

# WFT-C<sup>x</sup>

precise • robust • quick setup



Flexible 6-component wheel force transducer for road testing and test stands

# The most productive wheel force transducer

The newly developed 6-component wheel force transducer WFT-C<sup>x</sup> combines numerous innov

## saves time

1 h set-up time for four wheels  
no calibration after assembly

stores calibration values internally

## balanced

## is more flexible

one sensor for all vehicles  
one sensor for test bench & mobile

universal adapter system

## optimal dissipation of heat

## saves money

high investment security

## short set-up time



**of all time**

ations and expands application possibilities many times over.

**measures more precisely**  
detects the smallest details

**24 bit**

Crosstalk less than 0,2 %

**is more robust**

operates in all weathers and  
performs all off-road testing

**protection rating: IP67**

100 g shock resistance

**designed for e-mobility**

solves challenges in electric cars

protected against EMC interference

# Saves time

Test-ready in just an hour



**Four WFT-C<sup>x</sup> can be installed in just one hour**

“With our wheel force transducers, we provide our customers with a high-precision tool for acquiring mechanical loads on the wheel. In order to simultaneously meet the growing personnel and economic pressure in development departments, we have consistently paid attention to short set-up times and simple, convenient handling. Using our WFT-C<sup>x</sup>, our customers increase the quality of their testing as well as their productivity.”

**Sebastian Asmuß, Senior Engineer at CAEMAX**

# Is more flexible

## One sensor for everything: from passenger cars to SUVs to test benches

With the flexible CAEMAX adapter system, the wheel force transducer can be used with minimal effort on a variety of vehicle types - from compact cars and sedans to SUVs and light trucks - even on the test bench.

The WFT-C<sup>x</sup> sensor housing, telemetry module and adapter can be combined as desired. This covers a wide range of wheel sizes and vehicles. A quick system set-up and convenient software functions, such as zero calibration, allow the system to be test-ready within a very short time.



**1** Hub adapter: The hub adapter connects the WFT to the vehicle. It can be used for different types of vehicles, as long as the bolt circle and the wheel offset are the same. With just a few hub adapters, an entire vehicle fleet can be covered.

**2** Rim adapter: As with a conventional rim, the rim adapter serves as a mount for the tire. The rim adapter is not directly specific to the vehicle, but depends on the tire. This allows it to be used on different vehicles with the same tire size.

**3** WFT-C<sup>x</sup> sensor housing: The sensor housing connects the hub adapter and the rim adapter to each other. These three components together form the vehicle-specific wheel. Since the calibration factors are permanently stored in the sensor, you can recombine adapters and sensor housings at any time without having to calibrate the wheel again. Thus, based on a modular design, a WFT-C<sup>x</sup> wheel force transducer can be adapted to the vehicle in a time-saving, space-saving and cost-effective manner.

# Is more robust

## Increase productivity with CAEMAX wheel force transducers

Wheel force transducers from CAEMAX deliver high-precision results even under harsh environmental conditions. Whether used in handling tests with extreme braking under heavy thermal loads or for testing during freezing temperatures, snow, rain and ice - the absolutely watertight design allows for testing in any weather. Thanks to its shock resistance of up to 100 g, the wheel force transducers can withstand even the toughest off-road applications.

### Robust and weatherproof

- Waterproof sensor housing - IP66, IP67
- High mechanical strength
- Robust digital data transmission
- High thermal conductivity: active cooling can also be omitted during brake tests



# Measures more precisely

## Increase productivity with CAEMAX wheel force transducers

The WFT-C<sup>x</sup> measures all forces and torques during test drives with an accuracy typically better than 0.5%. The subjective driving feeling, the so-called "in-seat experience" of the driver, can thus be objectively verified with high-precision data. Even with very hard tests on the strength of the components, the amount of measurement error remains minimal. The wheel force transducer measures both very low and very high forces and torques with high precision over a wide measurement range. The same sensor is therefore well suited for a wide range of vehicle types – from compact cars and off-road SUVs to electric cars. In the field of e-mobility in particular, measurement technology faces great challenges due to increased mechanical stress and EMC interference. This is exactly what the WFT-C<sup>x</sup> was designed for. Because of its high precision, it delivers more accurate values in real tests than complex simulations in the laboratory.

### Highest precision

- Crosstalk, hysteresis, non-linearity < 0.2 %
- Angular resolution 0.072°
- Precise over a wide temperature range, even at high temperatures as with brake testing
- Forces and torques are calculated online
- Synchronous acquisition of all wheel sensors
- Calibration with crosstalk compensation

**"CAEMAX wheel force transducers are the most fair-minded on the market."**

Test & measurement expert



## „Designed for e-mobility“

Compared to conventional vehicles, wheel force transducers for e-mobility are exposed to greater mechanical loads. They must detect faster control interventions and be protected against EMC interference. The WFT-C<sup>x</sup> meets all these requirements.

Right from the start, the WFT-C<sup>x</sup> has been designed for applications with higher transverse dynamics. The higher transverse forces occur because electric vehicles are usually significantly heavier due to the batteries and at the same time have a lower center of gravity. This increases the lateral forces on the wheels that occur during travel, thus leading to significantly higher loads. CAEMAX wheel force transducers can safely handle these loads, especially with large diameter tires with optimized rolling resistance.

The wheel force transducer system ensures precise data acquisition even during very fast control interventions. This is essential for measurements on elec-

tric cars, as the electric motor reacts much more directly than an internal combustion engine. The time span between triggering the control intervention and changing the values is therefore very short. At the same time, the individual wheels are mechanically coupled together only via the road, no longer in the vehicle itself. In this case too, CAEMAX sensors measure the interaction between the wheels: with the WFT-C<sup>x</sup>, the data from all wheels can be acquired and compared synchronously in very high temporal resolution.

During the development of the WFT-C<sup>x</sup>, special attention was paid to protecting it against interference – especially EMC interference. This naturally plays an important role in electric cars, especially in the prototype stage. The signal quality remains excellent even under the influence of strong electromagnetic fields, and digital data transmission does not distort the results on the way to the receiving station.



## Save money

With the WFT-C<sup>X</sup>, you are deciding on a measurement system with high investment security. It is a high-precision system designed for a wide range of applications. The intelligent adapter system allows you to use one and the same sensor for very different vehicles or types of vehicles, if required. This means that you can successively measure an entire fleet with just one sensor. In addition, it is easy to convert the system from mobile off-road/on-road testing to stationary use on the test bench. The set-up times for the respective applications are short.

Once installed, the sensor withstands high mechanical loads even under difficult conditions and is also waterproof. This leads to a longer service life, and thus, to more test kilometers per transducer. The system always delivers the high-precision measurement data you need: for example, you will get the exact output values used in simulations. For predicting the service life of newly

developed components in particular, the most accurate data is required. Thus, when it comes to longevity, reliability and safety, you can't afford measurement errors.

Since the wheel force transducers have also been particularly designed for the special challenges encountered in electric cars, you are fit for the present and for the future with the WFT-C<sup>X</sup>!

**"In addition to their sensors, CAEMAX's customer service is also first class!"**

Long-time operator



## In practice

The WFT-C<sup>x</sup> shows its strengths in practical operations. Its range of applications extends from testing the fatigue strength of components on the test bench to measurements of driving dynamics. Data gathered in this way brings enormous added value for a wide range of applications.

### Determination of load spectra for prototypes

An ideal task for the CAEMAX wheel force transducer is its use during test drives. In the development of new vehicles, suitable load spectra can be determined in order to estimate the real load on the components during vehicle operation. The CAEMAX WFT-C<sup>x</sup> can be used for wheel sizes starting at 13", and thanks to its modular design, it covers a whole range of vehicle types: from compact cars and SUVs to electric cars. The robust and waterproof design proves itself particularly during test drives lasting several days. By optimally compensating for the measured values by means of thermal sensors distributed throughout the wheel, the sensor delivers precise values under all conditions.



### Off-road testing

Even off-road, the WFT-C<sup>x</sup> reliably delivers precise readings - and in all weather conditions. The sensor is designed for a temperature range between -40 °C and +150 °C. In addition, the wheel force transducer is mechanically robust and waterproof. This makes it well-suited for test drives even in ice, snow, rain and mud.



### Measurement data on driving dynamics

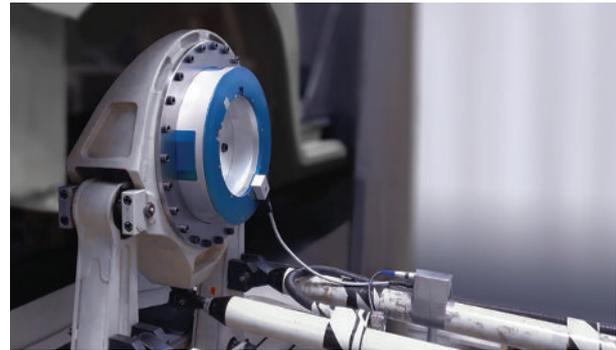
The WFT-C<sup>x</sup> wheel force transducer measures all forces and torques for driving dynamics with a high degree of accuracy. Data from all four wheels can be synchronously acquired and evaluated along with all other measurement data on the vehicle, e.g., from the chassis or the drivetrain. The driver's experience can be objectified with hard data.



### Fatigue and load tests of components on the test bench

The WFT-C<sup>x</sup> wheel force transducer delivers high-precision data even on the test bench. Thus, it is also well suited for testing load limits and durability tests.

Especially for these applications, CAEMAX offers fatigue-resistant sensor housings made of titanium or steel. If a static measurement is to be carried out on the test bench, the wired signal transmission to the control unit can be used. Since all CAEMAX 6-component wheel force transducers have the same mechanical interface, existing rim and hub adapters can still be used.



### Optimization of control interventions in driver assistance systems

The high precision and robustness of the WFT-C<sup>x</sup> also pays off in the development and optimization of driver assistance systems. With the WFT-C<sup>x</sup>, the effects of control interventions on the wheels can be acquired precisely and in real time. The measurement data obtained in the test drive form the basis for the further development of the control algorithms and the determination of the necessary control parameters, their validation and optimization. For each of these steps, the more accurate and reliable the measurement data are, then the better and more reliable the result.



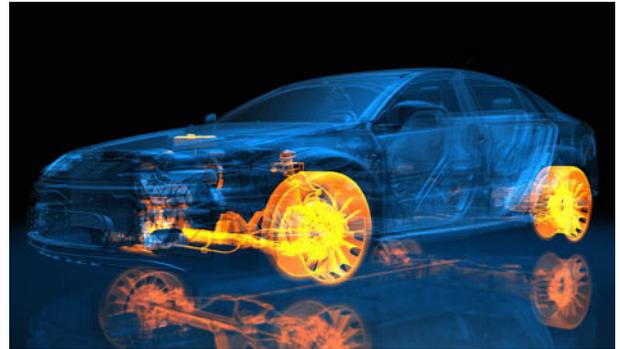
### Development of autonomous vehicles

CAEMAX offers solutions for the development of autonomous vehicles to reliably measure the driving behavior and the interactions of autonomous systems in real time during real-world testing. Considering the car as a black box, the CAEMAX steering sensor can detect the input to the system, while the WFT-C<sup>x</sup> wheel force transducers acquire the output. These data can then be prepared and further processed.



### Development process optimization

With the high-precision data obtained in practice, the development of new components can be significantly optimized. On the one hand, the real measured values serve as basic data for simulations, but on the other hand, the mathematical models themselves can be adapted and refined with them. In addition, original hypotheses that were used during development can be verified.



### Designed for electric cars

The WFT-C<sup>x</sup> wheel force transducer is well prepared for the high demands that occur in the development of electric vehicles. Since the connection between drive and wheels in electric cars is usually more direct than in conventional vehicles, control interventions take effect much faster. The lateral dynamics that occur in electrically powered cars are also usually significantly higher than in conventional cars. And last but not least, electromagnetic stress poses a major challenge for prototypes with electric motors. The high sampling rate of the WFT-C<sup>x</sup> ensures that fast control interventions are also measured. The sensor is also designed for high lateral accelerations. And of course, the measurement electronics are protected against EMC interference.



### Real tests are better than simulations

In all of these applications, the CAEMAX WFT-C<sup>x</sup> wheel force transducer delivers data that are more precise than even many complex simulations. The calculation of models is important for the development of vehicles, but nothing beats real physical testing.



# Acquire additional measurement variables: connecting with the imc world

When using the WFT-C<sup>x</sup> wheel force transducer from CAEMAX in holistic vehicle tests, many different physical variables have to be measured. In addition to wheel forces and torques, additional values such as acceleration, frequencies or ECU information are of interest. The CAEMAX WFT-C<sup>x</sup> connects directly to measurement devices from imc, which offer synchronous data acquisition of all signals. The imc software ensures convenient operation and has a wide range of functions for further analysis and visualization of the measurement data.



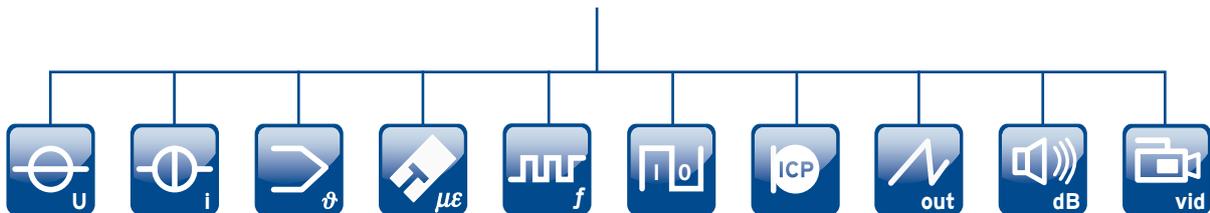
6-component wheel force transducer WFT-C<sup>x</sup>



measurement software:  
parameterize, visualize, evaluate



imc CRONOSflex:  
measurement system



Analog and digital signals

# Technical Data

## WFT-C<sup>x</sup> wheel force transducer

Parameter	Value			
	Aluminium	WFT-C <sup>x</sup>		WFT-C <sup>XS</sup>
Material	Aluminium	Titanium	Steel PH17-4	Aluminium
Measurement principle	temperature compensated strain gauge application			
Measurement range: forces	Fx, Fz = ± 45 kN Fy = ± 25 kN	Fx, Fz = ± 60 kN Fy = ± 30 kN	Fx, Fz = ± 60 kN Fy = ± 30 kN	Fx, Fz = ± 25 kN Fy = ± 20 kN
Measurement range: torques	Mx, My, Mz = ± 8,75 kNm	Mx, My, Mz = ± 10 kNm	Mx, My, Mz = ± 10 kNm	Mx, My, Mz = ± 6 kNm
Protection rating	IP66, IP67			
Sampling rate per channel	up to 5 kHz			
Angular resolution with 5000 increments	0,072 °			
Linearity	< 0.2 % FS			
Hysteresis	< 0.2 % FS			
Crosstalk	< 0.2 % FS			
Low pass filter	6-pol Butterworth filter, cut-off frequency 1200 Hz			
Weight without adapter (ca.)	7.5 kg	10.5 kg	17.5 kg	5.9 kg
Rim diameter	min. 14" (356 mm), 13" upon request			
Hub diameter with adapter	max. 5.5"			
Operating temperature sensor	- 40 °C to + 150 °C			
Operating temperature electronics	- 40 °C to + 105 °C			
Mechanical load	Stress analysis according to BMW QV 36026			
Shock proof	max. 100 g			
Rotational speed	max. 2300 rpm (ca. 278 km/h)			
Safety	mechanical breakage protection			
Dimensions:				
- Outer diameter (w/o adapter)	317.5 mm			
- Inner diameter (w/o adapter)	203 mm			
- Height	76 mm			61.5 mm
Temperature drift	0.005 % / °C			
Mounting bolts	32 Pieces			
Adaption	customer-specific adaption for any vehicle possible			

## Calibration

CAEMAX calibrates each WFT-C<sup>x</sup> on its own specifically developed test bench. Each force and torque is measured separately. Interactions (crosstalk) between the measured variables can thus be detected and compensated for. This results in an unprecedented precision of the measured values (crosstalk, non-linearity, hysteresis: all below 0.2%).

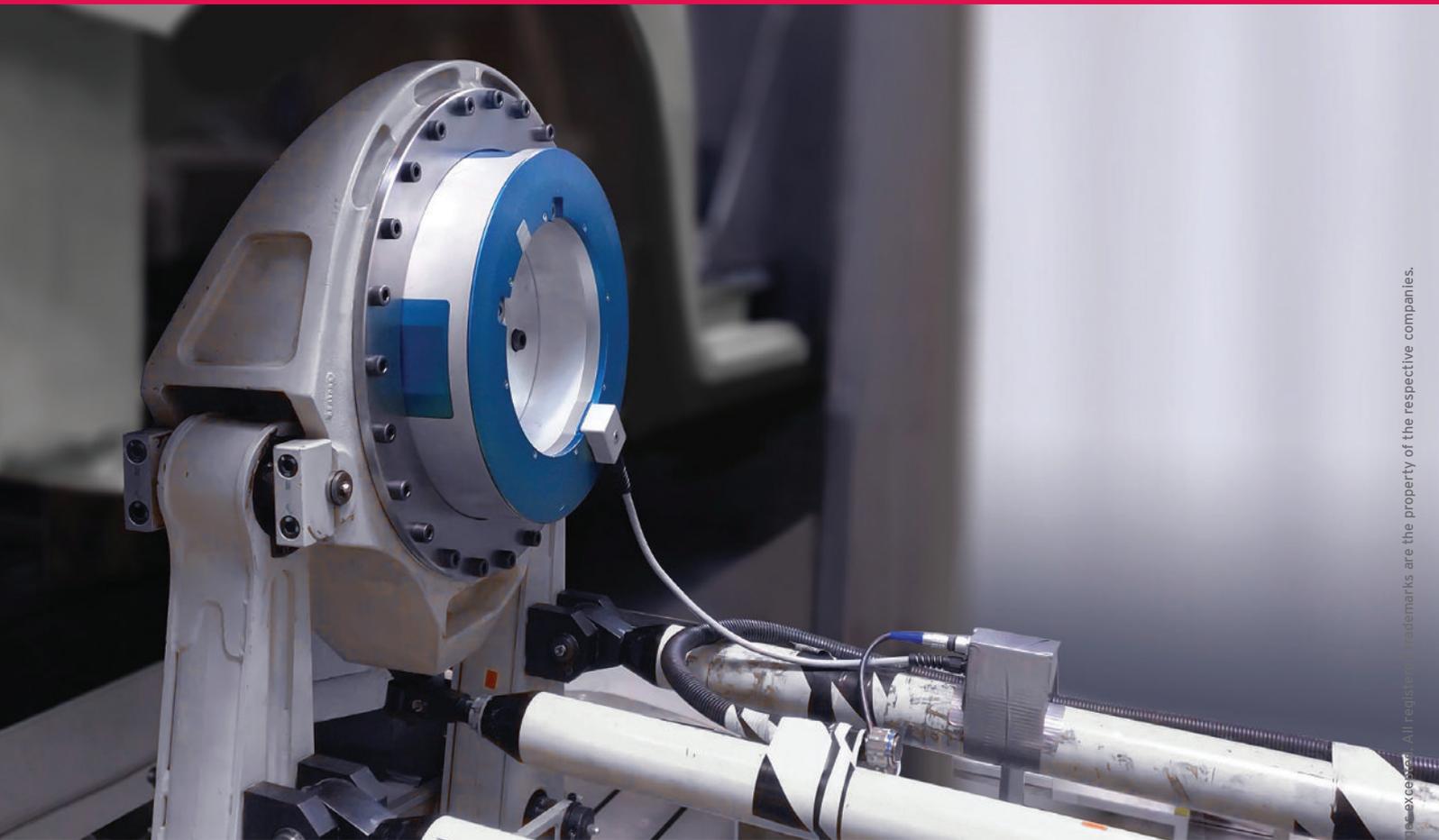
# Services



CAEMAX offers comprehensive services around its telemetry and sensor systems. We support you with the set-up of measurements, help with short throughput times for calibrations and provide practical training. In addition, we offer our customers our in-depth know-how even in challenging applications.

## **Device rental**

You need a wheel force transducer, but only for a short period of time? Or do you simply want to get to know the WFT-C<sup>x</sup> and experience its capabilities in practice? CAEMAX can provide you a rental opportunity for the appropriate device. In addition, our specialists will be happy to assist you if required.



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