Customer training workshop: Asymmetric_PWM_Generation for KIT_T2G-B-H_EVK

TRAVEO™ T2G CYT4BF series Microcontroller Training
V1.0.0 2022-06

Please read the **Important notice and warnings** at the end of this document

Scope of work

- This code example demonstrates the generation of asymmetric PWM signals using two compare/capture registers available in the TCPWM block. Compared to the asymmetric PWM realized with only one compare function (where the CPU is used to update the compare value twice every PWM cycle), this solution uses two independent buffered compare values and causes less load on the CPU (where the CPU is used to update the compare value once every PWM cycle). The PWM waveform can be modified through the command on the terminal.

- Device
  - The TRAVEO™ T2G CYT4BFBCH device is used in this code example.

- Board
  - The TRAVEO™ T2G KIT_T2G-B-H_EVK board is used for testing.

Copyright © Infineon Technologies AG 2022. All rights reserved.

Introduction

- **TCPWM has the following features:**
  - Supports up to four counter groups (device specific)
  - Each counter group consists of up to 256 counters (counter group specific)
  - Each counter can run in one of the following seven function modes:
    - Timer-counter with compare
    - Timer-counter with capture
    - Quadrature decoding
    - Pulse width modulation/stepper motor control (SMC) for pointer instruments
    - PWM with dead time/three-phase motor control (Brushless-DC, BLDC)
    - Pseudo-random PWM
    - Shift register mode
  - 16-bit or 32-bit counters (counter group specific)
  - Up, down, and up/down counting modes
  - Clock prescaling (division by 1, 2, 4, ... 64, 128)

Copyright © Infineon Technologies AG 2022. All rights reserved.

Introduction (contd.)

TCPWM has the following features:

- Up to two capture and compare functions (counter group specific)
- Double buffering of all compare/capture and period registers
- Two output trigger signals for each counter to indicate underflow, overflow, and capture/compare events; they can also directly be connected with the line output signal
- Supports interrupt on:
  - Terminal count - Depends on the mode; typically occurs on overflow or underflow
  - Capture/Compare - The count is captured in the capture registers or the counter value equals the value in the compare register
- Line out selection feature for stepper motor application including two complementary output lines with dead time insertion
- Selectable start, reload, stop, count, and two capture event signals for each TCPWM with rising edge, falling edge, both edges, and level trigger options
- Each counter with up to 254 (device-specific) synchronized input trigger signals and two constant input signals: '0' and '1'.

Copyright © Infineon Technologies AG 2022. All rights reserved.

Introduction (contd.)

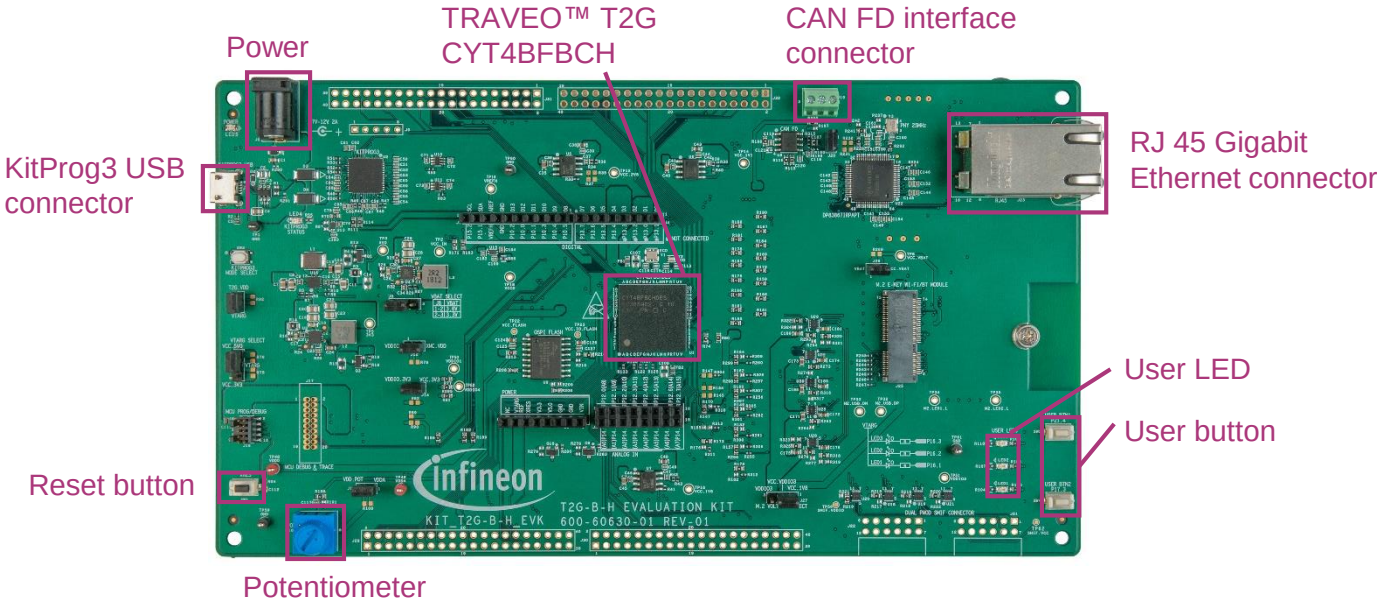
- **TCPWM has the following features:**
  - Two types of input triggers for each counter:
    - General-purpose triggers used by all counters
    - One-to-one triggers for specific counter
  - Synchronous operation of multiple counters
  - Debug mode support

Copyright © Infineon Technologies AG 2022. All rights reserved.

Hardware setup

› This code example has been developed for the KIT-T2G-B-H-EVK board.

› Connect your PC to the board using the provided USB cable through the KitProg3 USB connector.



Copyright © Infineon Technologies AG 2022. All rights reserved.

Implementation

This code example demonstrates generation of asymmetric PWM signals using dual compare/capture, which are configured in the device configurator.

The duty cycle and alignment of PWM can be adjusted through terminal software (e.g., Tera Term) connected to KitProg3 port.

Follow these steps to configure the this code example:

- Configure the STDIN / STDOUT
- Initialize and enable the TCPWM
- Start the TCPWM
- Changing duty / alignment of the PWM by command
- Using device configurator

Copyright © Infineon Technologies AG 2022. All rights reserved.

Implementation (contd.)

Configure the STDIN / STDOUT

- Call the ***cy_retarget_io_init ()*** function to use UART as STDIN / STDOUT.
  - Initialize P13.1 as UART TX, P13.0 as UART RX (these pins are connected to KitProg3 COM port)
  - The serial port parameters change to 8N1 and 115200 baud
- The UART receiving interrupt is configured in the ***cyhal_uart_enable_event ()*** function.
  - When the command is received through the terminal, interrupt occur and it reflects to PWM waveform by ***process_key_press ()***.

Command	Meaning
w	Increase duty cycle
s	Decrease duty cycle
a	Shift waveform to left
d	Shift waveform to right

- The ***cyhal_uart_register_callback ()*** function registers the interrupt service routine (ISR).

Copyright © Infineon Technologies AG 2022. All rights reserved.

Implementation (contd.)

Initialize and enable the TCPWM

- The ***Cy_TCPWM_PWM_Init ()*** function initializes the TCPWM once.
- The ***Cy_TCPWM_PWM_Enable ()*** function enables the TCPWM.
  - Default: center-aligned square wave with a 50 % duty cycle is generated on P5.0.
  - The default value is read from TCPWM registers into variables by PDL functions (***Cy_TCPWM_PWM_GetPeriod0 ()***, ***Cy_TCPWM_PWM_GetCompare1Val ()***, ***Cy_TCPWM_PWM_GetCompare0Val ()***)

Start the PWM

- The ***Cy_TCPWM_TriggerStart_Single ()*** function starts the TCPWM.

Changing duty / alignment of the PWM

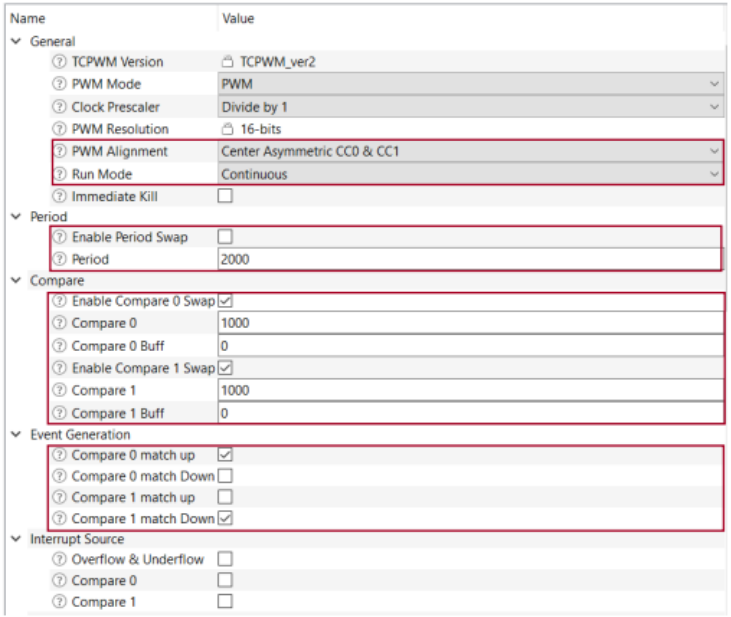
- In the ***process_key_press ()*** function, duty and alignment is changed by PDL functions (***Cy_TCPWM_PWM_SetCompare0BufVal ()***, ***Cy_TCPWM_PWM_SetCompare1BufVal ()***, ***Cy_TCPWM_TriggerCaptureOrSwap_Single ()***)

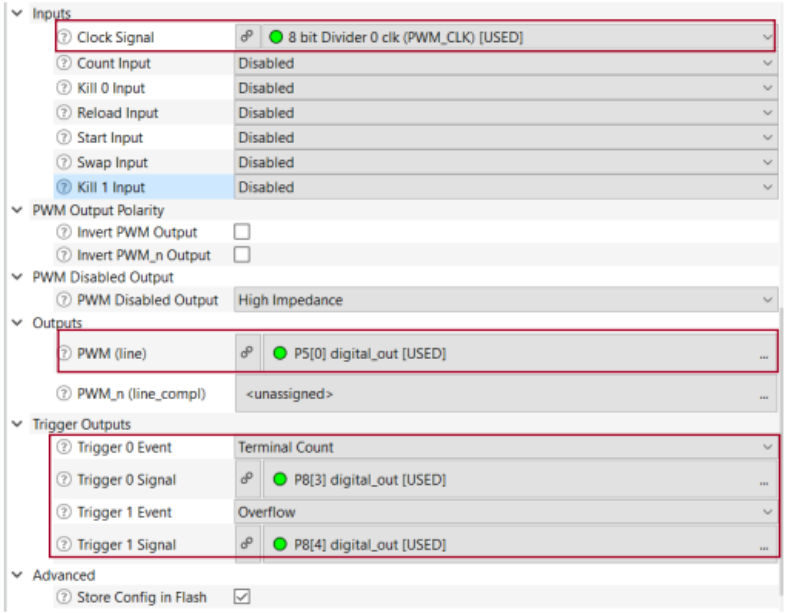
Copyright © Infineon Technologies AG 2022. All rights reserved.

Implementation (contd.)

Use the device configurator

› The configuration required for the TCPWM block is done in a custom *design.modus* file. This can be opened by the device configurator and can be modified. If saved, all settings will be reflected to codes.





Copyright © Infineon Technologies AG 2022. All rights reserved.

Compiling and programming

1. Connect to power and USB cable
2. Use Eclipse IDE for ModusToolbox™ software for compiling and programming
3. Compile
   a) Select the target application project in the Project Explorer
   b) In the Quick Panel, scroll down, and click "Build Asymmetric_PWM_Generation Application" in Asymmetric_PWM_Generation (KIT-T2G-B-H-EVK)



4. Open a terminal program and select the KitProg3 COM port. Set the serial port parameters to 8N1 and 115200 baud.
5. Programming
   a) Select the target application project in the Project Explorer
   b) In the Quick Panel, scroll down, and click "Asymmetric_PWM_Generation Program (KitProg3_MiniProg4)" in Launches

Copyright © Infineon Technologies AG 2022. All rights reserved.

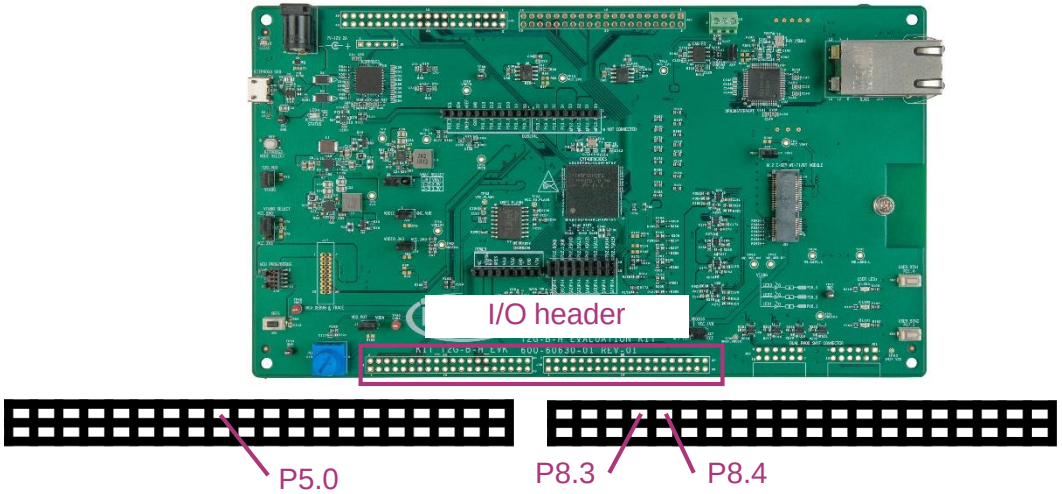
Run and test

1. After successful programming, the terminal must display the following message:

```
************************************************************
PDL: TCPWM in PWM Mode with Dual Compare/Capture
************************************************************

================================================
Instructions:
================================================
Press 'w' : To increase the duty cycle
Press 's' : To decrease the duty cycle
Press 'a' : To shift waveform towards left
Press 'd' : To shift waveform towards right
================================================
```

- Prepare oscilloscope and connect to the I/O header and observe the PWM waveform as follows:

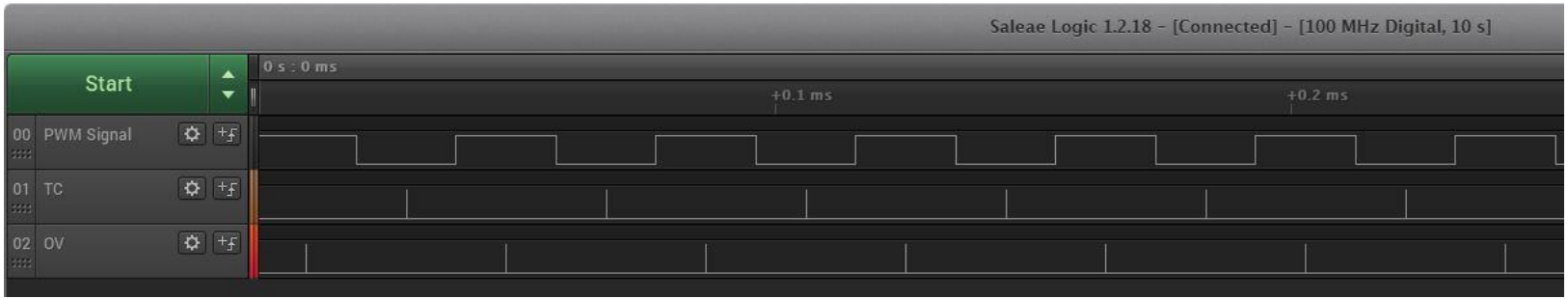


Copyright © Infineon Technologies AG 2022. All rights reserved.

Run and test (contd.)

2. On the oscilloscope, observe that a center-aligned square wave with a 50% duty cycle is generated on P5.0. Use the signals from P8.3 and P8.4 to verify the alignment.

   – P5.0 - PWM output (periodic square wave)
   – P8.3 - Terminal count (marks the end of the period)
   – P8.4 - Overflow (marks the center of the period)

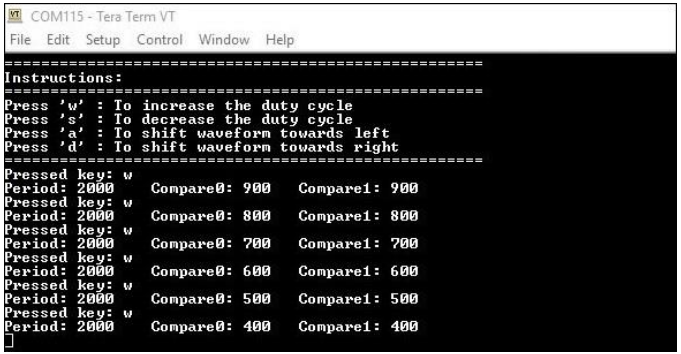


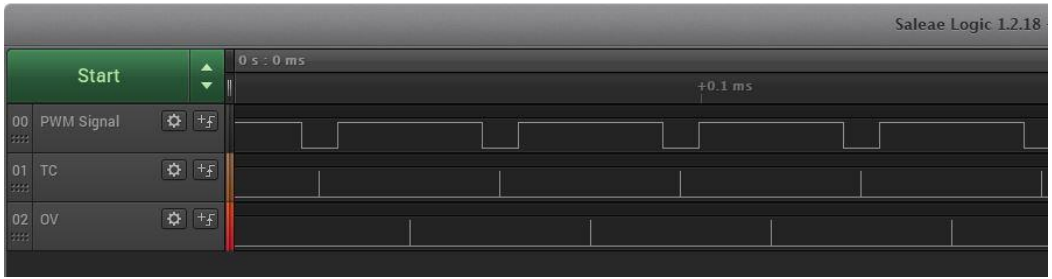
Copyright © Infineon Technologies AG 2022. All rights reserved.

Run and test (contd.)

3. Follow the instructions printed on the terminal to modify the waveform. Verify the output on the oscilloscope simultaneously.

   – ‘w’: Increase duty cycle

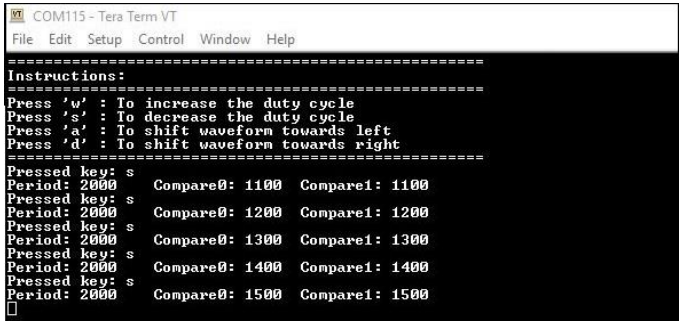


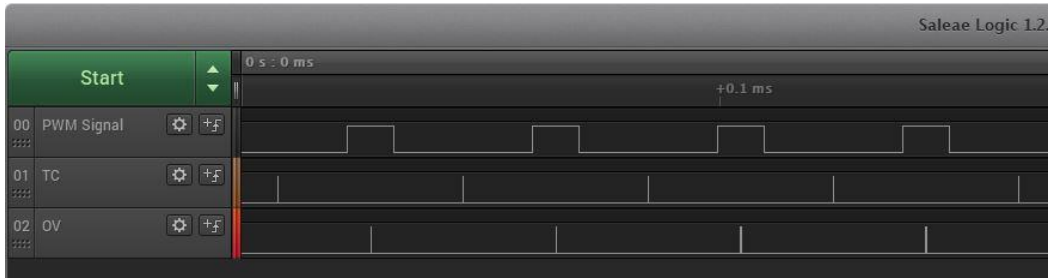


Copyright © Infineon Technologies AG 2022. All rights reserved.

Run and test (contd.)

– ‘s’: Decrease duty cycle

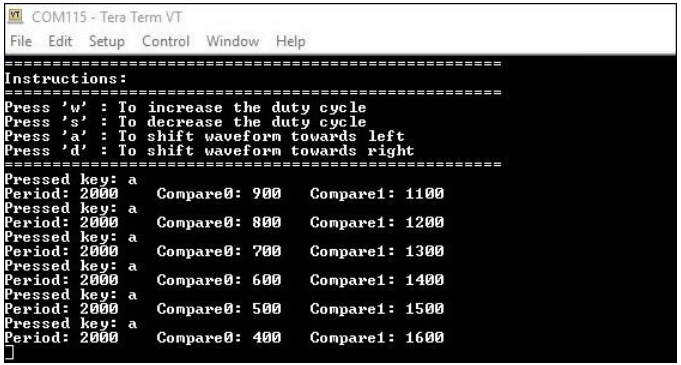


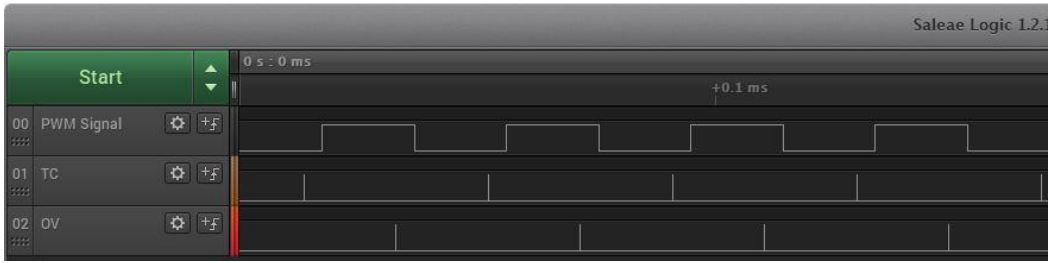


Copyright © Infineon Technologies AG 2022. All rights reserved.

Run and test (contd.)

– ‘a’: Shift waveform to left

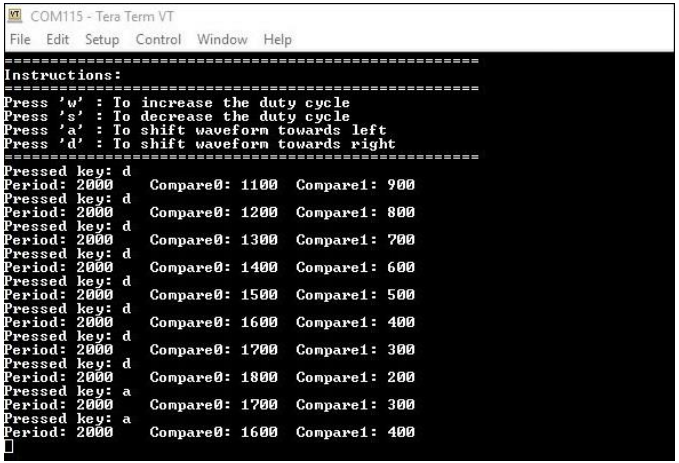


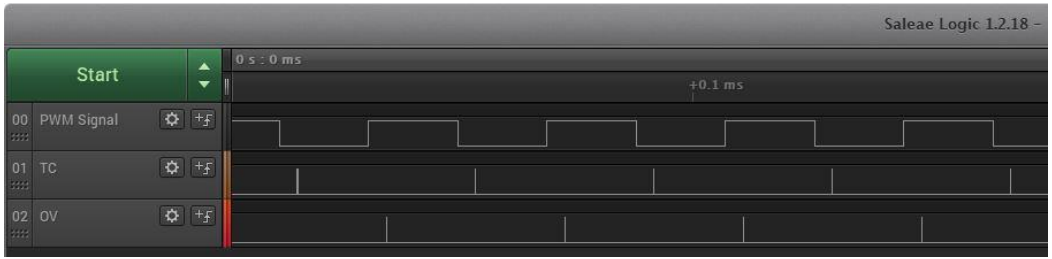


Copyright © Infineon Technologies AG 2022. All rights reserved.

Run and test (contd.)

– ‘d’: Shift waveform to right





Copyright © Infineon Technologies AG 2022. All rights reserved.

References

Datasheet

› CYT4BF datasheet 32-bit Arm® Cortex®-M7 microcontroller TRAVEO™ T2G family

Architecture technical reference manual

› TRAVEO™ T2G automotive body controller high family architecture technical reference manual

Registers technical reference manual

› TRAVEO™ T2G automotive body controller high registers technical reference manual

PDL/HAL

› PDL

› HAL

Training

› TRAVEO™ T2G Training

Copyright © Infineon Technologies AG 2022. All rights reserved.

Revision History

Revision	ECN	Submission Date	Description of Change
**	7781926	2022/06/27	Initial release

Copyright © Infineon Technologies AG 2022. All rights reserved.

Important notice and warnings

All referenced product or service names and trademarks are the property of their respective owners.

Edition 2022-06
Published by
Infineon Technologies AG
81726 Munich, Germany

© 2022 Infineon Technologies AG.
All Rights Reserved.

Do you have a question about this document?
Go to:
www.infineon.com/support

Document reference
002-35576 Rev. **

IMPORTANT NOTICE

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie") .

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

For further information on the product, technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies office (**www.infineon.com**).

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.

Copyright © Infineon Technologies AG 2022. All rights reserved.