

# 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.

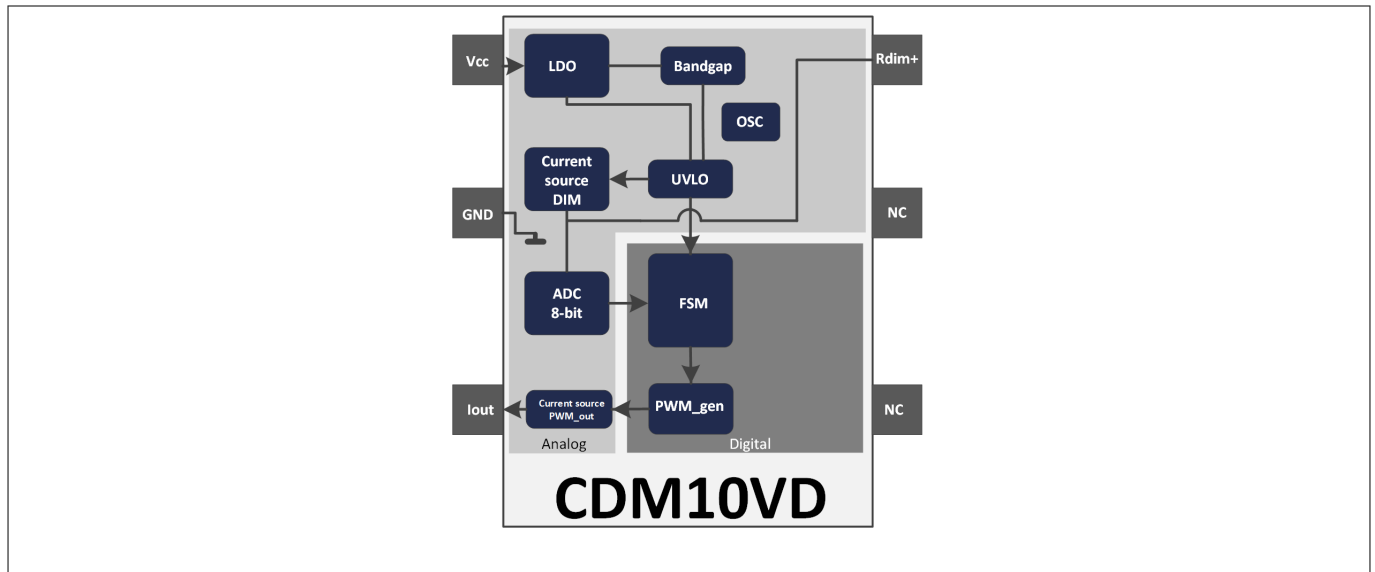
Embedded digital signal processing maintains minimum variations from device to device.

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**Block Diagram**

**1 Block Diagram**



**Figure 1** Block Diagram of the CDM10VD

**2 Pin Configuration**

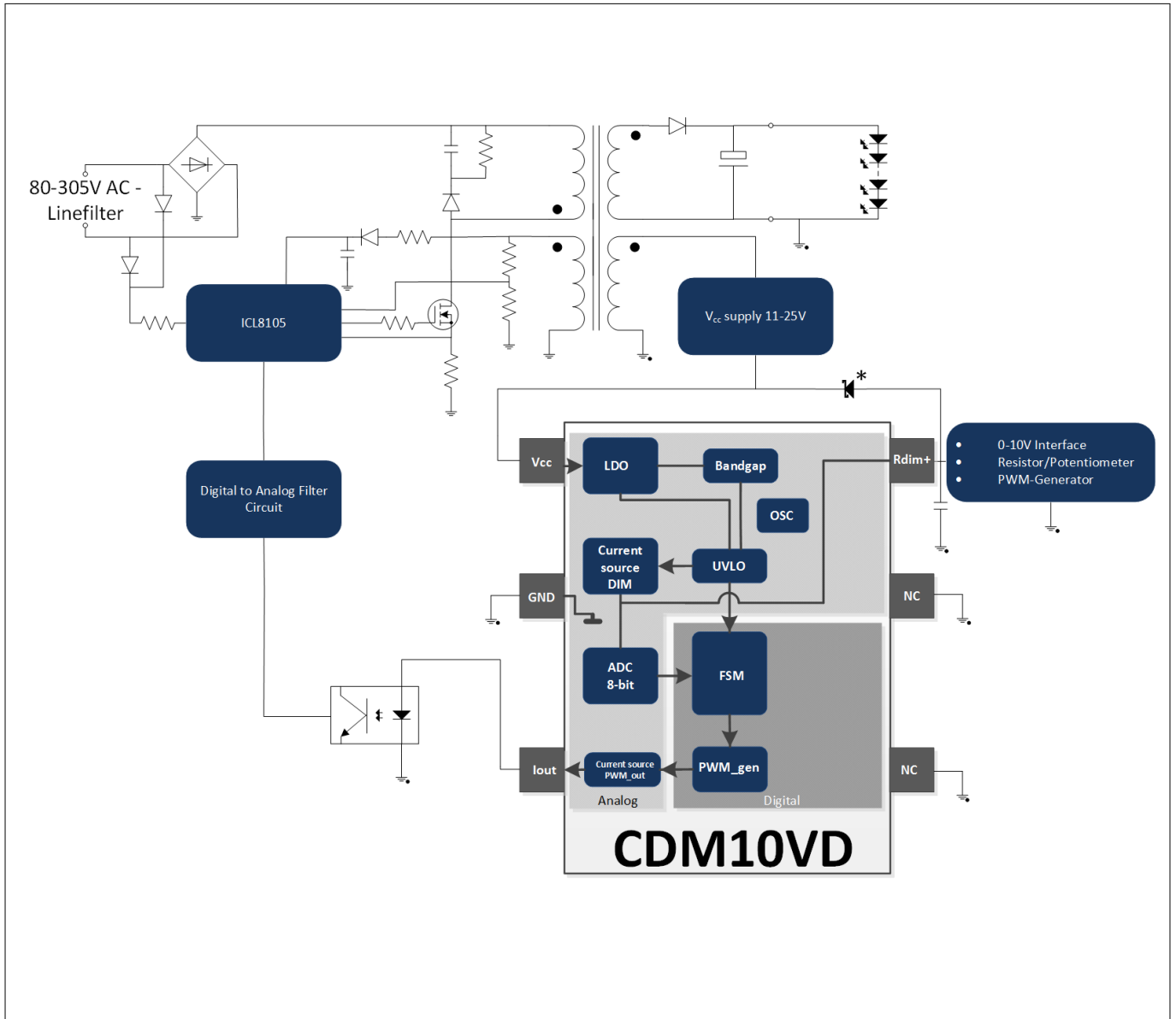
**Table 1** Pin configuration

Pin	Name	Function
1	V <sub>CC</sub>	Input supply voltage
2	GND	GND
3	I <sub>out</sub>	PWM output current
4	NC	GND
5	NC	GND
6	R <sub>dim+</sub>	Dimmer current output /Voltage sense

**Functional Description**

**3 Functional Description**

**Typical Application Circuit**



**Figure 2 Typical Application Circuit**

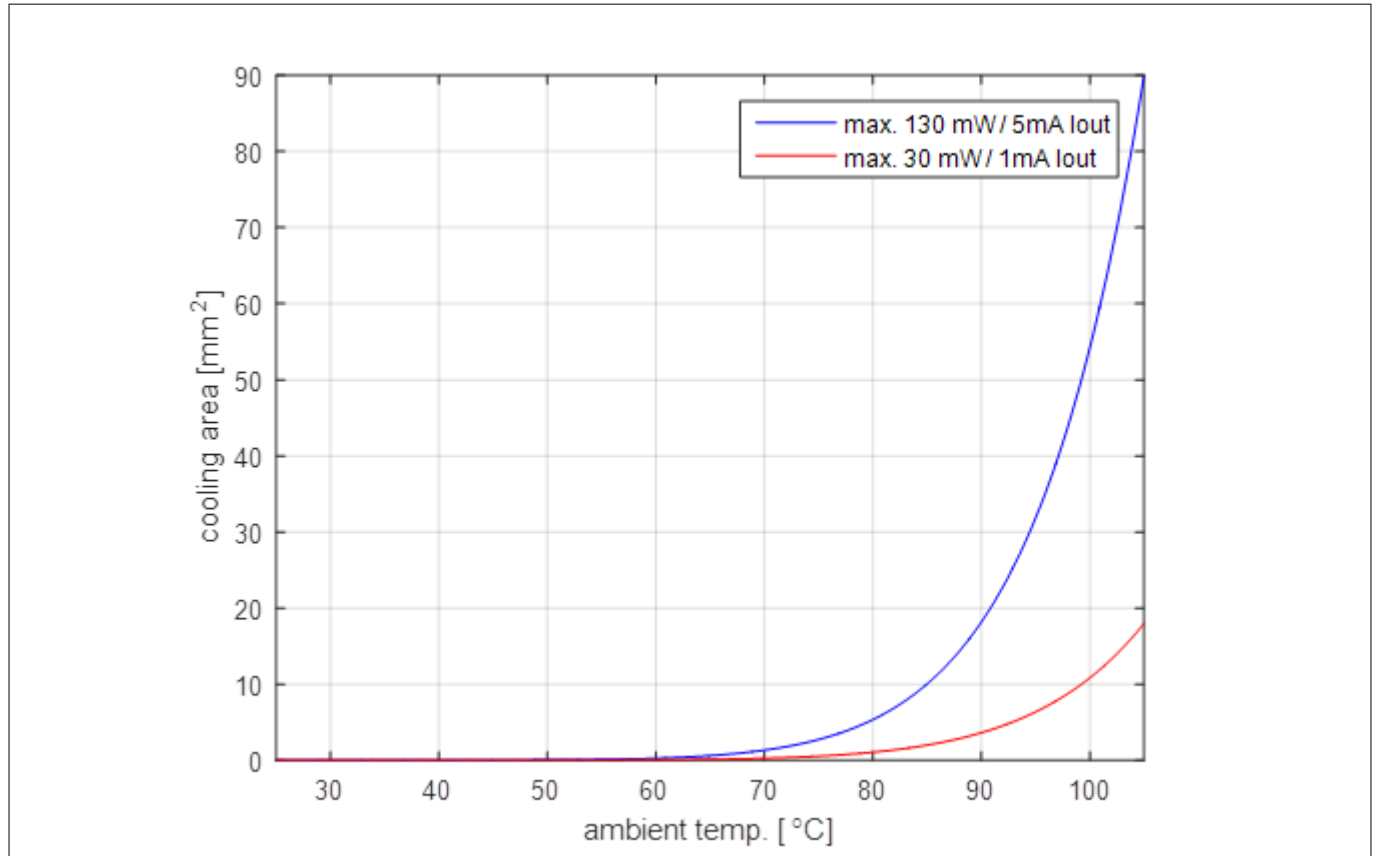
*Note:* The Diode marked with \* is for the protection of the  $R_{dim+}$ -Pin when active dimming is used. This is because the voltage on this Pin is not allowed to be higher than  $V_{CC}+0.5V$ . It is advised to use a low leakage, low reverse current Schottky-Diode in order to not influence the dimming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

**Functional Description**

**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](#).



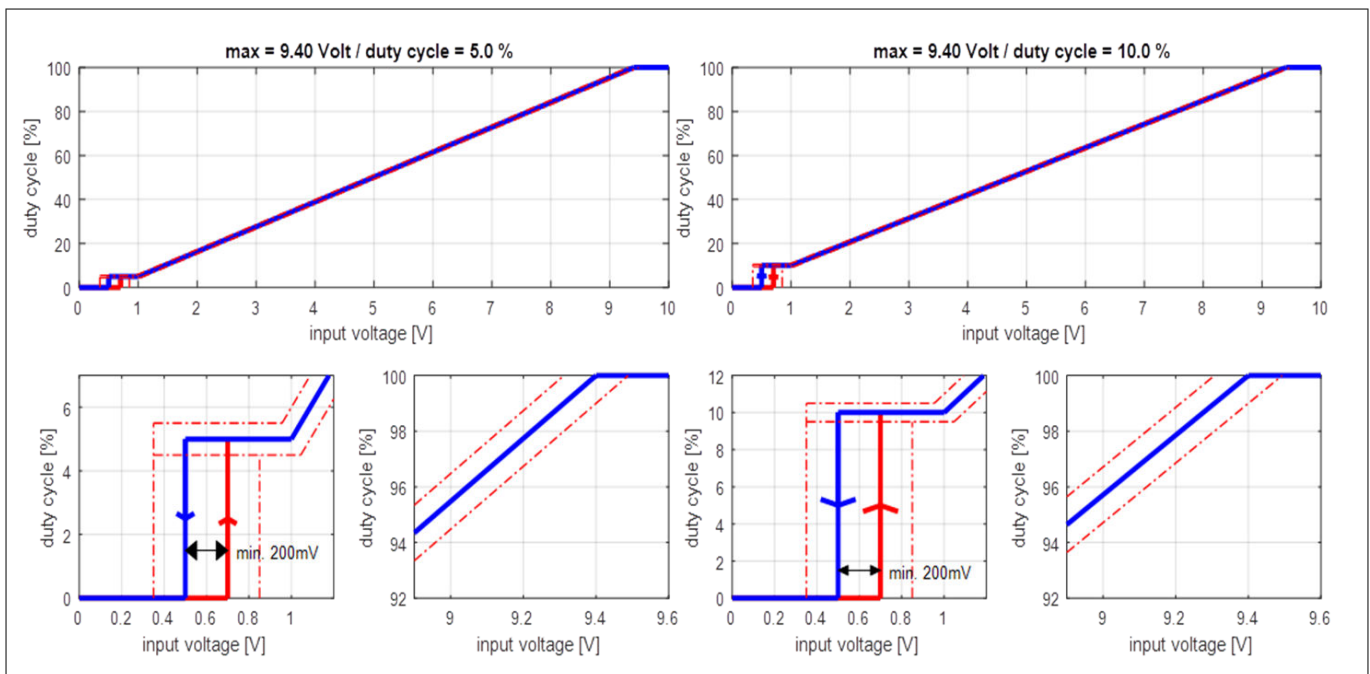
**Figure 3 Cooling area over ambient temperature CDM10VD**

**Functional Description**

**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

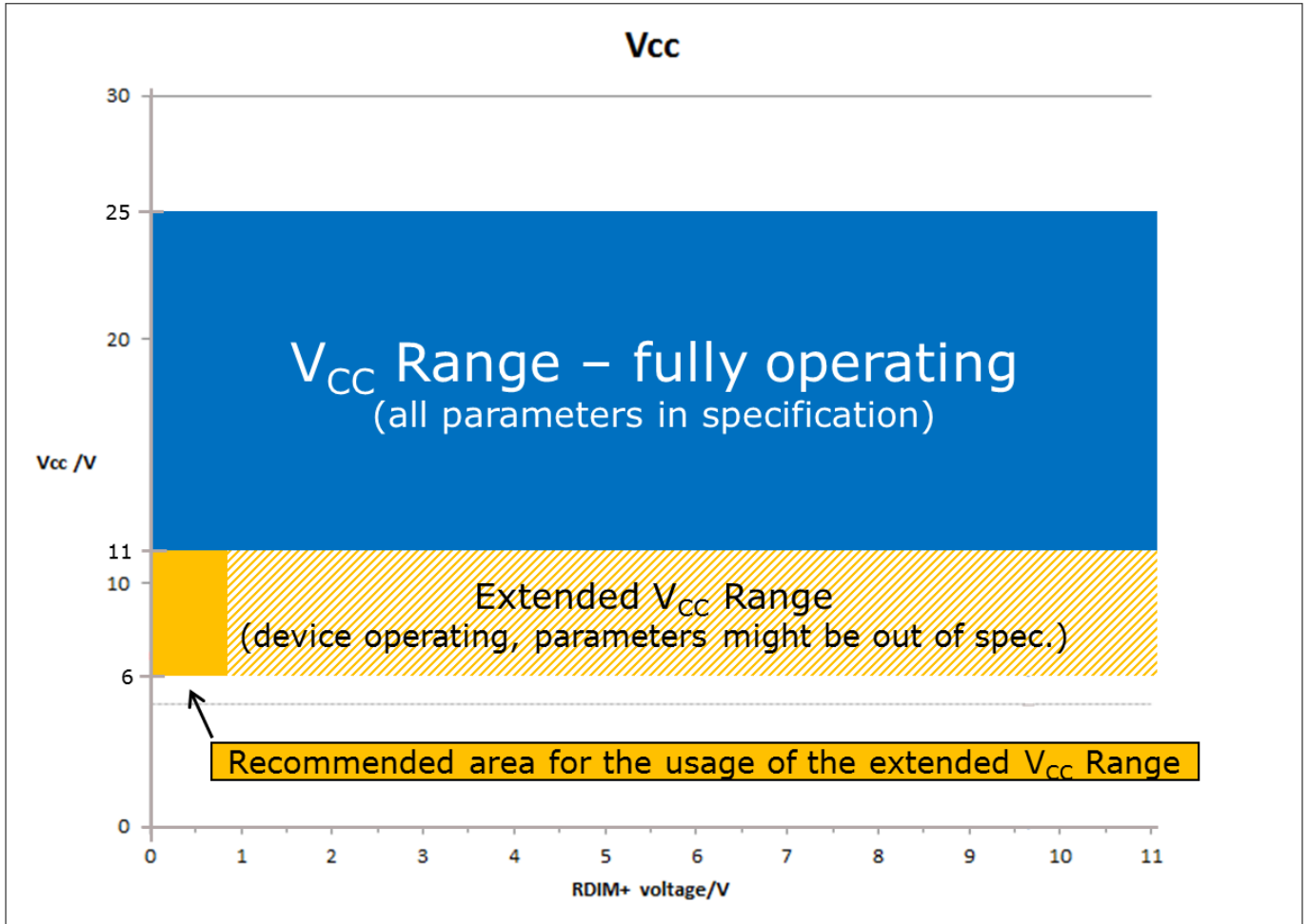
The CDM10VD device has two operating ranges, as seen in [Figure 5](#), in regards of the supply voltage  $V_{CC}$ . The following conditions must be taken into consideration:

- 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

**Functional Description**

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

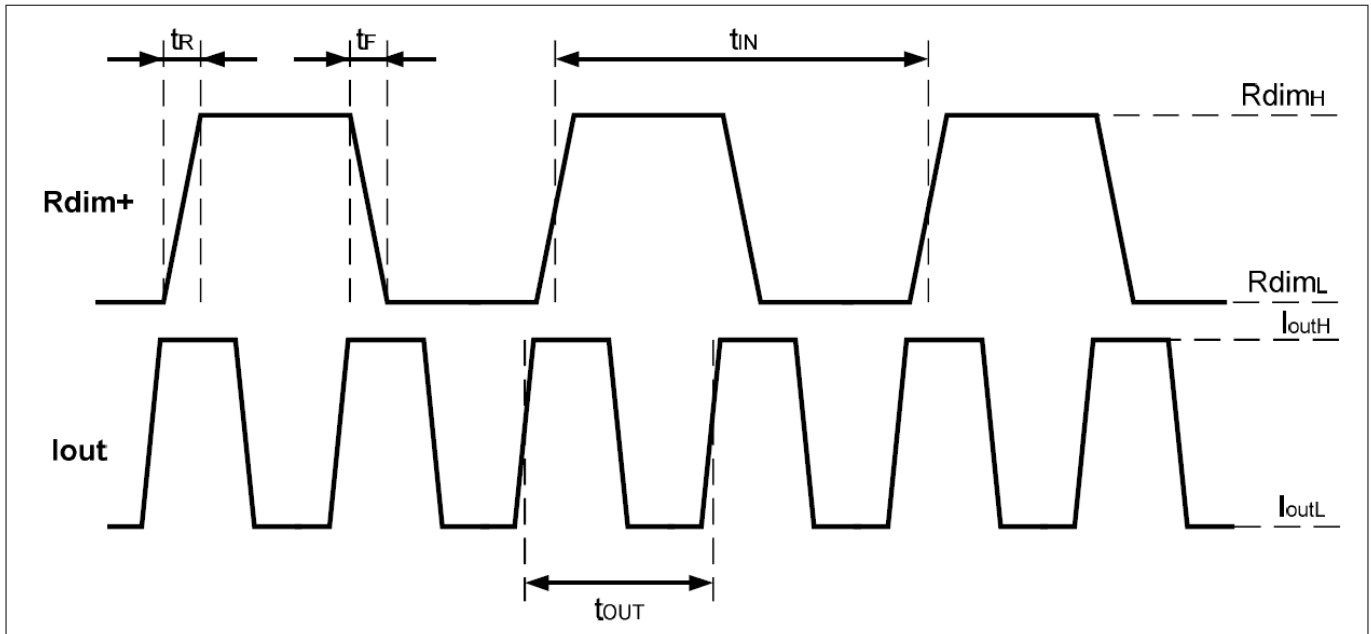


**Functional Description**

**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

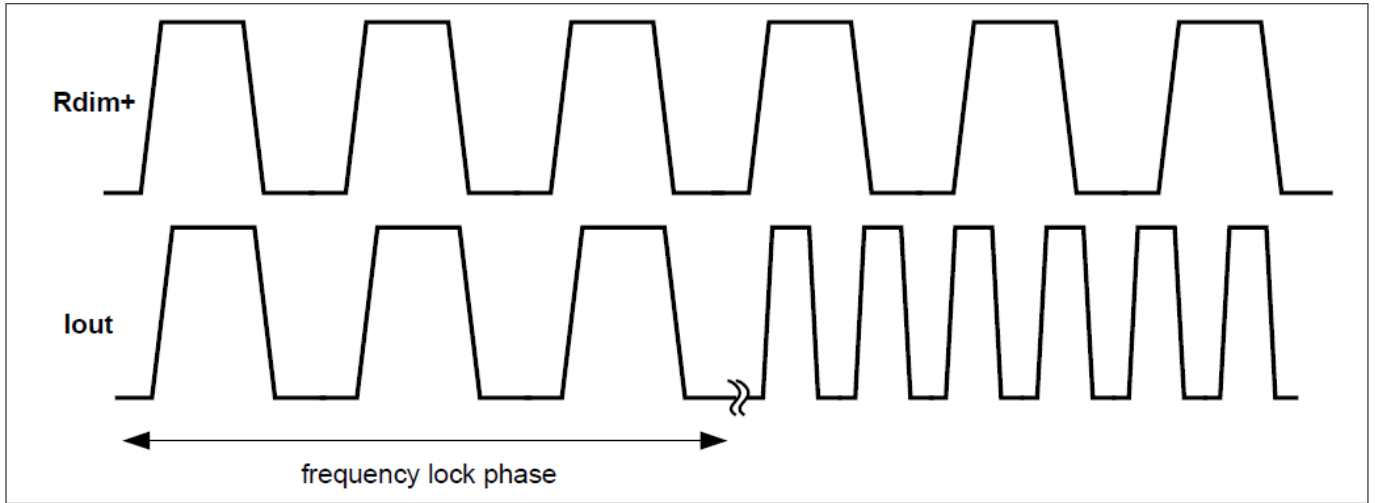
**Table 4** Conditions for the Variable Frequency PWM Input Mode

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		$R_{Iout} * I_{out}^1$	
$I_{outL}$	$I_{out}$ Low Value		0.0 V	
$t_{IN}$	Period input signal	0.33 ms	1.0 ms	10.0 ms
$t_{OUT}$	Period output signal	1.0 ms - 5 %	1.0 ms	1.0ms + 5 %
$t_R$	Rising edge time			1.8 $\mu$ s
$t_F$	Falling edge time			1.8 $\mu$ s

Note: <sup>1</sup>  $R_{Iout}$  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](#).

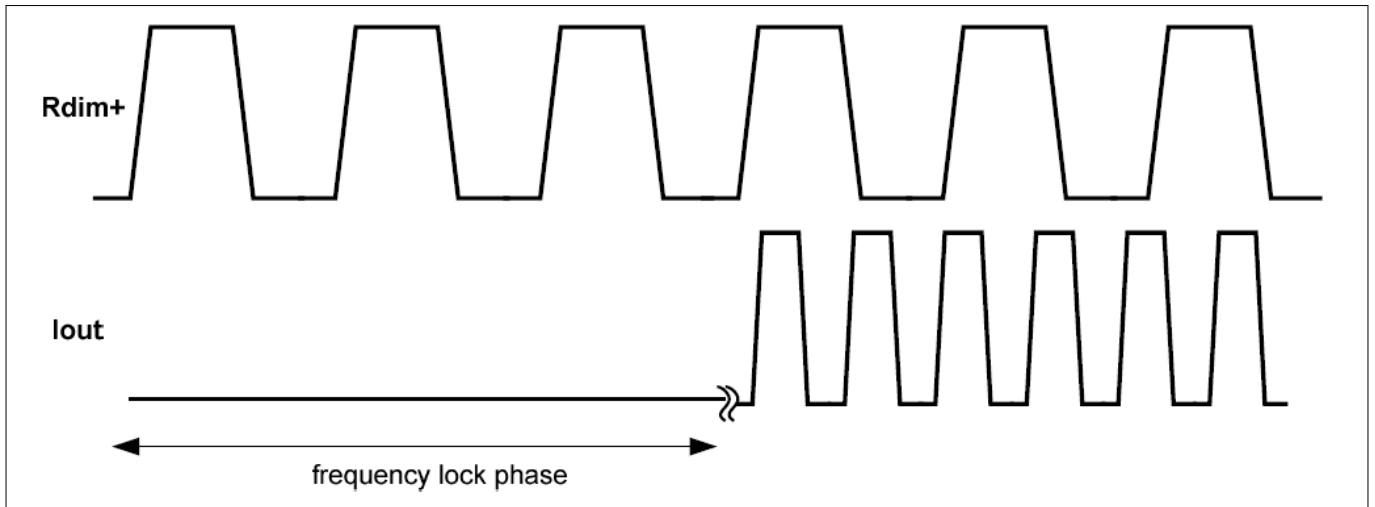
**Functional Description**



**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 CDM10VD 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**

**Electrical Characteristics and Parameters**

## 4 Electrical Characteristics and Parameters

**Table 5 Absolute Maximum Ratings**

Pin	Name	Values		Unit	Note or Test Condition
		Min.	Max.		
1	V <sub>CC</sub>	0	26	V	
2	GND	0	0	V	Point of reference
3	I <sub>out</sub>	-0.5	3.63	V	Depending on the optocoupler 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 <sub>dim+</sub>	-0.5	V <sub>CC</sub> + 0.5	V	An applied voltage above max value leads to the destruction of the device. Also valid if V <sub>CC</sub> 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 <sub>in</sub>	11		25	V	Operating Voltage
Extended Input Voltage	V <sub>ext</sub>	6		10.9	V	Parameters might be out of spec.
Junction Temperature Range	T <sub>J</sub>	-40		135	°C	
Ambient Temperature Range	T <sub>A</sub>	-40		105	°C	All limits guaranteed
Startup Ambient Temperature Range	T <sub>A</sub>	-55		105	°C	IC startup guaranteed
Current Consumption	I <sub>CC</sub>			1	mA	Current Consumption of the IC for self supply
Output Current for Dimmer	I <sub>dim</sub>	-5%	120	+5%	µA	Current flow out of R <sub>dim+</sub> -Pin
PWM frequency	f <sub>PWM</sub>	-5%	1000	+5%	Hz	
Dimming accuracy		-1		+1	%	With active dimming incl. all variations

**Electrical Characteristics and Parameters**

**Table 6 Electrical Characteristics (continued)**

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Wake-up Time	$t_w$			40	$\mu\text{s}$	Time from $V_{CC} = 6\text{ V}$ 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 83.2 @ 70% duty cycle 54 @ 50% duty cycle 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 83.2 @ 70% duty cycle 54 @ 50% duty cycle 30.4 @ 30% duty cycle	160 @ 100% PWM & 25 $V_{in}$	mW	Dimmer current included

**Electrical Characteristics and Parameters**

**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 21 @ 70% duty cycle 15 @ 50% duty cycle 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 21 @ 70% duty cycle 15 @ 50% duty cycle 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.

Package Dimensions

5 Package Dimensions

Package Drawings

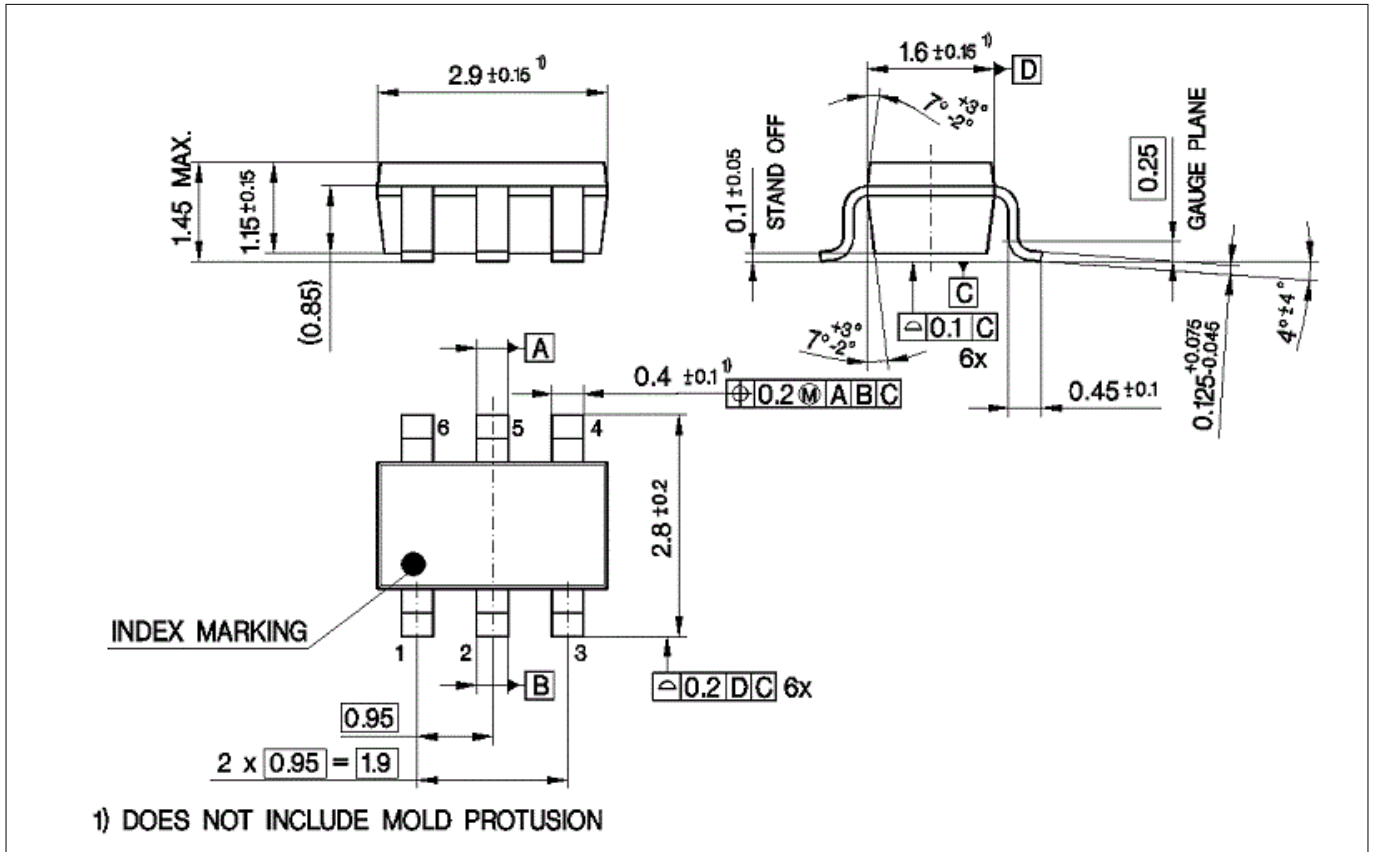
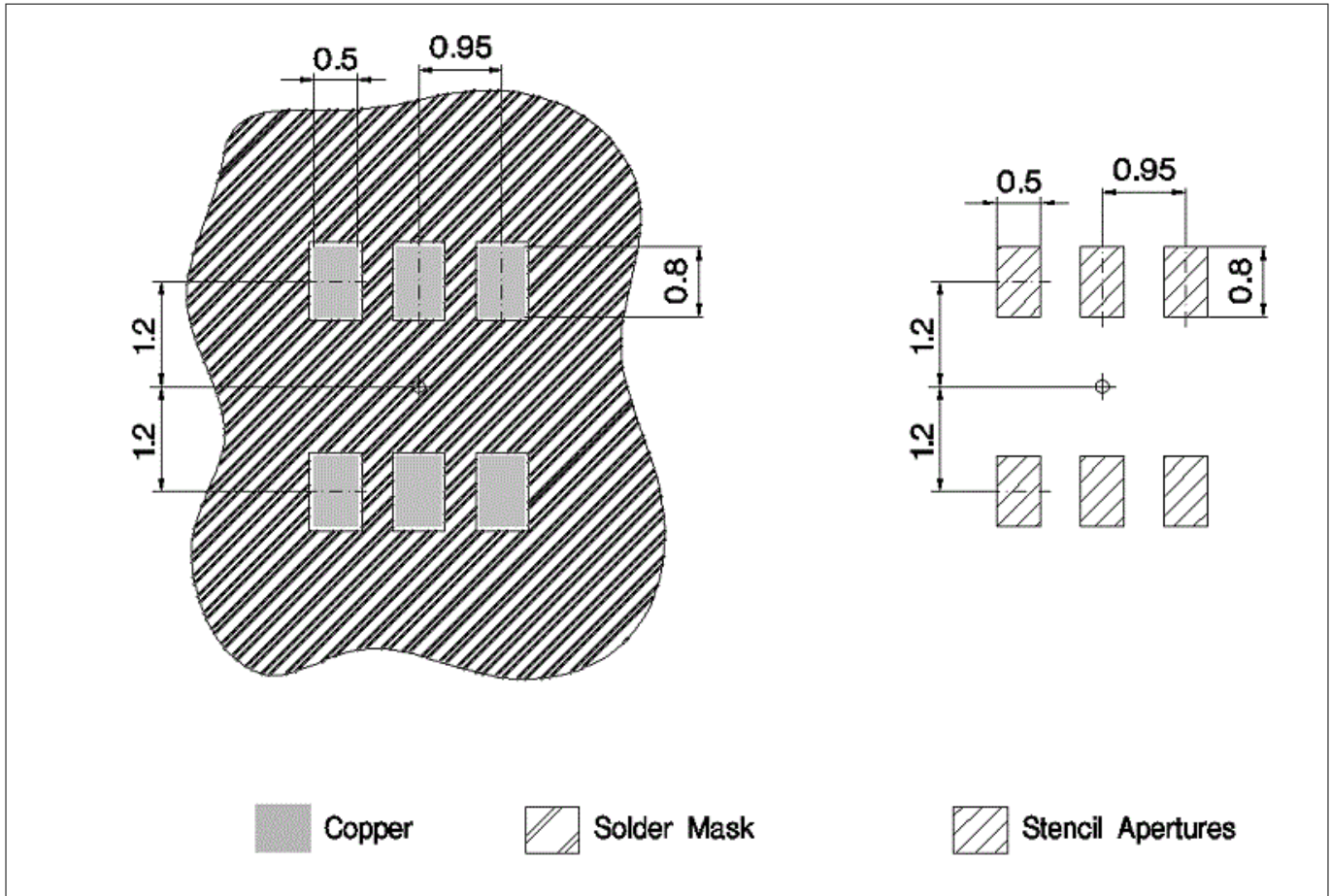


Figure 9 Package Drawings

**Package Dimensions**

**Footprint**

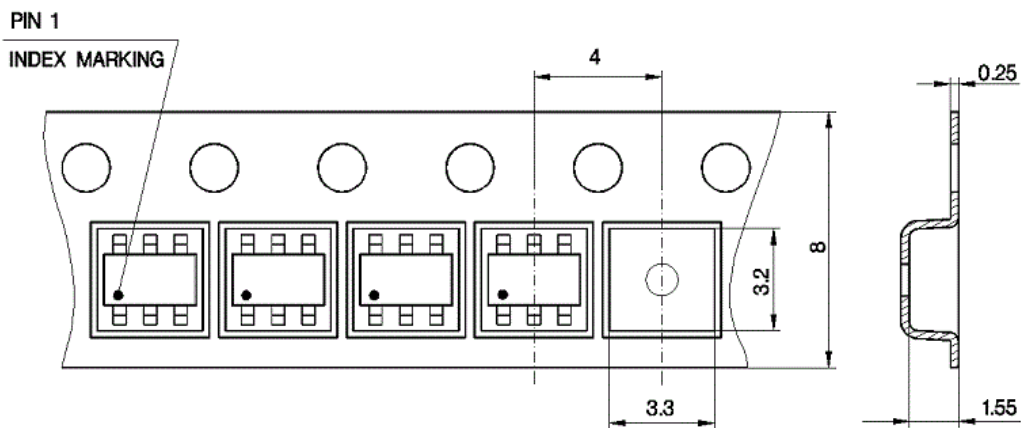


**Figure 10 Footprint**

**Packing Description**

**Packing Type**

Tape and Reel  
 Ø Reel: 180  
 Pieces / Reel: 3000  
 Reels / Box: 1



**Figure 11 Packing**

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**References**

## **6 References**

**Related information**

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

## **Revision History**

Major changes since previous revision

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**Revision History**

<b>Reference</b>	<b>Description</b>
v1.0	First release
v1.1	Corrected value for min power dissipation in table 10.