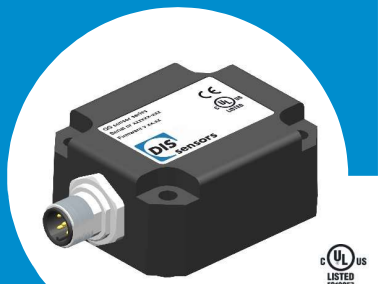
QG65/76D series Analog Inclinometers

Features

- Gyro-compensated MEMS-based Inclinometer
- 1-axis ± 180° / 2-axis ±10° / ±30° / ±90°
- Analog Outputs: 4-20mA/0-10V (combination possible)
- Dynamic applications
- Zero adjustment available
- Factory programmable: measuring range, output value, filter…
- OEM customise options possible



Intended use

The **QG65/76D Inclinometer** is a high-performance **MEMS-based**, **gyro-compensated** inclination sensor with an **analog** interface, designed specifically for accurate and stable measurements in **dynamic environments**. With its advanced **Kalman filter** algorithm, this sensor ensures high precision, effectively filtering out noise and compensating for movement to deliver reliable inclination data even in challenging, rapidly changing conditions. The use of this device in a machine or system is permitted only under the following conditions:

- The user is trained and competent in integrating and using inclination sensors in machinery.
- The user is familiar with the contents of both the datasheet and user manual.
- The device is used within the specified environmental conditions.
- The device is properly configured for its intended use.
- The device is mounted correctly as described in the datasheet and user manual.
- The device data is expressly not interpreted as safety data, except when used redundantly in a control system that is designed and tested for cross-check functionality between the primary and redundant devices.

Application

- Construction equipment(excavator, cranes…)
- Agricultural Machinery (levelling, tilt control…)
- Marine and offshore platforms(changing tilt angles caused by waves and motion…)

Technical Data

Measuring Range: depending on type:	2-axis ±10° / ±30° / ±90° 1-axis ±180°
Supply voltage:	10/12 - 32 V DC
Output Current type: Output Voltage type:	4 - 20 mA 0 – 10 V
Frequency Response	0 – 50 Hz
Resolution:	0.01°
Accuracy High: Accuracy Standard:	0,08° typ. 0,12° typ.
Current Consumption:	≤ 25 mA
Output refresh rate	10 ms
Connection:	5p M12 male
Housing Material:	QG65: Faradex DS QG76: Stainless steel
Operating temperature:	-40 .. +80 °C
Degree of protection:	IP67, IP69K

Further details can be found in the datasheets.

Certification, conformity

Available on the DIS website under Downloads and Datasheets.

Mechanical drawing

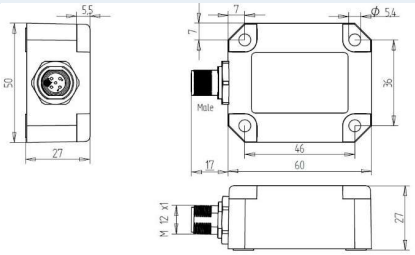


Figure 1 QG65 housing size – 60 x 50 x 27 mm

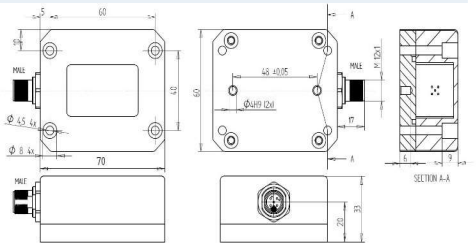


Figure 2 QG76 housing size – 70 x 60 x 33 mm

Mounting Instructions

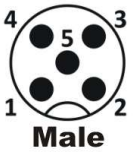
- **Prepare the Mounting Surface:**
  Ensure the surface is perfectly flat to secure proper alignment and accurate measurements. To reduce the impact of vibrations on sensor accuracy, consider placing a rubber layer between the sensor and the mounting surface.
- **Mounting the Sensor:**
  - 1-Axis: Mount the sensor vertically. The factory default zero position is with the male connector pointing downward (see Figure 3). The sensor can be zero-adjusted at any position within the full measurement range.
  - 2-Axis: Mount the sensor horizontally. The factory default zero position is as shown in Figure 4. After installation, you can zero-adjust the sensor to correct any mechanical offsets within a ±5° range.
- **Fastening the Sensor:**
  For QG65 plastic housing: Use 4 M5 pan head screws (available on demand).
  For QG76 stainless steel housing: Use 4 M4 hexagon socket head screws (available on demand).
- **Zero adjustment** can eliminate mechanical offsets.

Figure 3 1-axis mounting

Figure 4 2-axis mounting

Electrical Connections

Pin	Assignment 1-axis	Assignment 2-axis
Pin 1	+ Supply Voltage	
Pin 2	For factory use only	Output Y
Pin 3	Gnd	
Pin 4	Output X	
Pin 5	Zero adjustment input (Programming interface)	



- For ISO 13766-1 and -2 (earth moving machinery) and ISO 14982 (agricultural), the sensor may not be directly powered from the vehicle's battery.
- For automotive (regulation 10) purposes, the sensor may be used as an immunity related device. The sensor may be powered directly from the vehicle battery.
- For QG76 Stainless housing, the enclosure must be electrically connected to the chassis of the vehicle.

Product Code Identification

QG65D-KDXYh-010H-AV3-CM-UL

- **QG Series** — Inclination sensor
- **Housing Size** — 65 = 60 x 50 mm; 76 = 70 x 60 mm
- **Generation** — D = 2nd Generation; D = Dynamic
- **Housing Material** — K = Plastic; S = Stainless Steel
- **Measuring Axis** — IX = 1 axis (X-axis); DXY = 2 axis (X-axis and Y axis)
- **Mounting Orientation** — h = Horizontal; v = Vertical
- **Measuring Range** — 010 = ± 10°; 030 = ± 30°; 090 = ± 90°; 360 = ± 180°
- **Accuracy** — empty = Standard accuracy; H = High accuracy
- **Output configuration** — AV3 = Analog Voltage 0 – 10 V; AV = Analog Voltage 0.5 – 4.5 V; AI = Analog Current 4 – 20 mA
- **Connection** — CM = 5p M12 Male Connector; PT = PUR/TPE cable
- **USA&Canada** — UL = UL; U = cTUVus

Product Identification can be found on DIS website.

Order Code

1 measuring axis

Standard Accuracy

14337	QG65D-KIXv-360-AI-CM-UL	±180°, 4-20mA
14329	QG65D-KIXv-360-AV3-CM-UL	±180°, 0-10V

High Accuracy

14341	QG65D-KIXv-360H-AI-CM-UL	±180°, 4-20mA
14349	QG76D-SIXv-360H-AI-CM-UL	
14333	QG65D-KIXv-360H-AV3-CM-UL	±180°, 0-10V
14345	QG76D-SIXv-360H-AV3-CM-UL	

2 measuring axis

Standard Accuracy

14334	QG65D-KDXYh-010-AI-CM-UL	±10°, 4-20mA
14335	QG65D-KDXYh-030-AI-CM-UL	±30°, 4-20mA
14336	QG65D-KDXYh-090-AI-CM-UL	±90°, 4-20mA
14326	QG65D-KDXYh-010-AV3-CM-UL	±10°, 0-10V
14327	QG65D-KDXYh-030-AV3-CM-UL	±30°, 0-10V
14328	QG65D-KDXYh-090-AV3-CM-UL	±90°, 0-10V

High Accuracy

14338	QG65D-KDXYh-010H-AI-CM-UL	±10°, 4-20mA
14346	QG76D-SDXYh-010H-AI-CM-UL	
14339	QG65D-KDXYh-030H-AI-CM-UL	±30°, 4-20mA
14347	QG76D-SDXYh-030H-AI-CM-UL	
14340	QG65D-KDXYh-090H-AI-CM-UL	±90°, 4-20mA
14348	QG76D-SDXYh-090H-AI-CM-UL	
14330	QG65D-KDXYh-010H-AV3-CM-UL	±10°, 0-10V
14342	QG76D-SDXYh-010H-AV3-CM-UL	
14331	QG65D-KDXYh-030H-AV3-CM-UL	±30°, 0-10V
14343	QG76D-SDXYh-030H-AV3-CM-UL	
14332	QG65D-KDXYh-090H-AV3-CM-UL	±90°, 0-10V
14344	QG76D-SDXYh-090H-AV3-CM-UL	

Measuring axis and direction

A single-axis inclinometer (vertical mount) measures the inclination in the vertical plane over the full range 0-360° (X-output). The default 0° position and the measuring direction are shown in Figure 8.

A dual-axis inclinometer (horizontal mount) measures the inclination on both X and Y axis. Measuring range is up to 90°. Due to the measurement principle, to achieve the best accuracy only one axis may tilt more than 45°.

Other mounting options may require a customized model. Please contact our support team for further assistance.

Zero adjustment

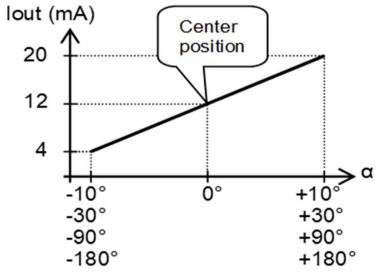
Zero adjustment allows users to compensate for mechanical offsets of a horizontally mounted 2-axis device or set a customised 0° position of a vertically mounted 1-axis sensor. The measured inclination value at the 0° position will be stored in the device as a permanent offset, which is used to calculate the actual inclination output of the device.

Method

1. Bring the object with the mounted sensor to its zero position.
2. Apply power to the sensor and within 1 minute perform the zero adjustment as follow.
3. Connect zero adjustment input to ground for at least 0,5 seconds
4. Disconnect the connection. Normally this input should be left unconnected

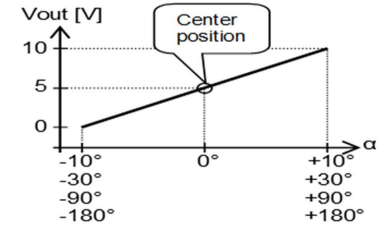
1-axis ±180° sensors can be zero adjusted over the full range, the position of the male connector is at customer discretion.
2-axis sensors can only be zero adjusted in a horizontal position within an offset limit of ±5°.

Output signal current 4 – 20mA



2-axis output with clipping outside measuring range.

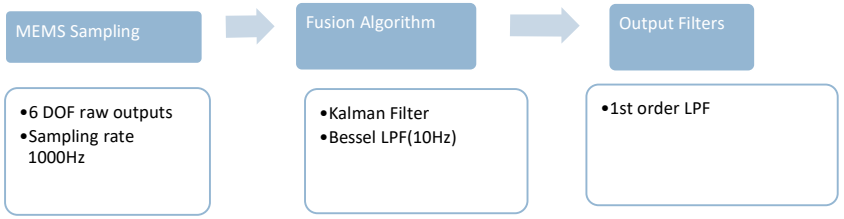
Output signal voltage 0 – 10V



2-axis output with clipping outside measuring range.

The output value is factory programmable to any value within the ranges of 4-20mA and 0-10V.

Signal processing



Sampling rate

Each axis of the acceleration MEMS and Gyroscope MEMS is sampled by the internal microcontroller at a rate of 1000 Hz. Those samples are fed into the fusion algorithm and will be processed further.

Fusion algorithm

This algorithm particularly effective for predicting a moving angle by combining acceleration and angular velocity data to estimate the sensor's true tilt angle. As the inclinometer moves, the filter separates real tilt changes from noise, allowing it to give a stable output even in environments with vibration or movement.

Kalman filter

Based on the previous state, the filter predicts the sensor's next state and estimates the uncertainty (or error) in this prediction. The filter then incorporates a new measurement, adjusting the prediction with this data to improve the accuracy of the estimate.

Bessel Low pass filter

Normally, an inclinometer with a bandwidth of 10Hz is fast enough for most applications. Therefore a 2nd order low-pass Bessel filter with a fixed cut-off frequency of 10Hz is implemented. You can only turn this filter ON/OFF. This filter is ON as default and effective on all sensing axes. For standard inclination measurements it is highly recommended to leave this filter on.

Output filter

An additional 1st order low-pass filter called '**output filter'** is implemented for further additional reduction of bandwidth and extra noise filtering. This filter is useful for slow-moving applications with a lower bandwidth than 10Hz. By setting a time-constant τ [1] the cut-off frequency can be calculated by the formula $f = 1 / (2\pi*\tau)$. A longer filter time results in a narrower bandwidth and therefore less noise, but also causes a longer phase delay. This filter is OFF as default and effective on all sensing axes.

Normally this filter is used in addition to the 2nd order Bessel LPF. Therefore, it does not make sense to set the output filter to a higher frequency than 10Hz (i.e. τ should be >16ms). Common filter time are 50ms (3Hz), 100ms (1.6Hz) or 200ms (0.8Hz).

[1] τ time in which the output changes to 70% of the step after a step response

Firmware management

If a firmware version is mentioned on the label, it is the factory-installed firmware number.

Figure 5 - Firmware version

⚠ *The currently-installed firmware version might vary from the version on the sticker due to a firmware update. Always check the actual version..*

The firmware release notes are available at www.dis-sensors.com under "downloads/user manuals".

Configuration Tool

The QG65/76D Analog Inclinometer includes a LIN programming interface. DIS is actively developing a configurator tool that will enable users to adjust sensor parameters and monitor live outputs. This configuration tool will be available soon and can be purchased separately.

Customise options

DIS offers a variety of customization options to meet your specific needs. You can choose from alternative cable lengths and types, including PVC, PUR, or TPE cables, to suit different environmental conditions. Additionally, we provide a range of connectors, such as M12, Deutsch, or custom-designed connectors, ensuring compatibility with your system.

Our sensors can also be factory-configured with specific measuring ranges, output signals, or filtering options to match your application requirements.

If you need further customization, such as unique cable materials or special calibration, our support team is ready to assist in creating a solution that fits your exact specifications.

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