component	<u>Transmission</u>	<u>Torque converter</u>	<u>Dual fly wheel</u>	<u>EGR cooler</u>	<u>Charge-Air Intercooler</u>
Testing method	Sniffing / Accumulation	Accumulation/ Vacuum	Vacuum	Accumulation/ Vacuum	Accumulation/ Vacuum
Typical leak rates	~ 10 ⁻² mbarl/s ~ 1 sccm	10 ⁻⁴ ... 10 ⁻⁵ mbarl/s	10 ⁻⁴ ...10 ⁻⁵ mbarl/s	~ 10 ⁻⁴ mbarl/s ~ 0.01 sccm	~ 10 ⁻³ mbarl/s
Recommended INFICON products	XL3000flex Protec P3000(XL) LDS3000 AQ Sensistor Sentrac	LDS3000 AQ LDS3000	Modul1000 LDS3000	LDS3000 AQ LDS3000	LDS3000 AQ LDS3000

Alternative drives – Electric drive



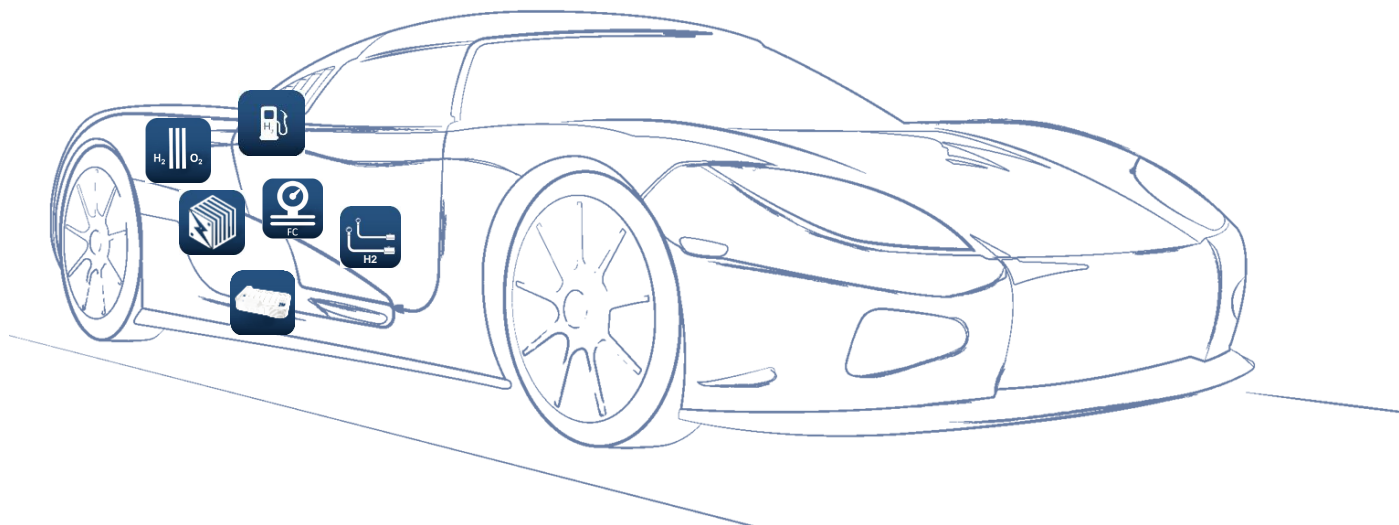
Automotive Component	<u>Lithium-ion battery cells</u>	<u>Cell cap</u>	<u>Battery case</u>	<u>Assembled battery pack</u>	<u>Hoses for electric battery cooling</u>	<u>Electric Drive</u>
Testing method	Vacuum / Bombing	Vacuum / Bombing	Vacuum / Accumulation	(Robotic) Sniffing / Accumulation	Sniffing	(Robotic) Sniffing / Accumulation
Typical leak rates	~ 10 ⁻⁶ mbarl/s	~ 10 ⁻⁶ mbarl/s	10 ⁻² ...10 ⁻⁴ mbarl/s	10 ⁻² ...10 ⁻⁴ mbarl/s	10 ⁻⁴ ...10 ⁻⁵ mbarl/s	10 ⁻³ ... 10 ⁻⁵ mbarl/s
Recommended INFICON products	<u>Modul1000</u> <u>LDS3000</u>	<u>Modul1000</u> <u>LDS3000</u>	<u>LDS3000</u> <u>LDS3000 AQ</u>	<u>LDS3000 AQ</u> <u>XL3000flex</u> <u>Protec P3000(XL)</u>	<u>XL3000flex</u> <u>Protec P3000(XL)</u>	<u>LDS3000 AQ</u> <u>XL3000flex</u> <u>Protec P3000(XL)</u>

Alternative drives – Electric drive



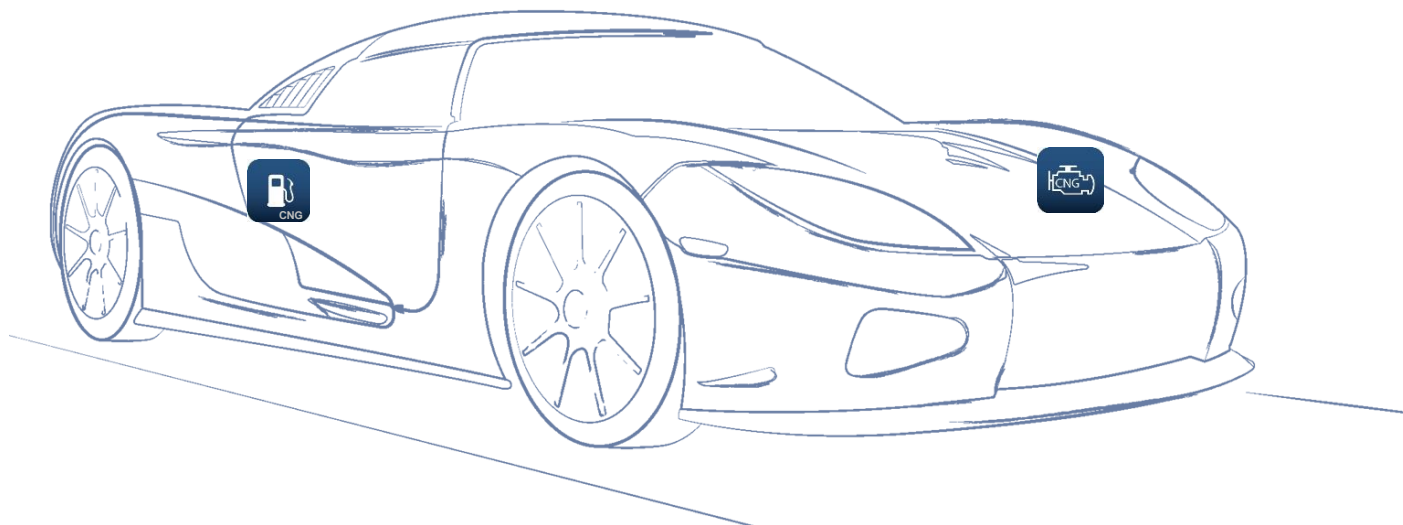
Automotive Component	Inter-cell cooler	Battery module cold plate	Sub-cooled loop radiator	Chiller	Cooling pipeline
Testing method	Vacuum / Accumulation	Accumulation / Vacuum	Accumulation / Vacuum	Accumulation / Vacuum	Accumulation / Sniffing
Typical leak rates	10 ⁻³ ... 10 ⁻⁵ mbarl/s	10 ⁻³ – 10 ⁻⁵ mbarl/s	10 ⁻⁴ – 10 ⁻⁵ mbarl/s	10 ⁻⁴ – 10 ⁻⁵ mbarl/s	10 ⁻⁴ – 10 ⁻⁵ mbarl/s
Recommended INFICON products	LDS3000 LDS3000 AQ	LDS3000 AQ LDS3000 Modul1000	LDS3000 AQ LDS3000 Modul1000	LDS3000 AQ LDS3000 Modul1000	LDS3000 AQ XL3000flex Protec P3000(XL) Sensistor Sentrac

Alternative drives – fuel cells



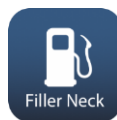
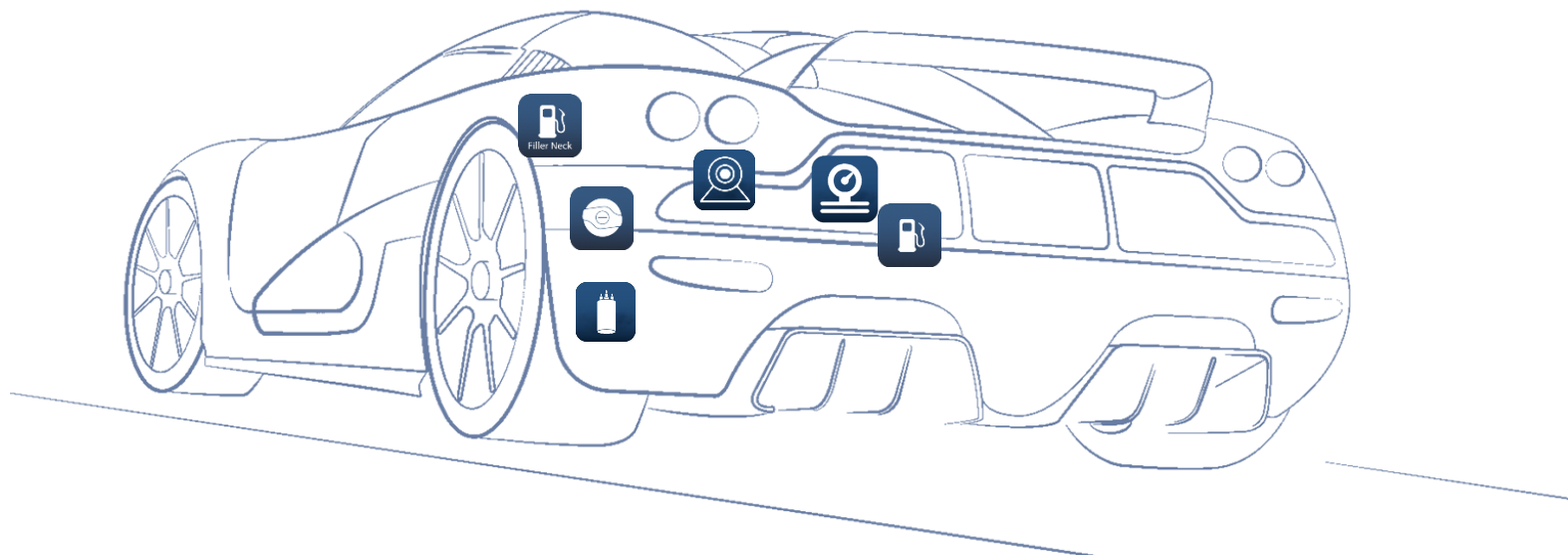
Automotive Component	Fuel cell plate	Fuel cell housing	Fuel cell stack (assembled)	FC pressure sensor	Hydrogen gas line	Hydrogen fuel tank
Testing method	Vacuum	Vacuum / Accumulation	(Robotic) Sniffing / Accumulation	Vacuum / Accumulation	Vacuum	Sniffing / Accumulation
Typical leak rates	10 ⁻⁴ ... 10 ⁻⁵ mbar/s	10 ⁻² ...10 ⁻⁴ mbar/s	10 ⁻² ...10 ⁻⁴ mbar/s	10 ⁻⁴ ... 10 ⁻⁵ mbar/s	10 ⁻⁴ ... 10 ⁻⁵ mbar/s	10 ⁻⁴ ... 10 ⁻⁵ mbar/s
Recommended INFICON products	<u>Modul1000</u> <u>LDS3000</u>	<u>LDS3000</u> <u>LDS3000 AQ</u>	<u>LDS3000 AQ</u> <u>XL3000flex</u> <u>Protec P3000(XL)</u>	<u>LDS3000</u> <u>LDS3000 AQ</u>	<u>Modul1000</u> <u>LDS3000</u>	<u>LDS3000 AQ</u> <u>XL3000flex</u> <u>Protec P3000(XL)</u>

Alternative drives – CNG / LNG



Automotive Component	Natural gas engine	Natural gas tank
Testing method	Sniffing	Sniffing
Typical leak rates	$10^{-4} \dots 10^{-5}$ mbar/s	~ 10^{-4} mbar/s ~ 0.01 sccm
Recommended INFICON products	<u>XL3000flex</u> <u>Protec P3000(XL)</u>	<u>XL3000flex</u> <u>Protec P3000(XL)</u>

Fuel system evap parts



Automotive Component	Fuel tank	Tank filler neck	Tank filler cap	Carbon canister	Fuel pump	Fuel tank pressure sensor
Testing method	Vacuum	Accumulation / Vacuum	Accumulation / Sniffing	Accumulation / Vacuum	Accumulation / Vacuum	Accumulation / Vacuum
Typical leak rates	$10^{-4} \dots 10^{-6}$ mbarl/s	$\sim 10^{-4}$ mbarl/s	$\sim 10^{-4}$ mbarl/s	$\sim 10^{-4}$ mbarl/s	$10^{-4} \dots 10^{-5}$ mbarl/s	$\sim 10^{-4}$ mbarl/s
Recommended INFICON products	<u>Modul1000</u> <u>LDS3000</u>	<u>LDS3000 AQ</u> <u>LDS3000</u>	<u>LDS3000 AQ</u> <u>XL3000flex</u> <u>Protec P3000(XL)</u>	<u>LDS3000 AQ</u> <u>LDS3000</u>	<u>LDS3000 AQ</u> <u>LDS3000</u>	<u>LDS3000 AQ</u> <u>LDS3000</u>

Drive Train

Alternative Drives

Fuel System

Oil & Water circuit

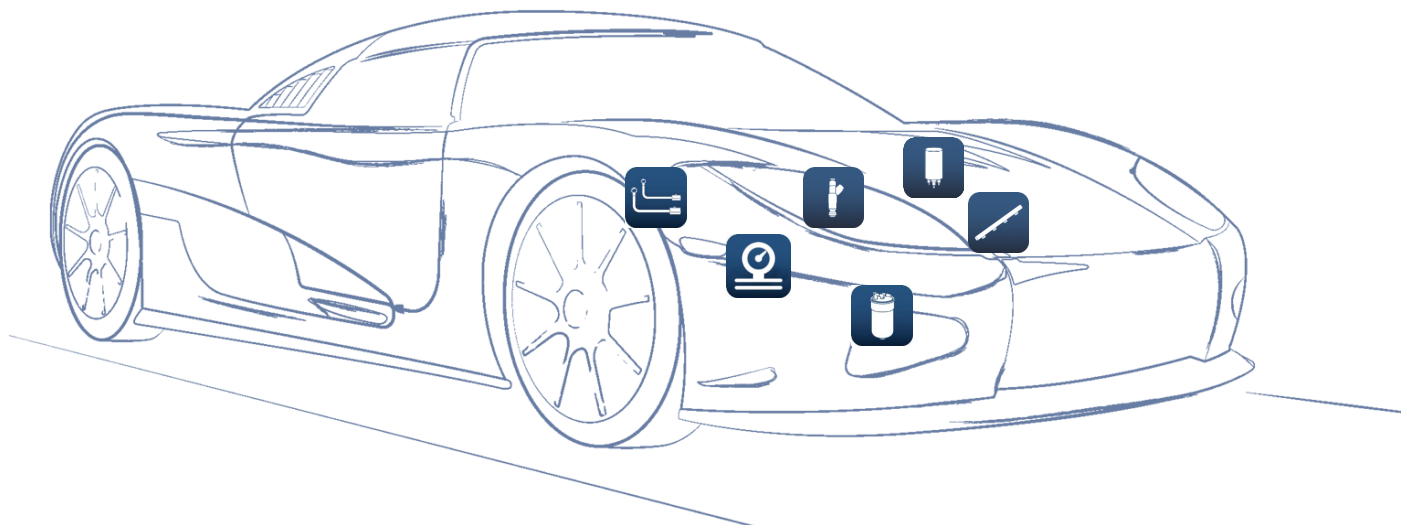
Safety Features

AC System

Various Components

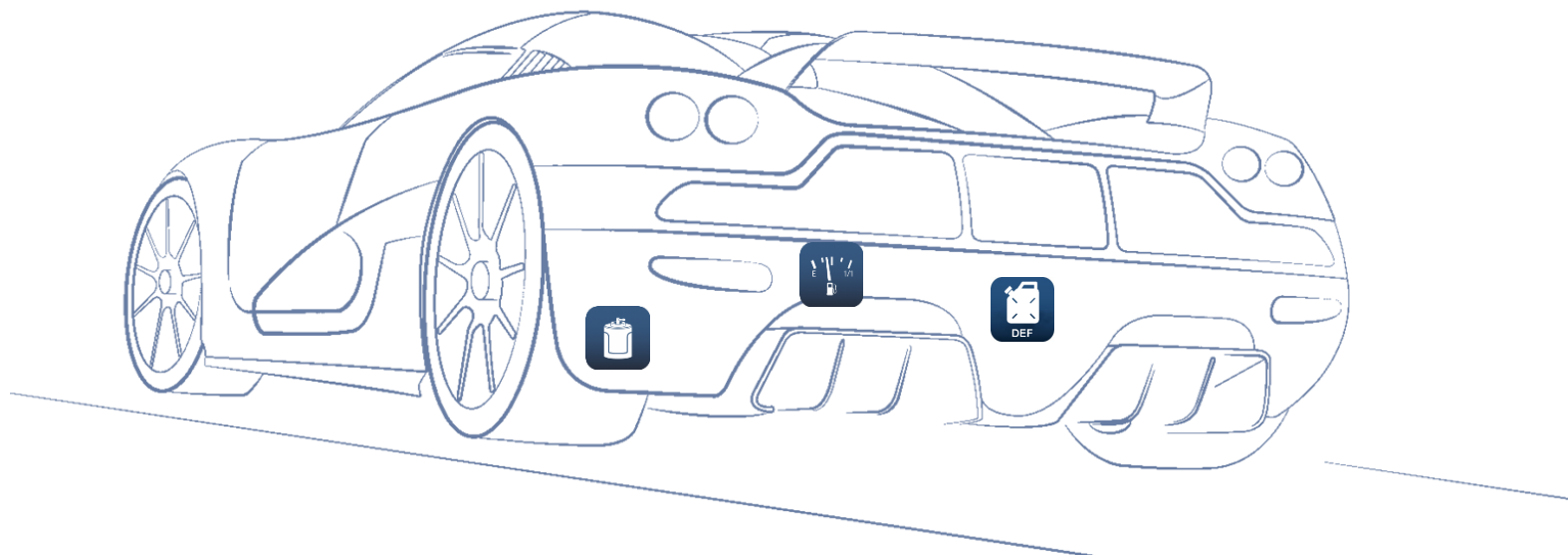
Final Assembly

Fuel delivery parts



Automotive Component	<u>Fuel Injector</u>	<u>High pressure fuel pump</u>	<u>High pressure fuel rail</u>	<u>High pressure fuel line</u>	<u>Fuel filter</u>	<u>Fuel pressure sensor</u>
Testing method	Accumulation	Accumulation / Vacuum	Accumulation	Accumulation / Vacuum	Accumulation	Vacuum
Typical leak rates	~10 ⁻⁴ mbarl/s	10 ⁻⁴ ..10 ⁻⁵ mbarl/s	~10 ⁻⁴ mbarl/s	10 ⁻⁴ ..10 ⁻⁵ mbarl/s	~ 10 ⁻² mbarl/s	10 ⁻⁴ ... 10 ⁻⁶ mbarl/s
Recommended INFICON products	<u>LDS3000 AQ</u> (<u>Sensistor ISH2000</u>)	<u>LDS3000 AQ</u> <u>LDS3000</u>	<u>LDS3000 AQ</u> <u>LDS3000</u>	<u>LDS3000 AQ</u> <u>LDS3000</u>	<u>LDS3000 AQ</u> <u>Sensistor ISH2000</u>	<u>Modul1000</u> <u>LDS3000</u>

Fuel system parts



Automotive Component

Fuel tank sending unit

Swirl pot (Diesel)

DEF („AdBlue“) tank

Testing method

Accumulation

Accumulation

Accumulation /
Vacuum

Typical leak rates

~ 10⁻⁴ mbar/s10⁻²...10⁻⁴ mbar/s~ 10⁻⁴ mbar/sRecommended
INFICON
products**LDS3000 AQ****LDS3000 AQ****LDS3000 AQ**
LDS3000

Drive Train

Alternative Drives

Fuel System

Oil & Water circuit

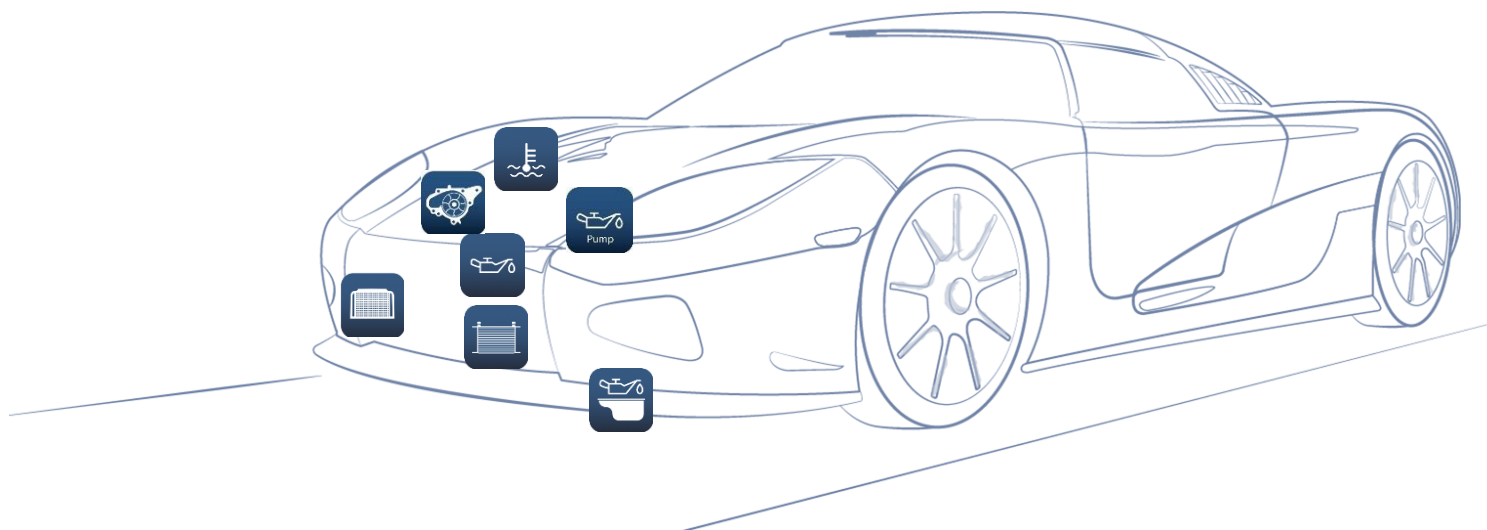
Safety Features

AC System

Various Components

Final Assembly

Oil & Water circuit



Automotive Component	<u>Plastic oil tank</u>	<u>Oil pan</u>	<u>Oil cooler</u>	<u>Oil pump</u>	<u>Coolant expansion tank</u>	<u>Water cooler</u>	<u>Water pump</u>
Testing method	Accumulation	Accumulation	Vacuum / Accumulation	Vacuum / Accumulation	Accumulation	Accumulation / Sniffing	Vacuum / Accumulation
Typical leak rates	~ 10 ⁻³ mbar/s	~10 ⁻² mbar/s	~ 10 ⁻² mbar/s	10 ⁻² ... 10 ⁻¹ mbar/s 1 .. 10 sccm	~ 10 ⁻² mbar/s ~ 1 sccm	~ 10 ⁻² mbar/s	10 ⁻² ... 10 ⁻¹ mbar/s 2 .. 15 sccm
Recommended INFICON products	<u>LDS3000 AQ</u>	<u>LDS3000 AQ</u> <u>Sensistor ISH2000</u>	<u>Modul1000</u> <u>LDS3000</u> <u>LDS3000 AQ</u>	<u>Modul1000</u> <u>LDS3000</u> <u>LDS3000 AQ</u>	<u>Sensistor ISH2000</u> <u>LDS3000 AQ</u>	<u>Sensistor Sentrac</u> <u>LDS3000 AQ</u> <u>(LDS3000)</u>	<u>Modul1000</u> <u>LDS3000</u> <u>LDS3000 AQ</u>

Drive Train

Alternative Drives

Fuel System

Oil & Water circuit

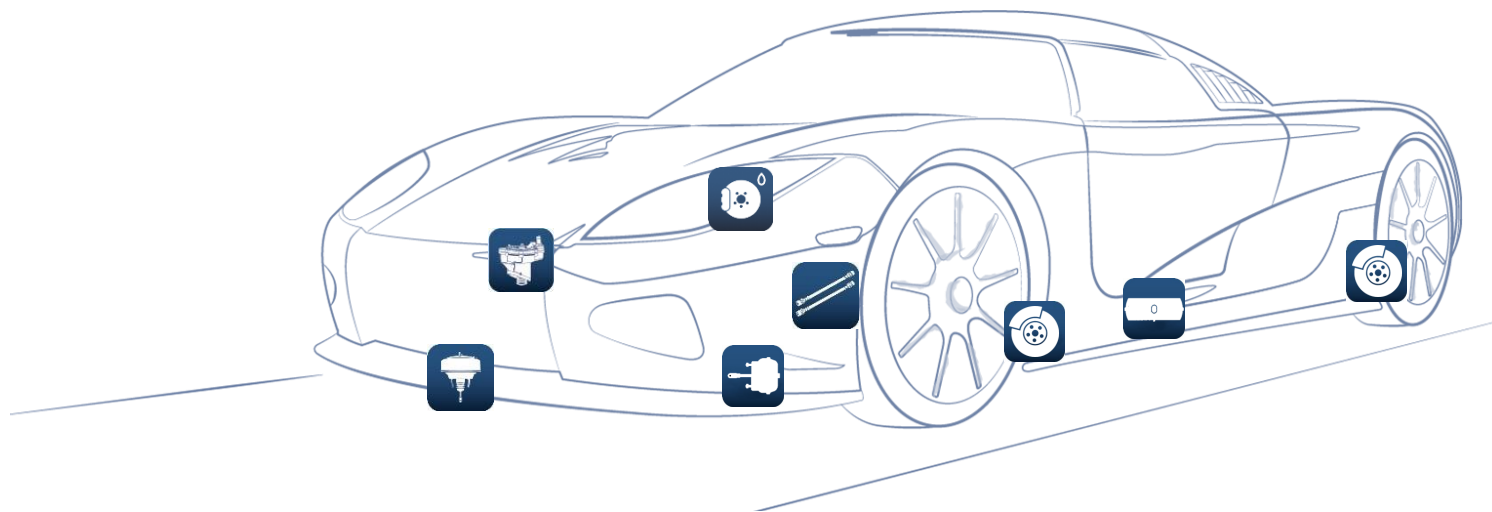
Safety Features

AC System

Various Components

Final Assembly

Safety features



Automotive Component	Brake fluid reservoir	Power brake booster	Vacuum brake pump	Brake hoses	Brake Callpers	Air brakes	Air brake tank
Testing method	Accumulation	Accumulation	Accumulation	Accumulation	Vacuum / Accumulation	Vacuum	Vacuum
Typical leak rates	10 ⁻³ ...10 ⁻⁴ mbarl/s	10 ⁻³ ...10 ⁻⁴ mbarl/s	~ 10 ⁻¹ mbarl/s 5 ... 20 sccm	10 ⁻³ ...10 ⁻⁴ mbarl/s	10 ⁻³ ...10 ⁻⁴ mbarl/s	10 ⁻⁴ ...10 ⁻⁵ mbarl/s 0.03 to 0.006 sccm	10 ⁻⁴ ...10 ⁻⁵ mbarl/s 0.03 to 0.006 sccm
Recommended INFICON products	<u>LDS3000 AQ</u>	<u>LDS3000 AQ</u>	<u>LDS3000 AQ</u>	<u>LDS3000 AQ</u>	<u>Modul1000</u> <u>LDS3000</u> <u>LDS3000 AQ</u>	<u>Modul1000</u> <u>LDS3000</u>	<u>Modul1000</u> <u>LDS3000</u>

Drive Train

Alternative Drives

Fuel System

Oil & Water circuit

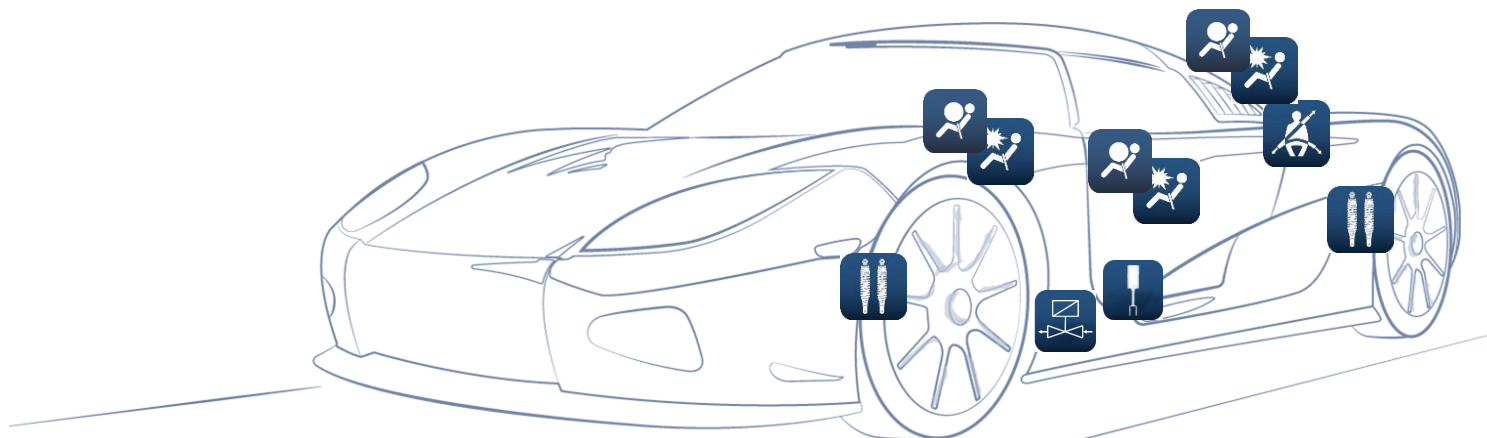
Safety Features

AC System

Various Components

Final Assembly

Safety features



Automotive Component	Air suspension valve	Air suspension cylinder	Shock absorber	Seat belt pretensioner	Airbag ignitor caps	Airbag generator
Testing method	Vacuum	Vacuum	Vacuum	Accumulation	Bombing	Vacuum
Typical leak rates	~ 10 ⁻⁵ mbarl/s	~ 10 ⁻⁵ mbarl/s	~ 10 ⁻⁴ mbarl/s	10 ⁻³ ...10 ⁻⁴ mbarl/s	~ 10 ⁻⁴ mbarl/s	Cold gas: 10 ⁻⁶ ...10 ⁻⁸ mbarl/s Hot gas: 10 ⁻³ ...10 ⁻⁵ mbarl/s
Recommended INFICON products	<u>Modul1000</u> <u>LDS3000</u>	<u>Modul1000</u> <u>LDS3000</u>	<u>Modul1000</u> <u>LDS3000</u>	<u>LDS3000 AQ</u>	<u>Modul1000</u> <u>LDS3000</u>	<u>Modul1000</u> <u>LDS3000</u>

Drive Train

Alternative Drives

Fuel System

Oil & Water circuit

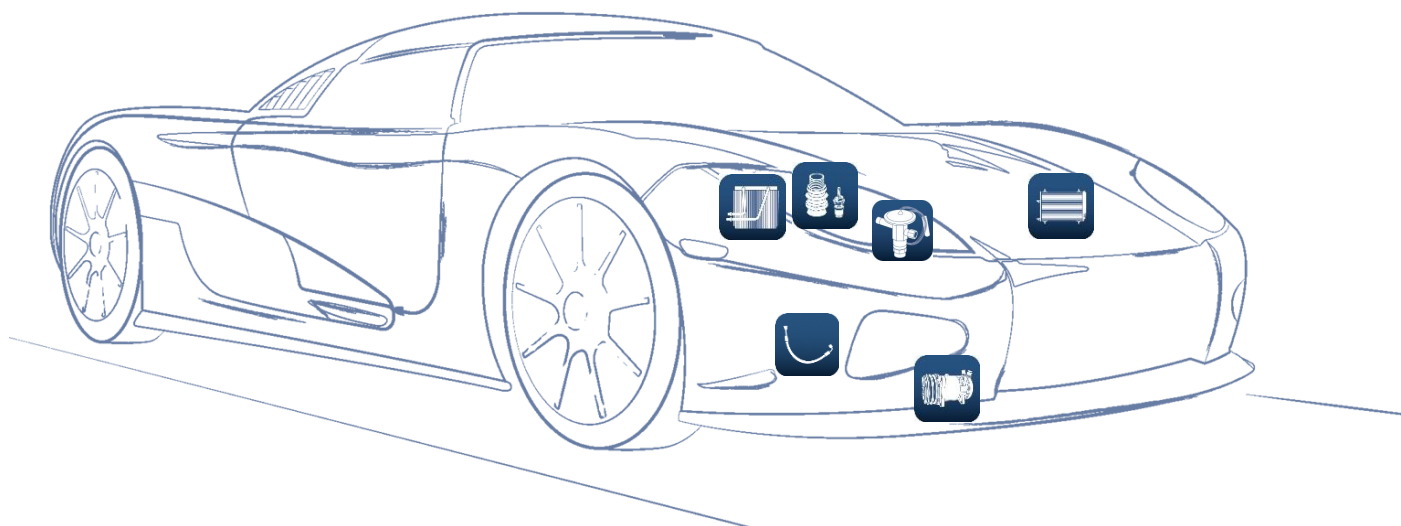
Safety Features

AC System

Various Components

Final Assembly

AC system



Automotive Component	AC hoses	AC compressor	Evaporator	Condensor	Filling valve	Expansion valve
Testing method	Accumulation	Accumulation / Vacuum	Accumulation / Vacuum	Accumulation / Vacuum	Accumulation / Vacuum	Accumulation / Vacuum
Typical leak rates	~ 10 ⁻⁵ mbar/s	~ 10 ⁻⁵ mbar/s	~ 10 ⁻⁵ mbar/s	~ 10 ⁻⁵ mbar/s	~ 10 ⁻⁵ mbar/s	~ 10 ⁻⁵ mbar/s
Recommended INFICON products	<u>LDS3000 AQ</u>	<u>LDS3000 AQ</u> <u>LDS3000</u> <u>Modul1000</u>	<u>LDS3000 AQ</u> <u>LDS3000</u> <u>Modul1000</u>	<u>LDS3000 AQ</u> <u>LDS3000</u> <u>Modul1000</u>	<u>LDS3000 AQ</u> <u>LDS3000</u> <u>Modul1000</u>	<u>LDS3000 AQ</u> <u>LDS3000</u> <u>Modul1000</u>

Drive Train

Alternative Drives

Fuel System

Oil & Water circuit

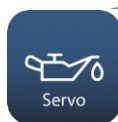
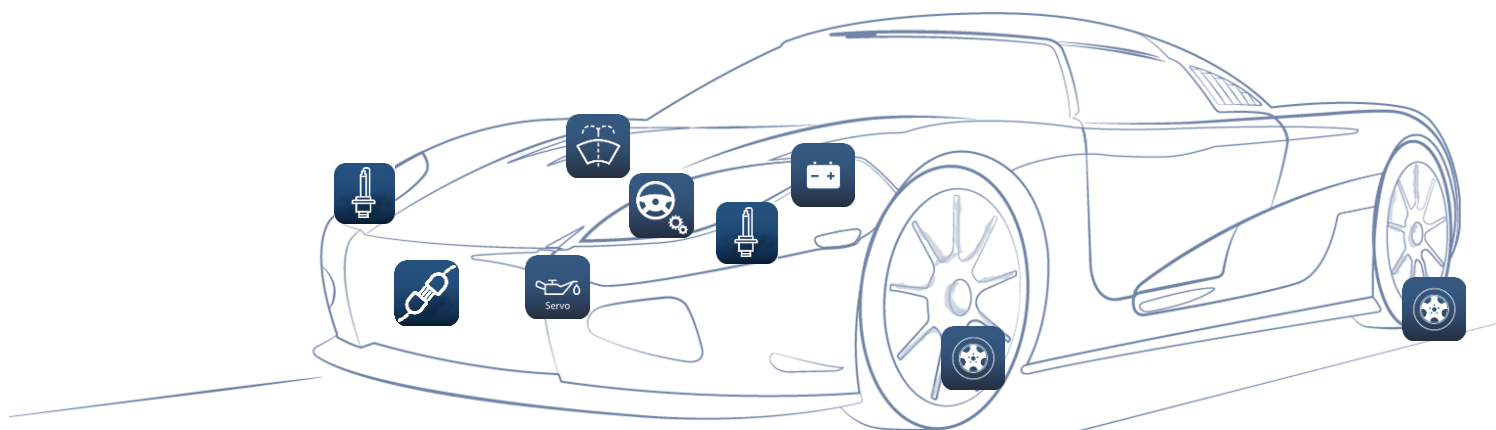
Safety Features

AC System

Various Components

Final Assembly

Various components



Automotive Component	Power steering housing	Servo oil reservoir	Windshield wiper fluid container	Wheel rims	Xenon light bulbs	Starter battery
Testing method	Accumulation	Accumulation	Accumulation	Vacuum	Sniffing	Accumulation
Typical leak rates	$10^{-2} \dots 10^{-4}$ mbar/s	$10^{-2} \dots 10^{-4}$ mbar/s	$\sim 10^{-2}$ mbar/s	$\sim 10^{-4}$ mbar/s	$\sim 10^{-6}$ mbar/s	$\sim 10^{-3}$ mbar/s
Recommended INFICON products	LDS3000 AQ Sensistor ISH2000	LDS3000 AQ Sensistor ISH2000	Sensistor ISH2000 LDS3000 AQ	Modul1000 LDS3000	Ecotec E3000	LDS3000 AQ Sensistor Sentrac

Drive Train

Alternative Drives

Fuel System

Oil & Water circuit

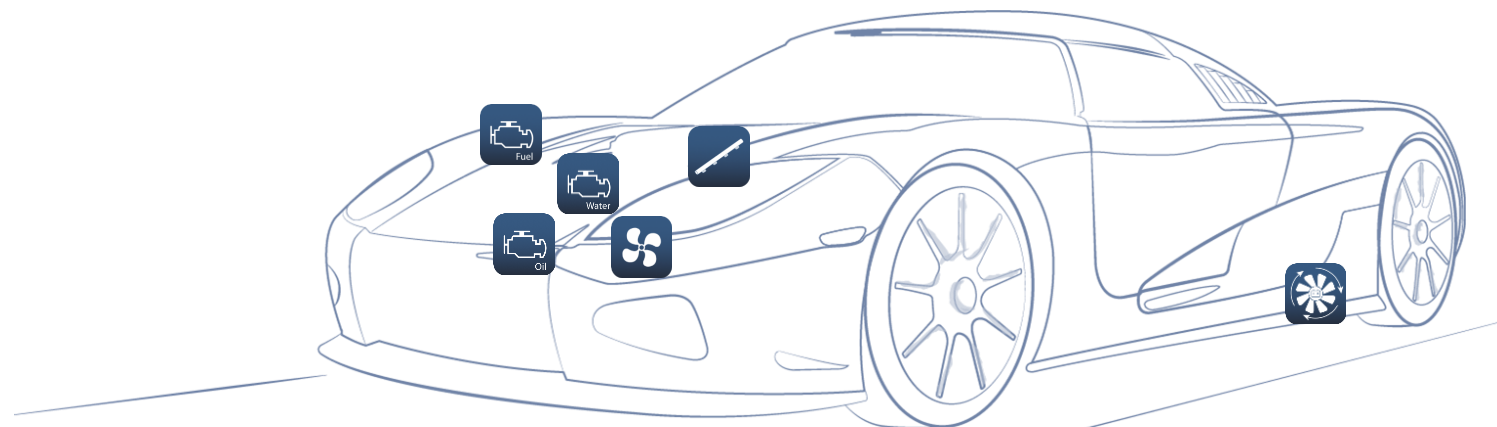
Safety Features

AC System

Various Components

Final Assembly

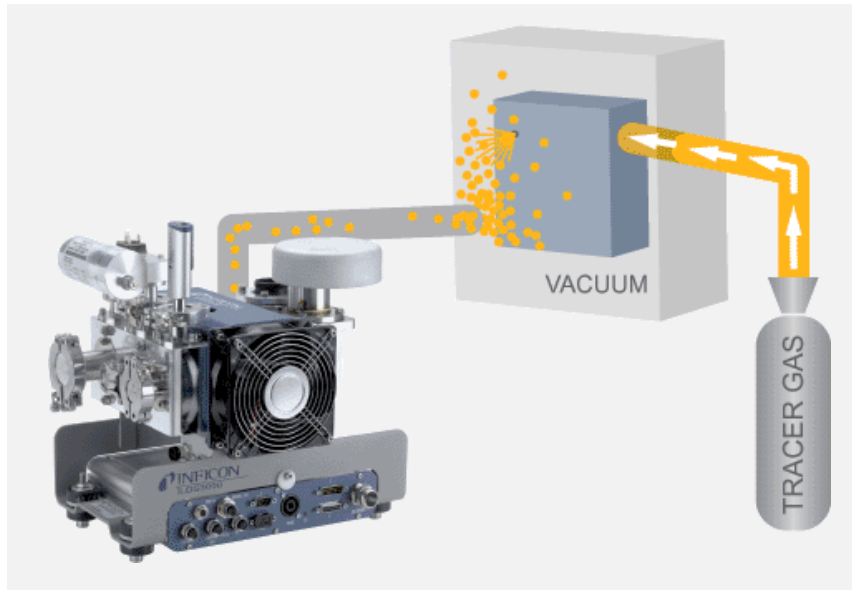
Leak Testing in Final Assembly



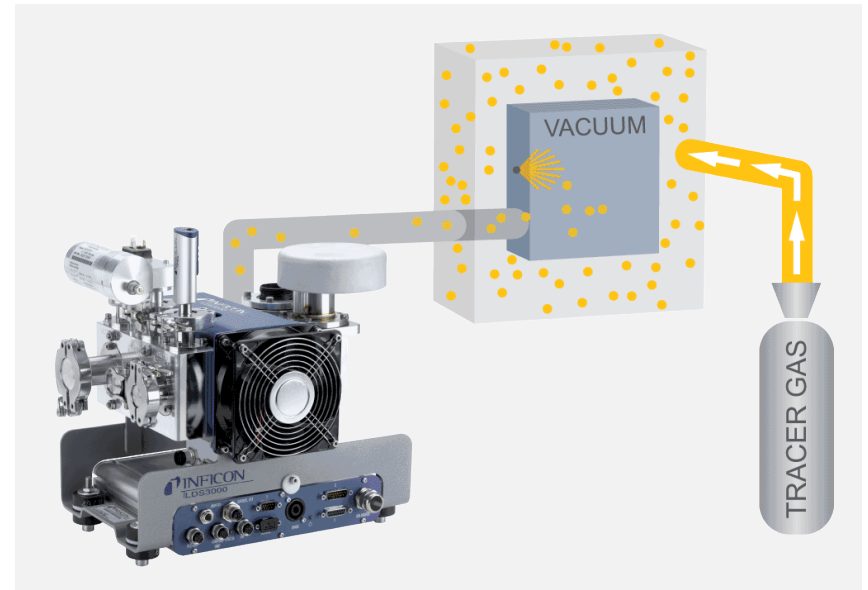
Automotive Component	Air conditioning systems	Engine oil circuit	Engine water circuit	Engine fuel circuit	Cooling circuit for Drive battery	Fuel rail connections
Typical leak rates	5 g/a of refrigerant per joint	~10 ⁻¹ mbar/s ~ 10 sccm	~10 ⁻¹ mbar/s ~ 10 sccm	10 ⁻³ ...10 ⁻⁵ mbar/s	5 g/a of refrigerant per joint	~ 10 ⁻⁴ mbar/s
Recommended INFICON products	HLD6000 Ecotec E3000	Sensistor Sentrac	Sensistor Sentrac	Sensistor Sentrac XL3000flex Protec P3000(XL) Ecotec E3000	HLD6000 Ecotec E3000	HLD6000 Ecotec E3000

Leak testing methods 1

Integral testing



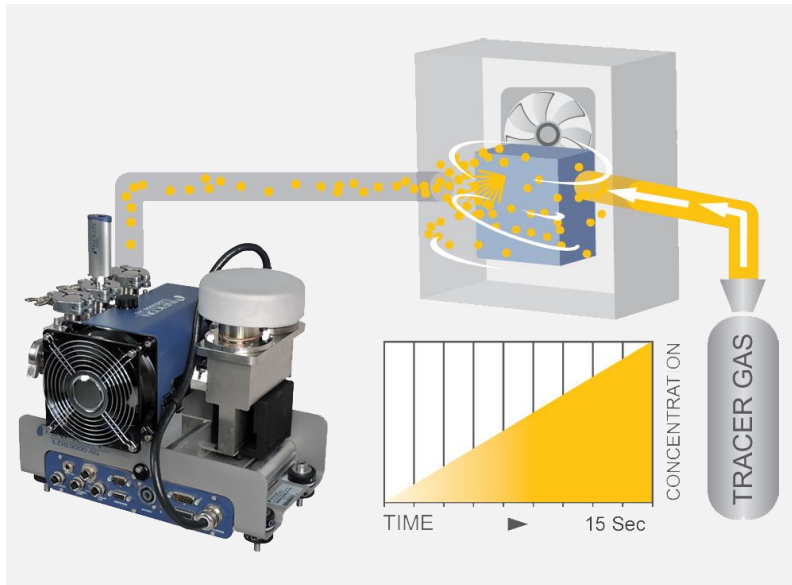
Vacuum leak testing Inside-out



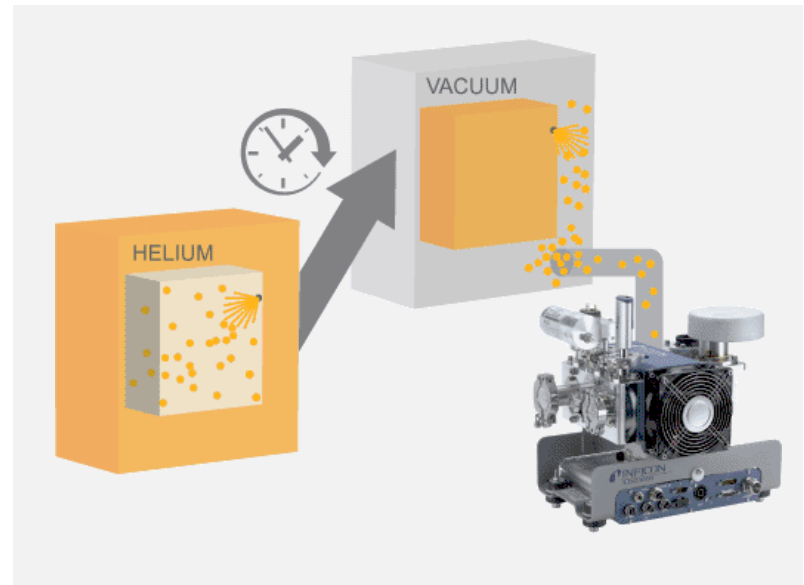
Vacuum leak testing Outside-in

Leak testing methods 2

Integral testing



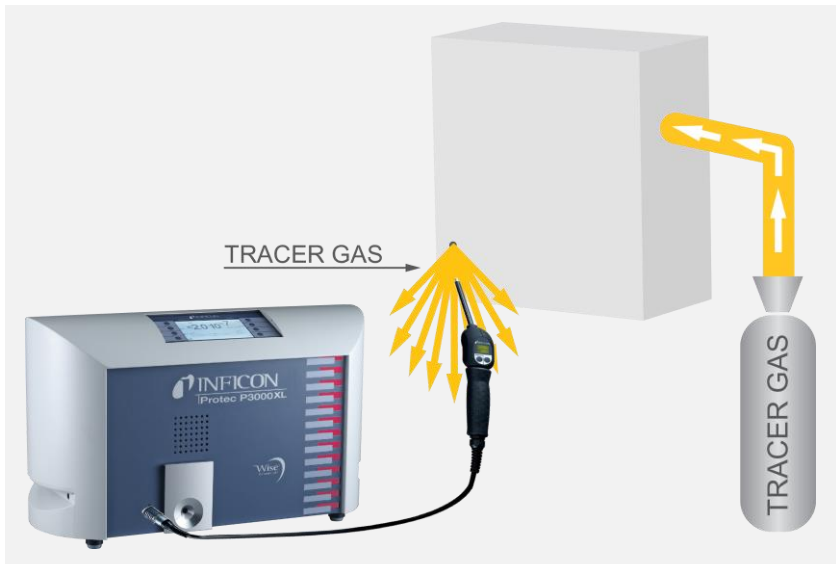
Accumulation leak testing



Bombing leak testing

Leak testing methods 3

Leak localization

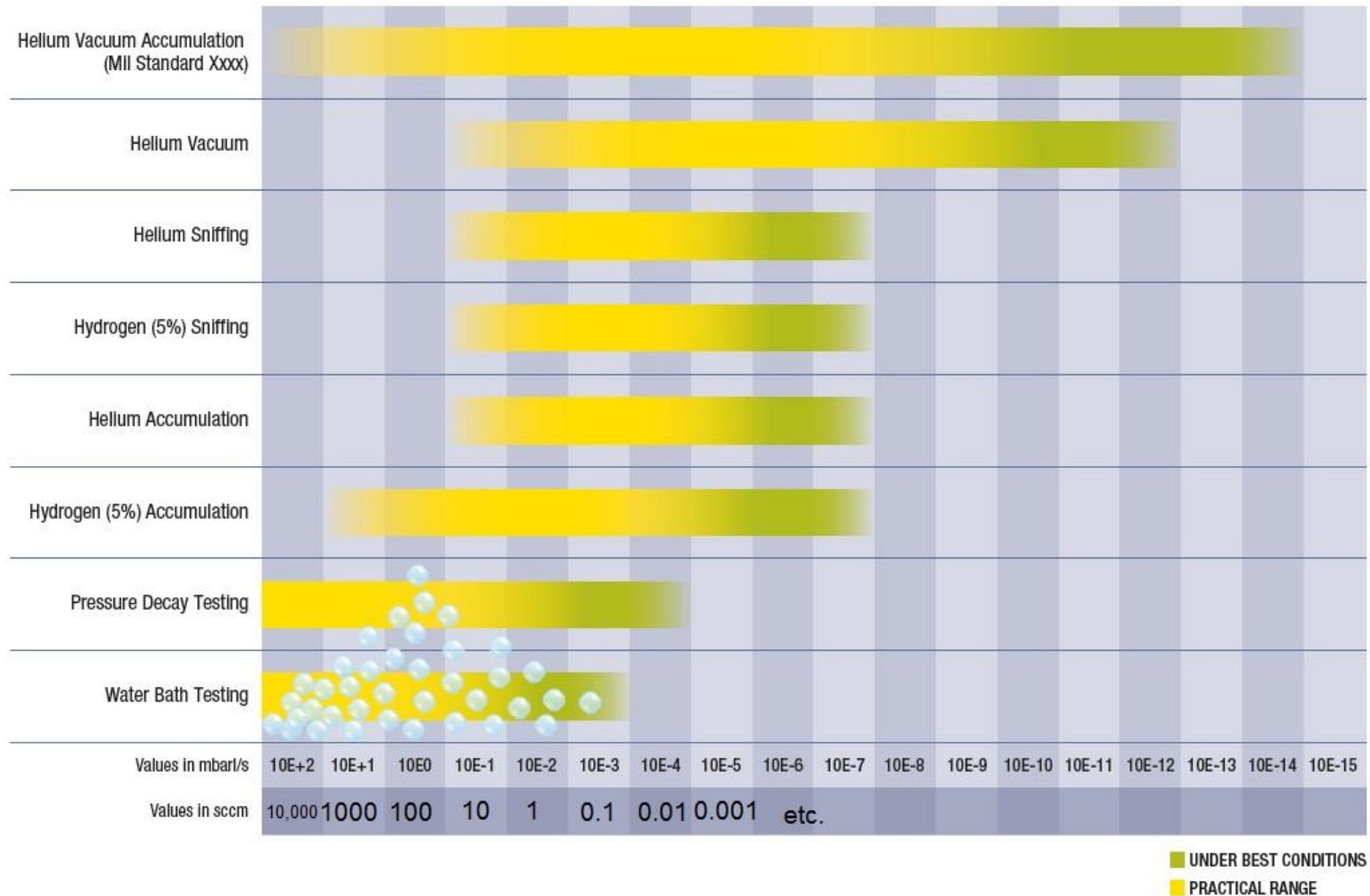


Sniffer leak testing



Spraying leak testing

Leak rate limits vs leak testing method



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DAIMLER



CHRYSLER



Mercedes-Benz



MITSUBISHI



TOYOTA

ISUZU



PSA PEUGEOT CITROËN



RENAULT

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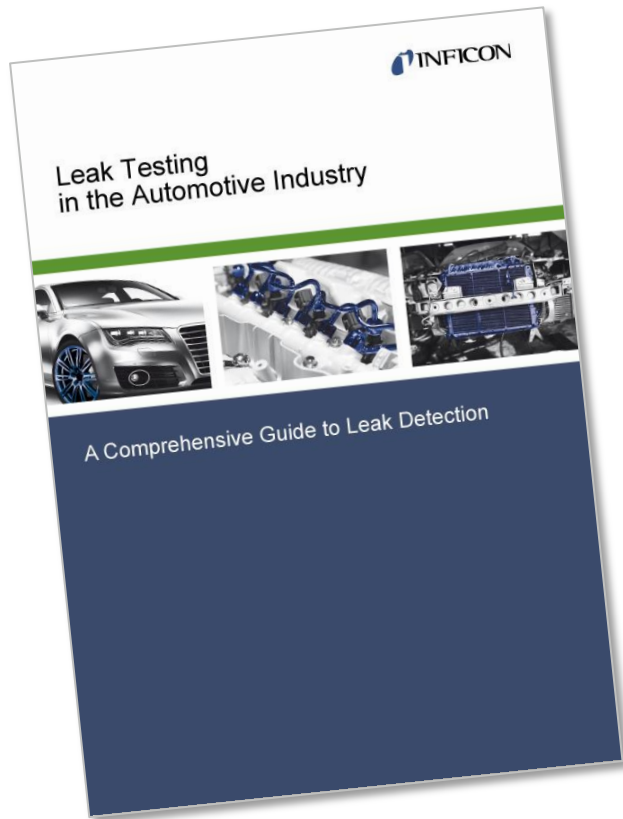
MOTOR COACH
INDUSTRIES

DETROIT DIESEL
CORPORATION



INFICON customers – Automotive Suppliers





NEW E-BOOK GUIDE

Leak Testing in the Automotive Industry

For vehicle manufacturers and their suppliers

The new INFICON e-book, "Leak Testing in the Automotive Industry: A Comprehensive Guide to Leak Detection," is designed to help manufacturers avoid possible pitfalls when selecting a leak detection method for their particular application.

FROM THE LEAK TESTING EXPERTS

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