PROTECTING INFRASTRUCTURE AND IMPROVING ROAD SAFETY

Weigh In Motion

The key to sustainable road management and protection

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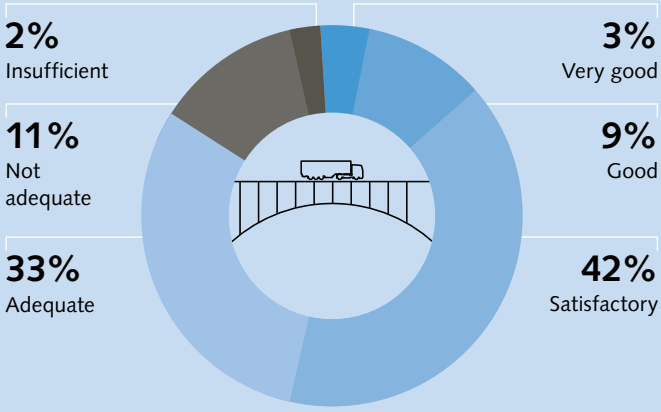
Contents



Germany's bridges – in need of refurbishment

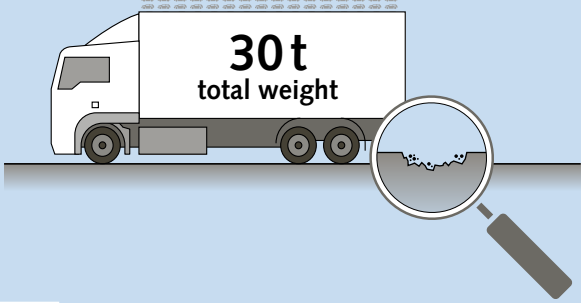
Structural condition of bridges on Federal highways, in percent
Not adequate: a repair must be carried out in the near future
Insufficient: stability is severely impaired, or the bridge is no longer stable

Source: German BMVI, 2018

Road lifetime

A three-axle truck with a total weight of 30 t causes the same amount of damage to the road surface as 7,500 passenger cars.

According to AASHO 4th power law

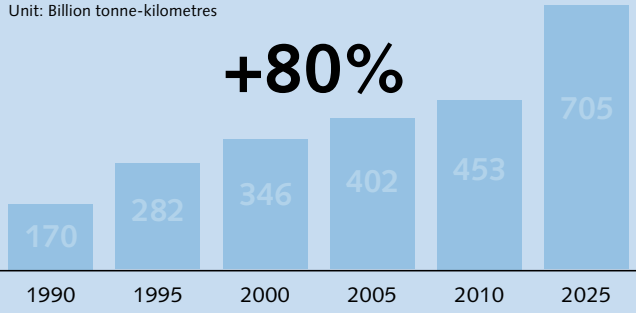


More safety on the roads

Truck traffic until 2025

By 2025, the Federal German government expects a total increase of over 80 percent in long-haul goods transport by road, as compared to the level in 2004.

Unit: Billion tonne-kilometres

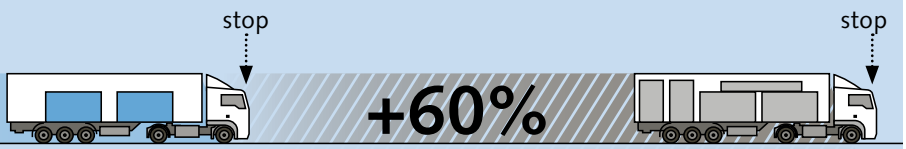


Danger on the roads

32,189 truck accidents on German roads in one year, with 759 lives lost (2017 figures) – trend is upwards.

Long braking distance caused by incorrect loading

The braking distance of an incorrectly loaded truck is up to 60 percent longer than for a correctly loaded vehicle.



Source: Forschungs- und Technologiezentrum Ladungssicherung Selm gGmbH, 2015

Protecting infrastructure and improving road safety

Overloaded or incorrectly loaded trucks are more likely to be involved in accidents and cause more road damage than legally loaded vehicles. This makes it essential to identify violators and remove them from the road. To achieve these goals, many highway authorities opt for complete WIM systems from Kistler – the key to improving road safety and cutting maintenance costs.

Overloaded trucks pose a real threat to highways and roads. A vehicle's impact on the road surface is related to its weight by a power of four. According to the Fourth Power Law, which was derived from road tests in the US during the 1950s, the increase in the force acting on the road is not linear, but exponential – by a power of four. So each additional kilogram vastly increases the hazard.

Risk to other road users

Incorrectly loaded trucks are less stable and more difficult to control, so they are more likely to be involved in accidents. Overloaded trucks cause brakes to overheat, leading to longer braking distances. An overloaded vehicle will often have a greater impact on other road users in case of an accident, with the risk of more serious damage and casualties.

Kistler WIM equipment is the key to detecting trucks that violate the loading regulations so they can be excluded from traffic – making the roads safer for everyone. And WIM technology from Kistler offers another benefit: roadside inspectors can automatically screen tire pressures on all passing vehicles to identify potentially unsafe or flat tires.

Reducing road infrastructure damage

WIM systems from Kistler provide enforcement authorities with an efficient solution for excluding overloaded vehicles. Less damage is inflicted on the road infrastructure, so maintenance costs can be greatly reduced. Another unwelcome problem for road operators is toll evasion – but a WIM system offers an effective way of detecting vehicles that attempt to use the highway without paying. WIM systems also optimize toll collection: available options include free-flow collection from vehicles moving at high speeds as well low-speed manual or electronic toll collection (ETC) at toll plazas.

The complete WIM system – from one single source

As well as single components, Kistler offers its customers complete and fully integrated systems. Covering the entire range from high-end solutions to entry-level equipment, customized solutions from Kistler ensure that every WIM system precisely meets the requirements of each user's specific application.

WIM application	Required GVW accuracy	Recommended WIM system
Traffic data collection and bridge protection	±10-15%	KiTraffic Statistics see page 16
Preselection for weight/tire enforcement and bridge protection	±5-10%	KiTraffic Basic see page 17
Direct weight and tire enforcement	±2-5%	KiTraffic Digital see page 14

System components

Quartz WIM sensor

Lineas Compact

- Excellent price-performance ratio
- Wide measuring range thanks to quartz technology
- Compact design for fast and simple installation in all types of road paving

Lineas Type G

- Wide measuring range thanks to quartz technology
- Meets OIML R134 (class 2) and ASTM E1318 Types I & III
- Very long lifetime with low maintenance
- Withstands temperature fluctuations
- Fast, simple installation in all types of road paving
- Compatible with Automated Tire Screening (ATS)

Lineas Digital

- Ultra-high precision quartz WIM sensor
- Reliable data in free-flow traffic (e.g. lane changes)
- Capable of screening tire properties (single/dual and flat tires)
- Digital output and Power over Ethernet (PoE)
- No loops required

Roadside equipment

Reliable weight and tire data with Kistler's WIM Data Logger

- High weighing accuracy (certified to OIML R134, classes F10 and F5 and ASTM E1318 Types I & III)
- Can monitor up to 4 traffic lanes
- Handles stop-and-go traffic
- Wide speed range (0 to 250 km/h)
- Measuring range up to axle loads of 50 tonnes
- Detects single/dual and flat tires
- Fast setup thanks to modern web interface

see page 19

Industrial grade standard electronics.

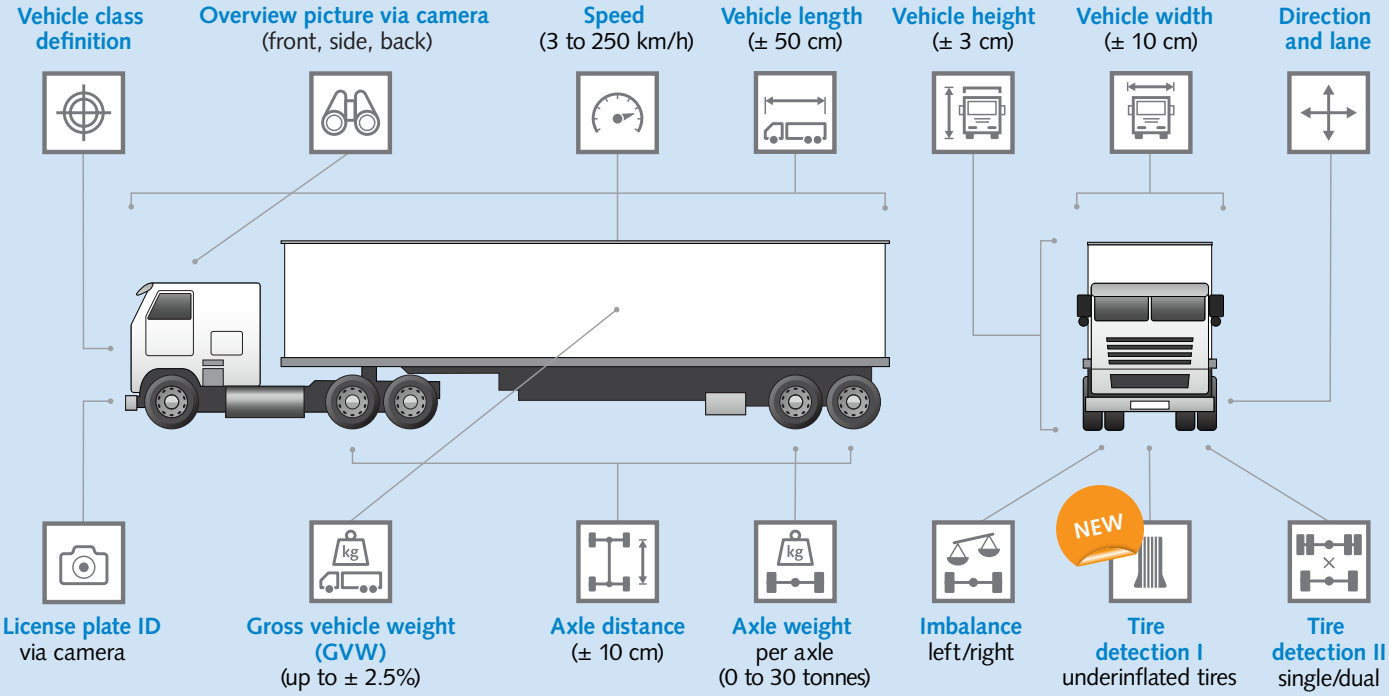
- Covers unlimited number of lanes

User interfaces

User-friendly interface of WIM systems from Kistler

- equipped with a state-of-the-art web-based user interface
- Operators can set up the entire system, read out measurement data and change settings with no need to install additional software
- all relevant information is available to other systems via the machine-readable REST API interface and Ethernet stream.

What data does a WIM system deliver?



One system – multiple applications

WIM systems from Kistler can measure much more than just weight. They collect critical information from vehicles traveling at widely varying speeds. Thanks to highly accurate measurement data, customers can monitor traffic in real time and collect vehicle data (such as number of axles, weight per axle or axle distance) as well as information on tire issues. With these capabilities, WIM systems from Kistler cover a diverse spectrum of applications:

WIM systems from Kistler

- **Traffic data collection** page 9
  for pavement design or load rate factor calculations; for bridge fatigue calculations
- **Bridge protection** page 10
  to extend bridge lifetimes and reduce risk
- **Weight and tire enforcement** page 11 and 12
  (preselection or direct enforcement) to increase traffic safety
- **Industrial truck weighing** page 13
  for ports, mines, logistics zones and other industrial facilities; to invoice industrial goods by weight and check axle loads or total loads
- **Toll collection** page 13
  (manual or electronic toll-by-weight) for fair weight-based charging

Traffic data collection

Information on traffic loads helps to optimize road and bridge maintenance, improve traffic safety, and enhance road and bridge design. Kistler's WIM technology delivers automated real-time traffic monitoring without disrupting the traffic flow.

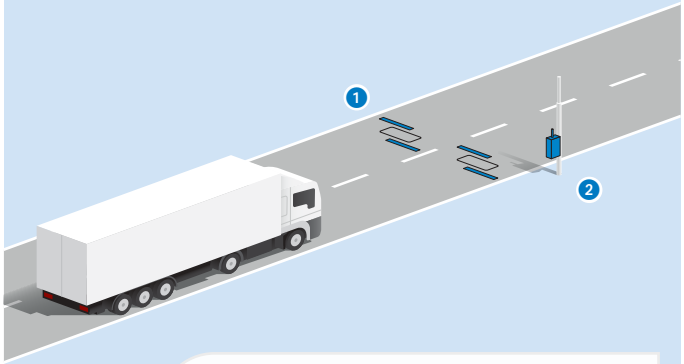
Automated traffic monitoring delivers a comprehensive overview of traffic flows. The results: optimized road infrastructure, better maintenance planning and lower costs. Kistler's KiTraffic Statistics system is easily integrated into existing traffic monitoring solutions to collect a wide range of traffic data in real time. It delivers years of detailed and reliable data on traffic volume, vehicle classification, axle loads and gross vehicle weight for all vehicles passing a WIM site.

Benefits of traffic data collection with Kistler:

- Automated non-stop traffic data collection
- Optimized infrastructure and maintenance planning
- Tracking of special transports

1 Lineas Compact WIM sensors (staggered layout) and inductive loops installed in the pavement

2 WIM electronics with wireless data transfer in roadside cabinet and power supply via wire or solar panel



Recommended WIM system
KiTraffic Statistics (page 16)

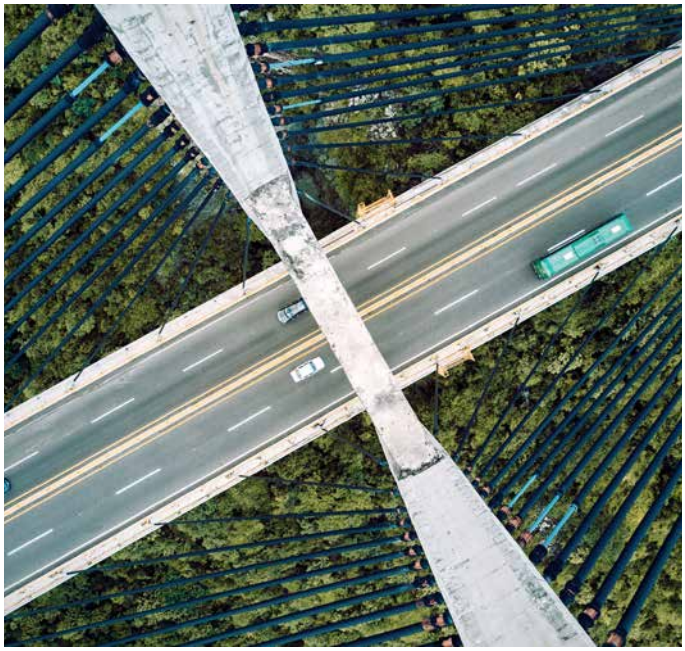
Bridge protection

Bridges are sensitive components of the traffic infrastructure, and their lifetimes are limited. WIM equipment from Kistler monitors real traffic loads and can detect overloaded vehicles. WIM systems ahead of a bridge can stop and divert overloaded vehicles, so the bridge is protected from excessive stress.

Traffic volumes are soaring all over the world, and many bridge structures are in the process of aging – two factors that combine to create a hazardous situation. Weigh In Motion systems from Kistler are the solution of choice for bridge protection: by supplying reliable data about actual loads on bridges, they ensure that maintenance is scheduled accurately. WIM can also detect overloaded vehicles before they drive onto the bridge, so access can be restricted.

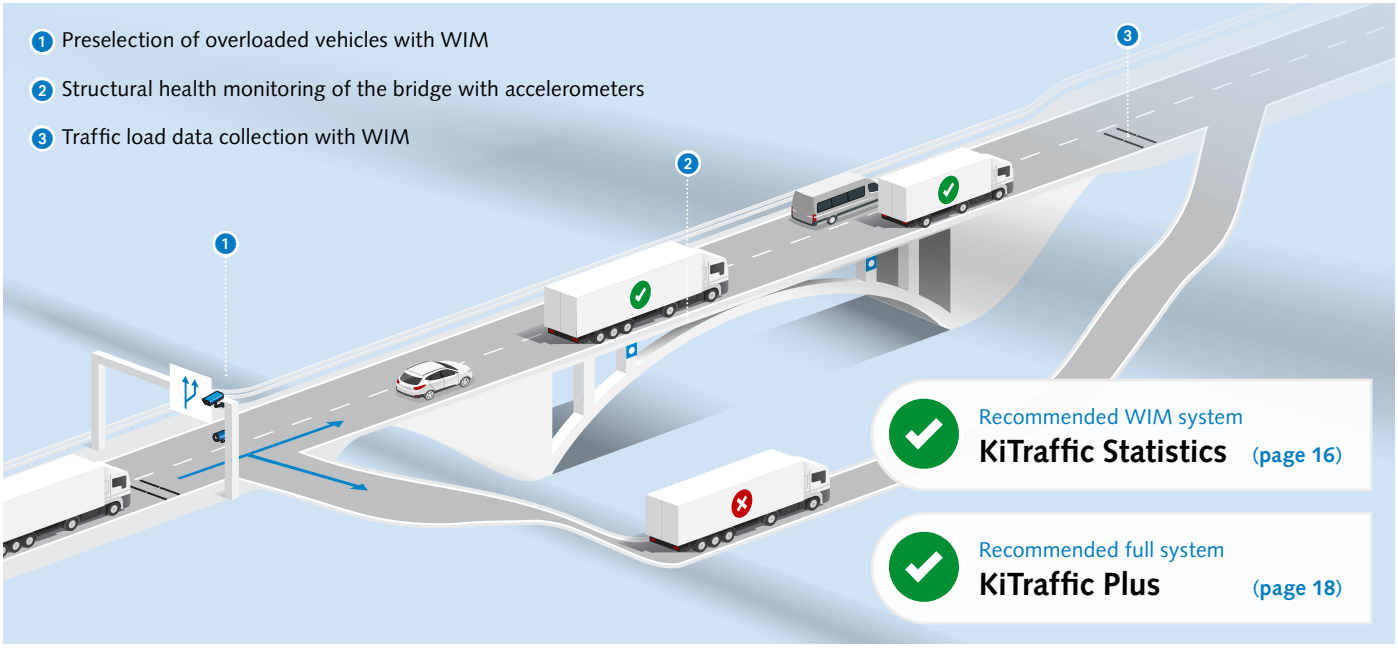
Kistler offers three approaches to protecting bridges, depending on the phase of the structure's lifetime:

- Before a bridge is identified as critical: real traffic load monitoring with Weigh In Motion. Traffic loads have a direct impact on bridge fatigue, so real traffic load analysis is an important factor in calculating a bridge's remaining lifetime.
- Structural health monitoring: strain gage sensors, accelerometers and many more technologies from Kistler are optimal solutions for monitoring changes in a bridge's structural behavior – so faults are detected at an early stage.
- Once a bridge is identified as critical: preselection of overloaded/heavy vehicles with Weigh In Motion. Identified trucks are rerouted via a detour.



Benefits of bridge protection with WIM by Kistler:

- Reliable calculation of remaining bridge lifetime: thanks to monitoring of real traffic loads
- Reduced risk: early detection and continuous monitoring of critical structures
- Longer bridge lifetimes: overloaded vehicles are prevented from crossing the bridge



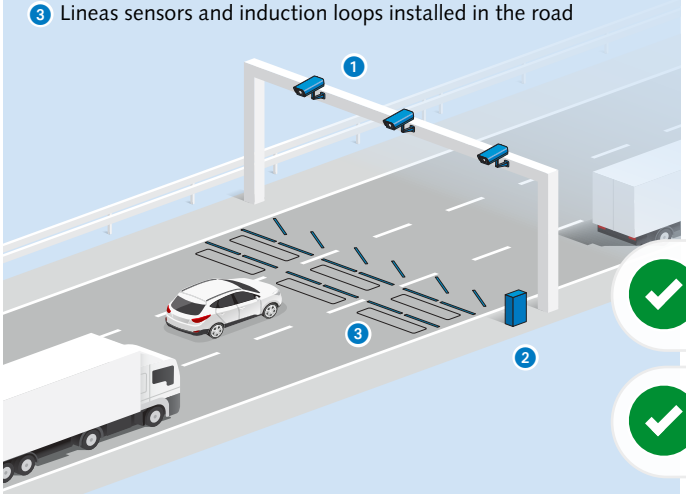
Preselection for weight and tire enforcement

Local authorities are required to identify and fine overloaded vehicles. Increasing road traffic volumes make it crucial to select the right vehicles for checking. Preselection or screening with WIM is an efficient method of sorting traffic so that legally compliant vehicles can be distinguished from potential violators. Inspection and evaluation can then focus on high-risk operators.

Screening is deployed to make more efficient use of enforcement resources. Quantifiable performance measurements eliminate the risk of stopping vehicles that are compliant with legal weight thresholds. This makes the authority's weight enforcement campaigns more efficient, leading to better hit rates for penalizing overloaded vehicles.

Cost-efficient detection of overloaded vehicles
Kistler's KiTraffic Plus system delivers cost-efficient detection of overloaded vehicles at any driving speed. The WIM system can easily be upgraded with the new Automated Tire Screening (ATS) solution by Kistler. This technology can automatically screen tire pressures on all passing commercial vehicles to identify potentially unsafe or flat tires. The combination of WIM and tire screening is a highly cost-effective solution: simply adding two extra sensors to the WIM site is enough to ensure reliable detection of flat tires.

1. Automatic Number Plate Recognition (ANPR) cameras, overview camera and variable message signs installed on a gantry
2. Roadside cabinet with WIM electronics
3. Lineas sensors and induction loops installed in the road



Benefits of preselection with WIM by Kistler:

- Automatic preselection of overloaded vehicles
- 24/7 recording of overloaded vehicles
- Better planning to make weight enforcement campaigns more efficient
- Less road damage, so public spending is reduced
- Illegal competition between transport companies is prevented
- A cost-effective solution: WIM combined with Automated Tire Screening (ATS)

Recommended WIM system
KiTraffic Basic (page 17)

Recommended full system
KiTraffic Plus (page 18)

Direct weight enforcement

Overloaded vehicles are not only dangerous for other road users – they are also responsible for most of the damage caused to road surfaces and bridges. Direct enforcement systems with Kistler's WIM equipment offer the most efficient way of enforcing overloaded vehicles in real time.

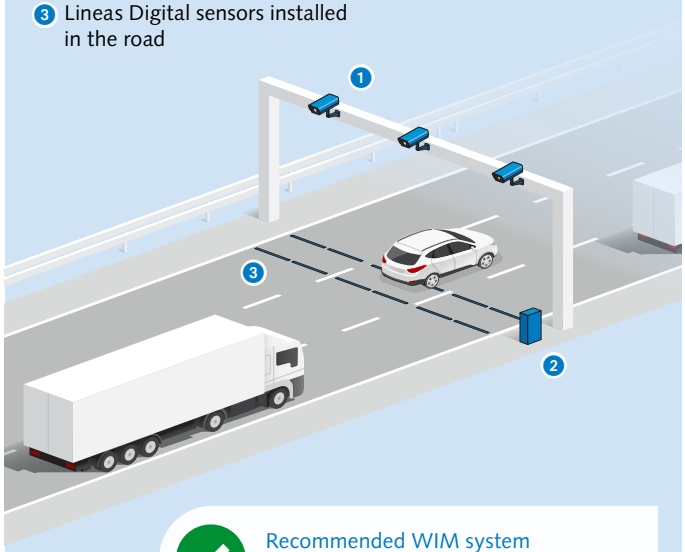
For vehicle identification, WIM solutions from Kistler can be combined with overview cameras and Automatic Number Plate Recognition (ANPR) systems. These additional subsystems are triggered automatically, providing an efficient tool for direct enforcement that eliminates the need to install a static scale. The KiTraffic system notifies the authority's office of any vehicle that exceeds the weight limit: the message includes the exact weight as well as a photograph of the vehicle including its license plate. Staff can then locate the owner in a national database and print a standard penalty letter. These systems have been already been implemented with successful results in Hungary, Russia and the Czech Republic. Direct enforcement is also under preparation in a number of other countries in Europe and Southeast Asia.

Benefits of direct enforcement with WIM by Kistler:

- Maximum hit rate to identify overloaded trucks
- 24/7 direct enforcement of overloading violations
- Direct fining of overloaded trucks – no need to install static scales
- Simplified planning for mobile weight controls
- Reduced road damage saves public spending
- Improved traffic safety

Kistler WIM systems and components are integral elements of **certified solutions** for direct enforcement in all countries where this procedure is permitted by law.

1. Automatic License Plate Recognition (ANPR) cameras with overview camera installed on a gantry
2. Roadside cabinet with WIM electronics
3. Lineas Digital sensors installed in the road



Recommended WIM system
KiTraffic Digital (page 14)

Recommended full system
KiTraffic Plus (page 18)

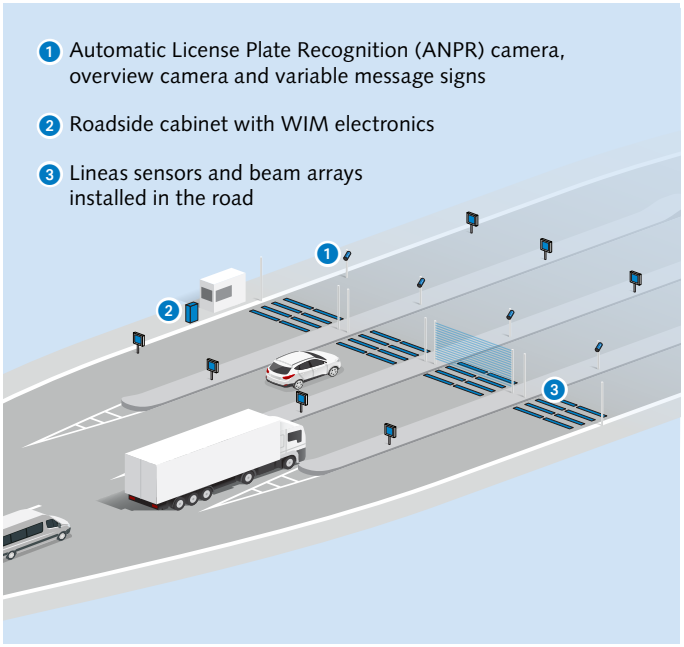
Industrial truck weighing

Industrial trucks are usually weighed for two reasons: to invoice industrial goods by weight, or to check axle and gross vehicle weight so as to prevent overloading and avoid the risk of heavy fines. With WIM equipment from Kistler, trucks can be weighed without stopping. This saves time and money: the investment pays for itself in a matter of months or even weeks.

Efficient and fast weighing of large numbers of trucks is a key advantage at industrial production sites such as cement plants or mines, and also in ports. Kistler's OIML-certified WIM Data Logger and piezoelectric Lineas quartz strip sensors can be used to weigh trucks moving at any speed. The WIM system increases throughput to several hundred trucks per hour and generates legally compliant commercial data for billing goods by weight. Kistler offers a complete WIM package for industrial weighing that includes all the components needed to set up the system.

Industrial truck weighing with WIM from Kistler:

- Certified to OIML R134 for legally compliant weighing
- Unique quartz measurement technology for extreme precision
- Rapidly installed with minimal disruption – ideal for ports, industrial facilities and mines
- Maintenance-free, even during continuous long-term usage



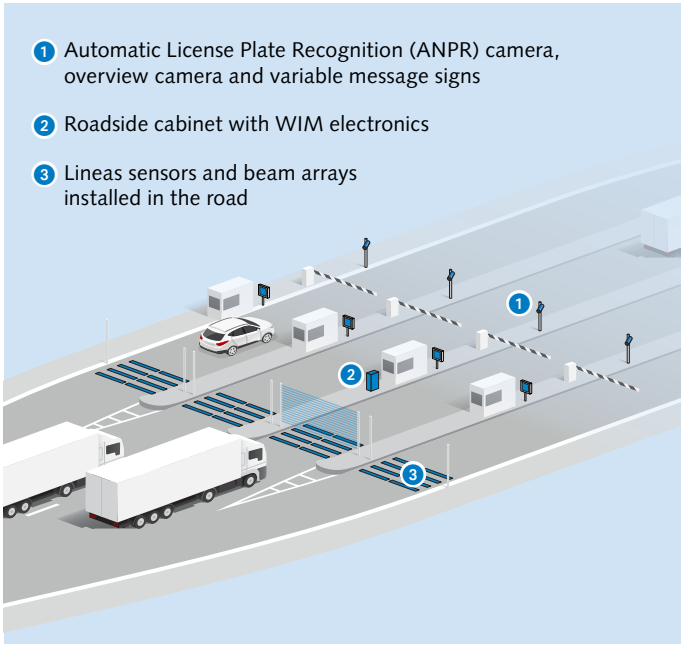
Toll-by-weight

In line with the "causer pays" principle, the fee for using a toll road should be proportional to the wear caused by the vehicle. Toll-by-weight solutions with Kistler's WIM equipment generate additional revenue to finance infrastructure and ensure fair road prices. With weight-based road tolls, road users pay according to the actual weight of their vehicles.

The WIM system for weight-based tolling helps to generate additional revenue for road construction and ensures that road usage fees are fair. Aided by these accurate and reliable systems, road owners and operators can sanction weight limit violations immediately. The WIM system uses integrated cameras to identify vehicles directly, so tolls can be levied automatically without hindering traffic flow.

Toll-by-weight with WIM from Kistler:

- Fair calculation of tolls
- Higher revenue to cover maintenance expenses
- Penalization of weight limit violations
- Denial of access for overloaded vehicles
- Systems for free flow or open road tolling available



KiTraffic Digital
– accurate, reliable and robust

KiTraffic Digital
OIML class F5 certified
WIM system

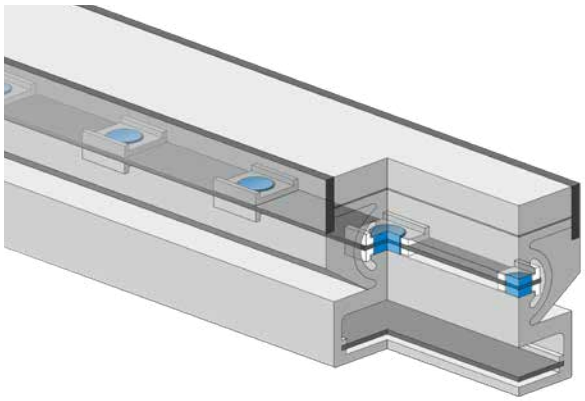
KiTraffic Digital: the robust new solution from Kistler delivers top performance with the advantage of a fully digitized measuring chain.

Kistler has achieved a breakthrough in WIM with the robust, all-new KiTraffic Digital system: we have now combined our tried-and-tested quartz-based sensors with cutting-edge digitalization technology.

KiTraffic Digital calculates wheel and axle loads as well as total vehicle weight with absolute precision, regardless of driving maneuvers. Multiple quartz crystals supply data independently via a digital interface, so each crystal can be calibrated individually with no signal interference on the transmission path. The new system promises accuracy of up to ±2% GVW, so weight violations can be identified immediately and penalized directly.

The design of KiTraffic Digital includes groundbreaking features to ensure robustness thanks to sensor health status monitoring, standard industrial grade electronics, digital signal transmission and Power over Ethernet. And KiTraffic Digital operates without the induction loops that were necessary in the past – in the new solution, the sensor itself detects the presence of vehicles and their classes.

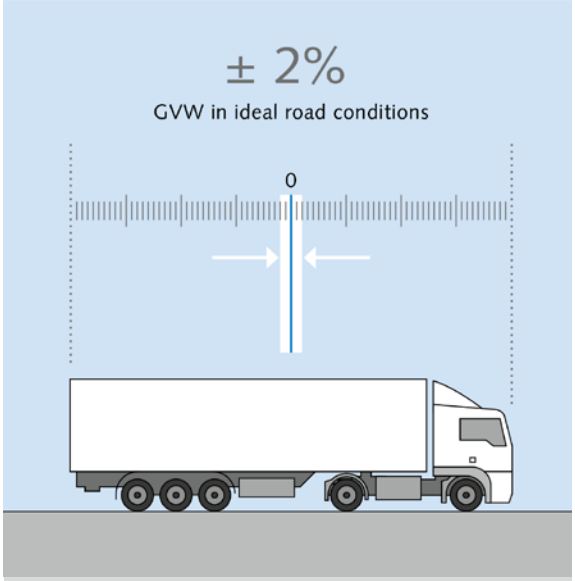
The list of benefits goes on: the position of the force signal is also used to reliably detect single and dual tires and compensate road influences. The same sensor that is already installed in the road can reliably detect flat tires. And standard interfaces ensure easy integration into higher-level or third-party systems (e.g. for weight enforcement, toll-by-weight or traffic monitoring)



All-new Lineas Digital sensor:
absolute accuracy because each single quartz is digitalized and calibrated

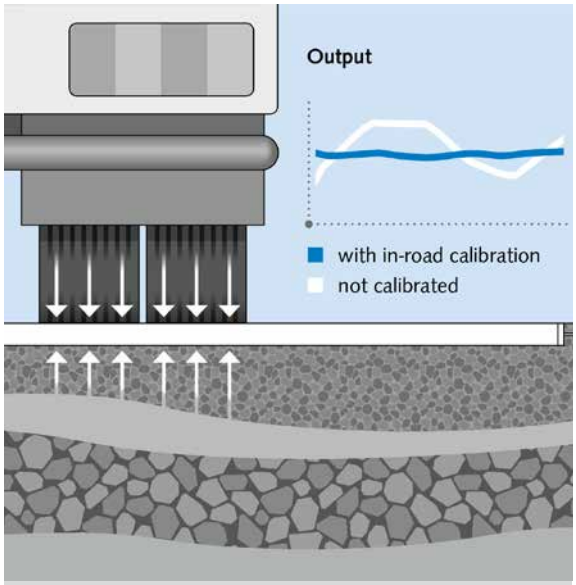
	KiTraffic Digital	
Typical system performance	**Standard**	**Advanced**
Gross vehicle weight (GVW)	±5%	up to ±2%
Speed	±1%	±1%
Axle distances	±5 cm	±5 cm
Vehicle length	±50 cm	±50 cm
System components		
Lineas Digital sensors	4 per lane	8 per lane
Inductive loop	0	0
Roadside cabinet with backpanel	1	1

Why is KiTraffic Digital the world's most advanced WIM system?



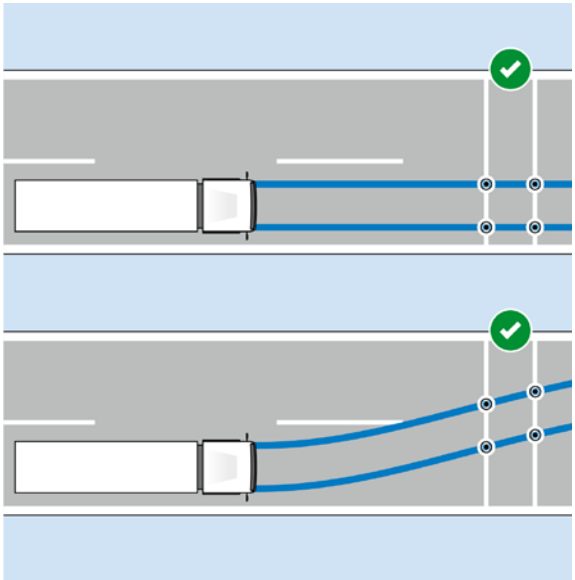
World's most accurate WIM sensor

- ± 1% in laboratory qualification tests
- ± 2% GVW in ideal road conditions
- < 5% GVW in almost any road conditions



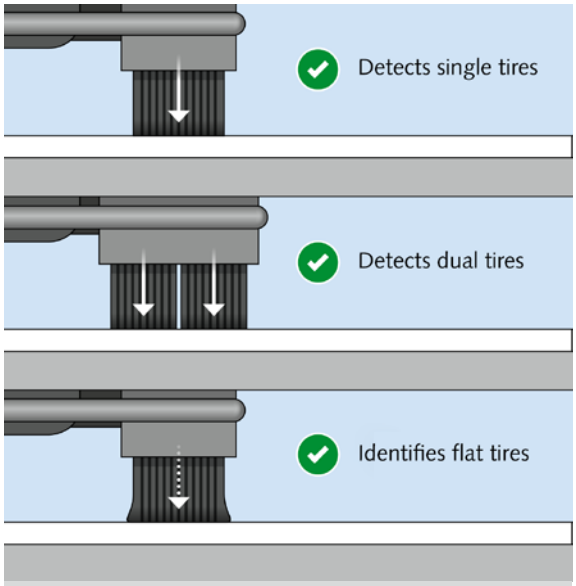
Can be adapted flexibly to WIM sites of all types

- Can be installed on an unlimited number of lanes
- Compensates influence of poor road quality



Guaranteed reliability in open-road traffic

- Regardless of driving maneuvers (lane changes)
- Regardless of lateral driving position



Cost-effective tire screening solution

- Detects single and dual tires
- Identifies flat tires

KiTraffic Statistics
– for optimized maintenance and protection

KiTraffic Statistics is the solution of choice for reliable, cost-effective vehicle counting and classification.

Valuable infrastructures such as roads and bridges demand efficient monitoring, optimized maintenance and long-term development planning. These goals can be achieved with automated systems to measure axle load and total weight – known throughout the world as WIM technology. KiTraffic Statistics, the complete package from Kistler, makes the job as simple as possible.

All over the world, traffic flows are soaring. Heavy and overloaded vehicles are exerting extreme stress on roads that are often subject to aging. A 30-tonne truck has the potential to cause just as much damage as 7,500 ordinary passenger cars. WIM systems from Kistler are the solution of choice for keeping track of road use, so operators can develop effective measures to protect and maintain bridges and highways. At relatively low cost, Kistler's systems deliver informative data about vehicle numbers and classes, axle loads and total weight throughout their long service lifetimes.

Real-time traffic data collection made easy with KiTraffic Statistics
Information on traffic volume and load plays a key part in long-term infrastructure planning, traffic safety improvement and road maintenance optimization. The WIM system from Kistler is the ideal choice for automated real-time traffic data collection.

The KiTraffic Statistics package contains all the necessary electronics, a WIM Data Logger and Kistler's latest Lineas Compact quartz sensors. These sensors are based on proven quartz technology and Kistler's large WIM experience, but come at an attractive price/performance ratio for statistical applications. KiTraffic Statistics is supplied as a pre-wired system that includes the induction loop detector, power supply and connectors – so setup is exceptionally fast.

Benefits of KiTraffic Statistics:

- Vehicle counting and classification, including weight data
- Wide measuring ranges for speed as well as weight
- Unique, tried-and-tested quartz sensor technology
- Quick and easy installation of sensors in road pavement
- Excellent price-performance ratio

	KiTraffic Statistics
Typical system performance	
Gross vehicle weight (GVW)	±15%
Speed	±5%
Axle distances	±10 cm
Vehicle length	±60 cm
System components	
Lineas Compact sensors	2 per lane
Inductive loop	1 per lane
WIM Data Logger	1 for up to 4 lanes

KiTraffic Basic
– the OIML-certified WIM system

KiTraffic Basic includes the WIM Data Logger with the vehicle separator and power supply unit, all pre-wired on a DIN rail for immediate operation.

Kistler's WIM package for basic traffic data collection contains all the key equipment you need to set up your high-performance WIM system. KiTraffic Basic includes the WIM sensors and grouting compound for the in-road installation as well as the roadside equipment, comprising the WIM Data Logger with loop card and the power supply unit, all pre-wired on a DIN rail for immediate operation.

KiTraffic Basic gives you the same accuracy, reliability and durability as all WIM systems from Kistler. Our maintenance-free quartz crystal Lineas WIM sensors are easily grouted into a slot in asphalt or concrete pavements. Throughout their long lifetimes, the sensors operate across very wide measuring ranges to ensure the same accuracy for light and heavy vehicles. And at the roadside, the WIM Data Logger is specifically designed to process signals from Lineas WIM sensors. It is easily integrated into existing solutions to deliver highly accurate data on gross vehicle weight, axle loads, wheel loads, vehicle length, axle distances, vehicle imbalance, speed, and driving behavior.

Everything you need for WIM – in one single package
KiTraffic Basic: one solution that performs multiple functions – traffic data collection, weight enforcement, toll collection and industrial truck weighing. The ideal way to protect road infrastructure and improve traffic safety.

Benefits of KiTraffic Basic:

- High accuracy and reliability thanks to unique quartz crystal technology
- Long-term stability (no aging), insensitive to temperature variations
- Robust design for high durability
- Can monitor up to four traffic lanes
- OIML-certified performance
- Digital inputs and outputs to interface with various peripherals

	KiTraffic Basic	
Typical system performance	**Standard**	**Advanced**
Gross vehicle weight (GVW)	±10%	±5%
Speed	±5%	±3%
Axle distances	±10 cm	±5 cm
Vehicle length	±50 cm	±50 cm
System components		
Lineas 9195G sensors	2 per lane	4 per lane
Inductive loop	1 per lane	2 per lane
WIM Data Logger	1 for up to 4 lanes	1 for up to 2 lanes

KiTraffic Plus
– the flexible solution for overload detection

A new and comprehensive solution for traffic monitoring based on Weigh In Motion: KiTraffic Plus gives you full control over direct enforcement or preselection of vehicles, bridge and tunnel protection, and many other applications.

With road usage and heavy truck traffic escalating all over the world, automated systems play a more important part than ever before: as well as monitoring traffic, they also have to enforce vehicles that violate laws or regulations governing weight, speed, dimensions and other parameters. KiTraffic Plus gives you a flexible solution that can be tailored to your specific scenario and application: you, the customer, are free to choose which components you need for preselection or direct enforcement of noncompliant vehicles.

As an open ecosystem, KiTraffic Plus can integrate field and measurement devices of all types. Standard options include:

- WIM system based on piezoelectric quartz sensors to capture axle load, gross weight, vehicle class and tire anomalies
- Integrated or external speed measurement
- Camera with ALPR (ANPR) capability for vehicle photos and license plate recognition
- Dimension scanner to capture a vehicle's width, length and height
- Software from Kistler to display preselection data live during traffic spot checks or post-processing of offenses

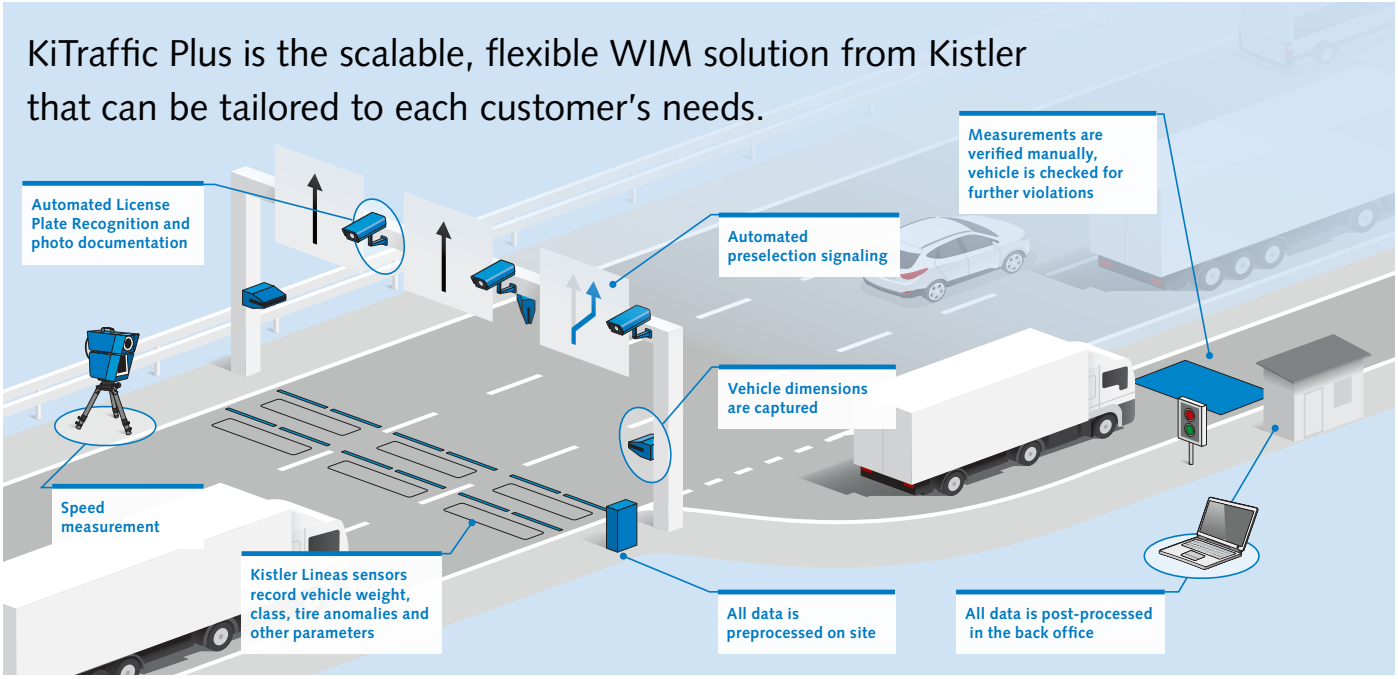
Main benefits of KiTraffic Plus:

- Efficient preselection of dangerous vehicles
- Open and adaptable system
- High reliability in all weather conditions
- Intuitive user interfaces
- Configurable alarms for different violations
- Versatile software packages
- Comprehensive Kistler services

Based on decades of WIM experience, KiTraffic Plus comes with full-scope WIM capability adaptable to your needs. Lineas piezoelectric sensors capture axle loads, overall weight and even tire anomalies with utmost precision.

Overloaded vehicles are one of the main causes of road damage, and they are also more likely to cause accidents. KiTraffic Plus helps to improve infrastructure protection and prevent accidents by capturing each vehicle's identity and class, along with key parameters such as axle load, gross weight (GVW), speed and dimensions; it can even detect tire imbalance and underinflated or flat tires. KiTraffic Plus: the solution of choice for vehicle monitoring and enforcement.

KiTraffic Plus is the scalable, flexible WIM solution from Kistler that can be tailored to each customer's needs.



Specifically designed to process signals from Lineas WIM sensors, the WIM Data Logger is the key to reliable traffic monitoring and accurate vehicle data.

WIM Data Logger – for dynamic vehicle weighing

The WIM Data Logger is the perfect match for Lineas WIM sensors. It offers multiple interfaces for a varied range of peripheral devices to monitor traffic and gather accurate vehicle data.

The WIM Data Logger is specifically designed to interface with Lineas Type G and Lineas Compact WIM sensors in real-time traffic monitoring and vehicle data collection applications. Thanks to enhanced conditioning and processing of signals from the WIM sensors, optimal weighing accuracy and maximum reliability are guaranteed – regardless of driving speed. The WIM Data Logger is easily integrated into the overall system as part of a customized solution tailored to the specific needs of each user. A simple firmware update also enables the logger to detect underinflated or flat tires.

Variable solution for individual requirements
Both the Lineas Type G and Lineas Compact sensors from Kistler can be connected directly to the WIM Data Logger. Various digital inputs and outputs are also provided to interface with peripheral devices such as loop cards, beam arrays, traffic signals, camera triggers and barriers. In Kistler KiTraffic Plus systems, multiple WIM Data Loggers can be combined to monitor a virtually unlimited number of lanes, and each lane can be equipped with two to eight WIM sensors – but for maximum ease of operation, the end user only needs to interact with one single interface.

Key product features and user benefits at a glance:

- High weighing accuracy (certified to OIML R134)
- One device can monitor up to four traffic lanes
- Compact design with integrated amplifier
- Fast setup thanks to modern web interface
- Can detect flat and underinflated tires
- Low energy consumption allows powering by solar cells

Kistler as a provider of Traffic Monitoring Solutions around the globe

Lineas WIM sensors from Kistler operate reliably all over the world under a variety of conditions and in many diverse environments.

Switzerland: preselection of overloaded trucks

- Multiple sites for preselection at crucial traffic points
- Kistler KiTraffic Plus solution with ANPR, overheight/dimension control and customized user interface for police authorities
- Kistler: the full-scope provider, from planning and implementation through to maintenance

USA: traffic data collection

- Kistler Lineas sensors are installed in 48 states
- First sensor was installed in 2003
- Kistler equipment is in widespread use to collect traffic data for statewide and federal programs
- Many weigh stations (including virtual stations for preselection) use Kistler WIM for weight enforcement

Italy: bridge protection

- Kistler KiTraffic Plus solution with WIM and ANPR to prevent infrastructure damage caused by overloaded trucks

Mexico: bridge protection

- Overloaded trucks are preselected before entering the bridge and are redirected to a toll station

Turkey: traffic load monitoring

- The weight of vehicles approaching or transiting the bridge is monitored

70,000
WIM sensors installed worldwide

50+
countries where Kistler WIM sensors are present

20+
years of experience with unique quartz technology

Czech Republic: direct weight enforcement

- 20 sites / 60 lanes / 240 Lineas sensors
- First European country to introduce direct high-speed enforcement with WIM
- Kistler sensors and Data Loggers for local WIM partners

Russian Federation: statistics and direct weight enforcement

- Installations in many locations including Moscow, Saint Petersburg, Novgorod, Novosibirsk, Kaliningrad and Tatarstan

China: weight enforcement

- > 1,500 lanes / > 5,000 Lineas sensors installed
- Preselection of overloaded vehicles ahead of the expressway entrance
- Direct free-flow enforcement of overloaded vehicles on provincial highways and local roads

Indonesia: container terminal in a port

- Trucks are weighed and identified on entering and exiting the port
- Even in monsoon season, the Lineas sensors still function reliably

Australia: aircraft identification

- 4 Lineas sensors are deployed to distinguish between A380s and smaller planes by measuring the nose wheel weight
- Pilots are warned if they are on the wrong taxiway
- Loads of up to 38 tonnes per double wheel

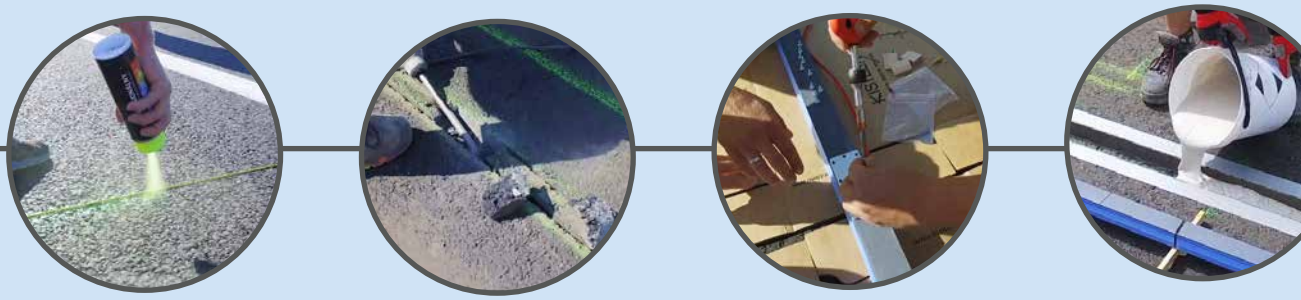
Highly skilled professionals assemble Lineas sensors with the utmost care.

Quartz crystal technology from Kistler – at the core of every sensor

Lineas WIM sensors from Kistler are renowned for their consistently high performance over time under all possible traffic and weather conditions. They have proven their durability in different pavements on all continents: under harsh and extreme winter conditions in northern Europe and North America, in the hot desert environments of the Middle East, and even when exposed to high humidity levels in China and Southeast Asia. Thanks to their wide measuring range, Lineas WIM sensors can measure both light and heavy vehicles with the same high levels of accuracy. The secret of their outstanding performance: Kistler quartz crystal technology combined with advanced sensor design and high-quality manufacturing processes.

WIM installation procedure

Installation in six easy steps



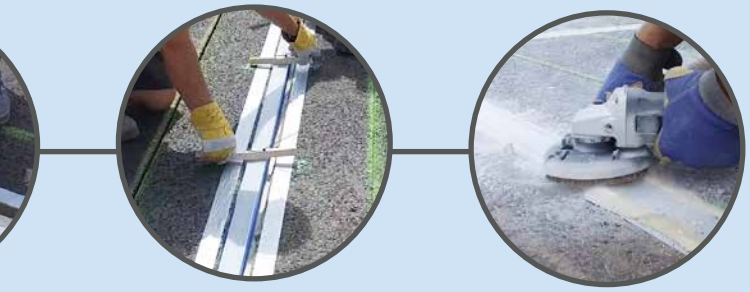
1. Mark **2. Break open** **3. Prepare** **4. Fill the slot**

The first step in installing Kistler Lineas quartz sensors is to mark the layout on the road. This helps the installers to cut the slots and break out the pavement. Before the sensors are installed in the road, they must be prepared and checked for correct operation. Two sensors are mounted together in a row, and then the leveling beams are fitted.

The next step is to mix the grouting compound and pour it into the slot. After this, the sensors are inserted into the slot and ground until they are level with the pavement. Finally, the cables are connected to the WIM Data Logger – and now the sensors are ready for calibration.

Quartz at the core
Quartz crystals are at the heart of every Lineas sensor. Up to 50 disk-shaped crystals, the same size as a contact lens, are installed in one sensor. The basic structure consists of an extruded aluminum profile. The dimensions and condition of the profile are checked with the utmost precision. Tolerances are extremely tight because the sensor will operate for a long period. Once the quartz crystals are installed, final assembly of the sensor can take place. This includes installing the cables and sealing the sensor to make it airtight and waterproof. As the last step, the aluminum profile is enclosed in a foam casing that dampens lateral forces. In-depth final inspection of the sensor includes a tightness check and various function tests. Uniform sensitivity throughout the sensor's entire length is verified on the calibration system.

High-precision tools check the quality of each sensor before it leaves our factory.



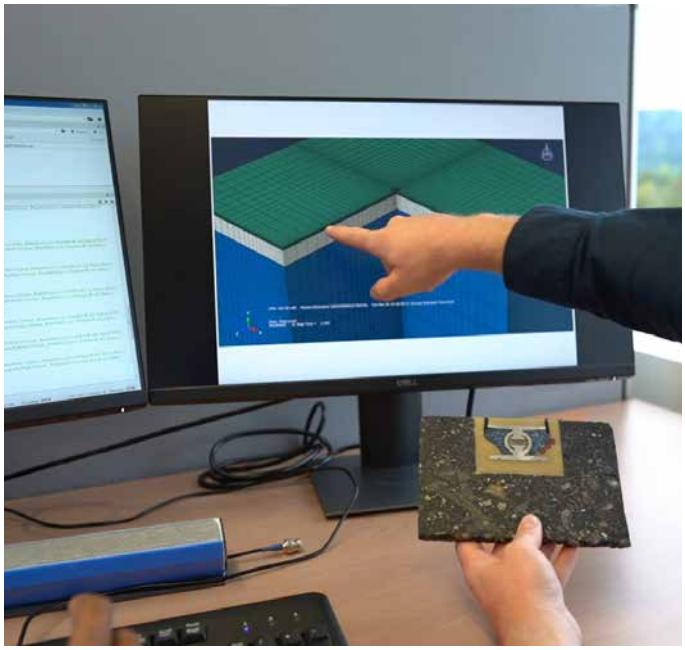
5. Insert the sensor

6. Grind

Don't forget to register your site with the WIM Service app.

Weigh In Motion system installation by Kistler
Scan the QR code or enter the address below to see a video of a recent installation of four Lineas G-type WIM Sensors in the Czech Republic.

https://www.kistler.com/wim



Structural Road Analysis (SRA) is the key to defining the ideal location for a WIM installation.

Comprehensive range of WIM services

Kistler offers a portfolio of added-value services to maximize the performance of every WIM solution. Customers can choose from a range of options to enhance their WIM user experience and prolong their system's lifetime.

Structural Road Analysis (SRA)

Structural Road Analysis (SRA) helps customers to identify and qualify the most suitable locations for installing their WIM systems.

Procedure for identifying the optimum location
The first step is to select a road section on the basis of a desk survey of envisaged usage requirements for the WIM system, together with local road and traffic conditions. This service includes on-site measurements as well as off-site assessments. The results are based on detailed measurements of road pavement properties and state-of-the-art assessment methods.

A certified Kistler Partner then performs in-depth measurements of pavement roughness and stiffness. This data is evaluated to narrow down the range of potential road sections for the planned WIM site.

The next step consists of measurements to assess the structural characteristics of the pavement and the potential locations, resulting in the final selection of the best available WIM site. SRA is based on innovative mathematical models developed by Kistler specialists to collate all data gathered during the process.

Aided by in-depth analysis of this data, a Kistler expert will then issue final recommendations for the best sensor layout and an appropriate calibration procedure, together with an assessment of expected performance under local conditions and the exact location for the WIM site.

Benefits of Structural Road Analysis at a glance:
- Defines the most suitable installation location for a WIM system
- Provides information about achievable performance at the selected location before the equipment is installed
- Avoids future WIM performance issues due to road properties that fail to meet the requirements
- Extends the WIM site's lifetime and reduces maintenance costs

Hands-on training by a Kistler expert

Installation training and certification

This service trains customers to install their own WIM equipment. A Kistler expert is present on site to provide hands-on training and ensure that the installation is executed correctly.

Benefits of installation training and certification:

- Customers' staff are trained and certified to perform high-quality installations
- Efficient and reliable installation optimizes WIM performance
- Customers can easily set up future WIM sites and systems without guidance from Kistler technicians

Calibration

This service ensures the appropriate calibration procedure for each customer's WIM system, application and budget. The calibration procedure is performed to professional standards and the calibration factors are calculated correctly.

Benefits of calibration:

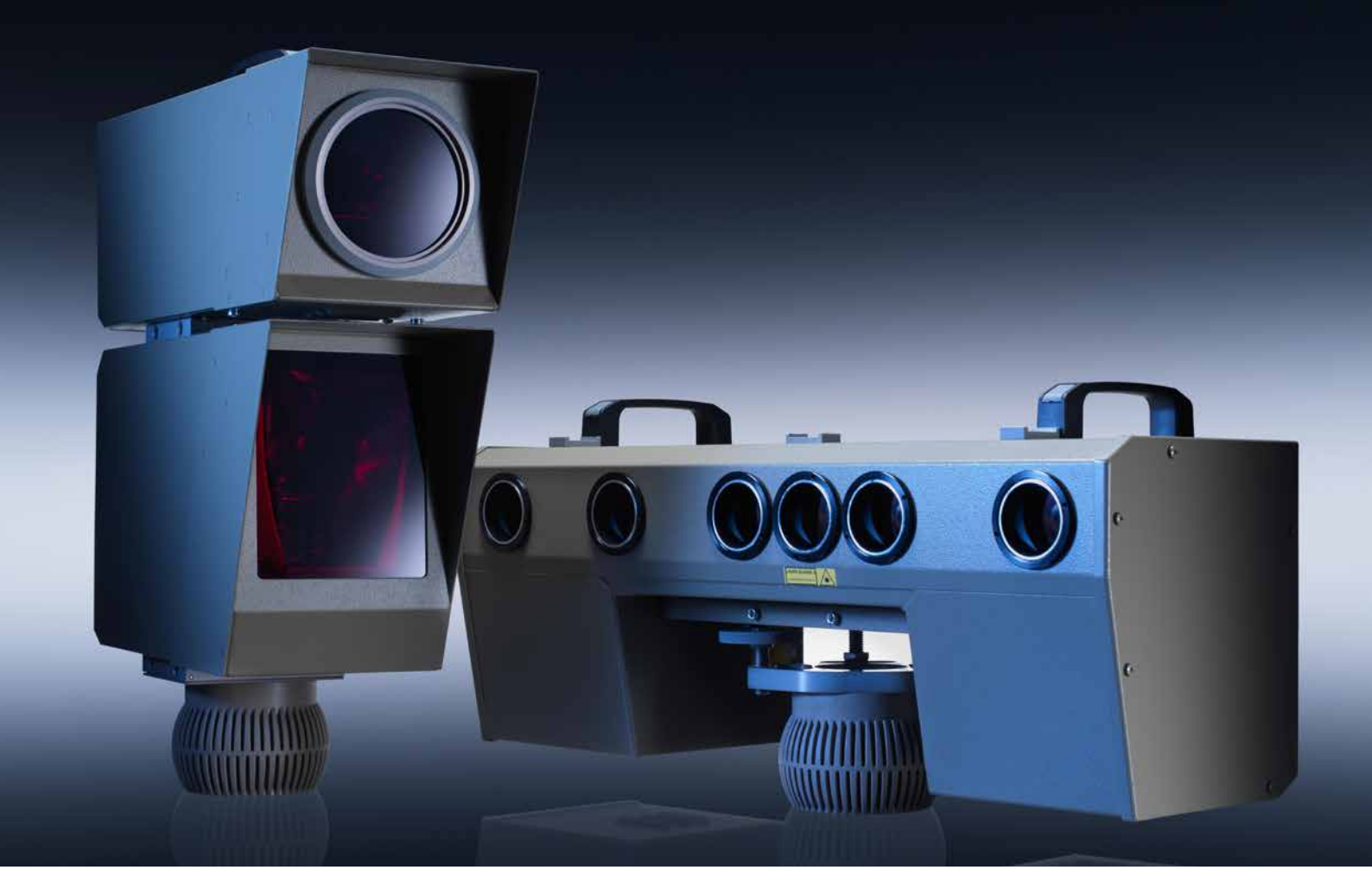
- Calibrated systems deliver maximum accuracy
- Guaranteed compliance with operating and certification requirements for toll-by-weight and direct enforcement
- Overall WIM performance is optimized

Warranty extension

With an optional extension of the standard warranty period, Kistler WIM products are replaced quickly and free of charge in case of defects – for many extra years of troublefree operation.

Benefits of a warranty extension:

- Security and long-term troublefree operation of WIM systems
- Minimized risk of system downtime due to faulty products
- Defective products are replaced free of charge throughout the warranty period



Mobile measurement solutions from Kistler help to increase traffic safety in many different application areas.

Accurate speed measurement with optical technology

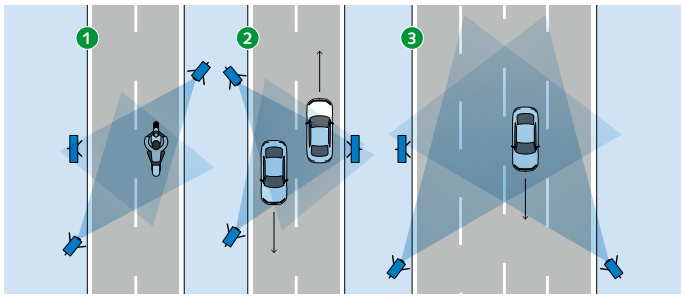
All around the world, speeding is one of the most common causes of road accidents – and it also presents a major challenge for police forces and local authorities. Certified eso measuring solutions from Kistler are the key to high-precision mobile or stationary speed enforcement – a critical factor in improving safety on our roads.

Downtown, on the open highway or even on a mountain pass: versatile complete systems from eso perform high-precision speed checks in virtually any environment. This measurement solution combines unique optical measuring technology with reliable driver and registration plate identification. Traffic violations are detected quickly and efficiently thanks to the short 50 cm measurement base – a tremendous advantage on interurban roads, highways and bends.

Unrestricted automatic measurement
One single instrument can measure the speed of vehicles in all classes (including motorcycles), in both traffic directions and across multiple lanes. A user-friendly software application supports evaluation and legal validation of the measured data. If needed, the mobile system can be converted into a stationary measurement solution at any time with minimal outlay.

Advantages of mobile speed enforcement:

- Universal, complete system for legally valid speed enforcement data
- Monitoring of different traffic directions with just one measuring instrument
- Precise measurements with high hit rates – regardless of vehicle class, speed or road condition, even on multiple-lane roads and bends
- Unique, easy-to-operate certified optical measurement technology
- Measurements in real time – even when traffic is heavy



1. Motorcycles: license plate and driver are photographed
2. Drivers of vehicles traveling in both directions are photographed
3. High-quality, sharply focused driver photos on up to four lanes in one direction

- Sales Center
- Tech Center
- Production Center

At our customers' service across the globe

Thanks to Kistler's global sales and service network, we are always close to our customers. Some 2,200 employees at more than 60 locations are dedicated to the development of new measurement solutions, and they offer customized on-site support for individual applications.

Would you like to learn more about our applications? Explore now:

www.kistler.com/applications

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