UM11541

Quaternion tiltmeter component user manual

Rev. 1 — 27 January 2021 User manual

Document information

Information	Content
Keywords	Component Library, Quaternion
Abstract	Getting started with quaternion component

1 Prerequisites

This document assumes the following prerequisites prior to attempting to use platform agnostic component library, quaternion component:

- User familiarity with the chosen microcontroller unit (MCU), corresponding software development kit (SDK), and cross-compilation tool chain to integrate quaternion component.
- User familiarity with the MCU SDK implementation for underlying microcontroller peripherals, such as I^2C, or SPI, to integrate with the sensor driver component.

2 Overview

Quaternion component is a development model that provides a quaternion calculation algorithm implemented using 3-axis accelerometer with platform independent interfaces. The platform interface provides abstraction to underline communication driver in SDK, tool chains, and MCUs.

2.1 Quaternion tiltmeter component design

This component provides an example algorithm for measuring quaternion values using a 3-axis accelerometer. Quaternions find their application in determining the 3D orientation of a sensor. A complete description of the orientation of a sensor would require a combination of 3-axis accelerometer, 3-axis magnetometer, and 3-axis gyroscope. The component described here applies only when a 3-axis accelerometer is used. A 3-axis accelerometer can also be called as a tiltmeter. Thus, at a tilt position, the quaternion values describe the orientation of the sensor. The platform interface provides abstraction to underlying communication drivers in the microcontroller SDK, tool chains, and host operating system. The quaternion tiltmeter component runs either as a standalone application in the application space or in a multi-threaded environment. In a multi-threaded environment, the user application is responsible for resource handling and multi-threading synchronization. The component is designed to work seamlessly in any SDK environment and application resource handlers.

All information provided in this document is subject to legal disclaimers.

© NXP B.V. 2021. All rights reserved.

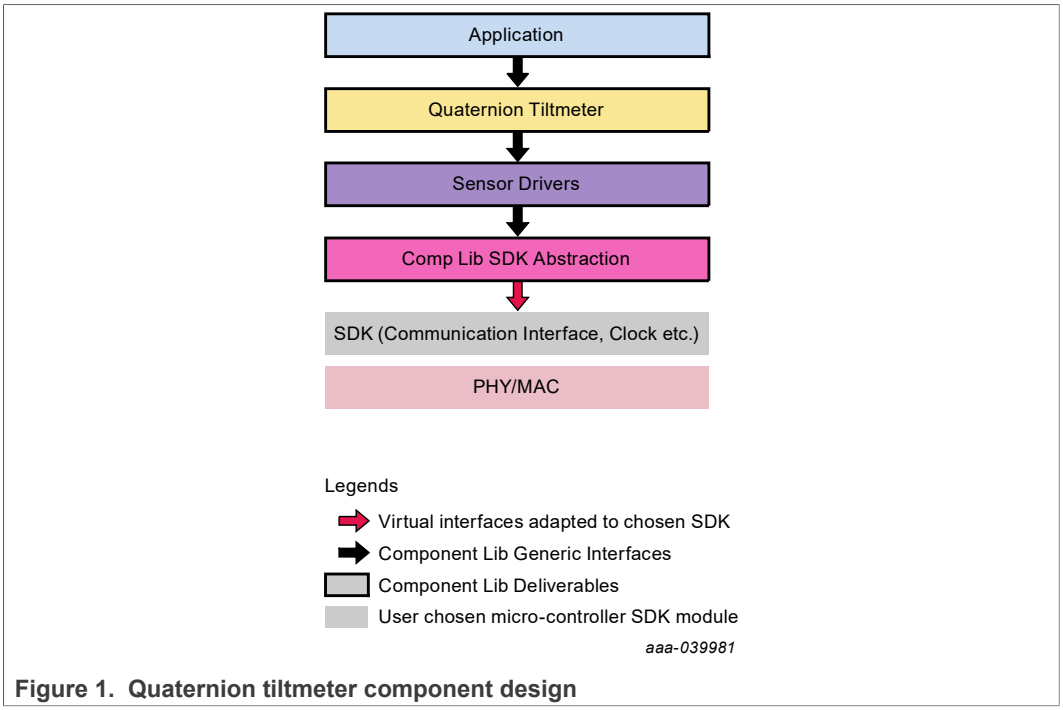

Figure 1. Quaternion tiltmeter component design

3 Quaternion tiltmeter component integration

The quaternion tiltmeter component design is microcontroller agnostic. This section describes details about quaternion tiltmeter component directory structure and content overview. For more details about quaternion tiltmeter interfaces, refer to Quaternion_Tiltmeter_API_Reference_Manual.

3.1 Quaternion tiltmeter component directory structure

This section provides a snapshot of the basic quaternion tiltmeter component directory structure. The below provided snapshot shows directory structure for the quaternion tiltmeter component.

```
Quaternion_tiltmeter/
|-- src
|   |-- quaternion_accel.c
|   |-- quaternion_accel.h
|   |-- matrix3x3.c
|   |-- matrix3x3.h
|   |-- config.h
|-- example
|   |-- MCUXpresso
|   |   └── <project_name>
`-- docs
    |-- CompLib_Quaternion_Tiltmeter_UG.docx
    |-- Quaternion_Tiltmeter_API_Reference_Manual.zip
```

The quaternion tiltmeter component provides platform independent implementation. End users should update the communication interface to visualize output using SDK implementation for underlying microcontroller peripherals such as UART. The quaternion tiltmeter component has been tested for NXP microcontrollers FRDM-K64F (Cortex

All information provided in this document is subject to legal disclaimers.

© NXP B.V. 2021. All rights reserved.

M4F core) integrating with MCUXpresso SDK. The reference example project for testing quaternion tiltmeter component integration with MCUXpresso SDK is available under the “example” folder.

3.2 Quaternion tiltmeter component content overview

This section provides a brief overview of the quaternion tiltmeter component source file contents and file descriptions.

```
Quaternion_tiltmeter/
|-- src[1]
|   |-- quaternion_accel.c[2]
|   |-- quaternion_accel.h[2]
|   |-- matrix3x3.c[2]
|   |-- matrix3x3.h[2]
|   |-- config.h[2]
|-- example[3]
|   |-- MCUXpresso[4]
|   |   └── <project_name>[5]
`-- docs[6]
    |-- CompLib_Quaternion_Tiltmeter_UG.docx[7]
    |-- Quaternion_Tiltmeter__API_Reference_Manual.zip[8]
```

```
[1]Folder containing quaternion tiltmeter component source files.
[2]Files containing quaternion tiltmeter implementations.
[3]Folder containing quaternion tiltmeter integration example with MCUXpresso SDK.
[4]Component libraries are provided with the NXP MCUXpresso SDK integration
 example application. The integration test example application demonstrates
 how to integrate platform agnostic component libraries with underlying
 microcontroller SDK communication interfaces using virtual interface
 abstraction provided by component libraries.
[5]Folder containing quaternion tiltmeter integration example with MCUX.
[6]Folder containing release documentation for quaternion tiltmeter component.
[7]Quaternion tiltmeter component user manual.
[8]Quaternion tiltmeter component API RM.
```

Note: *Before importing component library example projects for the standalone MCUXpresso IDE, the MCUXpresso IDE requires the corresponding microcontroller SDK package to be downloaded and installed on the IDE.*

3.3 Quaternion tiltmeter component testing

This section provides user guidance for component testing. The quaternion tiltmeter calculation algorithm uses the raw accelerometer values and converts those values into the form of a rotation matrix. The rotation matrix is converted to quaternion values. NXP suggests that users average the accelerometer values to obtain consistent quaternion values. NXP has determined that averaging by N = 16 is acceptable for the determination of quaternion values. Use the built-in FIFO (depth = 16) functionality by setting the USE_FIFO flag. By disabling the flag, normal averaging can be performed. A Hardware Abstraction Layer (HAL) has been applied on the tested board. Based on the board mounting conditions, the user must determine if HAL should be applied. If HAL is not applied, the function is not needed.

All information provided in this document is subject to legal disclaimers.

© NXP B.V. 2021. All rights reserved.

4 Revision history

Table 1. Revision history

Revision number	Date	Description
1	20210127	Initial release

All information provided in this document is subject to legal disclaimers.

© NXP B.V. 2021. All rights reserved.

5 Legal information

5.1 Definitions

Draft — A draft status on a document indicates that the content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included in a draft version of a document and shall have no liability for the consequences of use of such information.

5.2 Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors. In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory. Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification. Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products. NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Evaluation products — This product is provided on an "as is" and "with all faults" basis for evaluation purposes only. NXP Semiconductors, its affiliates and their suppliers expressly disclaim all warranties, whether express, implied or statutory, including but not limited to the implied warranties of non-infringement, merchantability and fitness for a particular purpose. The entire risk as to the quality, or arising out of the use or performance, of this product remains with customer. In no event shall NXP Semiconductors, its affiliates or their suppliers be liable to customer for any special, indirect, consequential, punitive or incidental damages (including without limitation damages for loss of business, business interruption, loss of use, loss of data or information, and the like) arising out the use of or inability to use the product, whether or not based on tort (including negligence), strict liability, breach of contract, breach of warranty or any other theory, even if advised of the possibility of such damages. Notwithstanding any damages that customer might incur for any reason whatsoever (including without limitation, all damages referenced above and all direct or general damages), the entire liability of NXP Semiconductors, its affiliates and their suppliers and customer's exclusive remedy for all of the foregoing shall be limited to actual damages incurred by customer based on reasonable reliance up to the greater of the amount actually paid by customer for the product or five dollars (US$5.00). The foregoing limitations, exclusions and disclaimers shall apply to the maximum extent permitted by applicable law, even if any remedy fails of its essential purpose.

Translations — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

Security — Customer understands that all NXP products may be subject to unidentified or documented vulnerabilities. Customer is responsible for the design and operation of its applications and products throughout their lifecycles to reduce the effect of these vulnerabilities on customer's applications and products. Customer's responsibility also extends to other open and/or proprietary technologies supported by NXP products for use in customer's applications. NXP accepts no liability for any vulnerability. Customer should regularly check security updates from NXP and follow up appropriately. Customer shall select products with security features that best meet rules, regulations, and standards of the intended application and make the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP. NXP has a Product Security Incident Response Team (PSIRT) (reachable at PSIRT@nxp.com) that manages the investigation, reporting, and solution release to security vulnerabilities of NXP products.

5.3 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

NXP — wordmark and logo are trademarks of NXP B.V.

All information provided in this document is subject to legal disclaimers.

© NXP B.V. 2021. All rights reserved.

Tables

Figures

All information provided in this document is subject to legal disclaimers.

© NXP B.V. 2021. All rights reserved.

Contents

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

© NXP B.V. 2021. **All rights reserved.**

For more information, please visit: http://www.nxp.com
For sales office addresses, please send an email to: salesaddresses@nxp.com

Date of release: 27 January 2021
Document identifier: UM11541