DiSens® EQ-3211 (USB)

Accéléromètre sismique triaxe MEMS - Interface USB

Triaxial
MEMS Capacitive
Measurement Range: ±3 and ±5 g
Resolution: up to 21.5 ENOB
Bandwidth (-3 dB): DC to 80 Hz
Aluminum Housing
Made in Germany

High-end digital conversion yet simple USB interface

The triaxial ASC DiSens® EQ is every bit as accurate and sensitive as its analog predecessor, plus comes equipped with a high-end analog-to-digital converter and a digital data processing unit with USB interface as additional features.

For smooth analog-digital conversion, the built-in 80 Hz (-3 dB) Butterworth anti-aliasing filter resolves up to 21.5 effective number of bits (ENOB) at a default 500 Hz sampling frequency, a stand-out in the world of digital accelerometers. Beyond these integrated electronics, ASC DiSens® EQ-3211 accelerometers are based on quality MEMS technology with capacitive operation. In addition to their resolution of less than 1 µg, noise levels are ultra-low.

However, a standard USB interface makes this sensor truly convenient for anyone using a conventional laptop computer. It enables plug-and-play operation, including adjustment of all sensor configurations, external synchronization as well as retrieving and immediate processing of the measured data. 5 VDC power is supplied through the USB port, so that no additional peripherals are required.

Description

The sensor features a reliable aluminum housing with protection class IP65 and is connected to a host (e. g. computer/notebook) using an integrated USB cable. Furthermore, there is a stereo audio jack input for external triggering and synchronization.

The ASC DiSens® EQ series features extremely high resolutions far superior to other analog sensors. With its ability to register amplitudes of a millionth of the earth's gravitational acceleration, it is often used in seismological monitoring of sensitive structures including tunnels, bridges, dams, power plants, or other buildings that may be critically impacted by even the tiniest tectonic vibrations.

Features

- Ultra-low Noise Output
- Built-in Butterworth anti-aliasing Filter
- Plug&Play Communication by virtual COM Port of a PC
- Powered directly by USB Port
- External Trigger Input
- External Time Sync Input

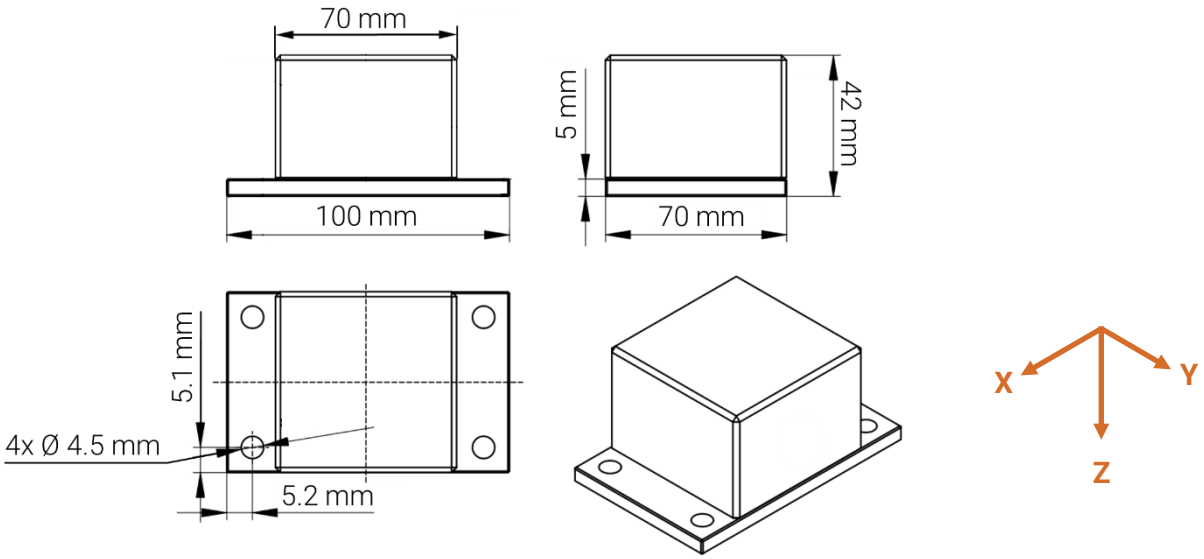
Options

- Customized Cable Length
- Customized Connectors

Applications

- Structural Health Monitoring
- Seismic Sensing
- Noise Measurements

More applications in several markets are figured out on our **www.pm-instrumentation.com**



DiSens® EQ-3211 (USB)

Accéléromètre sismique triaxe MEMS - Interface USB

Typical Specification of Sensor

The ASC DiSens® EQ-3211 is a very precise, ultra-low noise accelerometer with three sensitive directions. The sensor is based on the analog ASC EQ-Series and is extended with a very high accurate analog-digital converter and digital data processing unit with USB interface.

Features

Ultra-low noise output leading to a resolution of up to 21.5 effective number of bits (ENOB) at 500 Hz sampling frequency
Built-in low pass Butterworth anti-aliasing including filter bandwidth from DC to 80 Hz (-3 dB)
Adjustable sampling rates from 16 Hz to 4880 Hz (default 500 Hz)
Adjustable number of samples to be measured
External trigger input for “start measurement with next time sync signal”
External time sync input (e. g. 1PPS), used as soon as available

Electrical

Power Supply Voltage	V	5 VDC via USB (max. 5.3 VDC)
Operating Current Consumption	mA	<200
Isolation		Housing, shield of the integrated cable and GND pin of the audio jack are internally connected

Environmental

Operating Temperature Range	°C	-40 to +85
Storage Temperature Range	°C	-40 to +85
Protection Class		IP65

Physical

Sensing Element		MEMS capacitive
Case Material		Anodized Aluminum
Connector		Operation: USB type-A male at cable end Optional input: stereo audio jack for external signal
Mounting		Screw Holes
Weight (with 2 m cable)	gram	310
Cable		USB 2.0 | 28 AWG data line | 24 AWG power line | diameter 4 mm | double shielded | data transfer rate up to 480 Mb/s

Typical Specification of the integrated EQ Sensing Elements (analog part)

The key components in capacitive accelerometers 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, which can be used to calculate the velocity and displacement of moving objects. Depending on the design of the spring-mass-damping system, however, it is also possible to detect dynamic (AC) accelerations with a bandwidth of up to 700 Hz (±3 dB) and amplitudes up to ±5 g. Other advantages of capacitive accelerometers are their outstanding temperature stability, excellent response behavior and achievable resolution.

Dynamic

Measurement Range	g	±3	±5
Scale Factor (sensitivity)	mV/g	900	540
Noise Density	µg/√Hz	0.7	1.2
Frequency Response Range (±3 dB)	Hz	0 to 550	0 to 700
Amplitude Non-Linearity	% FSO	<0.3 (typ) | <1 (max)	
Transverse Sensitivity	%	<1	

Environmental

Temperature Coefficient of Scale Factor	ppm/K	120 (typ) | 20 to 220 (max)	
Temperature Coefficient of the Offset	mg/K	0.3 (max)	0.5 (max)
Shock Limit (0.15 ms, single shocks)	g	1500	

Modes of Operation

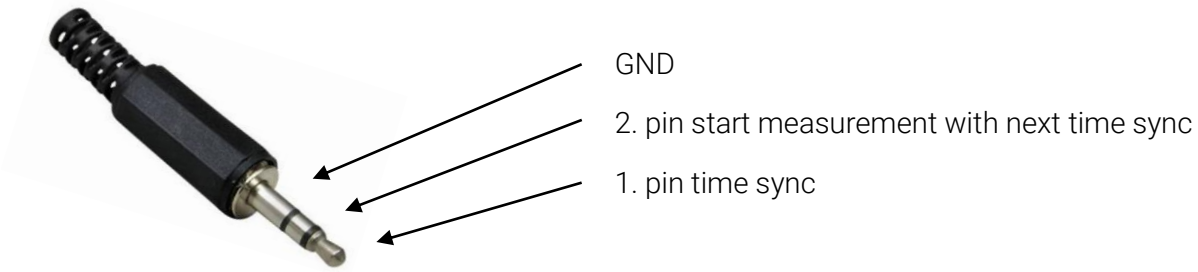
The ASC DiSens® EQ-3211 is able to operate in different modes. These modes can be changed via commands, which are sent over USB (see chapter communication). After the sensor is connected, it loads settings from flash and starts to measure and send data continuously. The measurements can be stopped and different parameters can be set. The measurement can be restarted with different options, described later. The settings can be stored to flash, so they are loaded with the next power-up. It is also possible to load and apply default settings. The stored settings remain intact even when a firmware update is applied.

Audio Jack Connector

In addition to the USB connector the ASC DiSens® EQ-3211 has a stereo audio jack. The audio jack contacts are used as following inputs (Low 0 V / High 3.3 V):

1. pin: the tip of the plug is used for time synchronization (e. g. 1PPS)

2. pin: the second contact is used as a “prepare to start” signal. The measurement is started with the next raising edge on the time synchronization pin (1. pin / 1PPS)



The audio jack can be used for connecting to an external trigger signal, such as a GPS signal. Time synchronization is achieved by restarting the internal timer with the rising edge of an external time synchronization signal. When this external signal is unavailable, the sensor relies solely on its internal timer. However, as soon as the external signal becomes available again, synchronization is promptly re-established. To start measurements aligned with the external time sync signal, the user can issue the $MEA,SE command, ensuring that the sensor begins measuring with the next rising edge of the time sync signal.

Communication

General

The ASC DiSens® EQ-3211 is connected via USB. The USB is realized as USB-CDC connection, so you will get a virtual COM port on your computer. If you are using Windows® operating systems: 98SE, 2000, XP, Vista®, 7, and 8.x, a special driver is needed.

It can be downloaded here: https://www.st.com/en/development-tools/stsw-stm32102.html

For newer Windows® versions or Linux the native build-in drivers can be used.

Message Structure Host → Sensor

The communication between ASC DiSens® EQ-3211 and host follows a special message structure in ASCII format. The message type always starts with a "$" sign, followed by the message type and separated by a comma "," the command and optional parameters. All letters have to be upper-case, the decimal separator is a dot. Every message is built in the same way as described in the overview table below, followed by detailed descriptions.

$Message Type		*Command*		*Parameter*	*Default*	*Description*
$SET Message type to configure the sensor	,	ID DF SP SF SN	,	0x00 to 0xFF R | V | G | M 205 to 65535 16 to 4880 0 to 4294967295	0x00 M 2000 500 0	Sensor ID in HEX format Data format (see examples) Sample period in µs Sample frequency in Hz Number of sample (0=continuous)
$MEA Message type regarding the measurement modes	,	SC SI SE SP				Measurement starts immediately Measurement starts with next time sync signal Sensor waits for external start and time sync Measurement stops immediately
$CMD Message type for general commands	,	SAVE LOAD DEFAULT FLASH_UPDATE				Save settings to flash Load settings from flash Load default settings Sensor is set to firmware mode
$GET Message type to get information from the sensor	,	ID UD SI				Actual sensor ID Actual sensor ID + unique ID Hard- and software versions and build info

Following commands are available for $SET

Set sensor ID: $SET,ID,0xYY *(example: $SET,ID,0x03 | Default: 0x00)*

0xYY is an ID in HEX format, which can be set individually to distinguish between up to 256 different sensors. This ID is transmitted with all measurement data. The set command is acknowledged by the corresponding return message.

Set data format: $SET,DF,X *(example: $SET,DF,R | Default: "M" [m/s²])*

X must be replaced by:

"R": transmit data in raw ADC codes
"V": measured data is transmitted in voltage
"G": measured data is converted to the unit [g]
"M": measured data is converted to the unit [m/s²]

Set sample period (in µ-seconds): $SET,SP,XXXXX *(example: $SET,SP,2000 | Default: 2000)*

That means the sample period is configured to 2000 µs while the value-range of this parameter is 205 to 65535. Setting of the sample period does affect the sampling frequency as they are inversely proportional to each other.

Set sample frequency (in Hz): $SET,SF,XXXXX *(example: $SET,SF,500 | Default: 500 Hz)*

That mean the sample frequency is configured to 500 Hz while the value-range of this parameter is 16 to 4880. Setting of the sample frequency does affect the sampling period as they are inversely proportional to each other

Set Number of Samples: $SET,SN,XXXXX *(example: $SET,SN,100 | Default: 0)*

This command set the number of samples to be sampled. When the limit is reached, the measurement is stopped and the sample counter is reset to the given value. So, with the next start of measurement the same number of samples will be sampled. If the number of samples is zero "0", the measurement is continuously processed and will not be stopped. Valid values for this parameter are 0 to 4294967295.

Following commands are available for $MEA

Start Measurement directly: $MEA,SC
Measurement is started immediately.

Start Measurement with next Time Sync Sig: $MEA,SI
Measurement is started with the next time sync signal.

Wait for External Event to Start Measurement with next time sync signal: $MEA,SE
The sensor waits for the external „Start Measurement Signal“ and starts afterwards measuring with the next „Time Sync Signal“.

Stop measurement: $MEA,SP
Measurement is stopped immediately.

Following commands are available for $CMD

SAVE settings: $CMD,SAVE
Save actual settings to flash. These settings are used when the sensor is powered-up.
Parameter, which are stored:

Sensor-ID	default: 0x00
Data Format	default: “M” [m/s²]
Sample Period	default: 2000 (500Hz)
Number of Samples	default: 0

LOAD settings: $CMD,LOAD
Load/Read settings from flash.

DEFAULT settings: $CMD,DEFAULT
Set parameters to default values. They are not automatically stored in flash-memory. This has to be done manually!

FLASH_UPDATE: $CMD,FLASH_UPDATE
Set sensor to firmware update mode. Please use STM32CubeProgrammer to update the firmware.
Download: https://www.st.com/en/development-tools/stm32cubeprog.html

Following commands are available for $GET

Get sensor ID: $GET,ID
Return-Message: $INF,0xYY,ID
0xYY is the actual sensor ID, which is always included in messages coming from the sensor.

Get sensor unique ID: $GET,UD
Return-Message: $INF,0xYY,UD,0xZZZZZZ ZZZZZZZZ ZZZZZZZZ
0xYY is the actual sensor ID, which is always included in messages coming from the sensor while 0xZZZZZZ ZZZZZZZZ ZZZZZZZZ are 88 bit forming an unique ID. Each sensor has an unique ID, which is fixed and NOT configurable.

Get sensor information: $GET,SI
This command returns hard- and software versions and build information.

Message Structure Sensor → Host

The communication between ASC DiSens® EQ-3211 and host follows a special message structure in ASCII format. The message type always starts with a "$" sign, followed by the message type and separated by a comma "," the sensor ID and return values. Every message is built in the same way as described in the following part.

Following messages are available for $ACC

$Message Type	Sensor ID	Counter	x-Value	y-Value	z-Value
$ACC,	0xYY,	0xYYYYYYYY	Float	Float	Float

$ACC,0xYY,0xYYYYYYYY,0.123456,0.123456,0.123456
(example: measurement values in [V], [g] or [m/s²])

$Message Type	Sensor ID	Counter	x-Value	y-Value	z-Value
$ACC,	0xYY,	0xYYYYYYYY	uint32_t	uint32_t	uint32_t

$ACC,0xYY,0xYYYYYYYY,2148462649,2148069677,2147694345
(example: measurement values are ADC codes)

The counter is always increased by 1.

Following messages are available for $INF

$Message Type	Sensor ID	Information Type
$INF,	0xYY,	ID

$INF,0x03,ID
(example: sensor ID is 0x03)

$Message Type	Sensor ID	Information Type	Return Value
$INF,	0xYY,	UD	0xZZZZZZ ZZZZZZZZ ZZZZZZZZ

$INF,0x03,UD,0x433589 34385104 30343839
(example: returning 88 bit unique sensor ID)

Ordering Information

Series	-	Sensitive Directions	Model	Housing Material	-	Range [g]	-	Cable Length [m]	Connector & Pinout	-	Interface
ASC DiSens EQ		3 (Triaxial)	21	1 (Aluminum)		003		2	ZH194		USB
						005		5			

Example:

ASC DiSens EQ-3211-003-2ZH194-USB

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
- When adhesives are used to mount the sensors, please select the corresponding products according to permanent or removable mounting, ambient temperature range as well as quality of the mounting surface
- Avoid any deformation during mounting the sensor
- Mounting tolerances may have an influence on the measured result

Electrical

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**.