

## 2.5 A Output Current IGBT and MOSFET Driver



19813



20530\_1



### FEATURES

- 2.5 A minimum peak output current
- 25 kV/ $\mu$ s minimum common mode rejection (CMR) at  $V_{CM} = 1500$  V
- $I_{CC} = 2.5$  mA maximum supply current
- Under voltage lock-out (UVLO) with hysteresis
- Wide operating  $V_{CC}$  range: 15 V to 32 V
- 0.2  $\mu$ s maximum pulse width distortion
- Industrial temperature range: - 40 °C to 110 °C
- 0.5 V maximum low level output voltage ( $V_{OL}$ )
- Reinforced insulation rated per DIN EN 60747-5-2
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### DESCRIPTION

The VO3120 consists of a 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 800 V/50 A. For IGBTs with higher ratings, the VO3120 can be used to drive a discrete power stage which drives the IGBT gate.

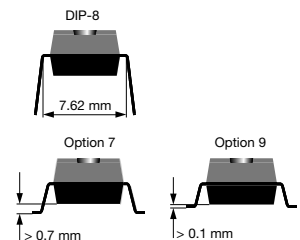
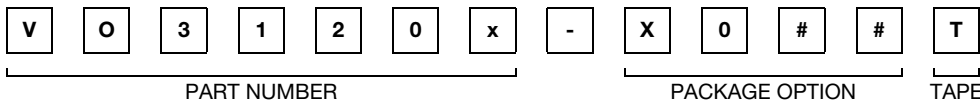
### APPLICATIONS

- 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 - file no. E52744 system code H, double protection
- cUL - file no. E52744, equivalent to CSA bulletin 5A
- DIN EN 60747-5-2 (VDE 0884) and reinforced insulation rating available with option 1

### ORDERING INFORMATION



PACKAGE	UL, cUL	UL, cUL, VDE
DIP-8, tubes	VO3120	VO3120-X001
SMD-8, option 7, tape and reel	VO3120-X007T	-
SMD-8, option 9, tape and reel	-	VO3120-X019T

**TRUTH TABLE**

LED	$V_{CC} - V_{EE}$ "POSITIVE GOING" (TURN ON)	$V_{CC} - V_{EE}$ "NEGATIVE GOING" (TURN OFF)	$V_o$
Off	0 V to 32 V	0 V to 32 V	Low
On	0 V to 11 V	0 V to 9.5 V	Low
On	11 V to 13.5 V	9.5 V to 12 V	Transition
On	13.5 V to 32 V	12 V to 32 V	High

**ABSOLUTE MAXIMUM RATINGS** ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

PARAMETER	TEST CONDITION	SYMBOL	VALUE	UNIT
<b>INPUT</b>				
Input forward current		$I_F$	25	mA
Peak transient input current	< 1 $\mu\text{s}$ pulse width, 300 pps	$I_{F(TRAN)}$	1	A
Reverse input voltage		$V_R$	5	V
Output power dissipation		$P_{diss}$	45	mW
<b>OUTPUT</b>				
High peak output current <sup>(1)</sup>		$I_{OH(PEAK)}$	2.5	A
Low peak output current <sup>(1)</sup>		$I_{OL(PEAK)}$	2.5	A
Supply voltage		$(V_{CC} - V_{EE})$	0 to + 35	V
Output voltage		$V_{O(PEAK)}$	0 to + $V_{CC}$	V
Output power dissipation		$P_{diss}$	250	mW
<b>OPTOCOUPLER</b>				
Isolation test voltage (between emitter and detector)	$t = 1\text{ s}$	$V_{ISO}$	5300	$V_{RMS}$
Storage temperature range		$T_S$	- 55 to + 125	$^{\circ}\text{C}$
Ambient operating temperature range		$T_A$	- 40 to + 110	$^{\circ}\text{C}$
Total power dissipation		$P_{tot}$	295	mW
Lead solder temperature <sup>(2)</sup>	For 10 s, 1.6 mm below seating plane		260	$^{\circ}\text{C}$

**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> Maximum pulse width = 10  $\mu\text{s}$ , maximum duty cycle = 0.2 %. This value is intended to allow for component tolerances for designs with  $I_O$  peak minimum = 2.5 A. See applications section for additional details on limiting  $I_{OH}$  peak.

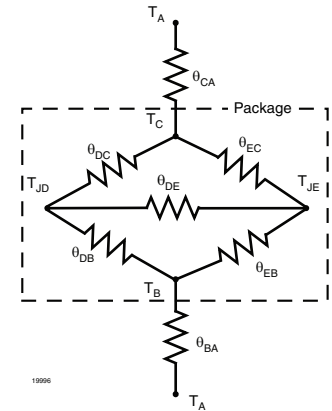
<sup>(2)</sup> Refer to reflow profile for soldering conditions for surface mounted devices (SMD). Refer to wave profile for soldering conditions for through hole devices (DIP).

**RECOMMENDED OPERATING CONDITION**

PARAMETER	SYMBOL	MIN.	MAX.	UNIT
Power supply voltage	$V_{CC} - V_{EE}$	15	32	V
Input LED current (on)	$I_F$	7	16	mA
Input voltage (off)	$V_{F(OFF)}$	- 3	0.8	V
Operating temperature	$T_{amb}$	- 40	+ 110	$^{\circ}\text{C}$

**THERMAL CHARACTERISTICS**

PARAMETER	SYMBOL	VALUE	UNIT
LED power dissipation	$P_{diss}$	45	mW
Output power dissipation	$P_{diss}$	250	mW
Total power dissipation	$P_{tot}$	285	mW
Maximum LED junction temperature	$T_{jmax.}$	125	°C
Maximum output die junction temperature	$T_{jmax.}$	125	°C
Thermal resistance, junction emitter to board	$\theta_{JEB}$	169	°C/W
Thermal resistance, junction emitter to case	$\theta_{JEC}$	192	°C/W
Thermal resistance, junction detector to board	$\theta_{JDB}$	82	°C/W
Thermal resistance, junction detector to case	$\theta_{JDC}$	80	°C/W
Thermal resistance, junction emitter to junction detector	$\theta_{JED}$	200	°C/W
Thermal resistance, case to ambient	$\theta_{CA}$	2645	°C/W


**Note**

- The thermal characteristics table above were measured at 25 °C and the thermal model is represented in the thermal network below. Each resistance value given in this model can be used to calculate the temperatures at each node for a given operating condition. The thermal resistance from board to ambient will be dependent on the type of PCB, layout and thickness of copper traces. For a detailed explanation of the thermal model, please reference Vishay's Thermal Characteristics of Optocouplers application note.

**ELECTRICAL CHARACTERISTICS**

PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
High level output current	$V_O = (V_{CC} - 4 \text{ V})$	$I_{OH}^{(1)}$	0.5			A
	$V_O = (V_{CC} - 15 \text{ V})$	$I_{OH}^{(2)}$	2.5			A
Low level output current	$V_O = (V_{EE} + 2.5 \text{ V})$	$I_{OL}^{(1)}$	0.5			A
	$V_O = (V_{EE} + 15 \text{ V})$	$I_{OL}^{(2)}$	2.5			A
High level output voltage	$I_O = -100 \text{ mA}$	$V_{OH}^{(3)}$	$V_{CC} - 4$			V
Low level output voltage	$I_O = 100 \text{ mA}$	$V_{OL}$		0.2	0.5	V
High level supply current	Output open, $I_F = 7 \text{ mA}$ to $16 \text{ mA}$	$I_{CCH}$			2.5	mA
Low level supply current	Output open, $V_F = -3 \text{ V}$ to $+0.8 \text{ V}$	$I_{CCL}$			2.5	mA
Threshold input current low to high	$I_O = 0 \text{ mA}$ , $V_O > 5 \text{ V}$	$I_{FLH}$			5	mA
Threshold input voltage high to low		$V_{FHL}$	0.8			V
Input forward voltage	$I_F = 10 \text{ mA}$	$V_F$	1		1.6	V
Temperature coefficient of forward voltage	$I_F = 10 \text{ mA}$	$\Delta V_F / \Delta T_A$		-1.4		mV/°C
Input reverse breakdown voltage	$I_R = 10 \mu\text{A}$	$BV_R$	5			V
Input capacitance	$f = 1 \text{ MHz}$ , $V_F = 0 \text{ V}$	$C_{IN}$		60		pF
UVLO threshold	$V_O \geq 5 \text{ V}$	$V_{UVLO+}$	11		13.5	V
	$I_F = 10 \text{ mA}$	$V_{UVLO-}$	9.5		12	V
UVLO hysteresis		$UVLO_{HYS}$		1.6		V

**Notes**

- Minimum and maximum values were tested over recommended operating conditions ( $T_A = -40 \text{ °C}$  to  $110 \text{ °C}$ ,  $I_{F(ON)} = 7 \text{ mA}$  to  $16 \text{ mA}$ ,  $V_{F(OFF)} = -3 \text{ V}$  to  $0.8 \text{ V}$ ,  $V_{CC} = 15 \text{ V}$  to  $32 \text{ V}$ ,  $V_{EE} = \text{ground}$ ) unless otherwise specified. Typical values are characteristics of the device and are the result of engineering evaluations. Typical values are for information only and are not part of the testing requirements. All typical values were measured at  $T_{amb} = 25 \text{ °C}$  and with  $V_{CC} - V_{EE} = 32 \text{ V}$ .
- (1) Maximum pulse width = 50  $\mu\text{s}$ , maximum duty cycle = 0.5 %.
- (2) Maximum pulse width = 10  $\mu\text{s}$ , maximum duty cycle = 0.2 %. This value is intended to allow for component tolerances for designs with  $I_O$  peak minimum = 2.5 A.
- (3) In this test  $V_{OH}$  is measured with a dc load current. When driving capacitive loads  $V_{OH}$  will approach  $V_{CC}$  as  $I_{OH}$  approaches zero A. Maximum pulse width = 1 ms, maximum duty cycle = 20 %.

**TEST CIRCUITS**

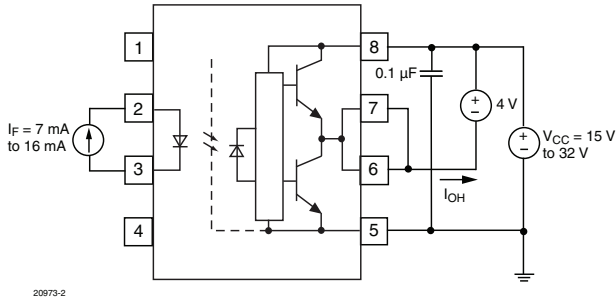


Fig. 1 - IOH Test Circuit

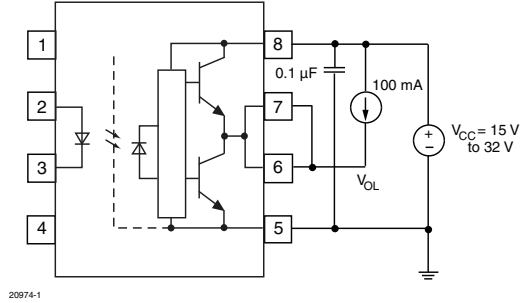


Fig. 4 - VOL Test Circuit



Fig. 2 - IOL Test Circuit



Fig. 5 - IFLH Test Circuit



Fig. 3 - VOH Test Circuit

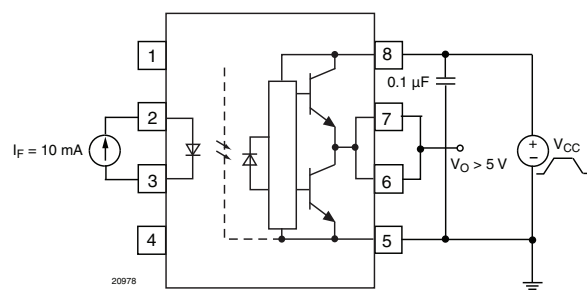


Fig. 6 - UVLO Test Circuit

**SWITCHING CHARACTERISTICS**

PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Propagation delay time to logic low output (1)	$R_g = 10 \Omega, C_g = 10 \text{ nF}, f = 10 \text{ kHz},$ duty cycle = 50 %	$t_{PHL}$	0.1		0.4	$\mu\text{s}$
Propagation delay time to logic high output (1)	$R_g = 10 \Omega, C_g = 10 \text{ nF}, f = 10 \text{ kHz},$ duty cycle = 50 %	$t_{PLH}$	0.1		0.4	$\mu\text{s}$
Pulse width distortion (2)	$R_g = 10 \Omega, C_g = 10 \text{ nF}, f = 10 \text{ kHz},$ duty cycle = 50 %	PWD			0.2	$\mu\text{s}$
Rise time	$R_g = 10 \Omega, C_g = 10 \text{ nF}, f = 10 \text{ kHz},$ duty cycle = 50 %	$t_r$		0.1		$\mu\text{s}$
Fall time	$R_g = 10 \Omega, C_g = 10 \text{ nF}, f = 10 \text{ kHz},$ duty cycle = 50 %	$t_f$		0.1		$\mu\text{s}$
UVLO turn on delay	$V_O > 5 \text{ V}, I_F = 10 \text{ mA}$	$T_{UVLO-ON}$		0.8		$\mu\text{s}$
UVLO turn off delay	$V_O < 5 \text{ V}, I_F = 10 \text{ mA}$	$T_{UVLO-OFF}$		0.6		$\mu\text{s}$

**Notes**

- (1) This load condition approximates the gate load of a 1200 V/75 A IGBT.
- (2) Pulse width distortion (PWD) is defined as  $|t_{PHL} - t_{PLH}|$  for any given device.
- (3) The difference between  $t_{PHL}$  and  $t_{PLH}$  between any two VO3120 parts under the same test condition.



Fig. 7 -  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_r$  and  $t_f$  Test Circuit and Waveforms

COMMON MODE TRANSIENT IMMUNITY						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Common mode transient immunity at logic high output <sup>(1)(2)</sup>	$T_A = 25^\circ\text{C}$ , $I_F = 10\text{ mA to }16\text{ mA}$ , $V_{CM} = 1500\text{ V}$ , $V_{CC} = 32\text{ V}$	$ CM_H $	25	35		kV/ $\mu\text{s}$
Common mode transient immunity at logic low output <sup>(1)(3)</sup>	$T_A = 25^\circ\text{C}$ , $V_{CM} = 1500\text{ V}$ , $V_{CC} = 32\text{ V}$ , $V_F = 0\text{ V}$	$ CM_L $	25	35		kV/ $\mu\text{s}$

**Notes**

- (1) Pins 1 and 4 need to be connected to LED common.
- (2) Common mode transient immunity in the high state is the maximum tolerable  $|dV_{CM}/dt|$  of the common mode pulse,  $V_{CM}$ , to assure that the output will remain in the high state (i.e.,  $V_O > 15\text{ V}$ ).
- (3) Common mode transient immunity in a low state is the maximum tolerable  $|dV_{CM}/dt|$  of the common mode pulse,  $V_{CM}$ , to assure that the output will remain in a low state (i.e.,  $V_O < 1\text{ V}$ ).



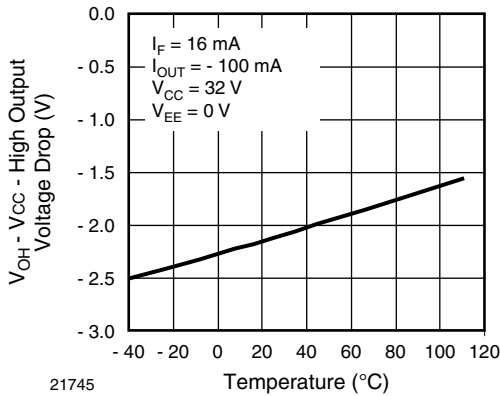
Fig. 8 - CMR Test Circuit and Waveforms

SAFETY AND INSULATION RATINGS						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Climatic classification (according to IEC 68 part 1)				40/110/21		
Comparative tracking index		CTI	175		399	
Peak transient overvoltage		$V_{IOTM}$	8000			V
Peak insulation voltage		$V_{IORM}$	890			V
Safety rating - power output		$P_{SO}$			500	mm
Safety rating - input current		$I_{SI}$			300	mm
Safety rating - temperature		$T_{SI}$			175	°C
Creepage distance	Standard DIP-8		7			mm
Clearance distance	Standard DIP-8		7			mm
Creepage distance	400 mil DIP-8		8			mm
Clearance distance	400 mil DIP-8		8			mm

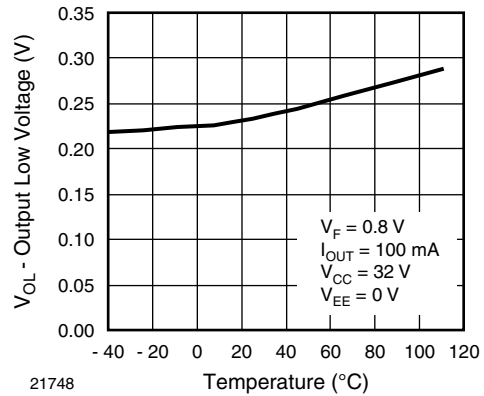
**Note**

- 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.

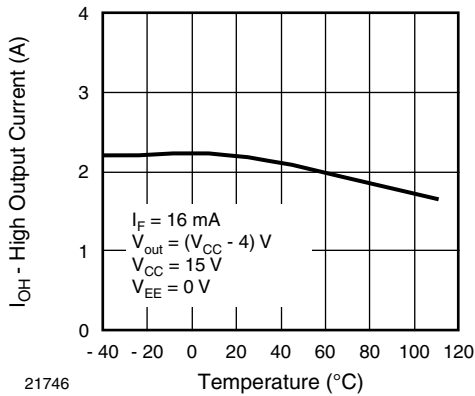
**TYPICAL CHARACTERISTICS** ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)



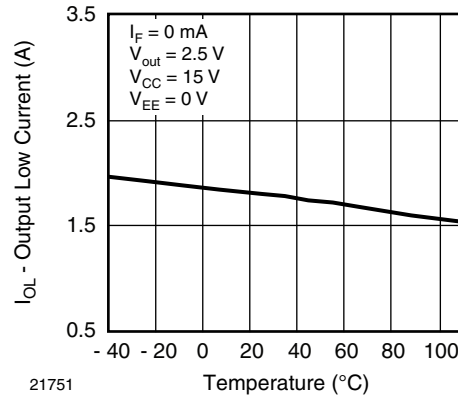
21745 Fig. 9 - High Output Voltage Drop vs. Temperature



21748 Fig. 11 - Output Low Voltage vs. Temperature



21746 Fig. 10 - High Output Current vs. Temperature



21751 Fig. 12 - Output Low Current vs. Temperature



Fig. 13 - Output Low Voltage vs. Output Low Current



Fig. 16 - Supply Current vs. Supply Voltage



Fig. 14 - Output High Voltage Drop vs. Output High Current



Fig. 17 - Low to High Current Threshold vs. Temperature



Fig. 15 - Supply Current vs. Temperature



Fig. 18 - Transfer Characteristics



Fig. 19 - Propagation Delay vs. Supply Voltage



Fig. 22 - Propagation Delay vs. Series Load Resistance



Fig. 20 - Propagation Delay vs. Temperature



Fig. 23 - Propagation Delay vs. Series Load Capacitance

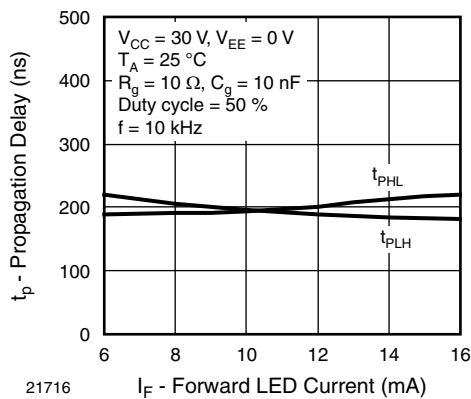
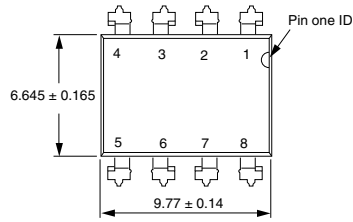


Fig. 21 - Propagation Delay vs. Forward LED Current



**PACKAGE DIMENSIONS** in millimeters



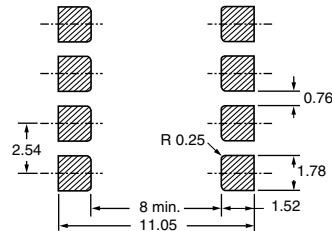
**Option 7**



**Option 9**



20802-16



**PACKAGE MARKING**



**Notes**

- The VDE logo is only marked on option 1 parts.
- Tape and reel suffix (T) is not part of the package marking.



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