

## MEMS Capacitive Tilt Sensor

### ASC TS-9xV1 | ASC TS-9xV5

Uniaxial, Biaxial  
 MEMS Capacitive  
 Measurement Range:  $\pm 90^\circ$   
 Resolution: <0.005°  
 Frequency Range ( $\pm 3$  dB): DC to 100 Hz  
 Aluminum or Stainless-Steel Housing (IP68)  
**Made in Germany**



CE

### MEMS Capacitive Tilt Sensor

The key components in capacitive tilt sensors are high-quality micro-electro-mechanical systems (MEMS) that feature excellent long-term stability and reliability. This technology enables the measurement of static (DC) and constant accelerations, like the gravity vector of the Earth. By measuring the acceleration (within  $\pm 1$  g) the tilt between the sensitive direction of the sensor and the horizon is calculated by trigonometric principles. Other advantages of capacitive tilt sensors are their outstanding temperature stability, excellent response behavior and achievable resolution.

### Description

The tilt sensors of type ASC TS-9xVx are based on proven MEMS technology and capacitive operating principle. The integrated electronic circuitry enables a quasi-differential analog voltage output ( $\pm 2.0$  V FSO) and flexible power supply voltage from 6 to 40 VDC. The tilt sensors feature a resolution of <0.005°. In addition, the long-term stability of the scale factor ( $\pm 300$  ppm) and bias ( $\pm 0.009$ °) are a basic requirement for the demands of condition and structural health monitoring applications.

The sensor ASC TS-9xV1 features a lightweight aluminum housing with protection class IP67 and the sensor ASC TS-9xV5 provides a robust stainless-steel housing with protection class IP68, both with an integrated cable with configurable length and connectors.

Their outstanding resolution and long-term stability make these tilt sensors ideal for the detection of tower swaying, for track alignment and axle alignment, compensation of truck chassis or angular positioning of machine tools.

### Features

- Low Noise Differential Voltage Output
- DC Response, Gas damped
- Very High Shock Resistance
- Excellent long-term Bias and Scale Factor Stability

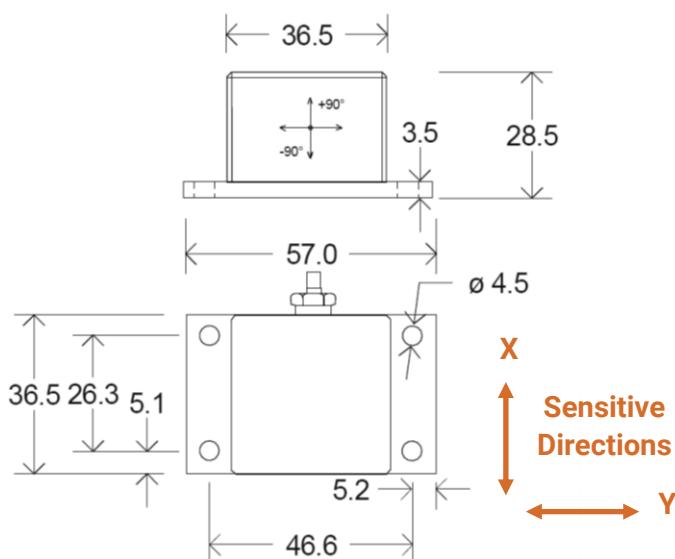
### Options

- Customized Cable Length
- Customized Connector
- TEDS Module
- Current Output Signal

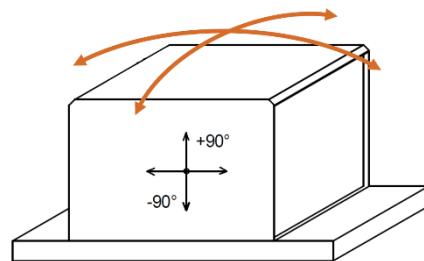
### Applications

- Structural Health Monitoring
- Infrastructure Monitoring
- Renewable Energy and Industrial Applications

More applications in several markets are figured out on our web page [www.asc-sensors.de](http://www.asc-sensors.de)



### Change of the Tilt in Biaxial Configuration



**MEMS Capacitive Tilt Sensors****Typical Specification****Dynamic**

Measurement Range	°	±90
Scale Factor (sensitivity)	mV/g	2000
Noise Density	°/√Hz	<0.001
Resolution	°	<0.005
Bandwidth, Frequency Response Range ( $\pm 3$ dB)	Hz	0 to 100
Amplitude Non-Linearity	% FSO	<1 (max)
Transverse Sensitivity	%	<1

**Electrical**

Power Supply Voltage	V	6 to 40
Operating Current Consumption	mA	<2 (per axis)
Offset (bias)	mV	±10
Isolation		Case Isolated

**Environmental**

Temperature Coefficient of the Scale Factor	ppm/K	100 (typ)   -50 to 250 (max)
Temperature Coefficient of the Offset	°/K	±0.003 (typ)   ±0.02 (max)
Long-term Scale Factor Stability	ppm	300 (typ)   1000 (max)
Long-term Offset Stability	°	0.01 (typ)   0.15 (max)
Operating Temperature Range	°C	-30 to +125
Storage Temperature Range	°C	-40 to +125
Shock Limit (0.1 ms, half-sine)	g	5000
Protection Class ASC TS-9xV1		IP67
Protection Class ASC TS-9xV5		IP68
Please note: the housing is hermetically sealed and therefore not repairable.		

**Physical**

Sensing Element		MEMS Capacitive
Case Material		ASC TS-9xV1: Anodized Aluminum ASC TS-9xV5: Stainless-Steel
Connector at Cable End		Optional
Mounting		Adhesive   Screw Holes
Weight (without cable)	gram	ASC TS-9xV1: 78 ASC TS-9xV5: 192
Cable ASC		30 gram per meter   AWG 30   Polyurethane (PUR)   Diameter 4.5 mm
Cable ASC (optional)		29 gram per meter   AWG 30   Fluorethylenpropylen (FEP)   Diameter 3.75 mm   waterproof

**MEMS Capacitive Tilt Sensors****Sensor Calibration****Factory Calibration (order separately)**

Part Number	#14918	Uniaxial	#16844	#14867
Number of Sensitive Directions			Biaxial	
Applied Tilt Range (min)	°	-15	-90	-15
Applied Tilt Range (max)	°	15	90	15
Number of Measurement Steps		11	15	11
				15

**Calibration according DIN ISO 17025 (order separately)**

Part Number	#16449	Uniaxial	#16159	#16360	#16160
Number of Sensitive Directions				Biaxial	
Applied Tilt Range (min)	°	-15	-90	-15	-90
Applied Tilt Range (max)	°	15	90	15	90
Number of Measurement Steps		11	15	11	15

Remarks:

- If any other calibration procedure is required, don't hesitate to contact us. Our services include both factory calibration and calibration in accordance with DAkkS guidelines.
- Furthermore, sensors have to be calibrated regularly to ensure accurate and precise results. On request we will be glad to remind you of the next scheduled calibration of your sensors.

**Cable Code / Pin Configuration, Uniaxial (4 Wire System)**

Pin	Color Code	Description
1	Supply +	Red Power: supply Voltage +6 to +40 VDC
2	Supply -	Black Power: GND
3	Signal +	Green Positive, analog output voltage signal (+0.5 V to +4.5 V)
4	Ref. Signal	White Reference analog output voltage signal for quasi-differential mode (+2.5 V)

**Cable Code / Pin Configuration, Biaxial (8 Wire System) including separate Power Supply for both Axes**

Pin	Color Code	Description
1	Supply +	X-Axis: power supply voltage +6 to +40 VDC
2	Supply -	X-Axis: power GND
3	Signal +	X-Axis: positive, analog output voltage signal (+0.5 V to +4.5 V)
4	Signal -	X-Axis: reference analog output voltage signal for quasi-differential mode (+2.5 V)
5	Signal +	Y-Axis: power supply voltage +6 to +40 VDC
6	Signal -	Y-Axis: power GND
7	Signal +	Y-Axis: positive, analog output voltage signal (+0.5 V to +4.5 V)
8	Signal -	Y-Axis: reference analog output voltage signal for quasi-differential mode (+2.5 V)

## MEMS Capacitive Tilt Sensors

### Principle of Operation

The sensors of the ASC TS-series are based on low-g MEMS capacitive sensing elements which enables the measurement of static (DC) accelerations, like the gravity vector of the Earth. Depending on the angle between the sensitive direction of the sensor and the horizon, an acceleration is measured which is equal to the sine of the tilt. Based on trigonometric principles and the voltage output signal of the sensor, the tilt  $\Theta$  is calculated by following formula:

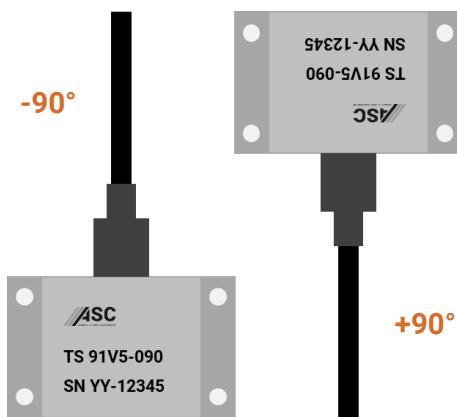
$$\theta = \arcsin\left(\frac{V_{out} - K_0}{K_1 \times 1g}\right)$$

where:

$V_{out}$  is the voltage output signal of the sensor [V]  
 $K_0$  is the offset of the sensor [V]  
 $K_1$  is the scale factor of the sensor [V/g]

#### Sensitive Direction X-Axis

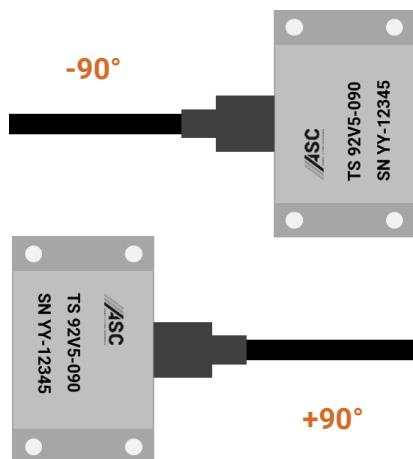
Uniaxial and biaxial version ASC TS-9xVx



1 g  
↓

#### Sensitive Direction Y-Axis

Biaxial version ASC TS-92Vx



### Ordering Information

Series	- Sensitive Directions	Output	Housing Material	- Range [°]	- Cable Length [m]	Connector & Pinout
ASC TS	91 (Uniaxial)	V (Voltage)	1 (Aluminum)	015	6	A
	92 (Biaxial)		5 (Stainless-Steel)	090		
				015-K		
				090-K		

Example:

**ASC TS-91V1-015-6A**

Ordering information are based on standard configurations. All customized versions regarding connector and/or pinout will lead to a corresponding product match code:

- Current output signal of 4-20 mA is available on request.
- Measurement range selection of 15° ("015") or 90° ("090") don't changes the performance specification but defines the range of the measured steps during calibration. The identifier "K" is added within the ordering information when a certain calibration is requested.
- Standard length of the integrated cable is 6 meters. However, different customized cable lengths are possible on request.
- Standard version has no connector at the cable end which is identified by "A" in the product match code. However, it is possible to assemble almost all connector types during production.

## MEMS Capacitive Tilt Sensors

### Safety Precaution for Installing and Operating

This data sheet is a part of the product. Read the data sheet carefully before using the product and keep it available for future operation. Handling, electrical connections, mounting or any other work performed at the sensor must be carried out by authorized experts only. Appropriate safety precautions must be taken to exclude any risk of personal injury and damage to operating equipment as a result of a sensor malfunction.

### Handling

The sensor is packaged in a reliable housing to protect the sensing elements and integrated electronic components from the ambient environment. However, poor handling of the product can lead to damages that may not be visible and cause electrical failure or reliability issues. Handle the component with caution:

- Avoid shocks and impacts on the housing, such as dropping the sensor on hard surface
- Never move the sensor by pulling the cable
- Make sure that the sensor is used within the specified environmental conditions
- Transport and store the sensor in its original or similar packaging
- The sensor should be mounted on a stable flat surface with all screws tightened or other mounting options
- Avoid any deformation during mounting the sensor
- Mounting tolerances may have an influence on the measured result

### Electrical

ASC's inertial sensors are working with many established data acquisition systems. However, make sure that a proper DAQ is used, for the corresponding operation principle of the sensor. Furthermore, suitable precautions shall be employed during all phases of shipment, handling and operating:

- Active sensor pins are susceptible to damage due to electrostatic discharge (ESD)
- Make sure that the sensor is used within the specified electrical conditions
- Check all electrical connections prior to initial setup of the sensor
- Completely shield the sensor and connecting cable
- Do not perform any electrical modifications at the sensor
- Do not perform any adaptions on the wiring or connectors while the device under power
- Never plug or unplug the electrical connection while the sensor is under power
- When a certain pin is not used during operation, make sure that the pin is insulated

### Quality

- We have a quality management system according to ISO 9001:2015.
- The Deutsche Akkreditierungsstelle GmbH (DAkkS) has awarded to our calibration laboratory the DIN EN ISO/IEC 17025:2018 accreditation for calibrations and has confirmed our competence to perform calibrations in the field of mechanical acceleration measurements. The registration number of the certificate is **D-K-18110-01-00**.
- All ASC products are -compliant.

#### Made in Germany



analyzing



monitoring



testing



measuring