Diagnostic system for wheelsets

Type ARGUS II

For the inspection of wheelsets on moving trains

Hegenscheidt MFD

Argus II diagnostic system for wheelsets

Uses and possible applications

ARGUS II is a development of the ARGUS inspection and testing technology. Now for the first time, in addition to the diagnosis of railway vehicle wheelsets, it can also carry out the diagnosis of tram wheelsets in drive-through operation. Thanks to the new design the system is installed without a foundation, considerably reducing the installation time and the associated costs. The rail intended as the site of installation can be converted into the test rail within one day, so ensuring that the track is returned to service "in days" rather than "in weeks".

A fully-automated process identifies and measures vehicles when they enter the measuring section. All relevant measurement data are archived in a database. The operator can thus monitor his fleet of wheelsets on a continuous basis with no personnel costs or loss of time. On the basis of the collected measurements it is possible to determine a wear characteristic, which can provide the basis for a maintenance program that is economically-oriented as well as environmentally- and safety-conscious.

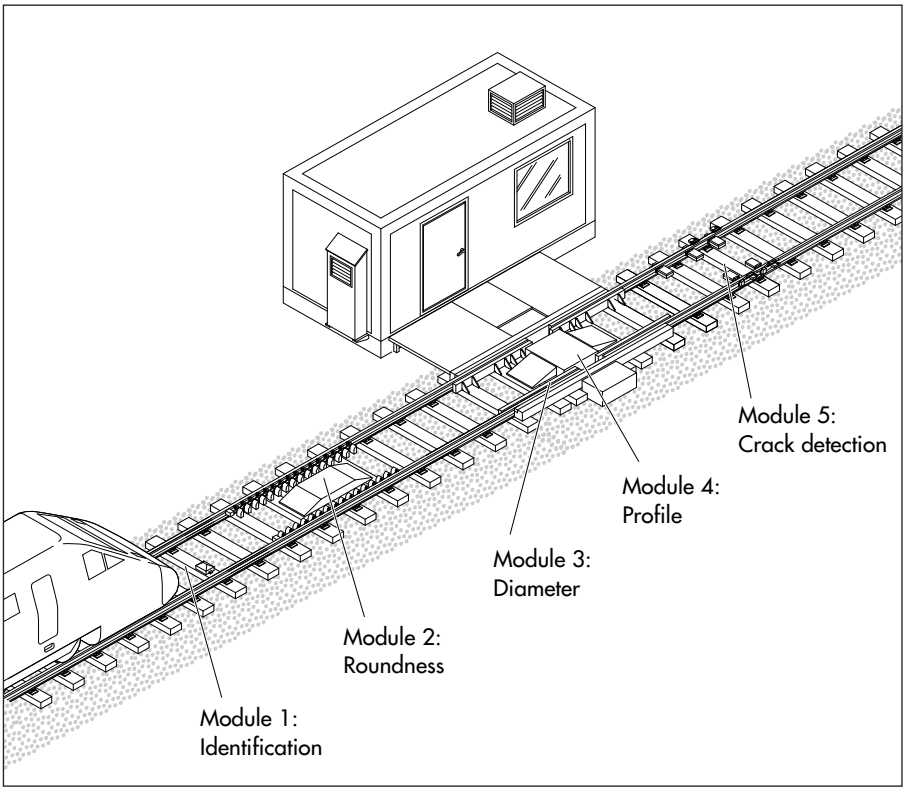
Benefits

- Fully-automated wheelset diagnosis without personnel costs, around the clock.
- Archiving of all measurement data in a database.
- Precise and easy-to-access information on the state of all wheelsets, along with their history and a wear forecast from the wheelset database.
- Low installation time, and therefore fast availability of the rail.
- Foundation for better workshop organization and logistical preparation.
- Increased operational reliability and punctuality, even without operating reserves. All the work required by the wheelsets is known before the vehicles enter the workshop.
- Suitability test according to VDI / VDE / DQG 2618 Bl. 27, VDA 5 / GUM by accredited calibration laboratory.

Diagnosis results

The system's modular design allows it to be configured in accordance with the customer's requirements.

The basis version of the system offers the modules IDENTIFICATION, DIAMETER and PROFILE, which have been developed for use with trams and standard-gauge wheelsets. A system for full-tracks can be extended with the modules ROUNDNESS and CRACK. The measurement uncertainty is listed below in the specification table.



Module	Task	Result displayed	Measuring uncertainty (k=1)	Measuring uncertainty (k=2)
BASE UNIT	Monitoring the measuring modules Controlling the measurement, Transfer measurement data to database	Total number of axles measured, status and number of axles per module, system status, outer temperature, process log		
IDENTIFICATION	Vehicle/train identification	Identity via ID tags		
ROUNDNESS	Tactile measurement of flange height deviation, Depth of the flat spots	Size of flange height deviation Depth of flat spots	Ra: (±)0,075 mm Pfh: (±)0,1 mm	Ra: (±)0,15 mm Pfh: (±)0,2 mm
DIAMETER	Optical determination of the measuring circle diameter, Diameter difference right/left	Actual measuring circle diameter Actual difference of measuring circle diameter	dM: (±)0,75 mm	dM: (±)1,5 mm
PROFILE	Optical measurement of wheel profile for full-track vehicles or trams	Flange height, flange thickness, transverse dimension/ wheel flange angle, flange size wheel back to back distance	Sd: (±)0,1 mm Sh: (±)0,125 mm Qr: (±)0,2 mm SR: (±)0,2 mm AR: (±)0,2 mm	Sd: (±)0,2 mm Sh: (±)0,25 mm Qr: (±)0,4 mm SR: (±)0,4 mm AR: (±)0,4 mm
CRACK	Ultrasonic detection of: Transverse cracks, covered transverse cracks, splinters in the running surface, corrugations. Error classification for transverse cracks deeper than approx. 5 mm and wider than approx. 10 mm at right angle to running direction or similar damage	Kl. 0: not evaluable Kl. 1: damage Kl. 3: no damage found	Recognition rate 95%	Recognition rate 95%

Module description

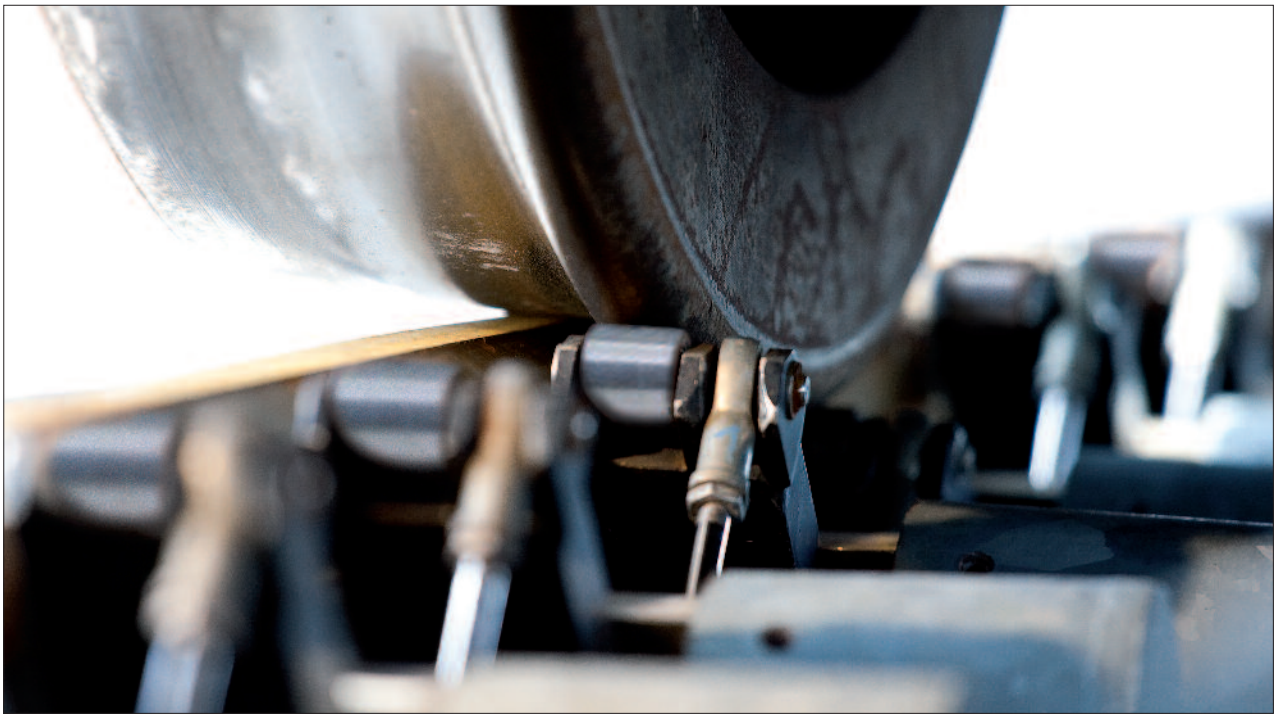
IDENTIFICATION

The identification module is used for detecting and allocating the different trains and wheelsets. The ID attached to the train is read by the module and transferred to the database, which allocates the measurement results to the relevant wheelsets. Generally the "Sofis" transponder system from Siemens is used. However, adaptation to the customer's existing identification system is also an option.

ROUNDNESS

Out-of-roundness and flat spots on a wheel set has an adverse effect on the vehicles ride performance. When these defects are present the running noise and the rate of wear on the wheels and rail increases. The degree of "unroundness" in wheel's circumference is referred to as the "radius variation" and is the factor that is used to decide when reprofiling is recommended. A direct geometric measurement while the vehicle is moving is impractical so a secondary variable is measured and used to derive the "roundness variation." The value chosen for this purpose is the flange height deviation. Experience has confirmed that this value can reliably be used to derive the value of the radial runout and the form of deviation measured at the wheels running radius. The height of the wheel flange is gauged using probes. The probes, which are housed beneath the rail/wheel interface are pushed up pneumatically above the rail/wheel flange boundary. The probes are then pushed down against the resistance of the pneumatic pressure as they come into contact with the wheel profile.

The stroke of the probes as a wheel rolls over them is recorded continuously by a rotary encoder and the data is transferred to an analysing software loaded onto the computer system. Within the computer, the stroke values measured over at least one complete wheel rotation are stored ready for further processing. The flange height deviation and thereby the radial runout of the wheel, including any flat spots, is then derived from this data.

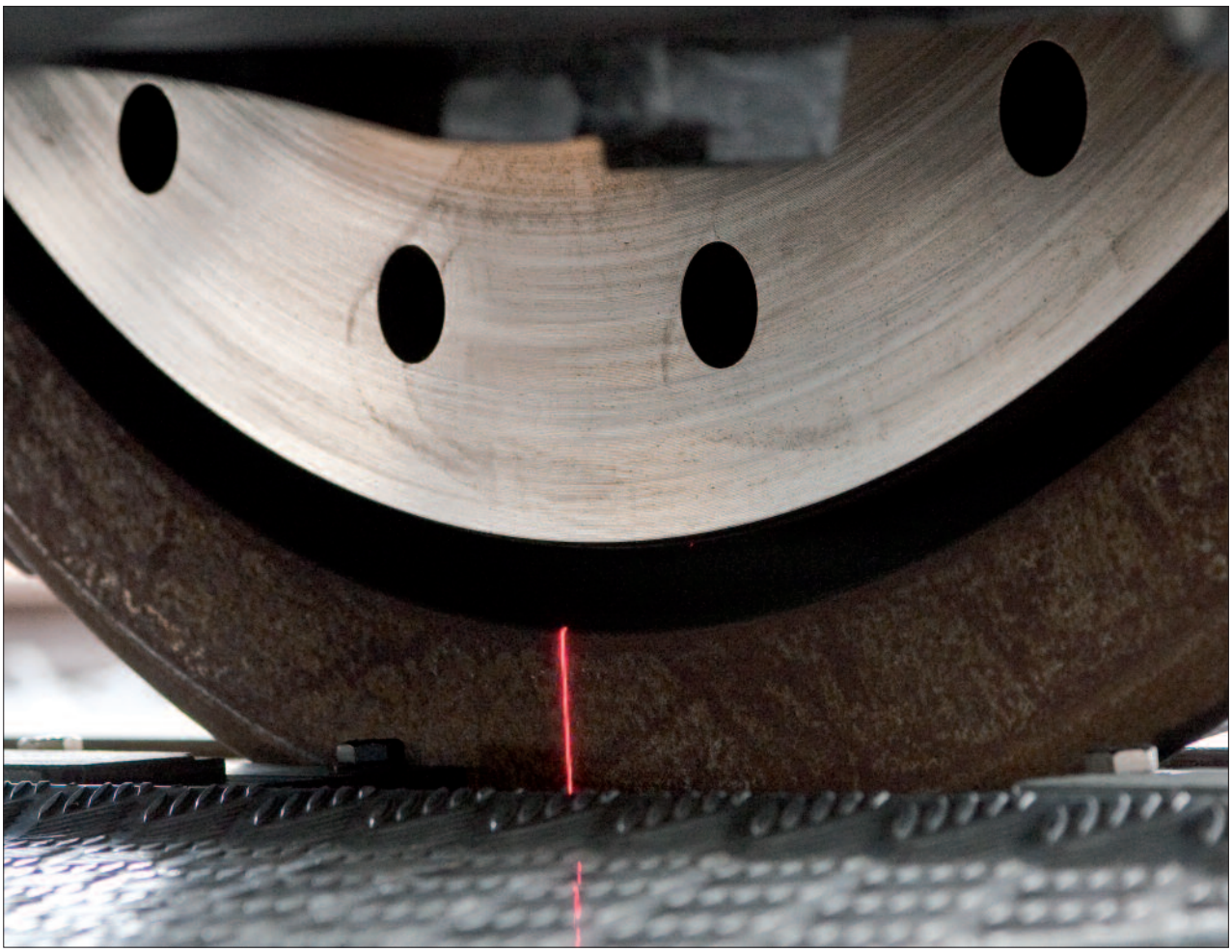


DIAMETER

Different loads on individual wheels or wheelsets during operation can lead to varying degrees of wear. Differing wheel diameters on a vehicle may lead to slipping of individual wheels or to the asymmetrical rubbing of the wheel flange against the rail. The effects of this type of wear can range from a poor ride to a serious safety hazard. The wheel diameter is calculated from the bend radius of the reflection of two laser light beams in the area of the taping line using the light section process.

Diameter measurement is a key attribute that is used to assess the actual wear state of the wheelset. Obtaining an actual real time value for the diameter provides the operator with valuable vehicle health management information. This information includes but is not limited to:

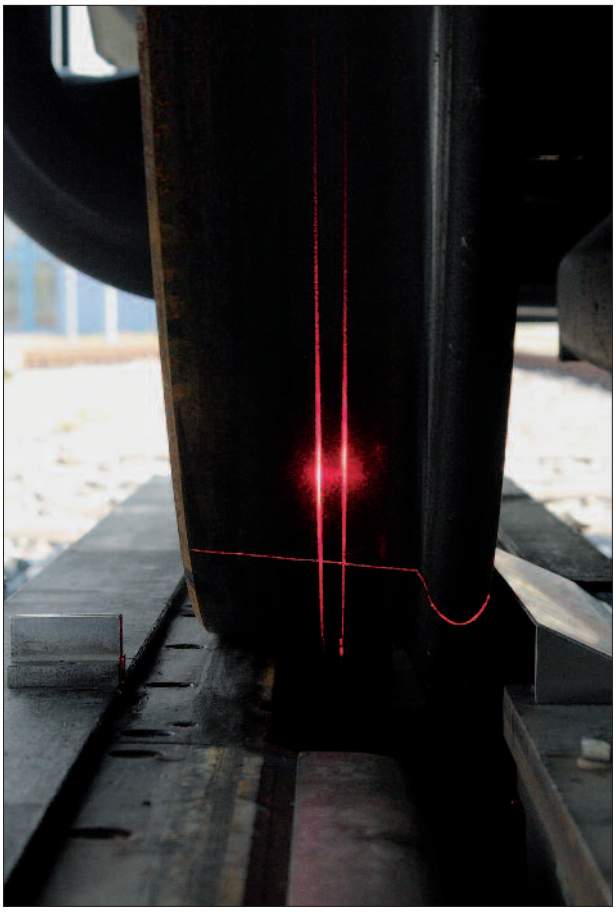
- Checking a wheelset's general state of wear. In conjunction with the Hegenscheidt-MFD specialist software, a forecast can be made as to the expected remaining service life before the permissible wear limit is reached.
- Comparison of the diameter of the left and right wheels of a wheelset can be used as a criterion for reprofiling the wheelsets. Large differences in the diameter can leads to "jittery running" and increased running noise. A comparison of the diameters of a wheel on different axles is also useful for vehicles fitted with mechanically coupled driven axles.
- As the information is gathered without removing the vehicle from service or requiring physical measurement of the wheels by depot staff, significant time savings can be recorded in obtaining the information.
- This information makes possible the real time comparison of predicted preventive maintenance control limit values against actually measured values enabling the manager to progressively fine tune availability and eliminate unscheduled outages.

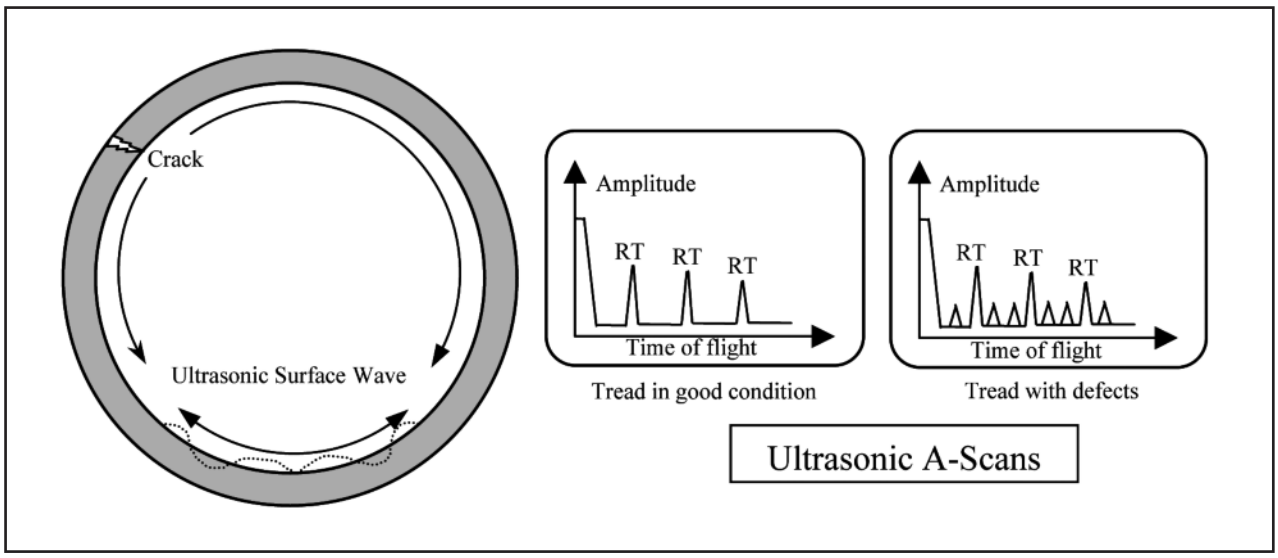


PROFILE

Knowing the state of a wheelset's profile is a keystone to a safe and affordable maintenance strategy. Hegenscheidt-MFD has selected the "light section process" to measure the profile. This robust, innovative and well proven procedure optically measures from below the profile cross-section of both wheels of a wheelset. The procedure illuminates the complete profile with two fanning laser beams and records the reflections with two separate camera systems. This procedure reduces the measurement uncertainty and is well suited for the measurement of complex profiles, such as those used on tram wheels.

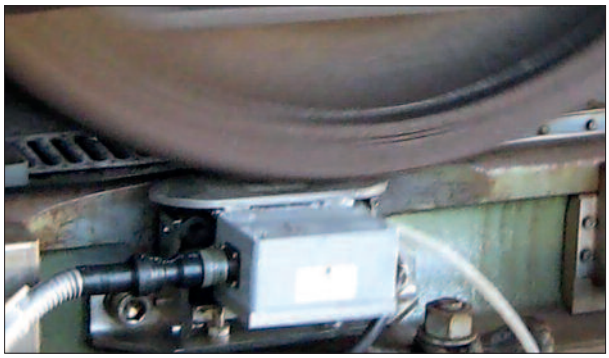
The recorded images of the light deflected by the wheels are captured and the analogue images are digitised and stored in the monitoring computer. The complete profile shape is determined by transforming the digitised optical images into real world metric images. The profile data is hence used to determine the profile values that describe the state of profile and the degree of wear.





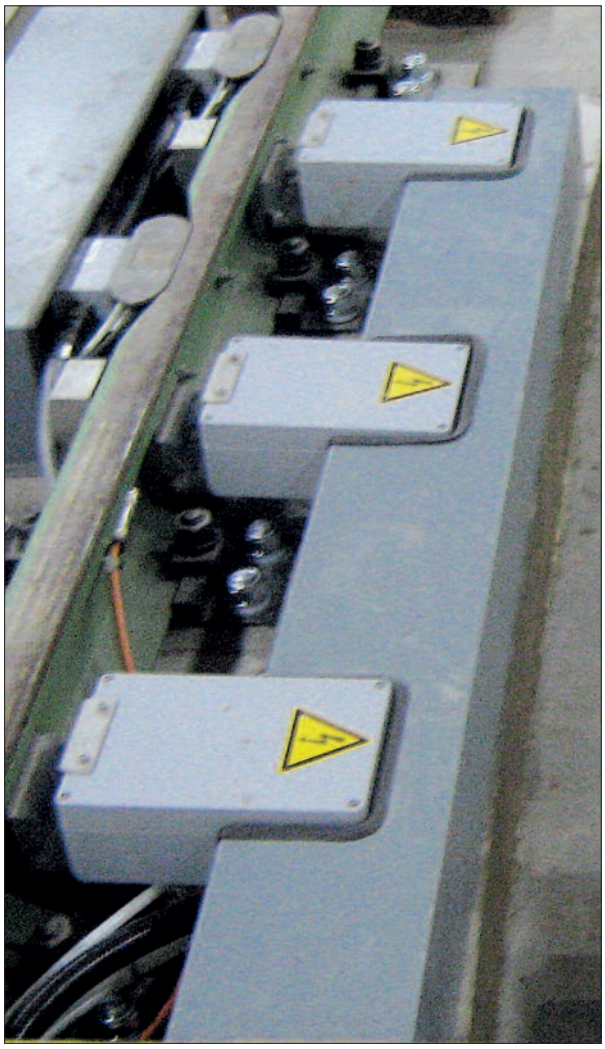
CRACK

The direct result of increasing vehicle speed and the total operating hours is the generation of surface cracks and similar defects that can appear in the wheel running surface. Their presence reduces the travelling comfort and in severe cases can represent a safety hazard.



Maintenance personnel check for the formation of this type of defect by conducting regular visual inspections of the wheels. Visual monitoring becomes ineffective when a crack on the surface is "rolled in" during normal vehicle operation. The surface defect is still present but is undetectable by visual inspection. It is therefore preferable to detect the surface defect before it is obscured. The CRACK module uses an automated, non destructive process to provide objective testing for surface cracks and similar defects.

Two ultrasonic probes are integrated in the left hand and right hand track rails. As soon as a wheel makes contact with the probe, it emits an ultrasonic Raleigh surface wave pulse. This pulse travels around the wheel several times and, if the running surface is undamaged, generates a series of rotation signals in the probe. The test acquires running surface information up to a depth of approx. 5 mm. If there is damage in this area in form of cracks or splintering, then in addition to the rotation signals, additional echoes from the fault points together with a strong rotation dampening are registered. When a defect is recorded, a damage report on the tested wheel detailing the amplitude and signal criteria is generated.



Data Processing

BASE UNIT

The basic unit monitors the operational readiness of the connected measuring modules and controls the progress of the automatic measurement.

The unit monitors the direction, speed and number of axles as they are driven over the monitoring section by means of axle counters sited at the start and the end of the section. When a train enters the measuring section within the specified speed range, the basic unit can start the measurement devices, opening the weather protection flaps and commencing measurement. As the train leaves the measuring section, the base unit deactivates the measurement modules, checks the completeness of the measured results and transfers the measurement data to the database.

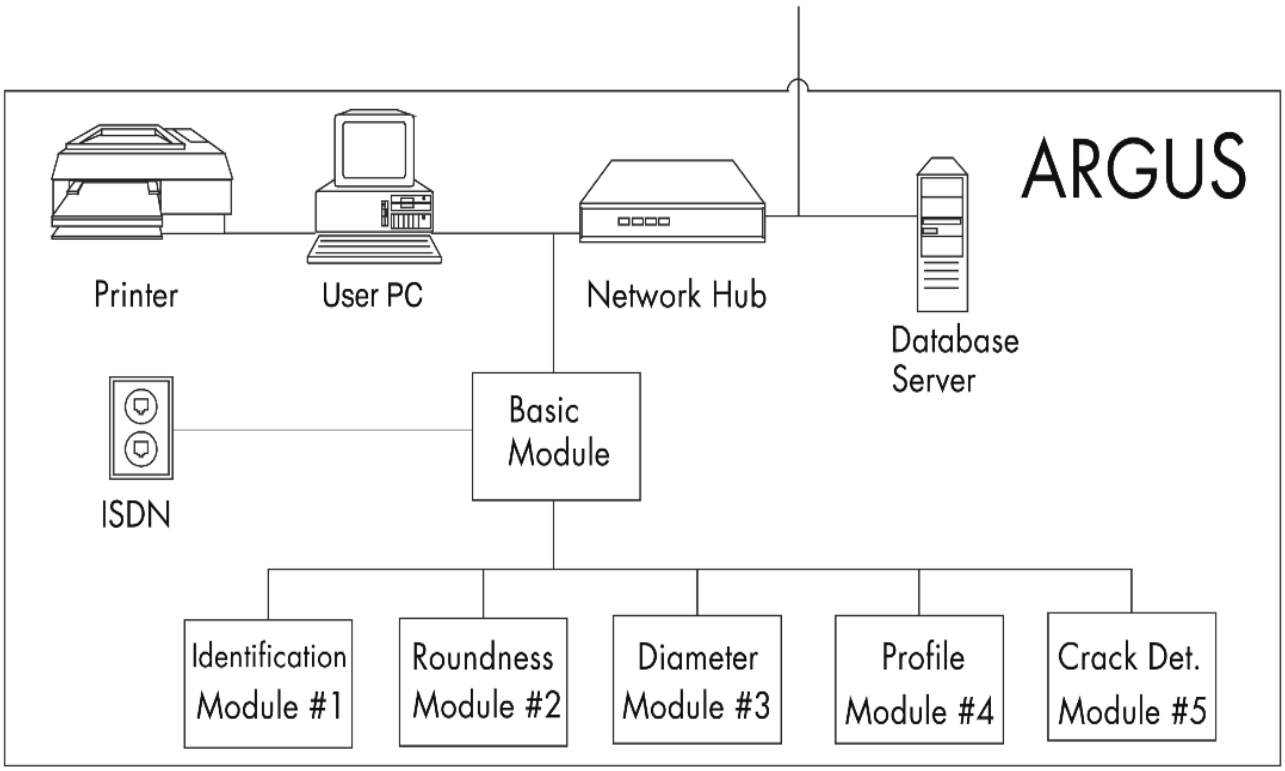
The basic unit is also responsible for monitoring and protecting the system health and function. For example, should a mains power failure occur, the base unit switches the measuring modules to the uninterruptible power supply (UPS) before shutting down the measurement systems in the normal, controlled sequence. As soon as the mains voltage is restored, the system is restarted.

Each computer can be maintained by means of a remote access software. The connection to another computer can be made by telephone using a dedicated ISDN connection or via a firewall protected WLAN/LAN connection. Remote access software enables online assistance to the personnel on site to be provided. A Hegenscheidt-MFD technician can analyse the state of the system and provide guidance to the operators personnel. Software updates can also be installed using the remote connection.

DATABASE SERVER

In addition to the measurement results, the database also stores the operating limit constraints for wheelsets and the train, wagon or tram configurations.

During the measurement, the identification module returns an ID that identifies the vehicle or train. By referring to the actual train or tram configuration, the database server can allocate the measurement results to the specific wheelset. So the condition of a wheelset during its entire service life, independent of its installed location, can be documented.



OPERATING-PC

The principle control and monitoring functions are carried out with the help of the operating PC. The operating PC is used to display the measurement data stored in the database. Measurement data and graphics can be reviewed and printed as hard copy. The PC is also used to check the current state of the measurement system.

Additional optional software packages extend the measurement systems core functions to provide:

- **A presentation of the wheelset history**
- **Remaining mileage prognosis for the wheelsets**
- **Produce machining recommendation based upon the measurement records**
- **Manage the vehicle configuration**
- **Input and maintenance of the operating limit values**

MEASURING CONTAINER

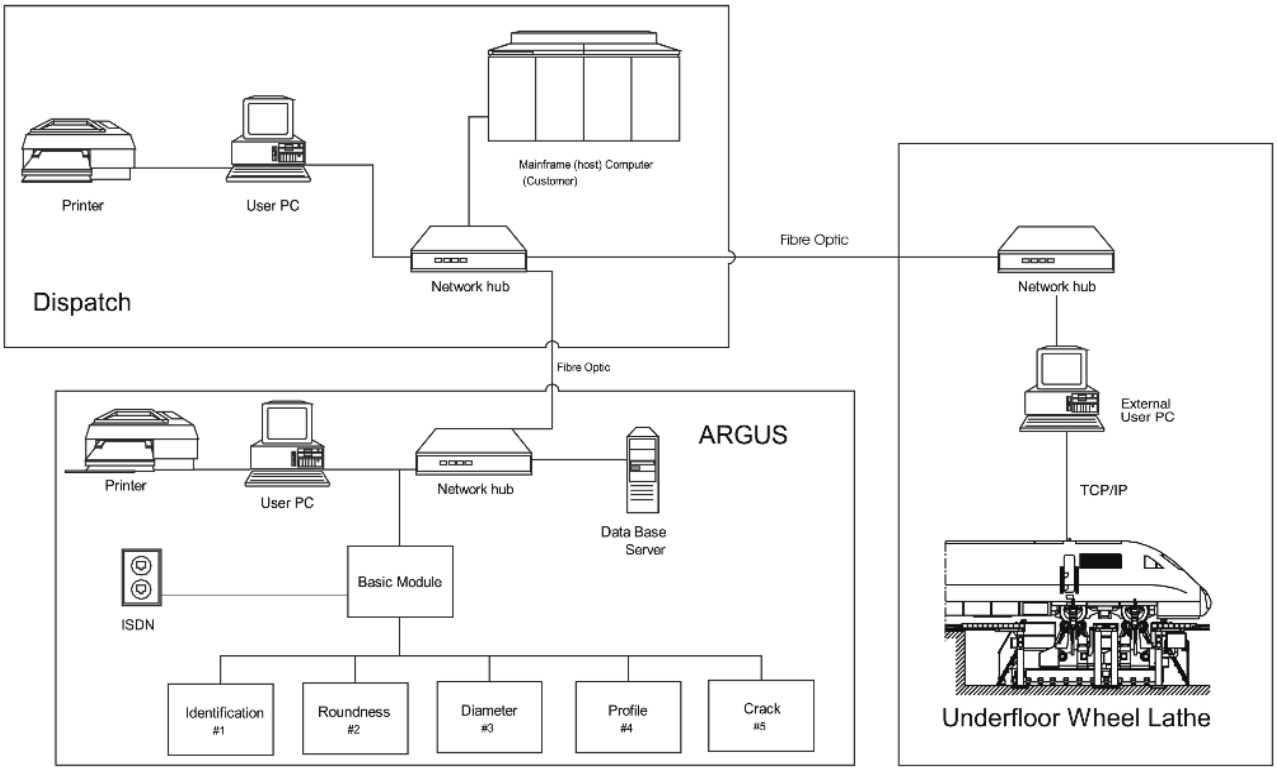
The air-conditioned measuring container is used to hold the following equipment:

- **Electrical cabinet**
- **Measuring module computers**
- **Control unit**
- **Database server**
- **Work station and work materials**
- **Confining air system**

The system provides a conditioned air supply to keep the measuring devices within a constant temperature range. The application of a conditioned air overpressure to the equipment housings and an airflow to the equipment heads protects the laser and camera optics from contamination. A compressor supplies compressed air to the sensing lever sensors and to the weather protection flaps.

The work station in the measuring container is a practical place to set up the operating PC, because in this way the measurement results can be viewed directly on location. The container has sufficient weather-protected storage room for the necessary consumer materials such as cleaning agents and lubricants.

Network installation



From a Hegenscheidt-MFD wheelset lathe to the ARGUS system

When a CNC-controlled Hegenscheidt-MFD underfloor wheelset lathe or a Mobiturn mobile lathe is available to reprofile the wheelsets, the lathe can make use of the ARGUS 2 data by connecting it to the database of the diagnostic system. This can be achieved by a remote network connection to the external database of the lathe. The maintenance shop manager and the lathe operator can then decide in advance:

- Which wheelsets are to be machined and in what sequence
- Which wheelsets cannot be successfully machined and must be exchanged. I.e. The reprofiling would result in the condemned limit for the wheelset being reached
- The post machining measurement data from the lathe can be transferred back to and stored within the ARGUS database as part of the wheelset record

From Hegenscheidt-MFD network to customer database

The measurement data, which is initially stored in the local database, can optionally be transferred via network connection (FTP/SFTP) to a customer system for further evaluation and documentation.

From customer system to Hegenscheidt-MFD database

The option is available of connecting the ARGUS system via network connection to a higher-level customer computer. The following data are transferred via the interface:

- Train assembly wheelsets
  (train number, vehicle number,
  wheelset number, wheelset type, sequence)
- Train's current service life.

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Main measurements and operating data

Main and operating data	
Track gauge	1.435 mm*
Wheel back distance	Nominal size ± 5 mm
Minimum axle distance in bogie	1.300 mm
Maximum axle load	250 kN
Measuring area measuring circle diameter	700 -1.300 mm*
Passing speed	max. 30 km/h
Measurement passage speed	3 bis 15 km/h
Speed fluctuation during measurement	± 10 %
Length of system	Approx. 15.000 mm*
Width of all modules	Approx. 2.500 mm*
Width basis unit/measuring container	Approx. 4.500 mm*
Rail forerun and after-run	Approx. 25 m
Evaluation speed	
Train units (≤70 wheelsets)	Approx. 1 min
Time between 2 measurements	Approx. 5 min
Connection data	
Designed in acc. with VDE, EN and EC specifications. (customer electrical regulations are taken into account after confirmation)	
Power supply	400 V* 50 Hz + 6% -10%
Total power input	Max. 30 kVA
Mains configuration	TN
Driving power feedback	Customer supplied
* or according to customer requirements	

Hegenscheidt MFD

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