ADI Driver Documentation

Release 1.7.0

Tokyo Opensource Robotics Kyokai Association

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Contents

The `adi_driver` pacakge contains driver nodes, configuration files and launch files for Analog Devices Inc.(ADI)'s sensor products such as accelerometers, gyroscopic sensors and IMUs (Inertial Mesurement Units).

Currently these sensor devices are supported:

- ADIS16470
  - Wide Dynamic Range Mini MEMS IMU
- ADXL345
  - 3-Axis, ±2 g/±4 g/±8 g/±16 g Digital Accelerometer
  - The support for this device is experimental

You need this interface hardware to connect the sensors and your computer:

- USB-ISS
  - USB to SPI/I2C/Serial converter by Devantec

CHAPTER 1

Prerequisite

This package has been tested on the following environment:

- ROS Kinetic Kame and Ubuntu Linux 16.04 "Xenial" 64bit
- ROS Indigo Igloo and Ubuntu Linux 14.04 "Trusty" 64bit

1.1 Install ROS

You need to install ROS system into your computer. If you have already installed ROS, skip this section.

The following snippet shows a simple way to install *ROS Kinetic* on Ubuntu linux 16.04 *Xenial*. For completeness, you're advised to see ROS wiki.

```
sudo sh -c 'echo "deb http://packages.ros.org/ros/ubuntu $(lsb_release -sc) main" >
↪ \
             /etc/apt/sources.list.d/ros-latest.list'
sudo apt-key adv --keyserver hkp://ha.pool.sks-keyservers.net:80 \
             --recv-key 421C365BD9FF1F717815A3895523BAEEB01FA116
sudo apt-get update && sudo apt-get install -y python-rosdep
sudo rosdep init && rosdep update

echo "### For ROS setting" >> ~/.bashrc
echo "source /opt/ros/kinetic/setup.bash" >> ~/.bashrc
source ~/.bashrc
```

If you need older version ROS Indigo, also please consult ROS wiki.

1.2 Install `adi_driver` from Internet(Recommended)

The `adi_driver` is released to ROS *Indigo* and *Kinetic*. You can install the package by ordinally apt-get command as:

```
sudo apt-get install ros-<kinetic or indigo>-adi-driver
```

1.3 Install `adi_driver` from Debian package files

Note that you should install from Internet if you want automatic upgrading of the pacakge.

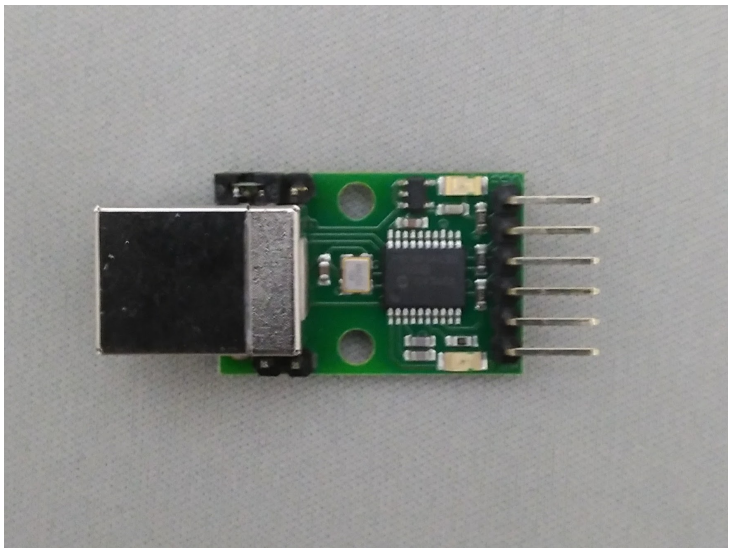
When you are going to install the package from a deb file, place it under current directory and run:

```
sudo apt-get install -y gdebi
sudo gdebi -n ros-kinetic-adi-driver_1.0.0-0xenial_amd64.deb
```

`gdebi` command helps to install all packages which the target package depends on.

CHAPTER 2

USB-SPI Adapter: USB-ISS



USB-ISS is a USB to Serial/I2C/SPI converter by Devantec, simple, small and easy to use. You don't need any extra library such as libusb and libftdi. Once plugged, the device is available on /dev/ttyACM* as a modem device.

USB-ISS provides 3.3V or 5V power to the sensor device from USB bus, so you don't need external power source if the sensor consume low current.

You need to remove the jumper block on `Power link` pins to provide 3.3V for the device. ADIS16470 and ADXL345 are in operation with 3.3V.

Please consult the product information and SPI documentation for detail.

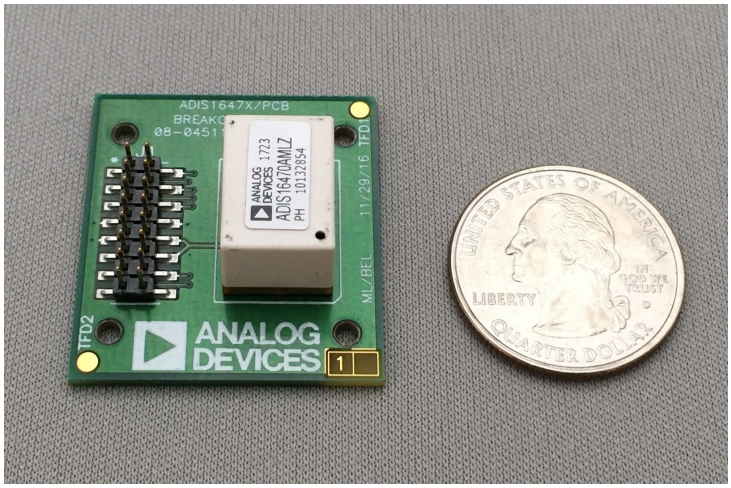
This product is widely on sale in the world, so that you can choose the distributer in your country.

- Amazon.com - https://www.amazon.com/Devantec-Usb-I2C-Serial-Interface/dp/B01BD9JZHU
- Robot Shop - https://www.robotshop.com/jp/ja/devantec-usb-i2c-spi-serial-interface.html

CHAPTER 3

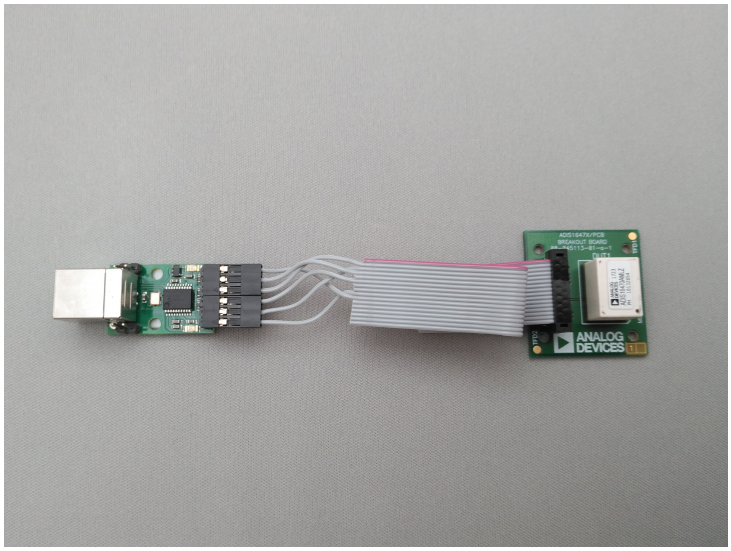
ADIS16470

ADIS16470 is a complete inertial system that includes a triaxis gyroscope and a triaxis accelerometer. It has a SPI interface.



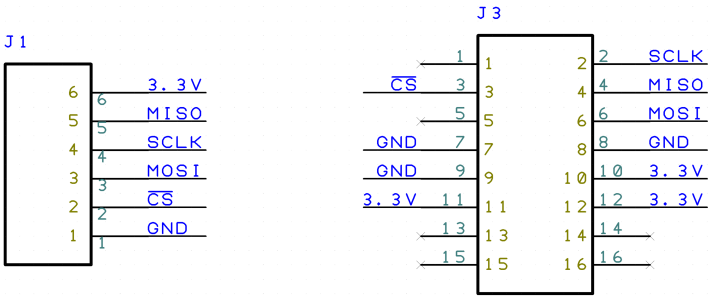
The sensor device is a BGA mounted chip, so it should be easier to use the breakout board . The following section assumes to use this breakout board.

3.1 Connection



You need to build a flat cable to connect the USB-ISS and the ADIS16470 breakout board. The picture shows an implementation.

Very simple schematic is here. J1 is the USB-ISS pin and J2 is the 2mm pin headers on the ADIS16470 breakout board.



Minimum pins are used and each pin is directly corresponds to another's. Note that you only need to connect one of the power-line(3.3V and GND), because they are connected in the breakout board.

3.2 Parts list

The parts list of the cable is here:

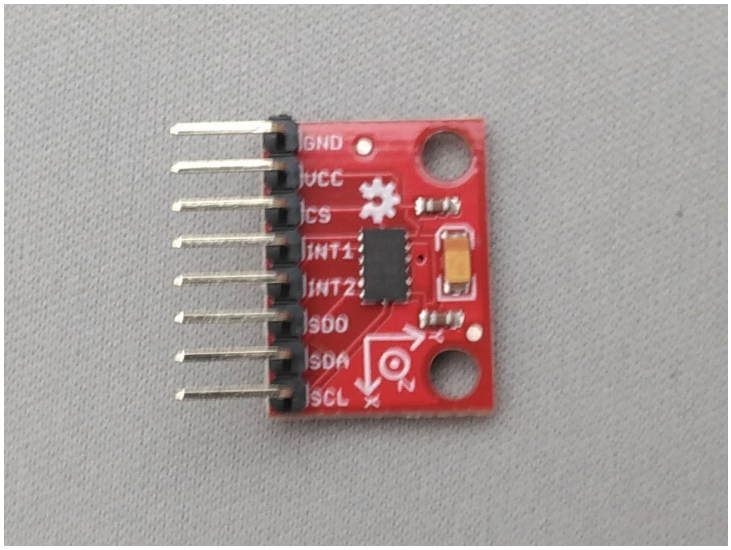
- J1: 2550 Connector 6pin
  - Akiduki denshi: http://akizukidenshi.com/catalog/g/gC-12155/
- J2: FCI Connector for 1.0mm pitch ribon cable
  - RS Components: https://jp.rs-online.com/web/p/idc-connectors/6737749/
- 1.0 mm pitch ribon cable
  - Aitendo: http://www.aitendo.com/product/11809

CHAPTER 4

ADXL345

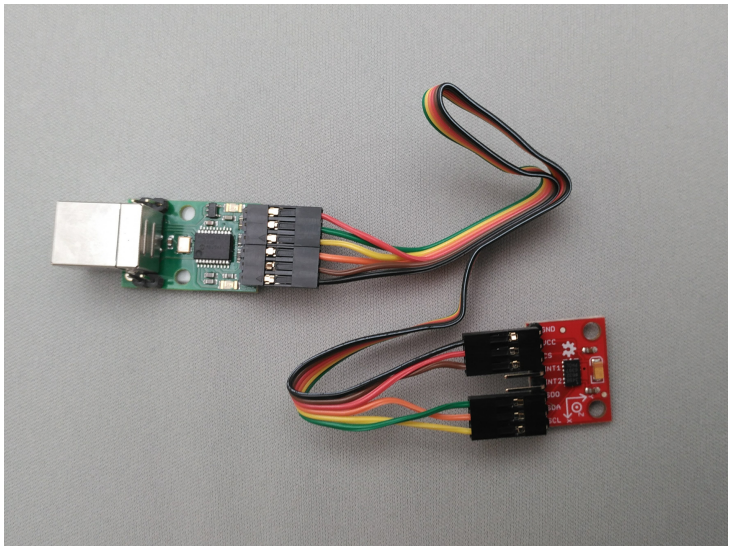
ADXL345 is a three axis accerometer sensor. It has a SPI interface. The following section assumes to use this breakout board.

- ADXL345 Breakout board
  - SparkFun: https://www.sparkfun.com/products/9836 <https://www.sparkfun.com/products/9836>‘_

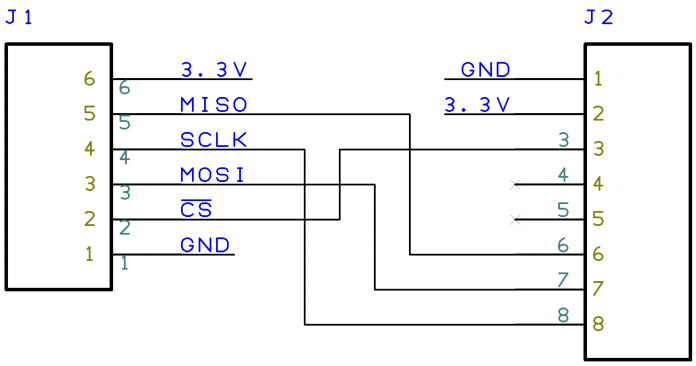


4.1 Connection

You need to build a flat cable to connect the USB-ISS and the ADXL345 breakout board. The picture shows an implementation.



The connection schematic is here.



J1 is for USB-ISS and J2 is for the ADXL345 breakout board.

- J1: 2550 Connector 6pin
- J2: 2550 Connector 8pin
- A ribon cable

CHAPTER 5

How to use the package

5.1 Check the connection

Assuming USB-ISS and the sensor are connected to your PC with a USB cable. Make sure you can see the device file at `/dev/ttyACM*`.

```
$ ls /dev/ttyACM*
/dev/ttyACM0
```

You need your user account is in the `dialout` group to acces /dev/ttyACM* . Check if you are already in the `dialout` group by `groups` command.

```
$ groups
your_user_name adm dialout cdrom sudo dip plugdev lpadmin sambashare
```

If you don't find `dialout` there, you should add the user into the group by `adduser` command. **Note that you need to _restart_ after you added the user into the ‘‘dialout‘‘ group**

```
$ sudo adduser your_user_name dialout
```

If a software called *modemmanager* is installed in your PC, it takes several seconds until /dev/ttyACM* available. You can avoid it to uninstall the modemmanager.

```
$ sudo apt remove modemmanager
```

5.2 Start AIDS16470 nodes

You can use a launch file to run the sensor nodes with visulalizer as:

```
$ roslaunch adi_driver adis16470.launch with_rviz:=true
```

This launch file has several arguments which configure the system.

- `with_filter`: Start a filter node of `imu_filter_madgwick` package to estimate the IMU's pose using Extended Kalman Filter. Default is `true`.
- `with_rviz`: Start a viewer to visualize the pose of the IMU. Default is `false`.

- `with_plot`: Start a viewer to plot the graph of angular velocity and acceleration. Default is `false`.
- `device`: Specify the device file name for USB-ISS. Default is `/dev/ttyACM0`.
- `frame_id`: Specify the name of frame of the sensor. Default is `imu`
- `burst_read`: If true, the sensor node uses the `burst read mode` which is on the ADIS16470 's manual. Default is `false`.
- `rate`: It define the sampling rate of the IMU in Hz. Default

is 100.

5.3 Senesor data topics

Once the system launched, the sensor data keep published on ROS topics. You can see the list of the ROS topic by `rostopic` command.

```
$ rostopic list
/imu/data
/imu/data_raw
/imu_filter/parameter_descriptions
/imu_filter/parameter_updates
/rosout
/rosout_agg
/tf
```

The sensor data are on these two topics:

- `/imu/data_raw`: The raw sensor data from ADIS16470, which contains only angular velocities and linear accelerations.
- `/imu/data`: The sensor data proceeded by EKF using `imu_filter_node` from `imu_filter_madgwick` package. It contains orientation information in addition to the angular velocities and linear accelerations.

5.4 Check sensor data

You can see the sensor data streaming by `rostopic` command.

```
$ rostopic echo /imu/data
---
header:
 seq: 2541
 stamp:
   secs: 1513238708
   nsecs: 838857288
 frame_id: "imu"
orientation:
  x: -0.0111724457234
  y: -0.0125930607599
  z: -0.710443497794
  w: 0.703552860643
orientation_covariance: [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
angular_velocity:
  x: 0.00750825006126
  y: -0.0128681014395
  z: 0.000681076817177
angular_velocity_covariance: [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
linear_acceleration:
```

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```
  x: 0.3929231987
  y: 0.00754166793823
  z: 10.0754171448
linear_acceleration_covariance: [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
---
```

5.5 Type of the sensor data

`sensor_msgs/Imu` is the sensor message type for IMUs.

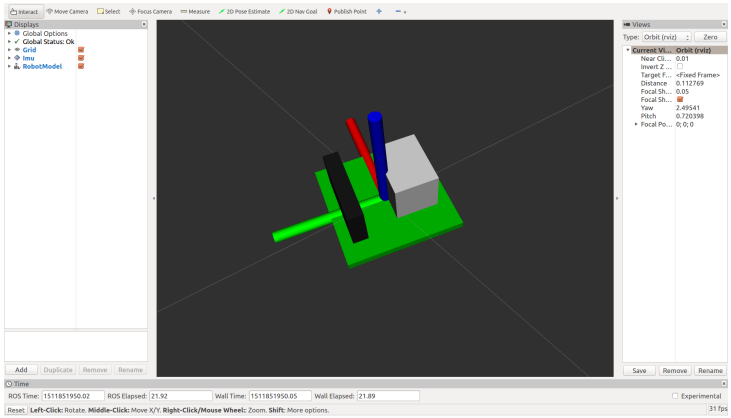
```
$ rosmsg show sensor_msgs/Imu

std_msgs/Header header
    uint32 seq
    time stamp
    string frame_id
geometry_msgs/Quaternion orientation
    float64 x
    float64 y
    float64 z
    float64 w
float64[9] orientation_covariance
geometry_msgs/Vector3 angular_velocity
    float64 x
    float64 y
    float64 z
float64[9] angular_velocity_covariance
geometry_msgs/Vector3 linear_acceleration
    float64 x
    float64 y
    float64 z
    float64[9] linear_acceleration_covariance
```

5.6 Visulaization

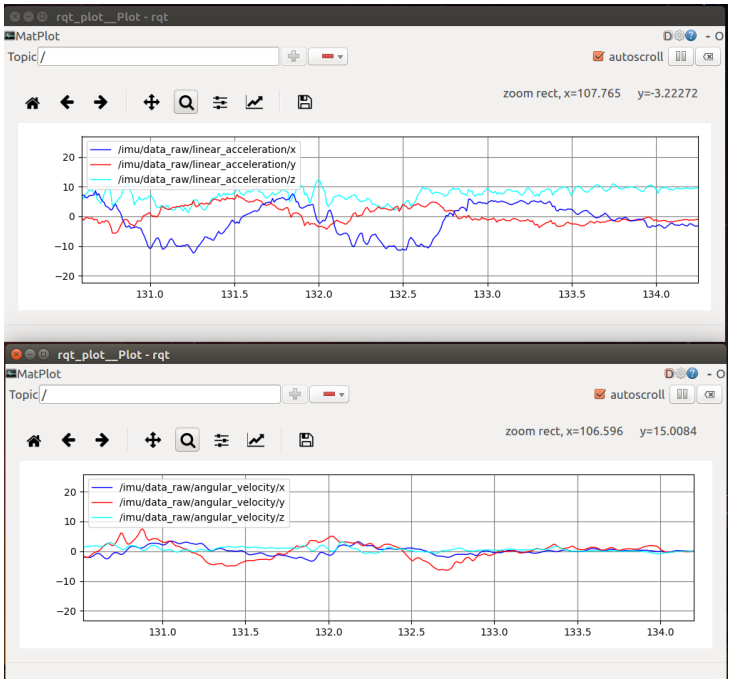
You can see the model of ADIS16470 breakout board in rviz panel. `launch/imu.rviz` is the config file for rviz.

```
$ roslaunch adi_driver adis16470.launch with_rviz:=true
```



You can plot the magnitude of sensor value on graphs using `rqt_plot`.

```
$ roslaunch adi_driver adis16470.launch with_plot:=true
```



5.7 Start ADXL345 nodes

You can use a launch file to run the sensor nodes with graph plot as:

```
$ roslaunch adi_driver adxl345.launch with_plot:=true
```