

## 2.5 A Output Current IGBT and MOSFET Driver



23052



### FEATURES

- 2.5 A minimum peak output current
- Rail-to-rail output stage
- 0.5  $\mu$ s maximum propagation delay time
- 35 kV/ $\mu$ s minimum common mode rejection (CMR) at  $V_{CM} = 1500$  V
- Wide operating  $V_{CC}$  range: 15 V to 30 V
- $I_{CC} = 3.5$  mA maximum supply current
- Industrial temperature range:  $-40$  °C to  $+105$  °C
- Under voltage lock-out (UVLO) with hysteresis
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### APPLICATIONS

- Isolated IGBT / MOSFET gate driver
- AC and brushless DC motor drives
- Induction stove top
- Industrial inverters
- Switch mode power supplies (SMPS)
- Uninterruptible power supplies (UPS)

### AGENCY APPROVALS

- [UL 1577](#)
- [cUL](#)
- [DIN EN 60747-5-5 \(VDE 0884\) and reinforced insulation rating available with option "V"](#)
- [CQC](#)

### DESIGN SUPPORT TOOLS

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### DESCRIPTION

The VOD3120A consists of a AlGaAs LED optically coupled to an integrated circuit with a power output stage. This optocoupler is ideally suited for driving power IGBTs and MOSFETs used in motor control inverter applications. The high operating voltage range of the output stage provides the drive voltages required by gate controlled devices. The voltage and current supplied by this optocoupler makes it ideally suited for directly driving IGBTs with ratings up to 1200 V / 100 A. For IGBTs with higher ratings, the VOD3120A can be used to drive a discrete power stage which drives the IGBT gate.

### ORDERING INFORMATION

|             |   |   |   |   |   |   |   |                |            |               |   |   |
|-------------|---|---|---|---|---|---|---|----------------|------------|---------------|---|---|
| V           | O | D | 3 | 1 | 2 | 0 | A | #              | -          | V             | T | # |
| PART NUMBER |   |   |   |   |   |   |   | PACKAGE OPTION | VDE OPTION | TAPE AND REEL |   |   |

| AGENCY CERTIFIED / PACKAGE | CMR (kV/ $\mu$ s) |
|----------------------------|-------------------|
| <b>UL, cUL, CQC</b>        | <b>35</b>         |
| DIP-8                      | VOD3120AD         |
| DIP-8, 400 mil             | VOD3120AG         |
| SMD-8                      | VOD3120AB-T       |
| SMD-8, 180° orientation    | VOD3120AB-T2      |
| <b>VDE, UL, cUL, CQC</b>   | <b>35</b>         |
| DIP-8                      | VOD3120AD-V       |
| DIP-8, 400 mil             | VOD3120AG-V       |
| SMD-8                      | VOD3120AB-VT      |
| SMD-8, 180° orientation    | VOD3120AB-VT2     |



| <b>TRUTH TABLE</b> |                  |                 |                      |
|--------------------|------------------|-----------------|----------------------|
| <b>LED</b>         | <b>HIGH SIDE</b> | <b>LOW SIDE</b> | <b>V<sub>O</sub></b> |
| Off                | Off              | On              | Low                  |
| On                 | On               | Off             | High                 |

| <b>ABSOLUTE MAXIMUM RATINGS</b> (T <sub>amb</sub> = 25 °C, unless otherwise specified) |                             |   |              |             |
|--|-----------------------------|---|--------------|-------------|
| <b>PARAMETER</b>   | <b>TEST CONDITION</b>       | <b>SYMBOL</b>                           | <b>VALUE</b> | <b>UNIT</b> |
| <b>INPUT</b>   |                             |   |              |             |
| Forward current  |                             | I <sub>F</sub>                          | 20           | mA          |
| Peak transient input current   | ≤ 1 μs pulse width, 300 pps | I <sub>F(TRAN)</sub>                    | 1            | A           |
| Reverse input voltage  |                             | V <sub>R</sub>                          | 5            | V           |
| Input current (rise / fall time) <sup>(1)</sup>  |                             | t <sub>r(in)</sub> / t <sub>f(in)</sub> | 500          | ns          |
| Output power dissipation   |                             | P <sub>diss</sub>                       | 45           | mW          |
| <b>OUTPUT</b>  |                             |   |              |             |
| High peak output current <sup>(2)</sup>  |                             | I <sub>OH(PEAK)</sub>                   | 2.5          | A           |
| Low peak output current <sup>(2)</sup>   |                             | I <sub>OL(PEAK)</sub>                   | 2.5          | A           |
| Supply voltage   |                             | (V <sub>CC</sub> - V <sub>EE</sub> )    | 0 to +35     | V           |
| Output voltage   |                             | V <sub>O(PEAK)</sub>                    | 35           | V           |
| Output power dissipation   |                             | P <sub>diss</sub>                       | 250          | mW          |
| Junction temperature   |                             | T <sub>j</sub>                          | 125          | °C          |
| <b>OPTOCOUPLER</b>   |                             |   |              |             |
| Storage temperature range  |                             | T <sub>S</sub>                          | -55 to +125  | °C          |
| Ambient operating temperature range  |                             | T <sub>amb</sub>                        | -40 to +105  | °C          |
| Total power dissipation  |                             | P <sub>tot</sub>                        | 295          | mW          |
| Soldering temperature  |                             | T <sub>sld</sub>                        | 260          | °C          |

**Notes**

- Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of this document. Exposure to absolute maximum ratings for extended periods of the time can adversely affect reliability

<sup>(1)</sup> The rise and fall times of the forward current should be less than 500 ns

<sup>(2)</sup> Exponential waveform, pulse width ≤ 0.3 μs, f ≤ 15 kHz

| <b>RECOMMENDED OPERATING CONDITION</b>           |                                   |             |             |             |
|--|-----------------------------------|-------------|-------------|-------------|
| <b>PARAMETER</b>                                 | <b>SYMBOL</b>                     | <b>MIN.</b> | <b>MAX.</b> | <b>UNIT</b> |
| Operating temperature                            | T <sub>amb</sub>                  | -40         | +105        | °C          |
| Power supply voltage                             | V <sub>CC</sub> - V <sub>EE</sub> | 15          | 30          | V           |
| Forward current (V <sub>O</sub> in "high" state) | I <sub>F(ON)</sub>                | 7           | 16          | mA          |
| Forward voltage (V <sub>O</sub> in "low" state)  | V <sub>F(OFF)</sub>               | 0           | 0.8         | V           |

| <b>ELECTRICAL CHARACTERISTICS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified) |   |                         |                         |                         |                          |                        |
|--|---|-------------------------|-------------------------|-------------------------|--------------------------|------------------------|
| PARAMETER  | TEST CONDITION  | SYMBOL                  | MIN.                    | TYP.                    | MAX.                     | UNIT                   |
| <b>INPUT</b>   |   |                         |                         |                         |                          |                        |
| Forward voltage  | $I_F = 10\text{ mA}$  | $V_F$                   | 1.2                     | 1.37                    | 1.8                      | V                      |
| Temperature coefficient of forward voltage   | $I_F = 10\text{ mA}$  | $\Delta V_F / \Delta T$ | -                       | -1.237                  | -                        | mV/ $^{\circ}\text{C}$ |
| Reverse breakdown voltage  | $I_R = 10\text{ }\mu\text{A}$                                       | $BV_R$                  | 5                       | -                       | -                        | V                      |
| Threshold forward current ( $V_O$ from "low" to "high")  | $V_{CC} = 30\text{ V}$ , $V_O < 5\text{ V}$                         | $I_{FLH}$               | -                       | 1.8                     | 5                        | mA                     |
| Threshold forward voltage ( $V_O$ from "high" to "low")  | $V_{CC} = 30\text{ V}$ , $V_O > 5\text{ V}$                         | $V_{FLH}$               | 0.8                     | -                       | -                        | V                      |
| Input capacitance  | $f = 1\text{ MHz}$ , $V_F = 0\text{ V}$                             | $C_{IN}$                | -                       | 33                      | -                        | pF                     |
| <b>OUTPUT</b>  |   |                         |                         |                         |                          |                        |
| High level supply current  | $I_F = 10\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $V_O = \text{open}$ | $I_{CCH}$               | -                       | 2.4                     | 3.5                      | mA                     |
| Low level supply current   | $I_F = 0\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $V_O = \text{open}$  | $I_{CCL}$               | -                       | 2.5                     | 3.5                      | mA                     |
| High level output current  | $V_O = (V_{CC} - 1.5\text{ V})$                                     | $I_{OH}^{(1)}$          | -                       | -                       | -1.0                     | A                      |
|  | $V_O = (V_{CC} - 4\text{ V})$                                       | $I_{OH}^{(2)}$          | -                       | -                       | -2.5                     | A                      |
| Low level output current   | $V_O = (V_{EE} + 1.5\text{ V})$                                     | $I_{OL}^{(1)}$          | 1.0                     | -                       | -                        | A                      |
|  | $V_O = (V_{EE} + 4\text{ V})$                                       | $I_{OL}^{(2)}$          | 2.5                     | -                       | -                        | A                      |
| High level output voltage  | $I_F = 10\text{ mA}$ , $I_O = -100\text{ mA}$                       | $V_{OH}$                | $V_{CC} - 0.3\text{ V}$ | $V_{CC} - 0.1\text{ V}$ | -                        | V                      |
| Low level output voltage   | $I_F = 0\text{ mA}$ , $I_O = 100\text{ mA}$                         | $V_{OL}$                | -                       | $V_{EE} + 0.1\text{ V}$ | $V_{EE} + 0.25\text{ V}$ | V                      |
| UVLO threshold   | $V_O > 5\text{ V}$ , $I_F = 10\text{ mA}$                           | $V_{UVLO+}$             | 11.0                    | 12.7                    | 13.5                     | V                      |
|  | $V_O < 5\text{ V}$ , $I_F = 10\text{ mA}$                           | $V_{UVLO-}$             | 9.5                     | 11.2                    | 12.0                     | V                      |
| UVLO hysteresis  |   | $UVLO_{HYS}$            | -                       | 1.5                     | -                        | V                      |
| <b>COUPLER</b>   |   |                         |                         |                         |                          |                        |
| Coupling capacitance   | $f = 1\text{ MHz}$  | $C_{IO}$                | -                       | 0.92                    | -                        | pF                     |

**Notes**

- All typical values at  $T_{amb} = 25^{\circ}\text{C}$  and  $V_{CC} - V_{EE} = 30\text{ V}$ , unless otherwise specified; all minimum and maximum specifications are at recommended operating condition
- (1) Maximum pulse width = 50  $\mu\text{s}$
- (2) Maximum pulse width = 10  $\mu\text{s}$

**TEST CIRCUITS**

 Fig. 1 -  $I_{FLH}$  Test Circuit


Fig. 2 - UVLO Test Circuit

| <b>SWITCHING CHARACTERISTICS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , $V_{CC} - V_{EE} = 30\text{ V}$ unless otherwise specified) |  |           |      |       |      |               |
|---|--|-----------|------|-------|------|---------------|
| PARAMETER   | TEST CONDITION   | SYMBOL    | MIN. | TYP.  | MAX. | UNIT          |
| Propagation delay time to $V_O = \text{"low"}$  | $R_g = 10\text{ }\Omega$ , $C_g = 25\text{ nF}$ ,<br>$f = 10\text{ kHz}$ , duty cycle = 50 %, $I_F = 7\text{ mA to }16\text{ mA}$ ,<br>$V_{CC} = 10\text{ V to }30\text{ V}$ ,<br>$V_{EE} = \text{ground}$ | $t_{PHL}$ | 0.05 | 0.13  | 0.5  | $\mu\text{s}$ |
| Propagation delay time to $V_O = \text{"high"}$   |  | $t_{PLH}$ | 0.05 | 0.13  | 0.5  | $\mu\text{s}$ |
| Pulse width distortion  |  | PWD       | -    | 0.005 | 0.07 | $\mu\text{s}$ |
| Propagation delay difference <sup>(1)</sup>   |  | PDD       | -0.1 | -     | 0.1  | $\mu\text{s}$ |
| Output rise time (10 % to 90 %)   |  | $t_r$     | -    | 0.035 | -    | $\mu\text{s}$ |
| Output fall time (90 % to 10 %)   |  | $t_f$     | -    | 0.035 | -    | $\mu\text{s}$ |

**Note**

<sup>(1)</sup> The difference between  $t_{PHL}$  and  $t_{PLH}$  between any two parts, series parts, or channels under same test conditions


 Fig. 3 -  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_r$  and  $t_f$  Test Circuit and Waveforms

| <b>COMMON MODE TRANSIENT IMMUNITY</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , $V_{CC} - V_{EE} = 30\text{ V}$ unless otherwise specified) |   |          |      |      |      |                         |
|--|---|----------|------|------|------|-------------------------|
| PARAMETER  | TEST CONDITION  | SYMBOL   | MIN. | TYP. | MAX. | UNIT                    |
| Common mode transient immunity at high level output ( $V_O = \text{"high"}$ ) <sup>(1)</sup>   | $I_F = 10\text{ mA to }16\text{ mA}$ ,<br>$V_{CM} = 1500\text{ V}$ , $V_{CC} = 30\text{ V}$ | $ CM_H $ | 35   | 50   | -    | $\text{kV}/\mu\text{s}$ |
| Common mode transient immunity at low level output ( $V_O = \text{"low"}$ ) <sup>(2)</sup>   | $V_F = 0\text{ V}$ , $V_{CM} = 1500\text{ V}$ ,<br>$V_{CC} = 30\text{ V}$                   | $ CM_L $ | 35   | 50   | -    | $\text{kV}/\mu\text{s}$ |

**Notes**

<sup>(1)</sup>  $CM_H$  is the maximum rate of rise of the common mode voltage that can be sustained with the output voltage in the logic high state ( $V_O > 15\text{ V}$ )

<sup>(2)</sup>  $CM_L$  is the maximum rate of fall of the common mode voltage that can be sustained with the output voltage in the logic low state ( $V_O < 1\text{ V}$ )



Fig. 4 - CMR Test Circuit and Waveforms



| SAFETY AND INSULATION RATINGS ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified) |   |            |           |                    |
|--|---|------------|-----------|--------------------|
| PARAMETER  | TEST CONDITION  | SYMBOL     | VALUE     | UNIT               |
| Comparative tracking index   | Insulation group IIIa   | CTI        | 175       |                    |
| Maximum rated withstanding isolation voltage   | According to UL1577, $t = 1\text{ min}$                           | $V_{ISO}$  | 5300      | $V_{RMS}$          |
| Maximum transient isolation voltage  | According to DIN EN 60747-5-5                                     | $V_{IOTM}$ | 6000      | $V_{peak}$         |
| Maximum repetitive peak isolation voltage  | According to DIN EN 60747-5-5                                     | $V_{IORM}$ | 891       | $V_{peak}$         |
| Isolation resistance   | $T_{amb} = 25\text{ }^{\circ}\text{C}$ , $V_{IO} = 500\text{ V}$  | $R_{IO}$   | $10^{12}$ | $\Omega$           |
|  | $T_{amb} = 100\text{ }^{\circ}\text{C}$ , $V_{IO} = 500\text{ V}$ | $R_{IO}$   | $10^{11}$ | $\Omega$           |
| Output safety power  |   | $P_{SO}$   | 250       | mW                 |
| Input safety current   |   | $I_{SI}$   | 25        | mA                 |
| Input safety temperature   |   | $T_S$      | 175       | $^{\circ}\text{C}$ |
| Creepage distance  |   |            | > 7       | mm                 |
| Clearance distance   |   |            | > 7       | mm                 |
| Insulation thickness   |   | DTI        | > 0.4     | mm                 |

**Note**

- As per IEC 60747-5-2, §7.4.3.8.1, this optocoupler is reinforced rated and suitable for “safe electrical insulation” only within the safety ratings. Compliance with the safety ratings shall be ensured by means of protective circuits

**TYPICAL CHARACTERISTICS** ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)



Fig. 5 - Forward Current vs. Forward Voltage



Fig. 7 - Threshold Current vs. Ambient Temperature



Fig. 6 - Output Voltage vs. Forward Current



Fig. 8 - High Level Output Voltage vs. Ambient Temperature

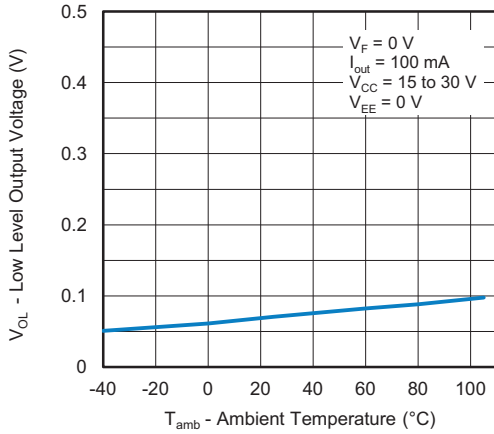


Fig. 9 - Low Level Output Voltage vs. Ambient Temperature

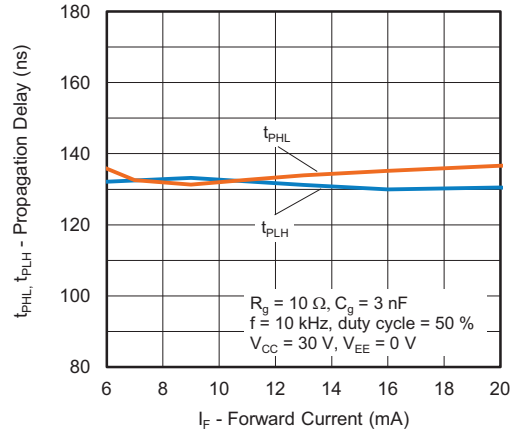


Fig. 12 - Propagation Delay vs. Forward Current

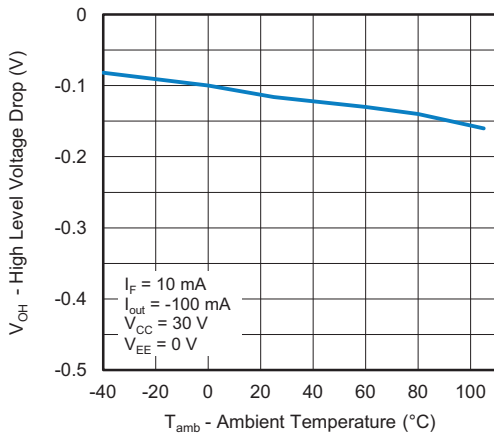


Fig. 10 - High Level Voltage Drop vs. Ambient Temperature

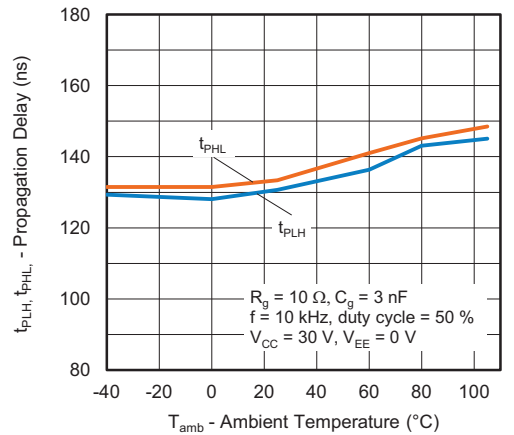


Fig. 13 - Propagation Delay vs. Ambient Temperature



Fig. 11 - Low Level Voltage Drop vs. Ambient Temperature

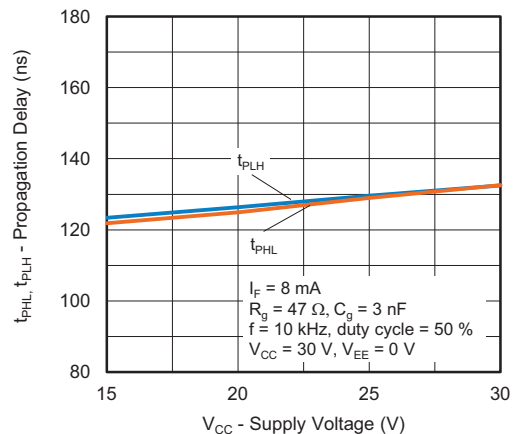


Fig. 14 - Propagation Delay vs. Supply Voltage



Fig. 15 - Propagation Delay vs. Load Resistance

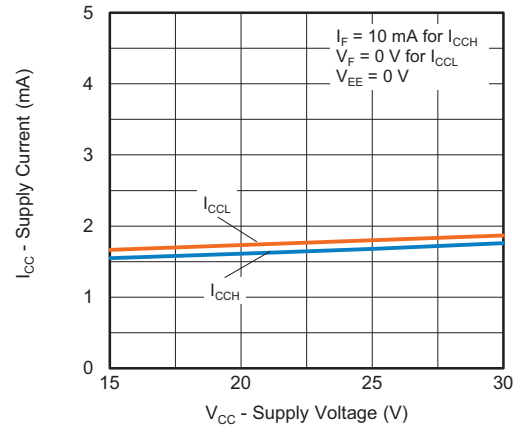


Fig. 17 - Supply Current vs. Supply Voltage

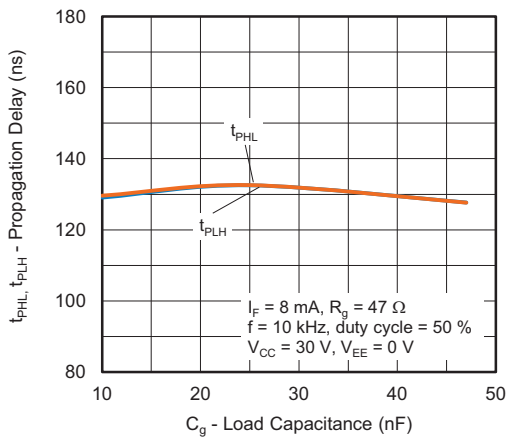


Fig. 16 - Propagation Delay vs. Load Capacitance



Fig. 18 - Supply Current vs. Ambient Temperature



## PACKAGE DIMENSIONS (in millimeters)

### DIP-8



Fig. 19

### DIP-8, 400 mil



Fig. 20



SMD-8

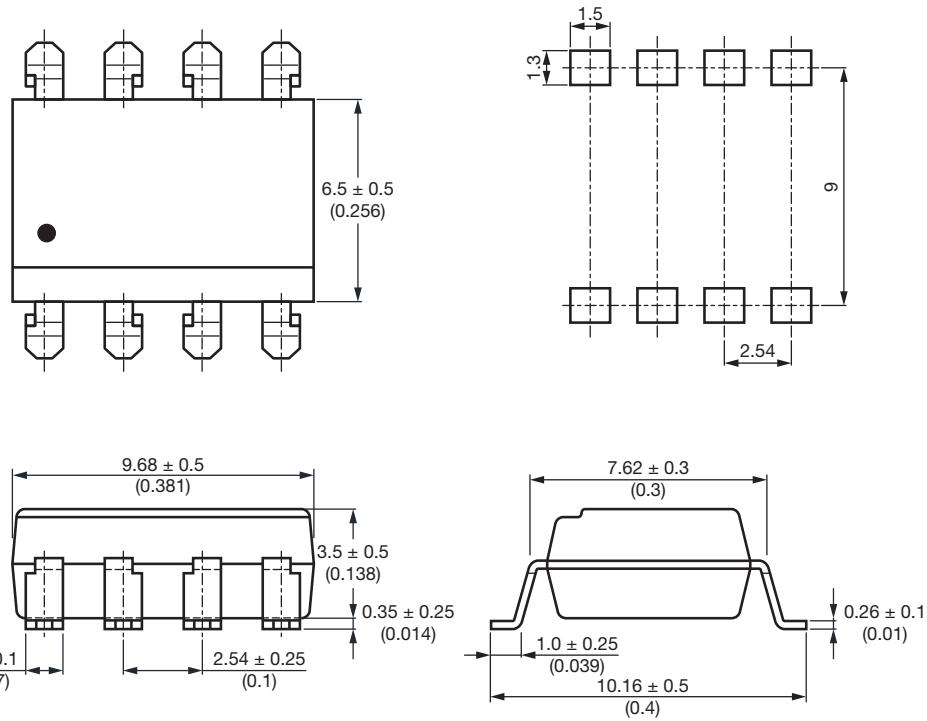


Fig. 21

## PACKAGE MARKING



Fig. 22 - Example of VOD3120AB-VT

### Notes

- "X" is only marked on VDE option parts
- Tape and reel suffix (T) is not part of the package marking



## PACKAGING INFORMATION (in millimeters)

| DEVICES PER TUBES |            |           |           |
|-------------------|------------|-----------|-----------|
| TYPE              | UNITS/TUBE | TUBES/BOX | UNITS/BOX |
| DIP-8             | 50         | 40        | 4         |
| DIP-8, 400 mil    | 50         | 40        | 4         |

### SMD-8 Tape



Fig. 23 - Tape and Reel Packaging (1000 pieces on reel)

### SMD-8 Tape, 180° Orientation



Fig. 24 - Tape and Reel Packaging (1000 pieces on reel)



## Reel

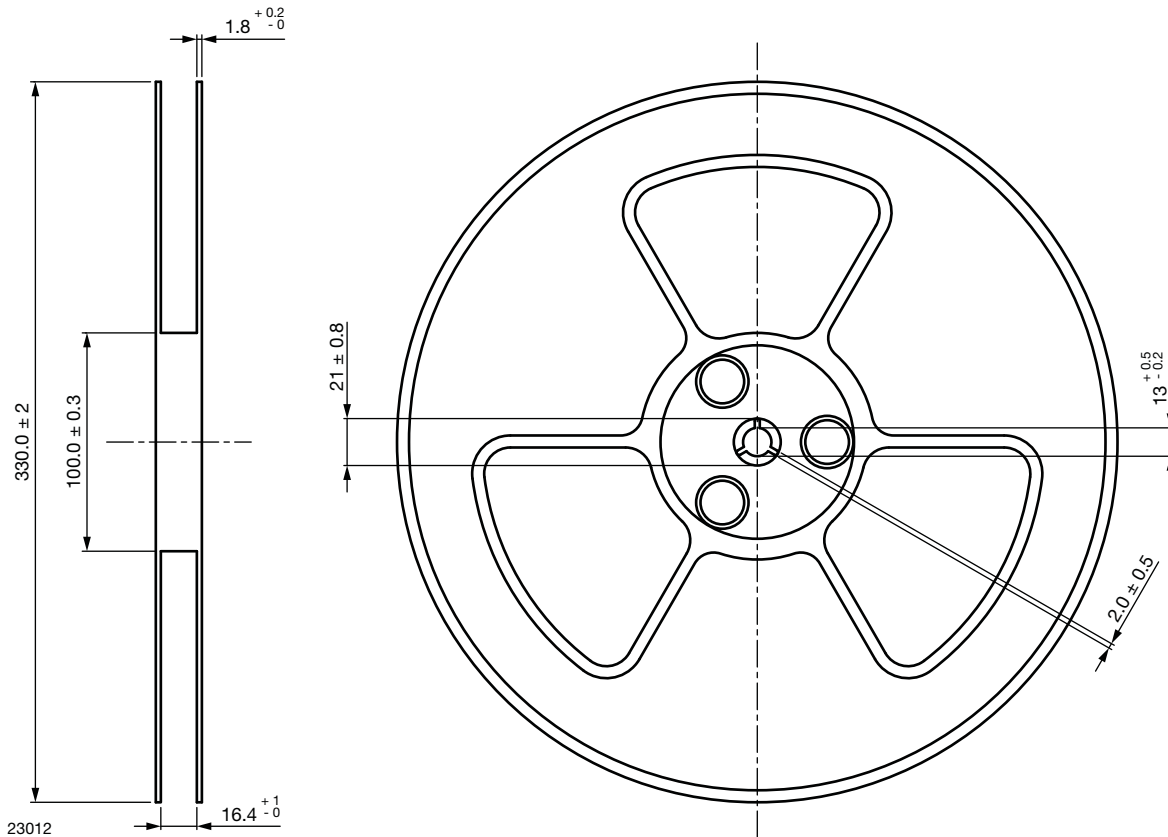


Fig. 25 - Tape and Reel Shipping Medium

**SOLDER PROFILES**
**IR Reflow Soldering (JEDEC® J-STD-020C compliant)**

One time soldering reflow is recommended within the condition of temperature and time profile shown below. Do not solder more than three times.

| PROFILE ITEM                                   | CONDITIONS       |
|--|------------------|
| Preheat  |                  |
| - Temperature minimum ( $T_{S \text{ min.}}$ ) | 150 °C           |
| - Temperature maximum ( $T_{S \text{ max.}}$ ) | 200 °C           |
| - Time (min. to max.) ( $t_S$ )                | 90 s ± 30 s      |
| Soldering zone                                 |                  |
| - Temperature ( $T_L$ )                        | 217 °C           |
| - Time ( $t_L$ )                               | 60 s             |
| Peak temperature ( $T_p$ )                     | 260 °C           |
| Ramp-up rate                                   | 3 °C/s max.      |
| Ramp-down rate                                 | 3 °C/s to 6 °C/s |



Fig. 1

**Wave Soldering (JEDEC JESD22-A111 compliant)**

One time soldering is recommended within the condition of temperature.

Temperature: 260 °C + 0 °C / - 5 °C

Time: 10 s

Preheat temperature: 25 °C to 140 °C

Preheat time: 30 s to 80 s



Fig. 2

23017

**Hand Soldering by Soldering Iron**

Allow single lead soldering in every single process. One time soldering is recommended.

Temperature: 380 °C + 0 °C / - 5 °C

Time: 3 s max.

**HANDLING AND STORAGE CONDITIONS**

ESD level: HBM class 2

Floor life: unlimited

Conditions:  $T_{\text{amb}} < 30 \text{ °C}$ , RH < 85 %

Moisture sensitivity level 1, according to J-STD-020



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### Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: [info@moschip.ru](mailto:info@moschip.ru)

Skype отдела продаж:

moschip.ru

moschip.ru\_4

moschip.ru\_6

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