# CDM10VD

## Flexible 0-10V Dimming Solution

**CDM10VD**
**CDM10VD-2**
**CDM10VD-3**
**CDM10VD-4**
**Quality Requirement Category: Standard**

## Features

- Simplest 0-10 V design on the market. CDM10VD-Series comes with the following default settings:
  - Minimum duty cycle 5% or 10% @1V
  - 1kHz PWM frequency
  - 120µA Dimmer/Resistor Bias current
  - 9.4 V dimming voltage for 100%
  - 1mA or 5mA output current for driving an optocoupler
- Wide input $V_{cc}$ range from 11 to 25 V plus extended range down to 6V
- Minimum 200mV dimming hysteresis between dimming to OFF and to ON
- Variable Frequency PWM Input Mode
- Replaces many external components with a single chip reducing BOM and PCB space
- Minimum variation from device to device

## Applications

- LED Drivers needing 0-10 V Dimming Circuits
- Industrial and Commercial Dimmable Applications: Luminaires, Troffers, Downlights, Sconces, Undercabinet, Office Lighting, Signage applications, Dali-applications

| Product Type | Output current / min. Duty Cycle | Package |
|---|---|---|
| CDM10VD | 5 mA / 5 % | SOT23-6 |
| CDM10VD-2 | 5 mA / 10 % | SOT23-6 |
| CDM10VD-3 | 1 mA / 5 % | SOT23-6 |
| CDM10VD-4 | 1 mA / 10 % | SOT23-6 |

## Description

CDM10V is a fully integrated 0-10 V dimming interface IC and comes in a SOT23-6 package to cover space requirements on small PCB designs.

The device is targeted for various dimming applications in lighting. The IC can be used to transmit analog voltage based signals from a 0-10 V dimmer or a potentiometer or a PWM input of a lighting controller IC, transformed to a 5 mA/1 mA current based fixed frequency PWM signal, to directly drive an external optocoupler. To avoid flickering when dimming, the light up and the light down threshold has a minimum implemented hysteresis of 200mV.

It replaces many components in a traditional solution and reduces BOM and PCB space significantly.

The CDM10VD-Series ICs outputs a 0 - 100% PWM current signal at a frequency of 1 kHz with an amplitude value of 1mA or 5 mA.

## Description

The duty cycle of the PWM signal can be selected to be either 5% or 10%. Dim-to-off feature is fully supported with a minimum hysteresis of 200 mV between dim-to-dark and dim-to-light.

Embedded digital signal processing maintains minimum variations from device to device.

# Table of contents

# 1 Block Diagram

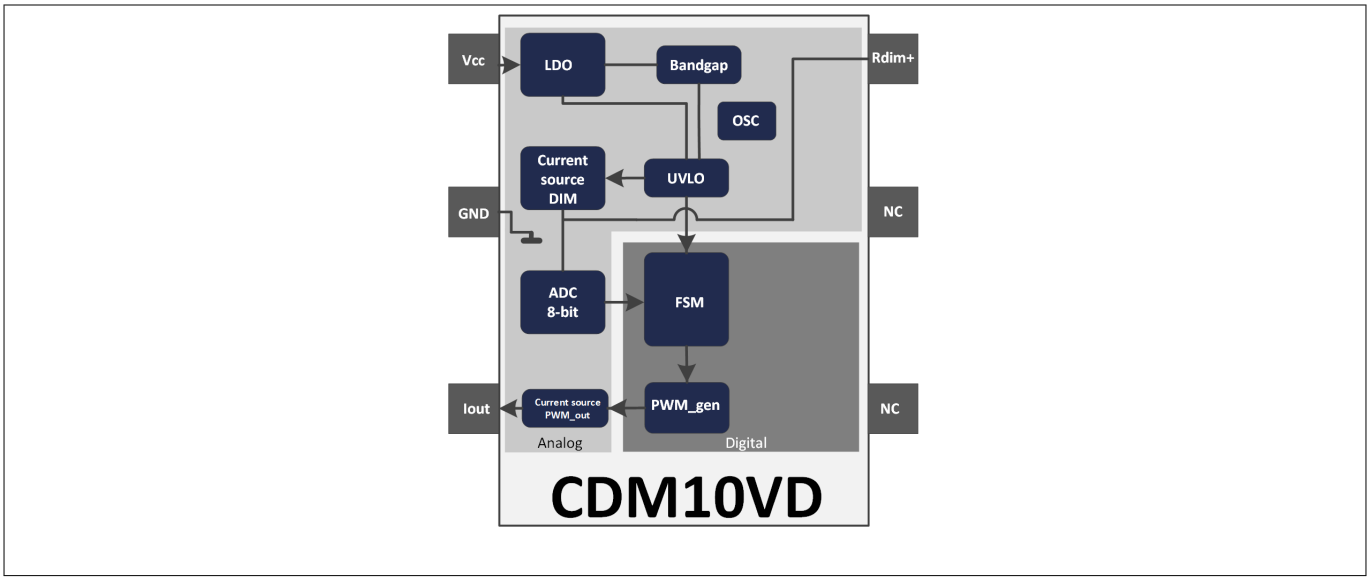


**Figure 1 Block Diagram of the CDM10VD**

# 2 Pin Configuration

**Table 1 Pin configutation**

| Pin | Name | Function |
|---|---|---|
| 1 | $V_{CC}$ | Input supply voltage |
| 2 | GND | GND |
| 3 | $I_{out}$ | PWM output current |
| 4 | NC | GND |
| 5 | NC | GND |
| 6 | $R_{dim+}$ | Dimmer current output /Voltage sense |

# 3 Functional Description

## Typical Application Circuit

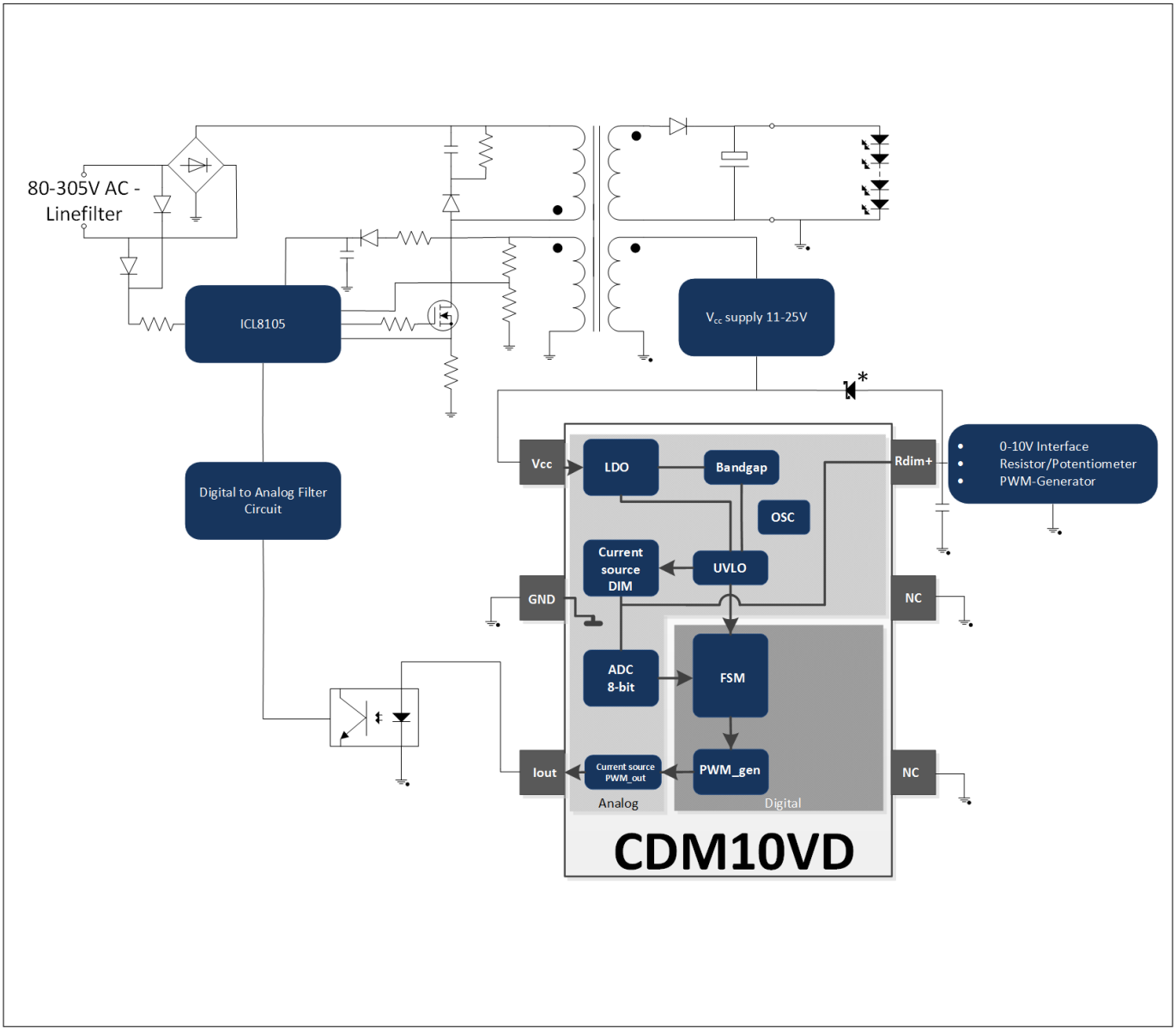


**Figure 2 Typical Application Circuit**

*Note: The Diode marked with * is for the protection of the $R_{dim+}$-Pin when active dimming is used. This is because the voltage on this Pin is not allowed to be higher than $V_{CC}$+0.5V. It is advised to use a low leakage, low reverse current Schottky-Diode in order to not influence the dimming performance (e.g. MMSD301T1G).*

*Note: The capacitor connected to the $R_{dim+}$-Pin reduces the amount of coupled noise to the dimming signal. The size of this capacitance should be in the range of 2.2 - 10 nF (typ. 4.7 nF), where a small capacitor allows steeper edges of the dimming signal, a larger capacitor enhances the noise reduction.*

### Recommended cooling area

In order to guarantee the full functionality of the CDM10VD device, the required cooling area has to be selected according to the graph in ***Figure 3***.

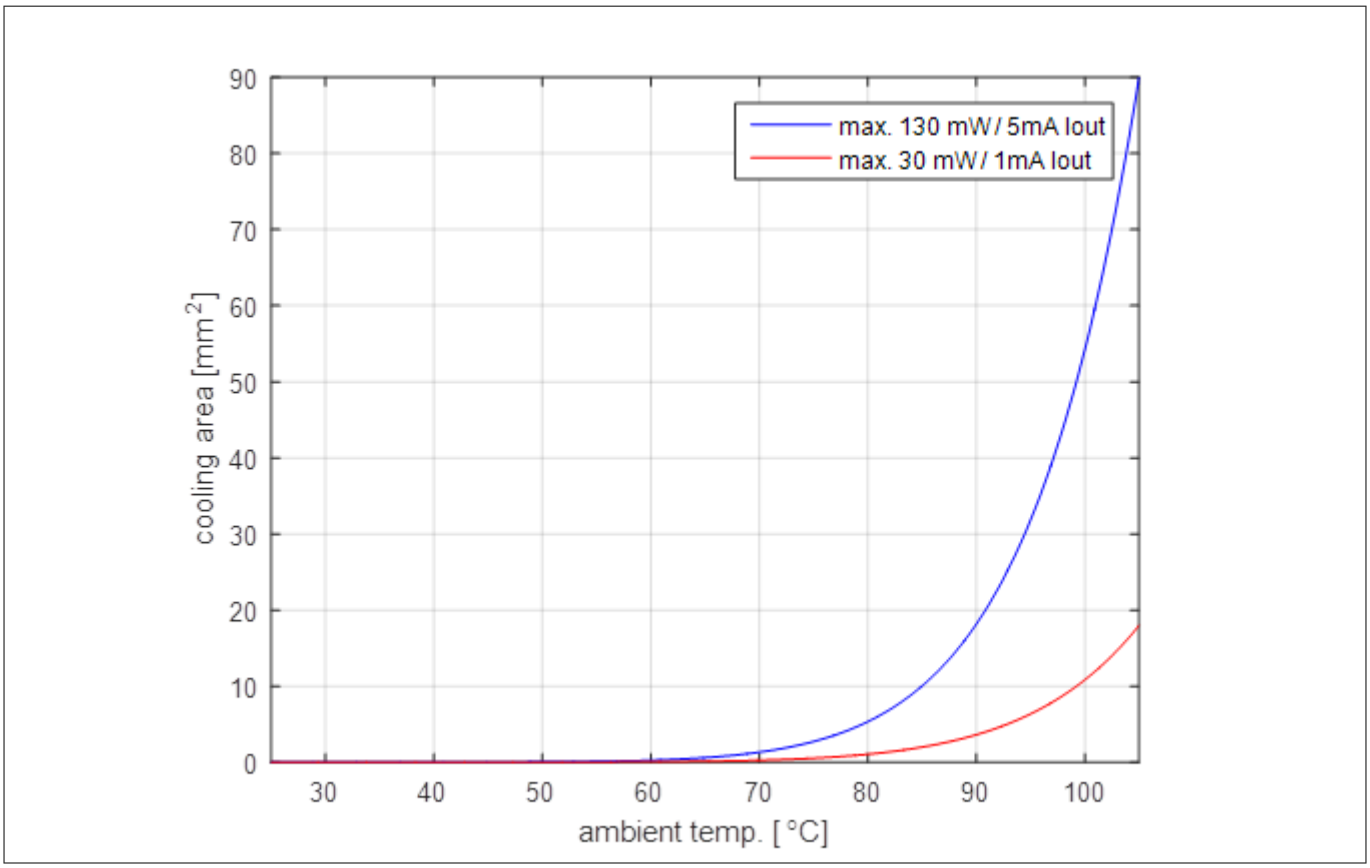


**Figure 3 Cooling area over ambient temperature CDM10VD**

### Dimming Characteristic

**Table 2 PWM Output current referring to $R_{dim+}$-Pin nominal Voltage**

| $R_{dim+}$ | $I_{out}$ |
|---|---|
| <0.5V (dim-to-dark) | OFF (0%) |
| 0.5V…1V (dim-to-dark) | Min duty cycle 5%/10% |
| <0.7V (dim-to-bright) | OFF (0%) |
| 0.7V…1V (dim-to-bright) | Min duty cycle 5%/10% |
| 1V….9.4V | Min duty cycle (@ 1V)...100% (@ 9.4V) |
| >9.4V | Always active (100%) |

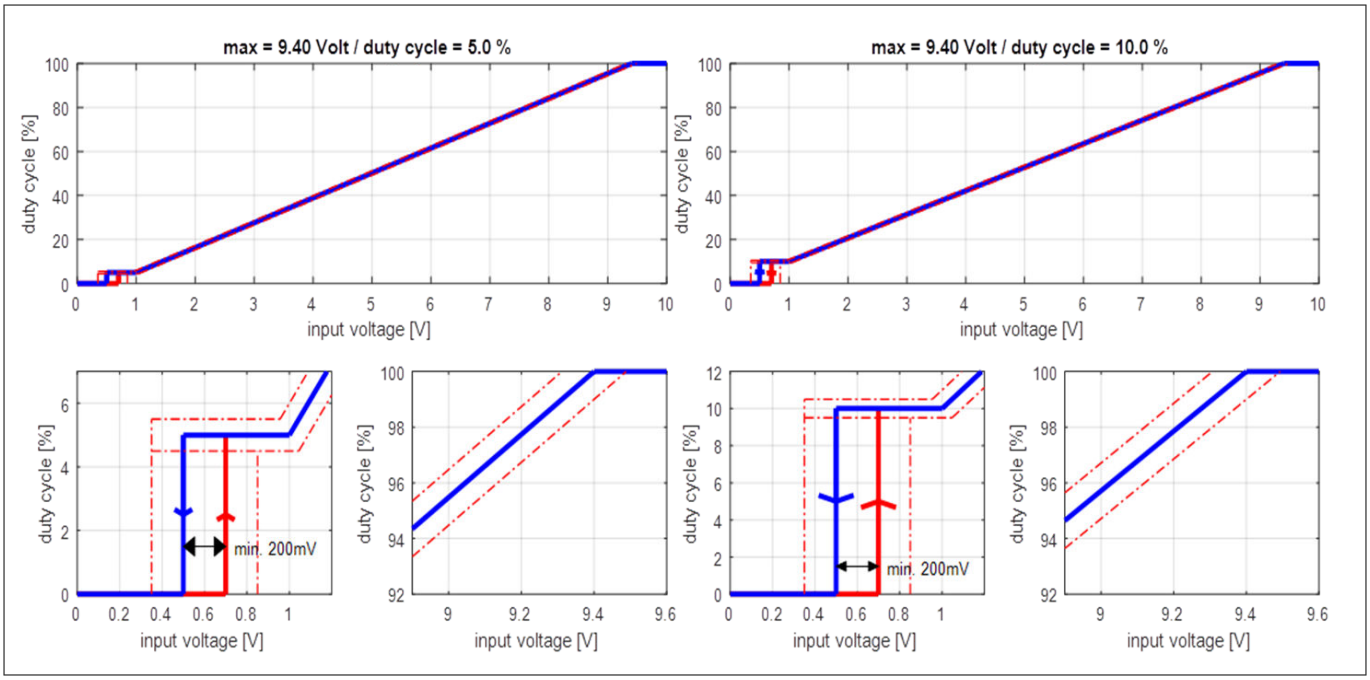


**Figure 4 Dimming Characteristic with +-1% error for start- & endpoint for 5% and 10% Min Duty Cycle**

**Table 3 Dim2bright and dim2off thresholds**

| Dim2off | | | | Dim2bright | | | | Hysteresis |
|---|---|---|---|---|---|---|---|---|
| min | nom | max | | min | nom | max | | min |
| 0,35 | 0,5 | 0,65 | | 0,55 | 0,7 | 0,85 | | 200mV |

The CDM10VD device has two operating ranges, as seen in ***Figure 5***, in regards of the supply voltage $V_{CC}$.
The following conditions must be taken into consideration:

- between 11 and 25V the device is fully operable and all parameters are in specification
- between 6 and 11V the device is functional but the parameters might be out of specification

The purpose of the extended $V_{CC}$ range is to use it during the off state of the LED. Here the secondary side supply voltage can be lowered down to 6V, which is sufficient to keep the CDM10VD device functional. The System has to be designed in an way that the remaining power, which is transferred to the output, is low enough so the LEDs' doesn't emit any visible light, but sufficient to keep the CDM10VD in this extended $V_{CC}$ range. If a voltage on the $R_{dim+}$-pin is sensed, which is higher than the dim2bright threshold, the system powers

the output to the normal operating voltage. This should also bring the $V_{CC}$ supply voltage to the normal operating area of the CDM10VD device where all parameters are in specification again.

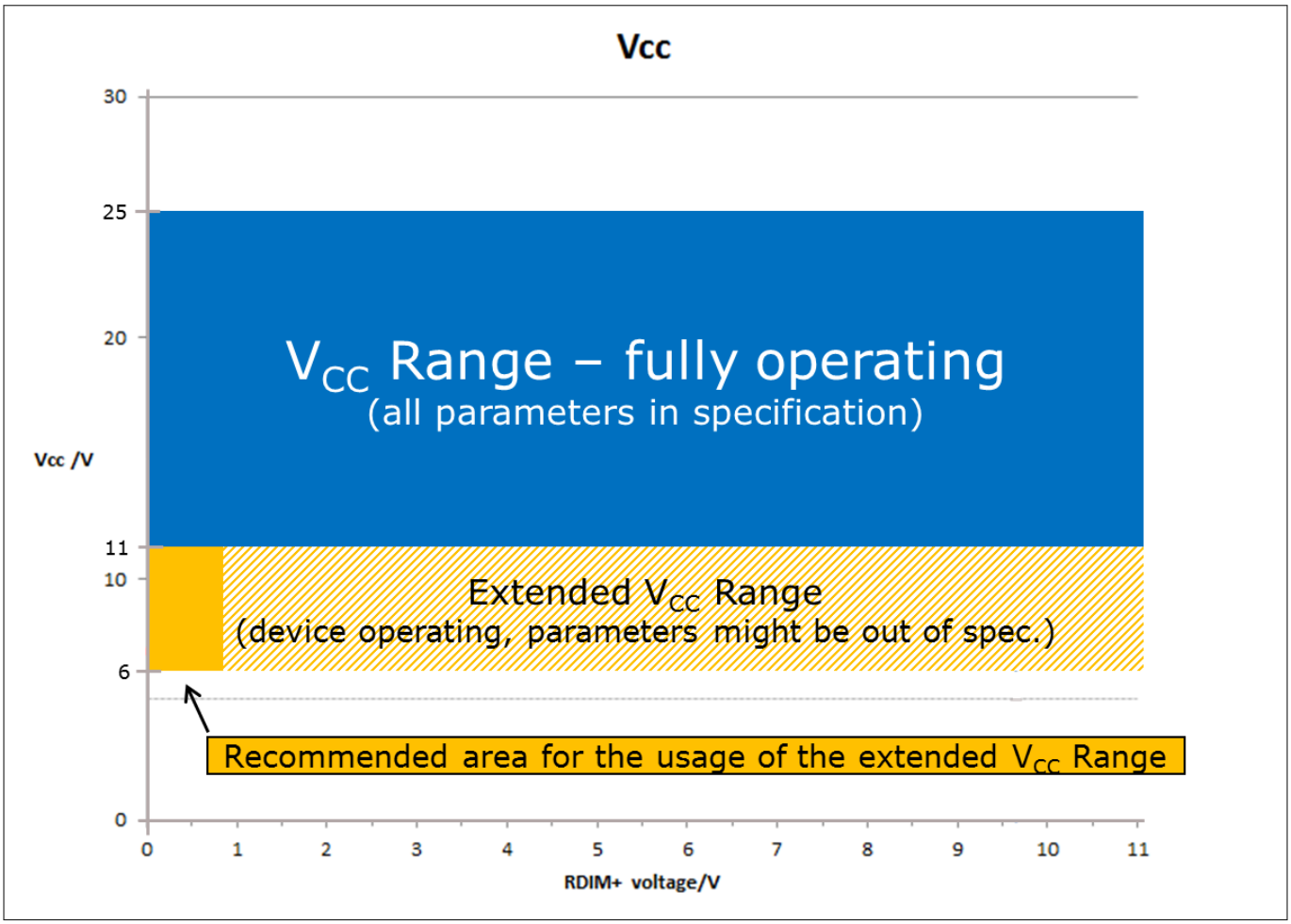


**Figure 5 Extended $V_{CC}$ range**

### Variable Frequency PWM Input Mode

CDM10VD device can be operated in a 'frequency conversion input mode'. In this mode the PWM input signal on $R_{dim+}$ with frequencies between 100 Hz and 3 kHz will be converted to 1 kHz signal on $I_{out}$. The duty cycle between input and output signals remain at the same level. The configuration and conditions are described below.

Variable frequency mode conditions

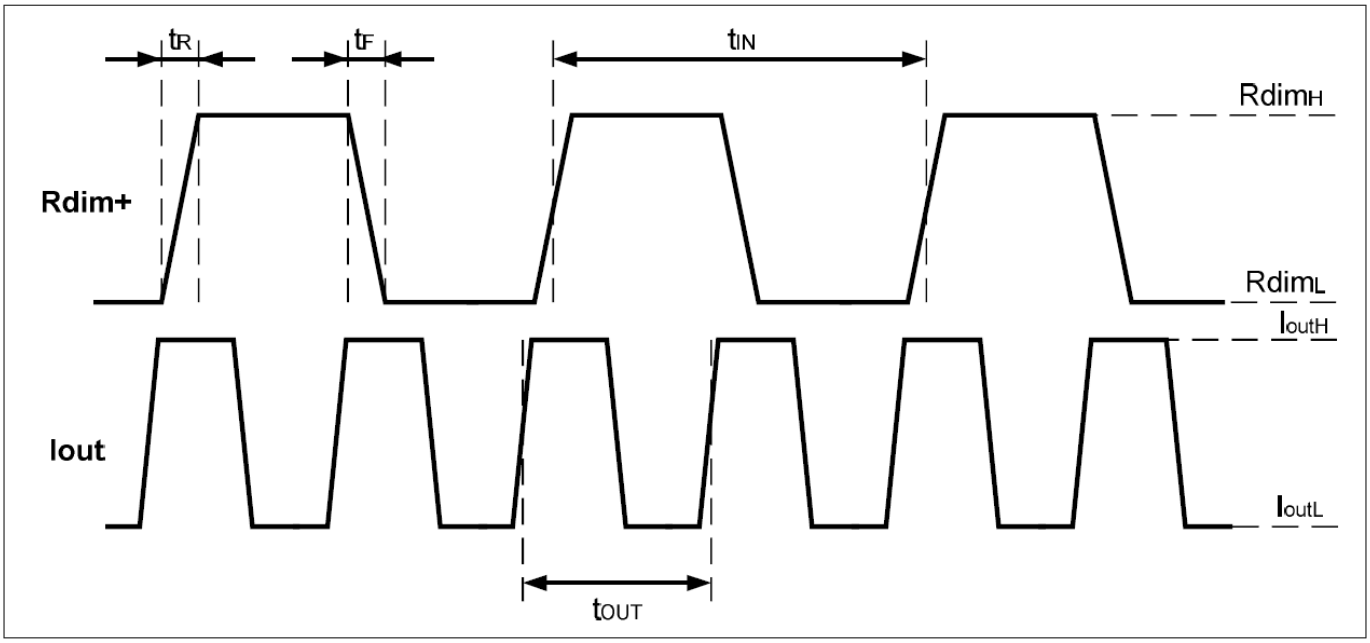


**Figure 6 Timing for the Variable Frequency PWM Input Mode**

**Table 4 Conditions for the Variable Frequency PWM Input Mode**

| Condition | Name | Min | Nom | Max |
|---|---|---|---|---|
| $R_{dimH}$ | $R_{dim+}$High Value | 9.6 V | | $V_{CC}$+0,5V |
| $R_{dimL}$ | $R_{dim+}$Low Value | -0.5 V | 0.0 V | 0.5 V |
| $I_{outH}$ | $I_{out}$High Value | | $R_{Iout}$ * $I_{Iout}$[1] | |
| $I_{outL}$ | $I_{out}$Low Value | | 0.0 V | |
| $t_{IN}$ | Period input signal | 0.33 ms | 1.0 ms | 10.0 ms |
| $t_{OUT}$ | Period ouput signal | 1.0 ms - 5 % | 1.0 ms | 1.0ms + 5 % |
| $t_R$ | Rising edge time | | | 1.8 µs |
| $t_F$ | Falling edge time | | | 1.8 µs |

*Note*: [1] *$R_{Iout}$ is the resistance connected between the $I_{out}$ and the GND-PIN. $I_{out}$ is 1 mA or 5 mA dependent on the CDM10VD version.*

Once the CDM10VD detects the frequency in the range 100 Hz and 3 kHz on the $R_{dim+}$ input the internal FSM will lock after min eight input signal periods. In this time the input $R_{dim+}$ signal is provided to the $I_{out}$ directly, see ***Figure 7***.

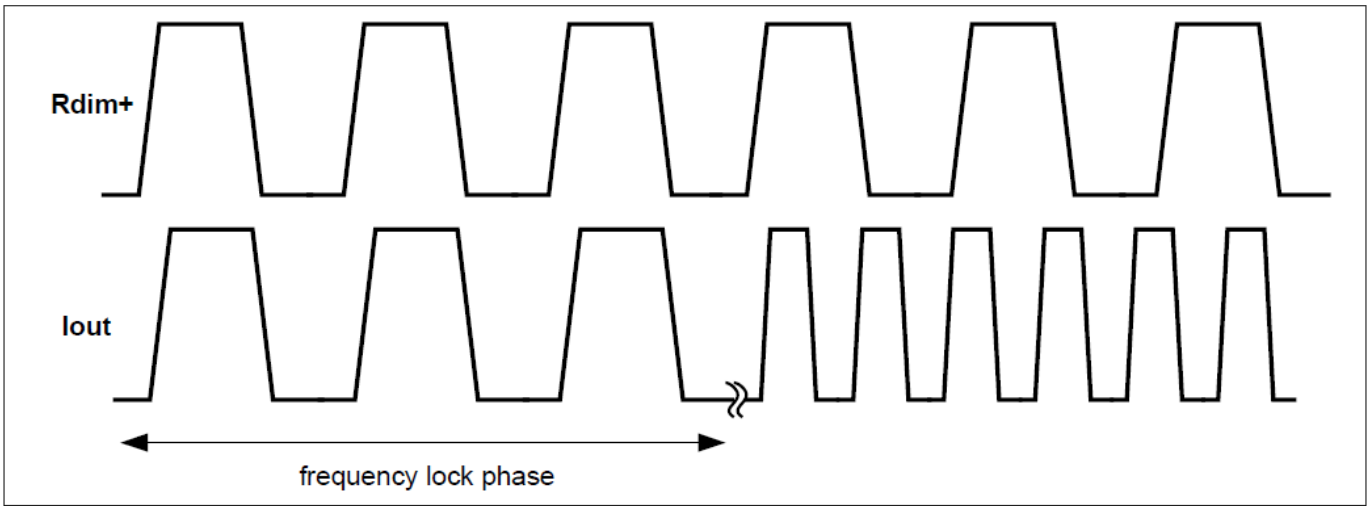


**Figure 7 Lock phase default mode**

### Backup mode

To avoid the $I_{out}$ behavior during lock phase in default mode, there is an additional option described below. In normal operation Pin 5 has to be connected to the GND level. In this mode the CDM10VD selects automatically between the standard hysteresis mode and the frequency conversion mode depending on the input signal on $R_{dim+}$. Leaving the Pin 5 unconnected, the CMD10VD device will switch directly to the frequency conversion mode and the $I_{out}$ pin will be tied to GND during the frequency lock phase, see ***Figure 8***. In this mode the standard hysteresis mode cannot be used.

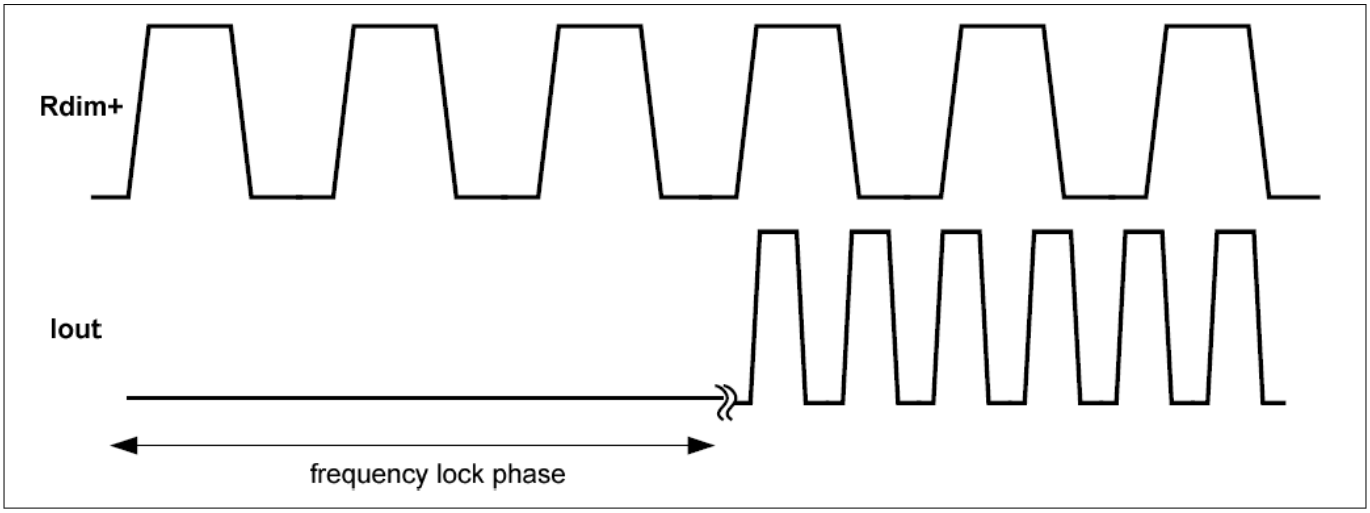


**Figure 8 Lock phase backup mode**

# 4 Electrial Characteristics and Parameters

**Table 5 Absolute Maximum Ratings**

| Pin | Name | Values | | Unit | Note or Test Condition |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| 1 | $V_{cc}$ | 0 | 26 | V | |
| 2 | GND | 0 | 0 | V | Point of reference |
| 3 | $I_{out}$ | -0.5 | 3.63 | V | Depending on the optocupler voltage @ 5mA or 1mA |
| 4 | NC | -0.25 | 0.1 | V | Connect to GND during operation |
| 5 | NC | -0.25 | 0.1 | V | During operation Connect to GND |
| 6 | $R_{dim+}$ | -0.5 | $V_{CC}$ + 0.5 | V | An applied voltage above max value leads to the destruction of the device. Also valid if $V_{CC}$ is 0 V. |

Absolute maximum ratings (***Table 5***) are defined as ratings which when being exceeded may lead to destruction of the integrated circuit. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit. These values are not tested during production test.

**Table 6 Electrical Characteristics**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input Voltage | $V_{in}$ | 11 | | 25 | V | Operating Voltage |
| Extended Input Voltage | $V_{ext}$ | 6 | | 10.9 | V | Parameters might be out of spec. |
| Junction Temperature Range | $T_J$ | -40 | | 135 | °C | |
| Ambient Temperature Range | $T_A$ | -40 | | 105 | °C | All limits guaranteed |
| Startup Ambient Temperature Range | $T_A$ | -55 | | 105 | °C | IC startup guaranteed |
| Current Consumption | $I_{CC}$ | | | 1 | mA | Current Consumption of the IC for self supply |
| Output Current for Dimmer | $I_{dim}$ | -5% | 120 | +5% | µA | Current flow out of $R_{dim+}$-Pin |
| PWM frequency | $f_{PWM}$ | -5% | 1000 | +5% | Hz | |
| Dimming accuracy | | -1 | | +1 | % | With active dimming incl. all variations |

**Table 6 Electrical Characteristics (continued)**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Wake-up Time | $t_w$ | | | 40 | µs | Time from $V_{CC}$ = 6 V to first output current |
| ESD capability HBM | $V_{HAB}$ | | | 1500 | V | according to ANSI/ESDA/JEDEC JS-001 |
| ESD capability CDM | $V_{CDM}$ | | | 500 | | according to JESD22 C101 |

**Table 7 Electrical Characteristics for CDM10VD**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Output Current for Optocoupler | $I_{out}$ | 4.5 | 5 | 5.5 | mA | |
| Min. duty cycle | $PW_{PWM}$ | -0.5 | 5 | +0.5 | % | Percentage of the pulse width |
| Power Dissipation | $P_{tot}$ | 8.25 @ 5% duty cycle; | 130 @ 100% duty cycle<br>83.2 @ 70% duty cycle<br>54 @ 50% duty cycle<br>30.4 @ 30% duty cycle | 160 @ 100% PWM & 25 $V_{in}$ | mW | Dimmer current included |

**Table 8 Electrical Characteristics for CDM10VD-2**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Output Current for Optocoupler | $I_{out}$ | 4.5 | 5 | 5.5 | mA | |
| Min. duty cycle | $PW_{PWM}$ | -0.5 | 10 | +0.5 | % | Percentage of the pulse width |
| Power Dissipation | $P_{tot}$ | 11 @ 10% duty cycle | 130 @ 100% duty cycle<br>83.2 @ 70% duty cycle<br>54 @ 50% duty cycle<br>30.4 @ 30% duty cycle | 160 @ 100% PWM & 25 $V_{in}$ | mW | Dimmer current included |

**Table 9 Electrical Characteristics for CDM10VD-3**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Output Current for Optocoupler | $I_{out}$ | 0.9 | 1 | 1.1 | mA | |
| Min. duty cycle | $PW_{PWM}$ | -0.5 | 5 | +0.5 | % | Percentage of the pulse width |
| Power Dissipation | $P_{tot}$ | 2.3 @ 5% duty cycle | 30 @ 100% duty cycle<br>21 @ 70% duty cycle<br>15 @ 50% duty cycle<br>9 @ 30% duty cycle | 53 @ 100% PWM & 25 $V_{in}$ | mW | Dimmer current included |

**Table 10 Electrical Characteristics for CDM10VD-4**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Output Current for Optocoupler | $I_{out}$ | 0.9 | 1 | 1.1 | mA | |
| Min. duty cycle | $PW_{PWM}$ | -0.5 | 10 | +0.5 | % | Percentage of the pulse width |
| Power Dissipation | $P_{tot}$ | 2.6 @ 10% duty cycle | 30 @ 100% duty cycle<br>21 @ 70% duty cycle<br>15 @ 50% duty cycle<br>9 @ 30% duty cycle | 53 @ 100% PWM & 25 $V_{in}$ | mW | Dimmer current included |

*Note*: *Please contact Infineon if you are in need of an inverted output current.*

# 5 Package Dimensions

## Package Drawings

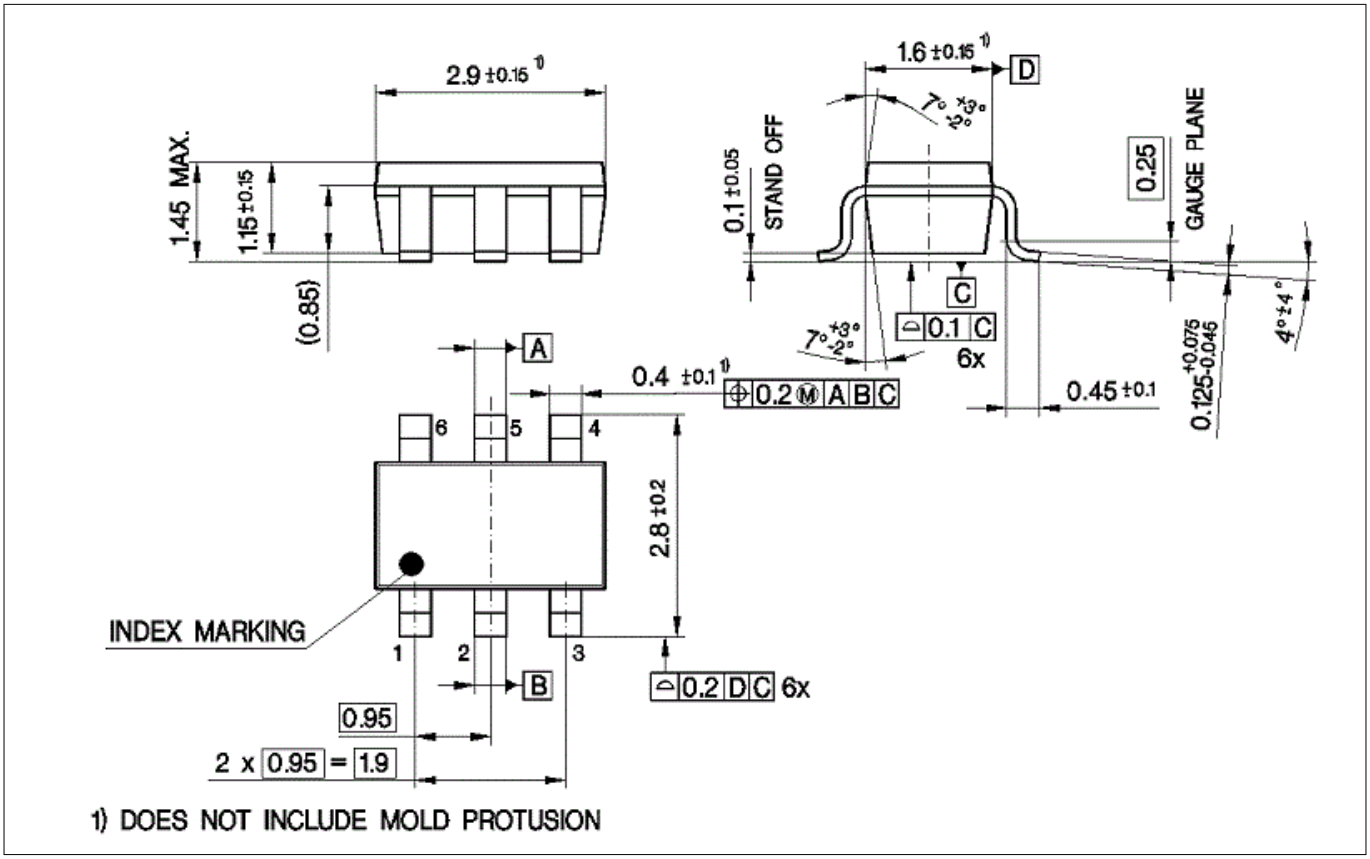


**Figure 9 Package Drawings**

## Package Dimensions

### Footprint

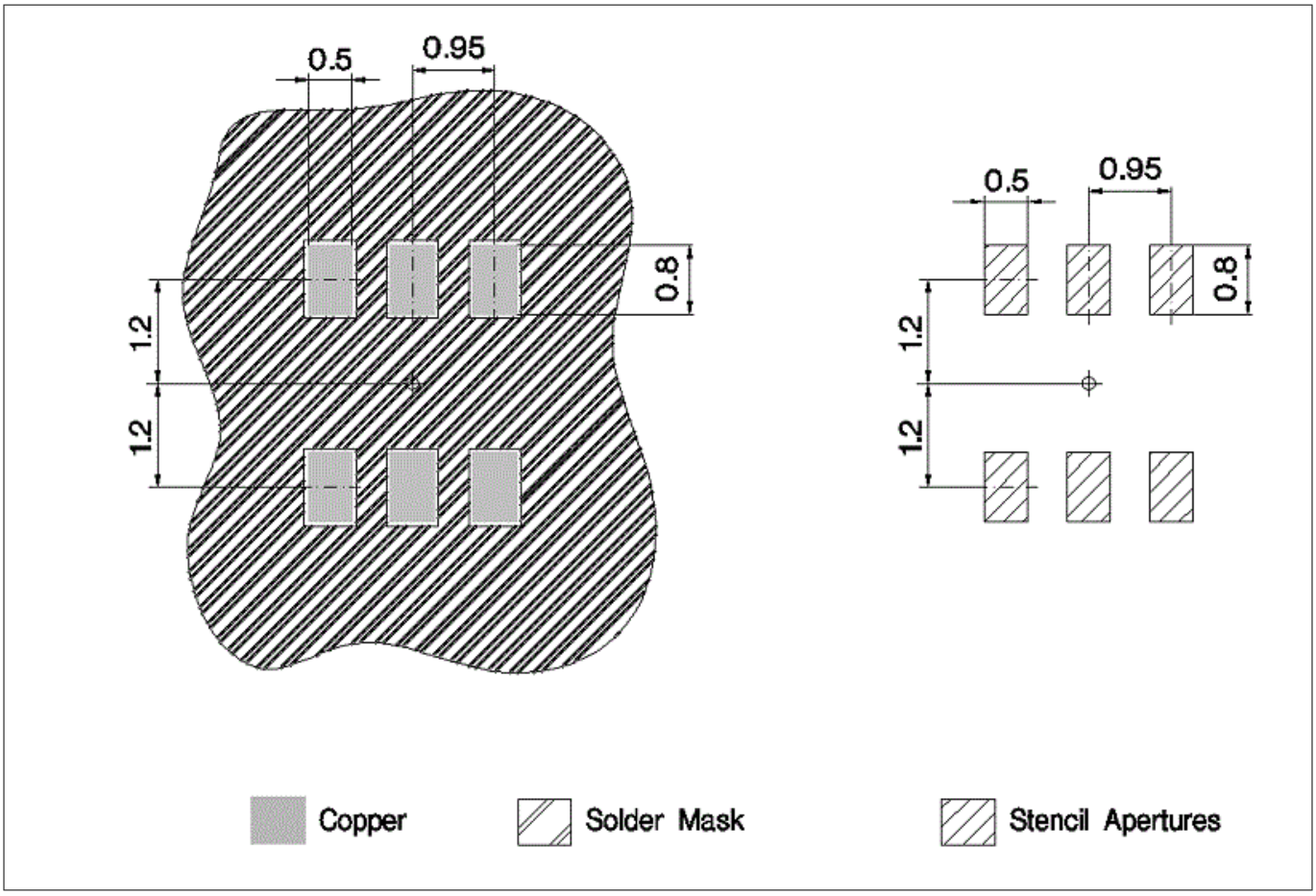


**Figure 10 Footprint**

### Packing Description

**Packing Type**
Tape and Reel
∅ Reel: 180
Pieces / Reel: 3000
Reels / Box: 1

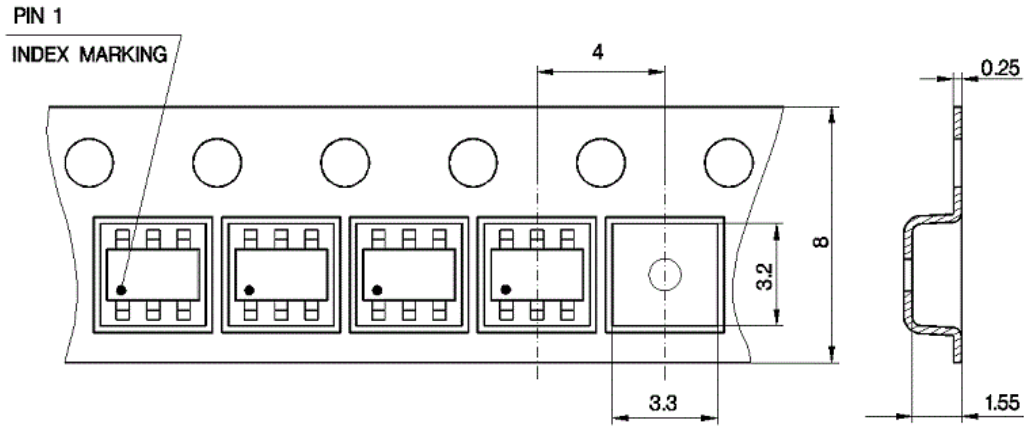


**Figure 11 Packing**

# 6 References

**Related information**

***Please refer to the Datasheet of the CDM10V for further application related information.***

# Revision History

Major changes since previous revision

**Revision History**

| Reference | Description |
|---|---|
| v1.0 | First release |
| v1.1 | Corrected value for min power dissipation in table 10. |

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**Edition 2017-08-02**

**Published by**

**Infineon Technologies AG**

**81726 Munich, Germany**



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**Document reference**
**IFX-jml1470032847985**

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