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DTA5102 Two-Axis Tilt and Acceleration Sensor Module User Manual

Dr Robot®

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Related Document:

    WiRobot PMS5005 Sensing and Motion Controller User Manual

I.   Introduction

The DTA5102 Tilt and Acceleration Sensor Module is capable of measuring both the static acceleration (tilt or orientation) caused by the Earth's gravity or the shock caused by an impact. The module uses a CMOS micro-machined accelerometer IC combined with on-board low-pass-filters and signal amplifiers. The measurement range of the DTA5102 module is ±1 g.

Features

- ±1 g tilt and shock detection
- On-board low-pass-filters and signal amplifiers
- Linear output
- Plug-and-play in the WiRobot system

Applications

- Robotic application
- Vibration monitoring
- Impact/Acceleration measurement
- Tilt, orientation and posture measurement
- Handheld appliance control
- Virtual reality input devices
- Electronic diagnostic system

II.   Operations

II.1.   Theory of Operation

The structure of the micro-machined accelerometer is shown as Figure II.1. The sensing cell is a micro-machined variable capacitive device. The center plate moves with the acceleration and hence the values of the capacitors will change according to the distance between the plates. The change of the value is then measured, converted, amplified and outputted.
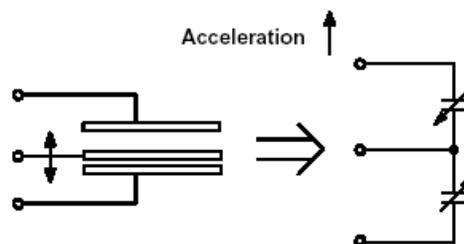

Figure II.1 Equivalent accelerometer model

The acceleration sensing directions of the DTA5102 are shown as Figure II.2. The output signals are basically consisting of static or low frequency data of tilt or orientation information and high frequency data of vibration or impact information. Either analog or digital filter or both can be used to extract relevant data for specific applications.
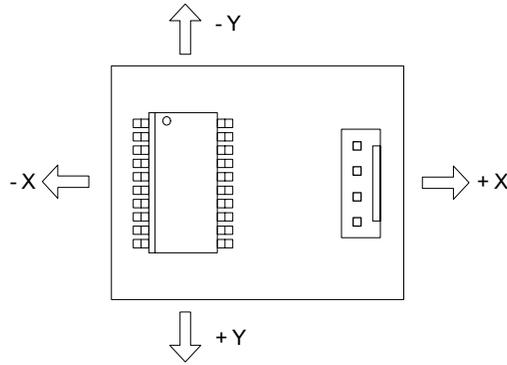
Figure II.2 Acceleration sensing directions

To measure the tilt or orientation of an object, the DTA5102 should be mounted in such a way that the axes of sensitivity are parallel to the surface of the Earth. In this configuration, the relationship between the output voltage and the tilt angle of each axis is shown by the following equation

$$V_{OUT} = V_{ZEROG} + (\frac{\Delta V}{\Delta G} \times G \times \sin\theta)$$

Where

V_{OUT} = Output voltage of each axis

V_{ZEROG} = Voltage at zero g

$\Delta V / \Delta G$ = Sensitivity

G = Earth's gravity (~9.81)

θ = Tilting angle

$\Delta V / \Delta G$ can be obtained by experiment by placing the sensor level (so that the gravity vector is perpendicular to the measured sensor axis) to take the V_{ZEROG} reading. Then, you should rotate the sensor so that the gravity vector is parallel with the measured axis and take the V_{ONEG} reading. The equation then can be rewritten as:

$$V_{OUT} = V_{ZEROG} + [\ (V_{ONEG} - V_{ZEROG}) \times \sin\theta\ ]$$

The tilting angle then can be calculated by ArcSin () function or by Taylor polynomial approximation

$$\theta = \sin^{-1}(z) = z + \frac{z^3}{6} + \frac{3z^5}{40} + ... \quad |z| < 1$$

To detect the high frequency data, the sampling rate must be at least twice of the signal frequency according to Nyquist Sampling Criterion. As a rule of thumb, using 5 to 10 time higher sampling rate will get good results for data recovering. Using some digital filter may require even higher sampling rate. However, sampling rate higher than 20 KHz is generally not recommended for the DTA5102 module. Also, be aware of the signal aliasing effects.

The relationship between the output voltage and the acceleration in each axis direction is shown by the following equation

$$V_{OUT} = V_{ZEROG} + (\frac{\Delta V}{\Delta G} \times Acc)$$

Where

Acc = value of the acceleration.

II.2. Running as part of WiRobot System

When using the DTA5102 with the WiRobot system, user can simply connect the module to the tilt sensor module connector on the PMS5005 controller board and the PMS5005 built-in sensor device driver will take care of the data acquisition. Users can simply call a function offered by the WiRobot SDK software on PC (requires Microsoft platform) or send a data request packet (platform independent) to obtain the data.

II.3. Running as a General Purpose Tilt and Acceleration Sensor Module

When using the DTA5102 with the third party controller, the power supply and the input/output signals should be connected properly (please refer to Section III). The controller can get the tilt and acceleration data via an analog to digital converter. The value of the angle or the acceleration can be calculated according to the equations in Section II.1.

For premium performance, several cautions need to be taken into account when operating the system:

- The power supply voltage should be 5 VDC nominal.
- The length of the cable connecting the DTA5102 and controller should be as short as possible.
- The DTA5102 module and the controller should not be in a high current path.
- If using switching power supply, be aware of the switching frequency may interfere with the DTA5102 module.

III. Connections

III.1. Board Structure

Figure III.1 shows the board structure.
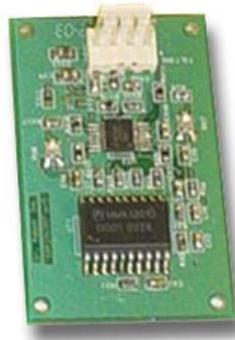
Figure III.1 DTA5102 Structure

III.2. Connector Description

The DTA5102 can be connected to the controller system via a 4-pin 2.54 mm-pitch single row connector:

Table III.1 Tilt and Acceleration Sensor Connectors

Pin	Name	Function
1	VCC	Positive power source, 5 V DC
2	YOUT	Y direction signal, analog output

| 3 | XOUT | X direction signal, analog output |
| 4 | GND | Power supply ground |

IV. Specifications

Table IV.1 DTA5102 Specification

Parameter	Conditions	MIN	TYP	MAX	Unit
Power Supply Voltage	VCC	4.75	5.0	5.25	V
Current Consumption	VCC = 5 V		10	15	mA
Acceleration Measuring Range			ffl 1		g
Nonlinearity		-2.0		+ 2.0	%
Bandwidth Response			30		Hz
Board Size			30 x 48		mm x mm