



DELLORTO

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DoIMU 6 axis 2022 Rev.3

Inertial Measurement Unit

INTRODUCTION

For the **2022 season**, the current 5 axis IMU production will be discontinued and a new 6 axis IMU will be introduced. Sensor packaging and electric interfaces will remain same as the old 5axis.

Based on IMU values, the ECU algorithm determine precisely the effective value of lean angle while cornering. The combination of rotational and lineal acceleration sensors gives highly precise signal output set, giving the real Moto3 vehicle dynamics.

The DoIMU 6 axis is the combination of 3 linear and 3 rotational accelerometers. The sensor features a specific, high speed CAN-signal output. Moto3 and MotoE sensor has diffent CAN speed, due to different system architectures.

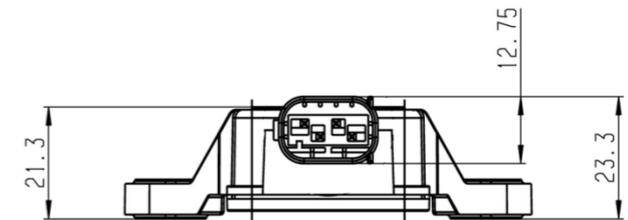
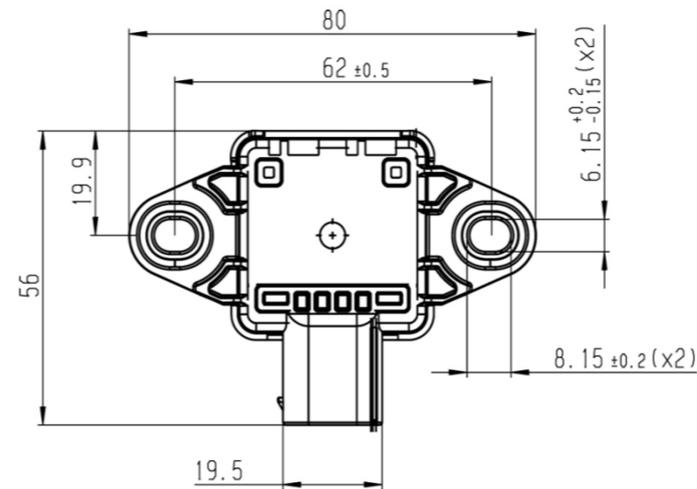
The sensor includes MEMS measuring elements connected to a specific integrated circuit. A rotational acceleration of sensor elements changes the internal capacity of the micro machined sensing parts. In addition, sensor element is used to measure the vehicle linear acceleration in all 3 axis.

DoIMU is designed to operate only in combination with the new Do POWER 1 ECU as well as the old DoPE 3.0. The Do POWER 1 ECU allows more degree of freedom regarding the IMU positioning.

Main Characteristic

Measuring range

roll rate / yaw rate / pitch rate $\pm 163^\circ/s$
 X, Y and Z acceleration $\pm 4.2 g$



Mechanical Data

Weight 35 g
 Size 80 x 56 x 21 mm

Electrical Data

Power supply 7 to 18 V
 Max input current 90 mA

Operating temperatures

Operating temperature range -20 to 85°C

IMU connector pin-out:

- Pin 1 Gnd
- Pin 2 CANL
- Pin 3 CANH
- Pin 4 VBat

Mating connector:

F 02U B00 435-01

Using instructions for Do POWER 1 & DoPE 3.0

Dellorto IMU has to be connected to ECU CAN bus.

Voltage supply is recommended under main switch.

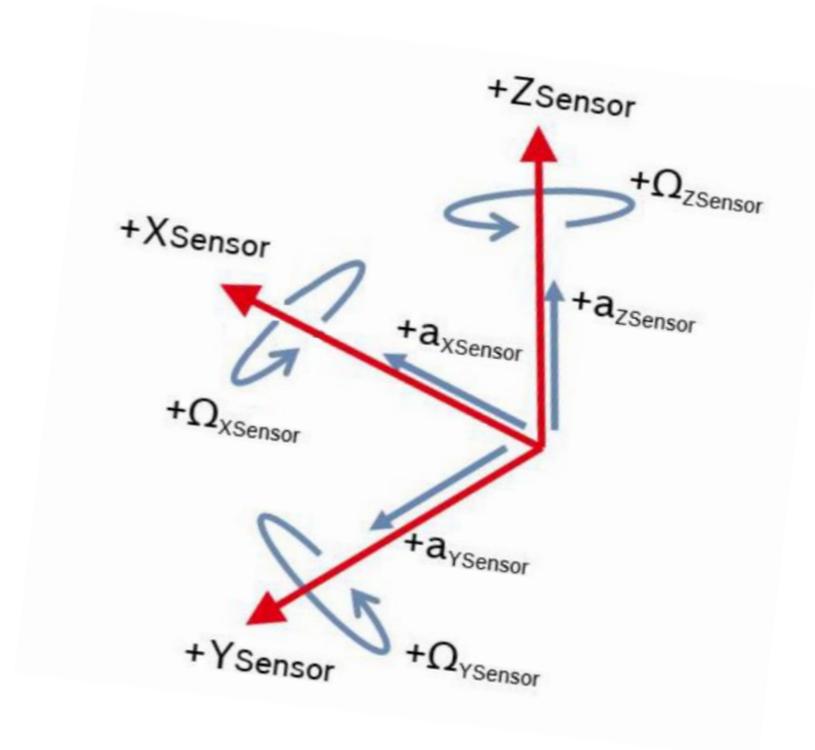
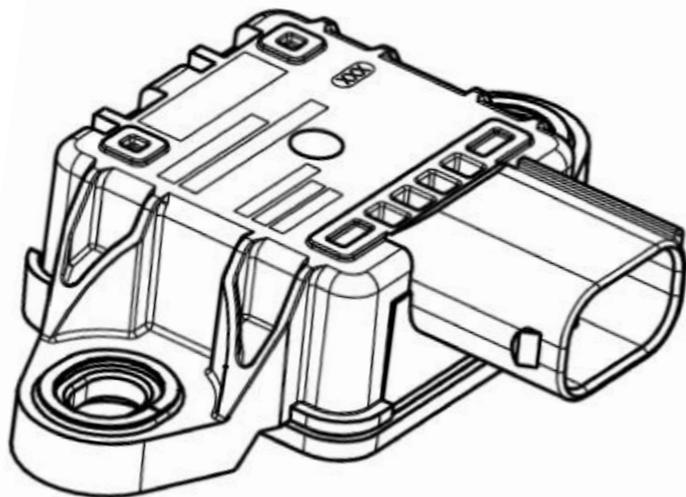
Bike reference system:

- +X points to the front of the bike
- +Y points to the right side of the bike
- +Z points to the ground

ECU provides an estimation of

- IMU_ROLL : lean angle [deg] positive in right turn
- IMU_PITCH: pitch angle [deg] positive in wheelie direction
- IMU_YAW: yaw angle [deg]

The following image shows the IMU axes orientation. The gyrometers follows right hand rule.



Wiring Harness

Inside the IMU housing a lower air pressure might occur due to ambient temperature changes. In this case the IMU is ventilated via the wiring harness. It has to be ensured, that water is not soaked through the wiring harness ends into the connector. Wiring ends potentially exposed to water spray or rain must be protected, such that water cannot penetrate into the wiring harness. Dellorto recommends the sealing of these wire ends.

Proper function of the IMU can only be guaranteed, if the specified mating connector is properly assembled.

All 4-wire seals have to be in place. With an unsealed connector, the IMU will be not waterproof.

IMU must not be connected / disconnected when supply voltage applied.

Mounting Location

Dellorto suggest to mount the sensor close to the vehicle center of gravity and align the sensor coordinate system to the vehicle coordinate system.

Vehicle vibration with high amplitudes (>20g) and in a critical frequency range (200Hz to 3kHz) must be avoided at the mounting location. This secondary acceleration may lead to malfunction or deviations in the sensor output signals. Metal contact between bushing and mounting surface is recommended. Carbon fiber reinforced materials and magnesium alloys must be avoided as contact material of the stainless steel bushings of the sensor, as it might result in extended corrosion and cracks in the housing of the IMU.

M6 screws tightening torque is 6Nm +2/-1 Nm. Flatness of mounting surface must be within 0,2mm. Bushing surface must contact the chassis completely. No other contact then the bushing surface is allowed.

Proper mounting is within user responsibility. IMU has to be handled with care, if it drops during mounting it may result in damage.

Settings for Do POWER 1 ECU

The new Do POWER1 ECU allows IMU 6-axis freedom of orientation.

When combined with the Do POWER1 ECU, the IMU can be mounted in every position, except upwards connector.

The IMU should be preferably installed close to the center of gravity or center plan of the bike.

The IMU_FIXING parameters x, y, z must be filled with the three rotation around the IMU axes to bring the IMU axis to the bike axis (by starting from IMU mounting position). Angles are expressed in deg [-180, +180°].

Starting from the IMU mounting the IMU_FIXING contains the three rotation on IMU axes needed to have the IMU axis pointing the bike axis. **The rotation order has to be z, y, x order, with right hand rule for rotation direction.**

By using the above fixing calibration the following data acq channels are described as follows:

- IMU_ACC_X(/Y/Z) [g] inertial acceleration (an axis pointing to ground measures -1g) is coming from IMU measurement but referred to **bike reference system**.

- IMU_GYR_X(/Y/Z) [deg/s] is coming from IMU measurement (positive: right hand rule) but referred to **bike reference system**.

Pitch angle estimation comes from suspension measurement. With a simplification of the geometry of the bike, the chassis pitch angle is computed as below:

$$\text{IMU_PITCH} = \text{SUSP_F} * \text{PITCH_FRONT} + \text{SUSP_R} * \text{PITCH_REAR}$$

For this purpose, PITCH_FRONT and PITCH_REAR gains in deg/mm shall be set properly, according to the bike chassis characteristic.

Settings for DoPE 3.0 ECU

Do IMU 6-axis works also with the old DoPE 3.0 ECU, like the previous 5-axis IMU.

To properly estimate the bike roll (lean) angle and for pitch angle estimation a gyrometer axis has to be placed on longitudinal bike axis. The other one has to be placed on transversal bike axis. Please refer to below table.

IMU calibrations description table (1/3)

Parameter name	Unit	Description	Range	Example
IMU_FIXING $\begin{bmatrix} x \\ y \\ z \end{bmatrix}$	deg	<p>Starting from IMU mounting it contains the three rotation on IMU axes to bring the IMU axis pointing the bike axis. The rotation order has to be z, y, x order with right hand rule for rotation direction.</p> <p>A. IMU mounted with connector pointing rear and marked area facing right:</p> <p>X bike = +X IMU Y bike = +Z IMU Z bike = -Y IMU</p> <p>Only a positive rotation of 90 degrees on X IMU axis is needed to virtually rotate the IMU to have IMU axes coincident to bike axes.</p> <p>B. IMU mounted with connector pointing right and marked area facing front:</p> <p>X bike = +Z IMU Y bike = -X IMU Z bike = -Y IMU</p> <p>A negative 90 deg rotation of IMU on its Y axis followed by a positive rotation of 90 deg on X IMU axis virtually rotates the IMU to bike axes.</p>	-180, +180	$\begin{bmatrix} +90 \\ 0 \\ 0 \end{bmatrix}$ $\begin{bmatrix} +90 \\ -90 \\ 0 \end{bmatrix}$

IMU calibrations description table (2/3)

<p>C. IMU mounted with connector pointing rear and marked area facing left: X bike = +X IMU Y bike = -Z IMU Z bike = +Y IMU</p>		$\begin{bmatrix} -90 \\ 0 \\ 0 \end{bmatrix}$
<p>D. IMU mounted with connector pointing right and marked area facing rear X bike = -Z IMU Y bike = -X IMU Z bike = +Y IMU</p>		$\begin{bmatrix} -90 \\ +90 \\ 0 \end{bmatrix}$
<p>E. IMU mounted with connector pointing left and marked area facing rear: X bike = -Z IMU Y bike = +X IMU Z bike = -Y IMU</p>		$\begin{bmatrix} +90 \\ +90 \\ 0 \end{bmatrix}$
<p>F. IMU mounted with connector pointing left and marked area facing front X bike = +Z IMU Y bike = +X IMU Z bike = +Y IMU</p>		$\begin{bmatrix} -90 \\ -90 \\ 0 \end{bmatrix}$

IMU calibrations description table (3/3)

		<p>G. IMU mounted with connector pointing front and marked area facing right:</p> <p>X bike = -X IMU Y bike = +Z IMU Z bike = +Y IMU</p> <p>H. IMU mounted with connector pointing front and marked area facing left:</p> <p>X bike = -X IMU Y bike = -Z IMU Z bike = -Y IMU</p>		$\begin{bmatrix} +90 \\ 0 \\ 180 \end{bmatrix}$ $\begin{bmatrix} -90 \\ 0 \\ 180 \end{bmatrix}$
PITCH_FRONT	deg/mm	Gain to estimate pitch angle from front suspension		-0.04
PITCH_REAR	deg/mm	Gain to estimate pitch angle from rear suspension		+0.08

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