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RoaDyn® S635 System 2000

Type 9267A1

Wheel Force Sensor for Heavy PassCars and High Performance Sports Cars

Wheel force sensor for measuring three forces and three moments on a rotating wheel; a major constituent in modern vehicle development.

- Modular sensor design with replaceable measuring cells and components
- CAD/FEM supported design: optimization of local stresses
- Low measuring wheel weight combined with high rigidity
- Precise signal measurement with individually calibrated strain gage load cells
- Automatic identification of components by ID chip
- Individual load cell calibration values taken into account
- Tested structural fatigue strength e.g. to SAEJ328

Description

The RoaDyn S635 measuring wheel has a modular, highly versatile design for mounting on different hubs and rim geometries. Five individual load cells are connected by adapter parts to a rim and to the vehicle hub. The requirements are met with regard to strength, mass and moment of inertia. The signals are amplified immediately in the load cells and fed via short cables to the wheel electronics Type 5241A... . Here they are filtered, digitized and coded. The data stream is transmitted via a rotor/stator pair Type 5242A5/5240A1,5... to the wheel inner side, transformed in the on-board electronic unit Type 9891A... and output to a data acquisition device.

With regard to production wheels, the measuring wheel should not exceed an excess weight of 10 %. Otherwise the vibration behavior of the wheel suspension and the inertial behavior of the wheel will change, and thus also the measuring results and vehicle handling characteristics.

Modern CAD and FEM techniques are used for design purposes. Vibration fatigue limit investigations on individual components and measuring wheels of various sizes make it possible to estimate the life of the measuring wheel structure.

Individual load cells Type 9190A are calibrated in the factory and produce temperature-compensated, amplified measuring signals in the three spatial directions. Identification data, calibration data and zero positions of the individual forces are saved allowing appropriate analysis in the vehicle coordinate system on the basis of individual calibrated values.

High measuring accuracy is retained during transmission, since digitization takes place on the wheel, thus eliminating transmission interference. Knowledge of the individual measured signals allows rapid diagnosis in the event of malfunctions. Individual cells can be exchanged without impairing the function of the wheel force sensor.

Additional signals on the rotating wheel, such as tire pressure, temperature, etc. can be directly connected to the wheel electronics and transmitted along with the wheel signals. Kistler offers optional amplifier module Type 2237A... for this purpose. Wheel electronics Type 5241A... is available in versions with 17 ... 24 channels. It can be used for all measuring wheel types S6xy, V6HT and V6MT. The unit is equipped with analog filters and digitizes all incoming measuring signals and modulates a data stream, which is fed from the rotating measuring wheel via the transmission unit to the on-board electronics.

For transmission to the on-board electronic unit Type 9891A..., preference is given to the inside of the wheel using rotor Type 5242A5 and stator Type 5240A1.5... . Out-board transmission unit Type 5248A0 is also offered as an alternative.

Note: see data sheets 5240A_000-561, 5248A_000-562 and 9891A_000-563 for the transmission units and the on-board electronics.

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Technical Data

Measuring range[1]	F_x	kN	–35 ... 35
	F_y	kN	–20 ... 20
	F_z	kN	–35 ... 35
	M_x	kN·m	–5 ... 5
	M_y	kN·m	–5 ... 5
	M_z	kN·m	–5 ... 5
Rotary angle accuracy		°	≈0,1
Max. weight measuring wheel[2]	m	kg	≈16,5

Maximum Loads

Permitted alternating stress (rotating bending fatique test)			
Requirements according to SAE J328 are exceeded			
500 000 LW 4,0 kN·m			
Degree of protection			IP64
Operating temperature range			
Al components		°C	<120
CFK components (Temperature warning)		°C	<110
Maximum speed (≈280 km/h)		min^{-1}	2 300
Max. impact accelerations	x	g	40
	y	g	20
	z	g	40

Accuracy

Crosstalk	F_y –> F_x, F_z	%	≤1
	F_x <–> F_z	%	≤1
	F_x, F_z –> F_y	%	≤2
Linearity		% v.E.	≤0,5
Hysteresis		% v.E.	≤0,5

[1] It is assumed that these extreme values do not occur simultaneously. The moments refer to the wheel center.

[2] With 7x16" aluminum rim, rotor, wheel electronics, hub adapter, but without ET adapter, wheel bolts and tires.

- Details for the modal analysis should always refer to the measuring wheel with rim and tire system. The tires attenuate frequencies above 300 Hz. Parameters are available for several combinations, which can be viewed on request.
- Overloads: The design of the wheel force sensor allows overloads to occur without restricting measurability. We will be pleased to provide you with information in this regard. The tolerance to overloads depends very much on their multi-axle situation; it is not possible to give an accurate estimate within a general description because of the many combination possibilities. A separate indication of overloads for individual force directions is not appropriate, since no single axle load conditions occur at the wheel. If the wheel force sensor is overloaded, its remaining service life may be reduced, even if no immediate damage is visible or detectable.

Application

- Measuring operating loads during typical vehicle driving maneuvers
- Input data for the design of new components
- Verification of design loads
- Measuring test stand control data for road simulators
- (Permanent) application as multi-axle force measuring unit in road simulators
- Development of active chassis control systems such as ABS, ESP, etc.
- Investigations of vehicle behavior in specific or critical driving situations
- Input data for fatigue calculations and numeric simulations
- Development of computer models (MKS, Adams)

Usually several measuring wheels (4 or 2 wheels) are used. Occasionally measurements with a single measuring wheel are also employed for component or tire development. The various test vehicles often require adaptation to new wheel/hub geometries. The modular design of the measuring wheels and proficient support by Kistler application centers has proved successful for this purpose.
At the same time as the measuring wheels, systems for wheel motion measurement or optical sensors (such as Corrsys sensors or sensors from other manufacturers for measuring tire and body slip angle, speed or accelerations) can also be used. Adaptations for applying individual sensors to the measuring wheels are available in the Kistler product range.

The measuring wheel system described above can also be used on a vehicle test stand. Its daily exclusive use on a test stand requires, among other things, certain special technical characteristics, which have led to the development of a special system Type 9267A2. Further information is contained in the data sheet 9267A_000-581.

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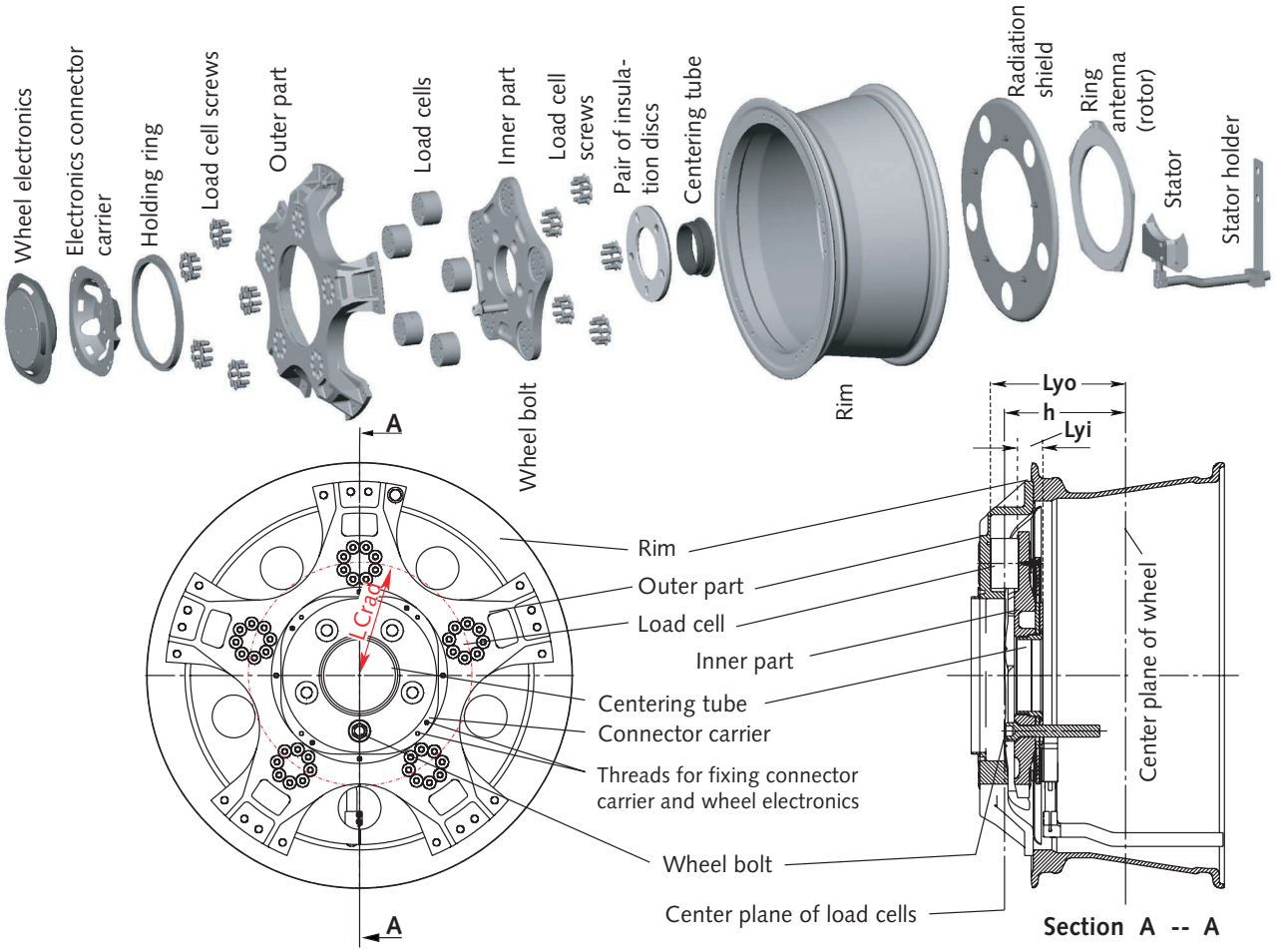

Fig. 1: RoadDyn® S635 structure/components with in-board transmission

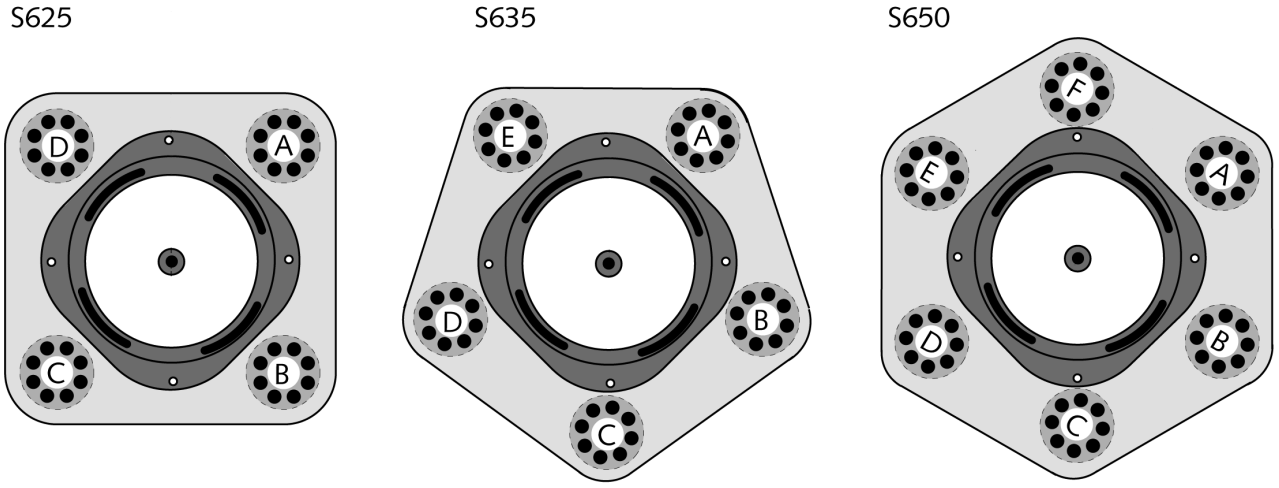

Fig. 2: Expandability of the RoadDyn® S measuring wheel system. The measuring wheel can be adapted for higher load limits or a test stand by expanding the wheel force system with exchangeable measuring cells and mechanical adaptations

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Configuration of the RoaDyn® S635 System 2000

Measuring Wheel with Wheel Force Sensor, Wheel Electronics, Outer Part, Rim and Tires	In-Board Transmission Unit consisting of Rotor and Stator	Extension Cable	On-Board Electronics	Remote Control for On-Board Electronics with Connecting Cable
Type 9267A1 with 9731A5, Z39913A..., 5241A...	Type 5242A..., 5240A...	Type 30430Axx Connection between Stator and On-Board Electronics	Type 9891A...	Type 5685A2

Measuring Wheel with Wheel Force Sensor, Wheel Electronics, Outer Part, Rim and Tires	Out-Board Transmission Unit	Extension Cable	On-Board Electronics	Remote Control for On-Board Electronics with Connecting Cable
Type 9267A1 with 5241A..., 5248A0, 9731A5, Z39913A...	Type 5248A0	Type 30430Axx Connection between Stator and On-Board Electronics	Type 9891A...	Type 5685A2

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Mounting
The sensor can be mounted with rims of most available sizes. For further information, please contact Kistler applications advisers.

Adaptation to the Hub
There is a wide variety of hub geometries on present-day vehicles. They are described among other characteristics by the following parameters:

- Number of stay bolts or tapped holes
- Dimensions of wheel bolts or stay bolts and nuts (thread diameter, pitch, length, thread length)
- Hole-circle diameter of the wheel bolt connections
- Dimensions of the axle centering as fitting dimension
- Wheel offset
- Brake contours
- Parts protruding from the hub

This makes it necessary to obtain precise details prior to adapter manufacture. For this purpose, a check list may be found in Kistler document 002-280 which, when filled out precisely, will considerably shorten the time spent on clearing up details.

Mounting the Stator Type 5240A... with In-Board Transmission
With in-board transmission, a suitable mounting device is mounted on the wheel carrier or suspension strut for the stator. The position of the stator and the location of the support is then established with a gauge.
With the stator installed, mounting a measuring wheel is comparable with that of a production wheel. The stator can also remain mounted on the vehicle if this is running on production wheels. When the measuring wheels are remounted, measurements can be made again immediately.

Included Accessories	**Type/Art. No.**
• Precision load cells (Strain gage basis), completely encapsulated, 1 set (5) per wheel	9190A46.5
• Internal part, 1 per wheel	9729A5
• Connector holder for wheel electronics, 1 per wheel	Z39904
• Radiation shield, 1 per wheel	Z39902
• Load cell screws for fastening, 1 set per wheel	Z30073

Accessories (absolutely essential for completing a measuring wheel)	**Type/Art. No.**
• External part, 1 per measuring wheel	9731A5
• Rim, 1 off per measuring wheel	Z39913A...
• Ring antenna (rotor), 1 per measuring wheel	5242A5
• Wheel electronics, 1 per measuring wheel	5241A...
• Hub adapter package, containing heat absorbing washers, centering sleeve and wheel bolts – 1 per measuring wheel	9711A3 Z39900 Z39901
• Wheel offset adapter, 1 per wheel	9713A...
• Load cell screws, titanium, 16 per measuring cell	Z30074

Optional Accessories	**Type/Art. No.**
• Transport case for 1 measuring wheel with tires, 1 per measuring wheel	V712.0004
• Precision spirit level, 1 per measuring system	Z30208
• Adjuster gage for stator mounting, 1 per system	Z39911
• Load cell tester, 1 per measuring system	5984A
• Tire mounting device, 1 per measuring system	Z30210
• Universal adapter for balancing machine, 1 per measuring system	V035.0000
• Key for centering sleeve Type Z39901, 1 per measuring system	Z30205
• Strain gage bridge amplifier (SGAM)	2237A1
• Thermocouple amplifier (TCAM)	2237A2

Ordering Code	**Type**
• RoaDyn S635 Wheel force sensor for heavy Pkw and high performance sports cars	**9267A1**

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