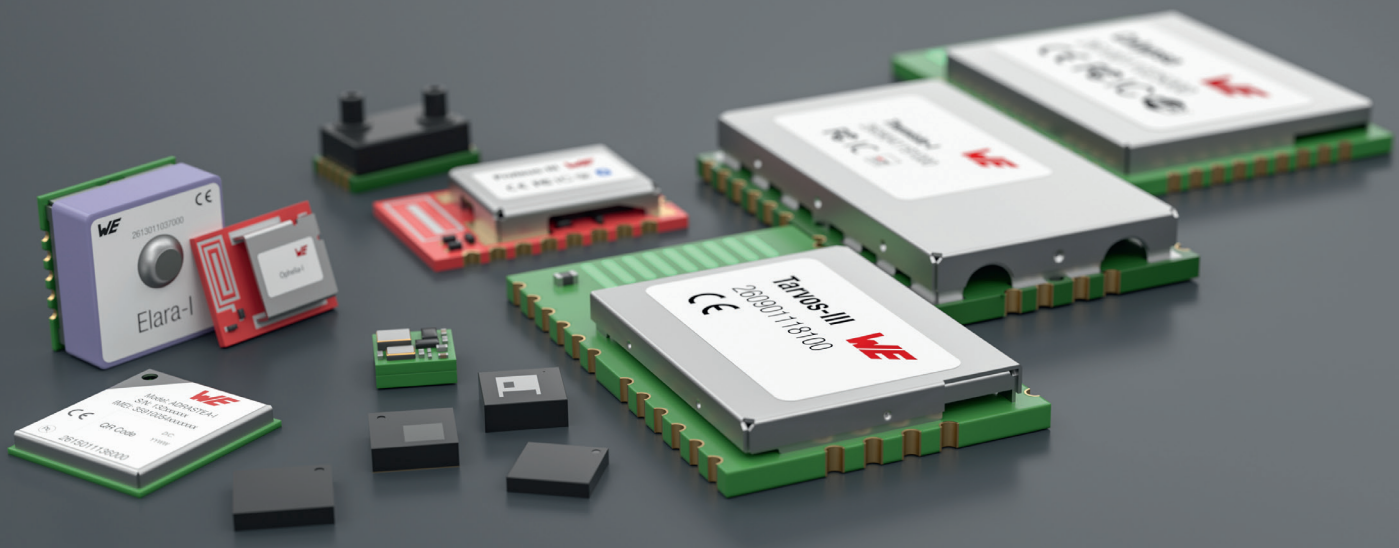

ANM004

Single and double tap event detection

2533020201601,
2533020201611,
2533203301691

Version 1.2

August 29, 2025

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

Contents

1 Abbreviations

Abbreviation	Description
FS	Full scale
I^2C	Inter integrated circuit
MEMS	Micro-electro-mechanical system
LSB	Least significant bit
ODR	Output data rate

2 Revision history

App note version	Notes	Date
1.0	• Initial release of the app note	August 2021
1.1	• Updated chapter `Important notes` • Updated chapter `Legal notice`	October 2024
1.2	• Improved the description	August 2025

3 Introduction

The WSEN-ITDS 3-axis acceleration sensor (Part No: 2533020201601, 25330202016011) is equipped with built-in tap detection features, enabling intuitive human-machine interaction with minimal coding effort. The sensor can be configured to generate an interrupt signal on a dedicated pin when a tap is detected in any direction. The sensor can detect single and double tap events. Single and double tap recognition feature works similar to single click and double click of a mouse. These features can easily replace mechanical buttons in a display or monitors for user interfacing. It also provides more robust, user-friendly, simple and cost-effective design in with high system integration.

The single tap detection feature recognizes a user's finger tap on a device. The impact from the tap is measured by analyzing the amplitude of the acceleration detected by the sensor. When the acceleration amplitude exceeds a certain threshold and returns back within a short time the single tap interrupt is generated.

Double tap detection feature will recognize two consecutive taps on the device from the user. When two quick single taps are captured within a defined time frame the double tap interrupt is generated.

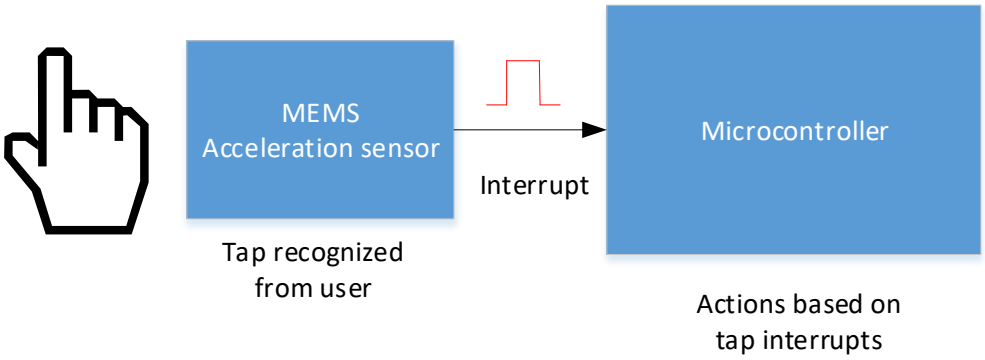

Figure 1: Tap event recognition from user

4 Single Tap Detection

When the high-pass filtered output data first rises above the defined threshold and then falls back below it within the specified shock time window, a single tap detection interrupt is generated. The direction of a single tap is recognised by enabling the TAP_X_EN, TAP_Y_EN and TAP_Z_EN bits of the TAP_Z_TH register.

Three parameters are necessary to enable the single tap detection feature which is shown in figure 2.

- Tap threshold
- Shock time
- Quiet time

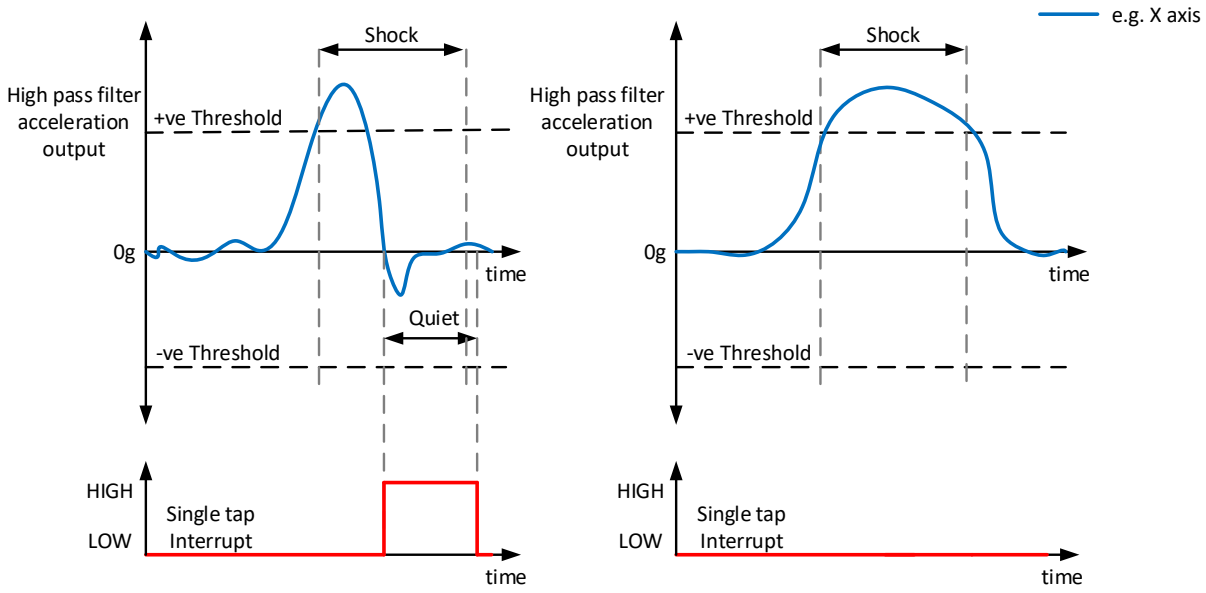

Figure 2: Single tap detection interrupt

4.1 Tap Threshold

The threshold defines the intensity of tap needed to generate the interrupt. The amplitude of tap is directly proportional to the force applied in either positive or negative axis of the sensor. The unsigned tap threshold is set using TAP_THSX[4_0], TAP_THSY[4_0], TAP_THSZ[4_0] bits of the TAP_X_TH, TAP_Y_TH and TAP_Z_TH registers. The tap threshold is valid for both positive and negative acceleration data. The value of 1 LSB change in threshold bits depends on the selected full scale range. i.e. 1 LSB = FS/32. Table 3 shows the possible tap threshold values for a full scale range of ±2g. Tap interrupts won't be generated if the threshold value is set to zero.

TAP_THX[4:0]	Threshold value (mg)
00001	1*(2/32) = 62.5
00010	2*(2/32) = 125
00011	3*(2/32) = 187.5
00100	4*(2/32) = 250
00101	5*(2/32) = 312.5
-	-
11111	31*(2/32) = 1937.5

Table 3: Tap threshold for ±2g

4.2 Shock Time Window

The shock time window sets the maximum allowed duration of a tap amplitude. After exceeding the set threshold when the acceleration falls below a set threshold within shock time window, an interrupt is generated. Otherwise the tap event is not recognised. The shock time window is set using SHOCK[1:0] bits of the INT_DUR register. By default SHOCK[1:0] bits are 00b which corresponds to 4/ODR. If the SHOCK[1:0] bits are set to different values, 1 LSB change in SHOCK[1:0] bits corresponds to 8/ODR time. Table 4 shows the possible shock time window values for a selected ODR of 400 Hz.

SHOCK[1:0]	Duration (ms)
00	(4/400) = 10
01	1*(8/400) = 20
10	2*(8/400) = 40
11	3*(8/400) = 60

Table 4: Shock time window

4.3 Quiet Time Window

The quiet time is a configurable interval in the WSEN-ITDS tap detection logic that defines the minimum amount of time during which no valid tap events should occur after a tap event is detected. It acts as a debounce period to prevent false or repeated detections caused by residual vibrations or unintended movements. It also determines the length of the interrupt pulse when latched mode is disabled. The quiet time window is set using QUIET[1:0] bits of the INT_DUR register. By default QUIET[1:0] bits are 00b which corresponds to 2/ODR. If the QUIET[1:0] bits are set to a different value, 1 LSB change in QUIET[1:0] bits corresponds to 4/ODR time.Table 5 shows the possible quiet time window values for a selected ODR of 400 Hz.

QUIET[1:0]	Duration (ms)
00	(2/400) = 5
01	1*(4/400) = 10
10	2*(4/400) = 20
11	3*(4/400) = 30

Table 5: Quiet time window

4.4 Tap Priority

The user can set the priority of tap direction using TAP_PRIOR[2:0] in the TAP_Y_TH register. TAP_PRIOR[2:0] bits are useful when a tap event is recognised on more than one axis at the same time. In this case, tap axis having higher priority set in TAP_Y_TH register is recognized.

4.5 Single Tap Interrupt Latching

The Latch feature on the single tap interrupt is enabled by LIR bit in CTRL_3 register. When the LIR bit is set to '1' the interrupt is kept high until the values of TAP_SRC or ALL_INT_SRC register is read. When LIR bit is set to '0' then latch feature is disabled. In this case, the single tap interrupt is kept high for the duration of quiet time which is set using QUIET[1:0] bits in INT_DUR register.

An output data rate of 400 Hz or above is required for the proper functioning of single and double tap detection

	Steps	Regsiters Involved
1	Enable high performance mode and select ODR	CTRL_1 (0x20)
2	Enable block data update and automatic address increment	CTRL_2 (0x21)
3	Select bandwidth and full scale range	CTRL_6 (0x25)
4	Set tap threshold for each axis, assign tap priority and enable tap detection on each axis	TAP_X_TH (0x30), TAP_Y_TH (0x31), TAP_Z_TH (0x32)
5	Set quiet time and shock time	INT_DUR (0x33)
6	Enable single tap detection & interrupts	WAKE_UP_TH (0x34), CTRL_7 (0x3F)
7	Route single tap detection to INT_0 pin	CTRL_4 (0x23)
8	Latch interrupt if needed	CTRL_3 (0x22)

Table 6: Configuration of single tap detection

5 Double Tap Detection

When configured for double tap detection, the WSEN-ITDS sensor generates an interrupt when two valid tap events are recognized in succession. Similar to single tap detection, double tap detection is governed by several parameters to minimize false positives and ensure accurate recognition.

The following parameters determine double tap detection:

- Tap threshold
- Shock time
- Quiet time
- Latency time

The first three parameters function the same as in single tap detection:

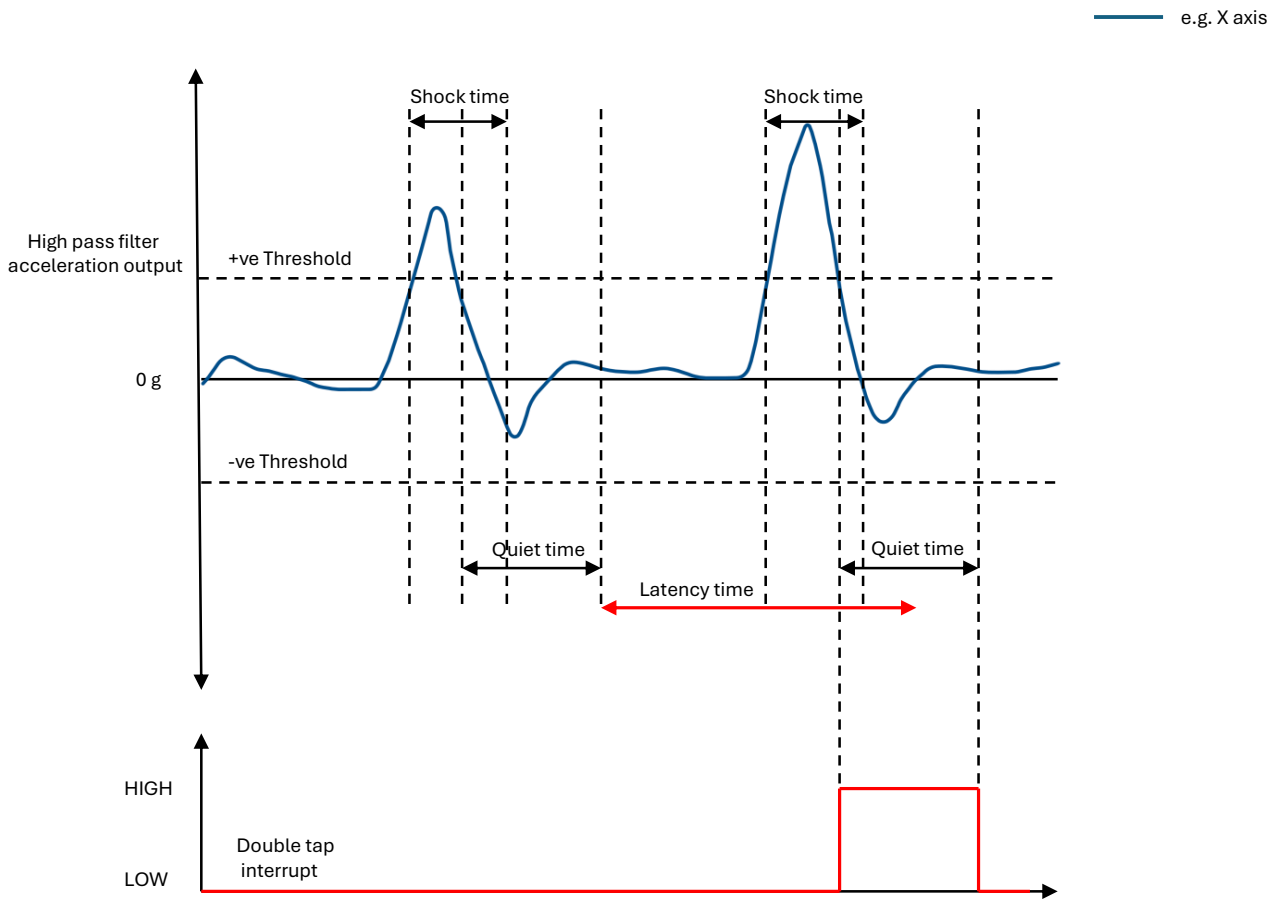

Figure 3: Double tap detection

The first tap is detected when the high pass filtered output exceeds the tap threshold and returns below it within the defined shock time. After detecting the first tap, the sensor waits for a

short interval, defined as the quiet time, during which any activity is ignored to prevent noise from triggering false taps. Following the quiet time, the sensor enters a window called latency time, during which it looks for a second tap. If a second tap is detected, meaning the high-pass filtered data again exceeds the threshold and falls back below it within the shock time, and this occurs within the latency time window, then a double tap interrupt is generated. Figure 3 shows how the double tap detection works when latched imterrupt is not enabled.

The SINGLE_DOUBLE_TAP bit in WAKE_UP_TH register needs to be set to 1 to enable both single tap and double tap detection. Setting this bit to 0 enables only single-tap detection.

A single tap event is always detected before a double tap event

5.1 Latency Time

Latency time is the time window during which the sensor expects a second tap after a valid first tap has been detected in double tap detection mode. This parameter ensures that only taps occurring within a specific time frame are considered part of the same double tap gesture.

Latency time is a crucial parameter for the proper functioning of double tap detection. If the latency time is set too low, there is a risk that the second tap may occur outside the allowed window, and the double tap event will not be detected, as illustrated in Figure 4. Conversely, if the latency time is set too high, the sensor may mistakenly group unrelated taps into a double tap event, potentially causing false positives. However, a single tap will be detected in the case of Figure 4.

The latency time window can be configured using the bits LATENCY[3:0] from the INT_DUR register (0x33). By default the bits are set to 0000b, which is equivalent to 16/ODR time. If different values are assigned to LATENCY[3:0], then 1 LSB equals to 32/ODR time. Table 7 shows the possible latency time window values for a selected ODR of 400 Hz.

LATENCY[3:0]	Duration (ms)
0000	(16/400) = 40
0001	1*(32/400) = 80
0010	2*(32/400) = 160
0011	3*(32/400) = 240
0100	4*(32/400) = 320
-	-
1111	15*(32/400) = 1200

Table 7: Latency time window

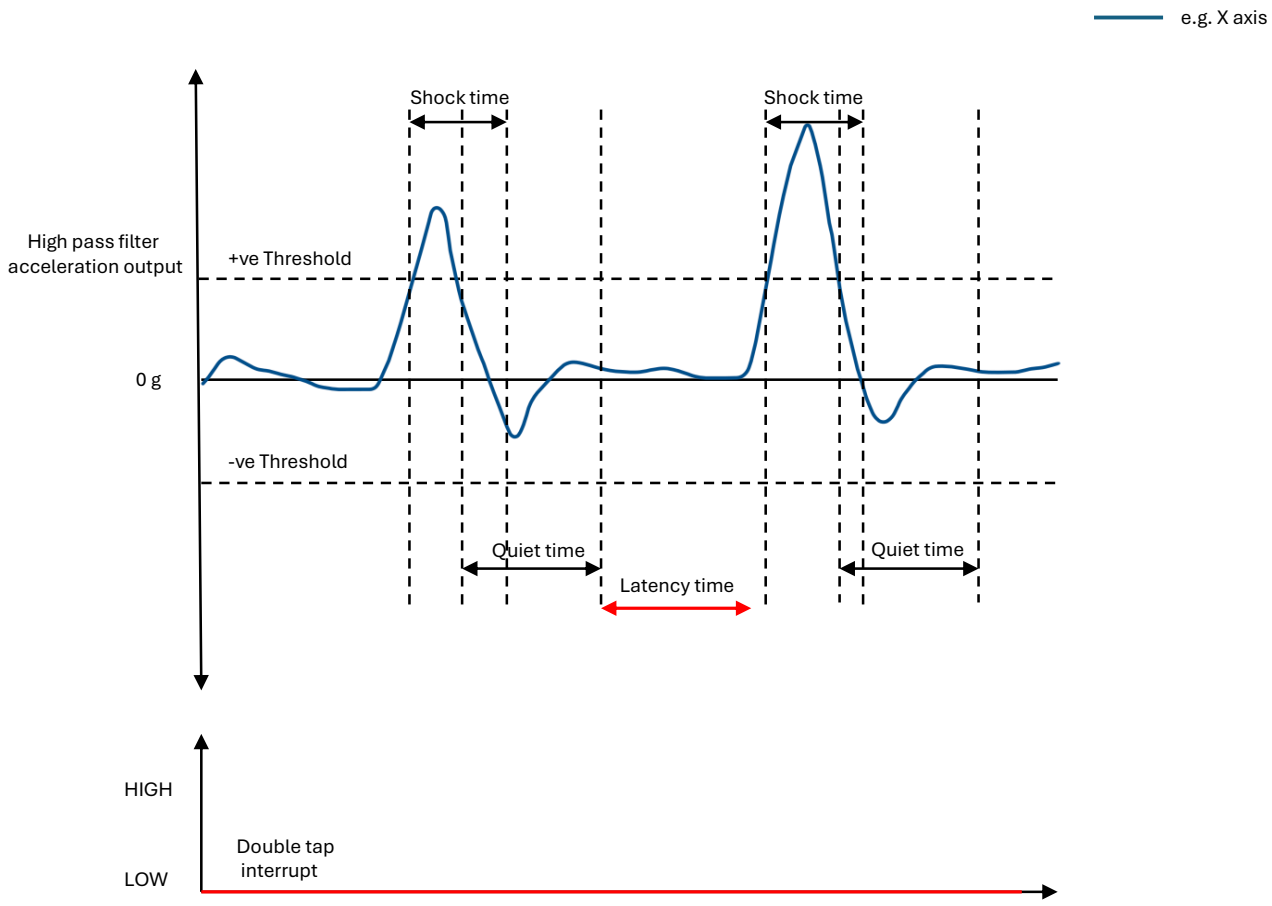

Figure 4: Double tap not detected

	Steps	Regsiters Involved
1	Enable high performance mode and select ODR	CTRL_1 (0x20)
2	Enable block data update and automatic address increment	CTRL_2 (0x21)
3	Select bandwidth and full scale range	CTRL_6 (0x25)
4	Set tap threshold for each axis, assign tap priority and enable tap detection on each axis	TAP_X_TH (0x30), TAP_Y_TH (0x31), TAP_Z_TH (0x32)
5	Set latency time, quiet time and shock time	INT_DUR (0x33)
6	Enable double tap detection & interrupts	WAKE_UP_TH (0x34), CTRL_7 (0x3F)
7	Route double tap detection to INT_0 pin	CTRL_4 (0x23)
8	Latch interrupt if needed	CTRL_3 (0x22)

Table 8: Configuration of double tap detection

6 Conclusion

The WSEN-ITDS 3-axis acceleration sensor offers an effective and compact solution for implementing physical tap-based user input through its built-in single and double tap detection features. By detecting intentional taps on a device's surface, it enables intuitive and responsive human-machine interaction. These features can replace traditional mechanical buttons, leading to simplified, cost-effective, and more reliable product designs. With easy configuration and minimal software requirements, the WSEN-ITDS is ideal for a variety of applications, including display controls, portable electronics, and embedded systems.

Visit our GitHub page for examples on tap detection

7 Important notes

The following conditions apply to all goods within the wireless connectivity and sensors product range of Würth Elektronik eiSos GmbH & Co. KG:

General customer responsibility
Some goods within the product range of Würth Elektronik eiSos GmbH & Co. KG contain statements regarding general suitability for certain application areas. These statements about suitability are based on our knowledge and experience of typical requirements concerning the areas, serve as general guidance and cannot be estimated as binding statements about the suitability for a customer application. The responsibility for the applicability and use in a particular customer design is always solely within the authority of the customer. Due to this fact, it is up to the customer to evaluate, where appropriate to investigate and to decide whether the device with the specific product characteristics described in the product specification is valid and suitable for the respective customer application or not. Accordingly, the customer is cautioned to verify that the documentation is current before placing orders.

Customer responsibility related to specific, in particular safety-relevant applications
It has to be clearly pointed out that the possibility of a malfunction of electronic components or failure before the end of the usual lifetime cannot be completely eliminated in the current state of the art, even if the products are operated within the range of the specifications. The same statement is valid for all software source code and firmware parts contained in or used with or for products in the wireless connectivity and sensor product range of Würth Elektronik eiSos GmbH & Co. KG. In certain customer applications requiring a high level of safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health, it must be ensured by most advanced technological aid of suitable design of the customer application that no injury or damage is caused to third parties in the event of malfunction or failure of an electronic component.

Best care and attention
Any product-specific data sheets, manuals, application notes, PCNs, warnings and cautions must be strictly observed in the most recent versions and matching to the products revisions. These documents can be downloaded from the product specific sections on the wireless connectivity and sensors homepage.

Customer support for product specifications
Some products within the product range may contain substances, which are subject to restrictions in certain jurisdictions in order to serve specific technical requirements. Necessary information is available on request. In this case, the Business Development Engineer (BDM) or the internal sales person in charge should be contacted who will be happy to support in this matter.

Product improvements
Due to constant product improvement, product specifications may change from time to time. As a standard reporting procedure of the Product Change Notification (PCN) according to the JEDEC-Standard, we inform about major changes. In case of further queries regarding the PCN, the Business Development Engineer (BDM), the internal sales person or the technical support team in charge should be contacted. The basic responsibility of the customer as per section 7 and 7 remains unaffected.
All software like ¨wireless connectivity SDK¨, ¨Sensor SDK¨ or other source codes as well as all PC software tools are not subject to the Product Change Notification information process.

Product life cycle
Due to technical progress and economical evaluation, we also reserve the right to discontinue production and delivery of products. As a standard reporting procedure of the Product Termination Notification (PTN) according to the JEDEC-Standard we will inform at an early stage about inevitable product discontinuance. According to this, we cannot ensure that all products within our product range will always be available. Therefore, it needs to be verified with the Business Development Engineer (BDM) or the internal sales person in charge about the current product availability expectancy before or when the product for application design-in disposal is considered. The approach named above does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.

Property rights
All the rights for contractual products produced by Würth Elektronik eiSos GmbH & Co. KG on the basis of ideas, development contracts as well as models or templates that are subject to copyright, patent or commercial protection supplied to the customer will remain with Würth Elektronik eiSos GmbH & Co. KG. Würth Elektronik eiSos GmbH & Co. KG does not warrant or represent that any license, either expressed or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, application, or process in which Würth Elektronik eiSos GmbH & Co. KG components or services are used.

General terms and conditions
Unless otherwise agreed in individual contracts, all orders are subject to the current version of the "General Terms and Conditions of Würth Elektronik eiSos Group", last version available at *www.we-online.com*.

8 Legal notice

Exclusion of liability
Würth Elektronik eiSos GmbH & Co. KG considers the information in this document to be correct at the time of publication. However, Würth Elektronik eiSos GmbH & Co. KG reserves the right to modify the information such as technical specifications or functions of its products or discontinue the production of these products or the support of one of these products without any written announcement or notification to customers. The customer must make sure that the information used corresponds to the latest published information. Würth Elektronik eiSos GmbH & Co. KG does not assume any liability for the use of its products. Würth Elektronik eiSos GmbH & Co. KG does not grant licenses for its patent rights or for any other of its intellectual property rights or third-party rights.
Notwithstanding anything above, Würth Elektronik eiSos GmbH & Co. KG makes no representations and/or warranties of any kind for the

provided information related to their accuracy, correctness, completeness, usage of the products and/or usability for customer applications. Information published by Würth Elektronik eiSos GmbH & Co. KG regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof.

Suitability in customer applications
The customer bears the responsibility for compliance of systems or units, in which Würth Elektronik eiSos GmbH & Co. KG products are integrated, with applicable legal regulations. Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of Würth Elektronik eiSos GmbH & Co. KG components in its applications, notwithstanding any applications-related information or support that may be provided by Würth Elektronik eiSos GmbH & Co. KG. Customer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences lessen the likelihood of failures that might cause harm and take appropriate remedial actions. The customer will fully indemnify Würth Elektronik eiSos GmbH & Co. KG and its representatives against any damages arising out of the use of any Würth Elektronik eiSos GmbH & Co. KG components in safety-critical applications.

Trademarks
AMBER wireless is a registered trademark of Würth Elektronik eiSos GmbH & Co. KG. All other trademarks, registered trademarks, and product names are the exclusive property of the respective owners.

Usage restriction
Würth Elektronik eiSos GmbH & Co. KG products have been designed and developed for usage in general electronic equipment only. This product is not authorized for use in equipment where a higher safety standard and reliability standard is especially required or where a failure of the product is reasonably expected to cause severe personal injury or death, unless the parties have executed an agreement specifically governing such use. Moreover, Würth Elektronik eiSos GmbH & Co. KG products are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. Würth Elektronik eiSos GmbH & Co. KG must be informed about the intent of such usage before the design-in stage. In addition, sufficient reliability evaluation checks for safety must be performed on every electronic component, which is used in electrical circuits that require high safety and reliability function or performance. By using Würth Elektronik eiSos GmbH & Co. KG products, the customer agrees to these terms and conditions.

9 License terms for Würth Elektronik eiSos GmbH & Co. KG sensor product software and source code

These license terms will take effect upon the purchase and usage of the Würth Elektronik eiSos GmbH & Co. KG sensor products. You hereby agree that these license terms are applicable to the product and the incorporated software, firmware and source codes (collectively, "Software") made available by Würth Elektronik eiSos in any form, including but not limited to binary, executable or source code form.
The software included in any Würth Elektronik eiSos sensor product is purchased to you on the condition that you accept the terms and conditions of these license terms. You agree to comply with all provisions under these license terms.

Limited license
Würth Elektronik eiSos hereby grants you a limited, non-exclusive, non-transferable and royalty-free license to use the software and under the conditions that will be set forth in these license terms. You are free to use the provided software only in connection with one of the products from Würth Elektronik eiSos to the extent described in these license terms.
You are entitled to change or alter the source code for the sole purpose of creating an application embedding the Würth Elektronik eiSos sensor product. The transfer of the source code to third parties is allowed to the sole extent that the source code is used by such third parties in connection with our product or another hardware provided by Würth Elektronik eiSos under strict adherence of these license terms. Würth Elektronik eiSos will not assume any liability for the usage of the incorporated software and the source code.
You are not entitled to transfer the source code in any form to third parties without prior written consent of Würth Elektronik eiSos.
You are not allowed to reproduce, translate, reverse engineer, decompile, disassemble or create derivative works of the incorporated software and the source code in whole or in part.
No more extensive rights to use and exploit the products are granted to you.

Usage and obligations
The responsibility for the applicability and use of the Würth Elektronik eiSos sensor product with the incorporated software in a particular customer design is always solely within the authority of the customer. Due to this fact, it is up to you to evaluate and investigate, where appropriate, and to decide whether the device with the specific product characteristics described in the product specification is valid and suitable for your respective application or not.
You are responsible for using the Würth Elektronik eiSos sensor product with the incorporated software in compliance with all applicable product liability and product safety laws. You acknowledge to minimize the risk of loss and harm to individuals and bear the risk for failure leading to personal injury or death due to your usage of the product.
Würth Elektronik eiSos' products are not authorized for use in safety-critical applications, or where a failure of the product is reasonably expected to cause severe personal injury or death. Moreover, Würth Elektronik eiSos' products are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. You shall inform Würth Elektronik eiSos about the intent of such usage before design-in stage. In certain customer applications requiring a very high level of safety and in which the malfunction or failure of an electronic component could endanger human life or health, you must ensure to have all necessary expertise in the safety and regulatory ramifications of your applications. You acknowledge and agree that you are solely responsible for all legal, regulatory and safety-related requirements concerning your products and any use of Würth Elektronik eiSos' products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by Würth Elektronik eiSos. YOU SHALL INDEMNIFY WÜRTH ELEKTRONIK EISOS AGAINST ANY DAMAGES ARISING OUT OF THE USE OF WÜRTH ELEKTRONIK EISOS' PRODUCTS IN SUCH SAFETY-CRITICAL APPLICATIONS.

Ownership
The incorporated software created by Würth Elektronik eiSos is and will remain the exclusive property of Würth Elektronik eiSos.

Disclaimer of warranty
THE SOFTWARE AND IT'S SOURCE CODE IS PROVIDED "AS IS". YOU ACKNOWLEDGE THAT WÜRTH ELEKTRONIK EISOS MAKES NO REPRESENTATIONS AND WARRANTIES OF ANY KIND RELATED TO, BUT NOT LIMITED TO THE NON-INFRINGEMENT OF THIRD PARTIES' INTELLECTUAL PROPERTY RIGHTS OR THE MERCHANTABILITY OR FITNESS FOR YOUR INTENDED PURPOSE OR USAGE. WÜRTH ELEKTRONIK EISOS DOES NOT WARRANT OR REPRESENT THAT ANY LICENSE, EITHER EXPRESS OR IMPLIED, IS GRANTED UNDER ANY PATENT RIGHT, COPYRIGHT, MASK WORK RIGHT, OR OTHER INTELLECTUAL PROPERTY RIGHT RELATING TO ANY COMBINATION, MACHINE, OR PROCESS IN WHICH THE WÜRTH ELEKTRONIK EISOS' PRODUCT WITH THE INCORPORATED SOFTWARE IS USED. INFORMATION PUBLISHED BY WÜRTH ELEKTRONIK EISOS REGARDING THIRD-PARTY PRODUCTS OR SERVICES DOES NOT CONSTITUTE A LICENSE FROM WÜRTH ELEKTRONIK EISOS TO USE SUCH PRODUCTS OR SERVICES OR A WARRANTY OR ENDORSEMENT THEREOF.

Limitation of liability
Any liability not expressly provided by Würth Elektronik eiSos shall be disclaimed.
You agree to hold us harmless from any third-party claims related to your usage of the Würth Elektronik eiSos' products with the incorporated software and source code. Würth Elektronik eiSos disclaims any liability for any alteration, development created by you or your customers as well as for any combination with other products.

Applicable law and jurisdiction
Applicable law to these license terms shall be the laws of the Federal Republic of Germany. Any dispute, claim or controversy arising out of or relating to these license terms shall be resolved and finally settled by the court competent for the location of Würth Elektronik eiSos registered office.

Severability clause
If a provision of these license terms is or becomes invalid, unenforceable or null and void, this shall not affect the remaining provisions of the terms. The parties shall replace any such provisions with new valid provisions that most closely approximate the purpose of the terms.

Miscellaneous
Würth Elektronik eiSos reserves the right at any time to change this terms at its own discretion. It is your responsibility to check at Würth Elektronik eiSos homepage for any updates. Your continued usage of the products will be deemed as the acceptance of the change.
We recommend you to be updated about the status of new software, which is available on our website or in our data sheet, and to implement new software in your device where appropriate.
By ordering a product, you accept these license terms in all terms.

List of Figures

List of Tables

Contact
Würth Elektronik eiSos GmbH & Co. KG
Division Wireless Connectivity & Sensors

Max-Eyth-Straße 1
74638 Waldenburg
Germany

Tel.: +49 651 99355-0
Fax.: +49 651 99355-69
www.we-online.com/wireless-connectivity

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT