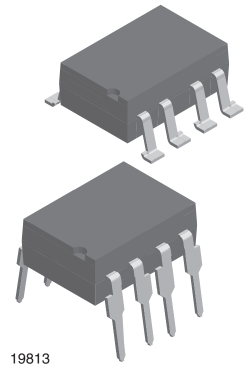
2.5 A Output Current IGBT and MOSFET Driver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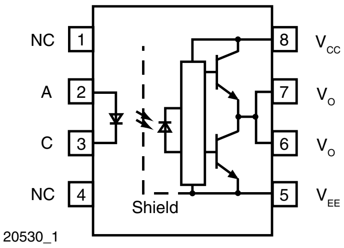


FEATURES

- 2.5 A minimum peak output current
- 25 kV/μs 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 μs 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
- Compliant to RoHS directive 2002/95/EC

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

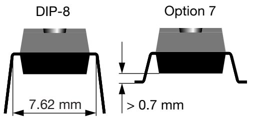
- Isolated IGBT/MOSFET gate driver
- AC and brushless DC motor drives
- Induction stove top
- Industrial inverters
- Switch mode power supplies (SMPS)
- Uninterruptible power supplies (UPS)

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

V	O	3	1	2	0	-	X	0	#	#	T
PART NUMBER							PACKAGE OPTION				TAPE AND REEL



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

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 (1) (T_{amb} = 25 °C, unless otherwise specified)				
PARAMETER	**TEST CONDITION**	**SYMBOL**	**VALUE**	**UNIT**
INPUT				
Input forward current		I_F	25	mA
Peak transient input current	< 1 µs pulse width, 300 pps	$I_{F(TRAN)}$	1	A
Reverse input voltage		V_R	5	V
Output power dissipation		P_{diss}	45	mW
OUTPUT				
High peak output current (2)		$I_{OH(PEAK)}$	2.5	A
Low peak output current (2)		$I_{OL(PEAK)}$	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
OPTOCOUPLER				
Isolation test voltage (between emitter and detector)	t = 1 s	V_{ISO}	5300	V_{RMS}
Storage temperature range		T_S	- 55 to + 125	°C
Ambient operating temperature range		T_A	- 40 to + 110	°C
Total power dissipation		P_{tot}	295	mW
Lead solder temperature (3)	For 10 s, 1.6 mm below seating plane		260	°C

Notes

(1) 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.

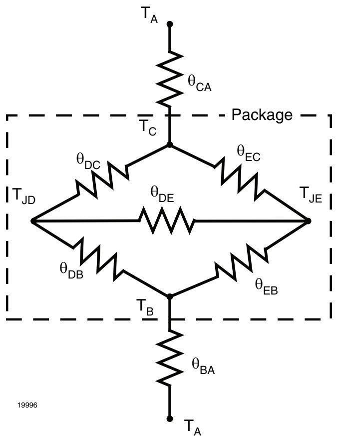
(2) Maximum pulse width = 10 µs, maximum duty cycle = 0.2 %. This value is intended to allow for component tolerances for designs with I_O peak minimum = 2.5 A. See applications section for additional details on limiting I_{OH} peak.

(3) 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	°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	θ_{JEB}	169	°C/W
Thermal resistance, junction emitter to case	θ_{JEC}	192	°C/W
Thermal resistance, junction detector to board	θ_{JDB}	82	°C/W
Thermal resistance, junction detector to case	θ_{JDC}	80	°C/W
Thermal resistance, junction emitter to junction detector	θ_{JED}	200	°C/W
Thermal resistance, case to ambient	θ_{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 (1)

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

Notes

(1) Minimum and maximum values were tested over recommended operating conditions (T_A = - 40 °C to 110 °C, $I_{F(ON)}$ = 7 mA to 16 mA, $V_{F(OFF)}$ = - 3 V to 0.8 V, V_{CC} = 15 V to 32 V, V_{EE} = 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 °C and with $V_{CC} - V_{EE}$ = 32 V.

(2) Maximum pulse width = 50 µs, maximum duty cycle = 0.5 %.

(3) Maximum pulse width = 10 µs, maximum duty cycle = 0.2 %. This value is intended to allow for component tolerances for designs with I_O peak minimum = 2.5 A.

(4) 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

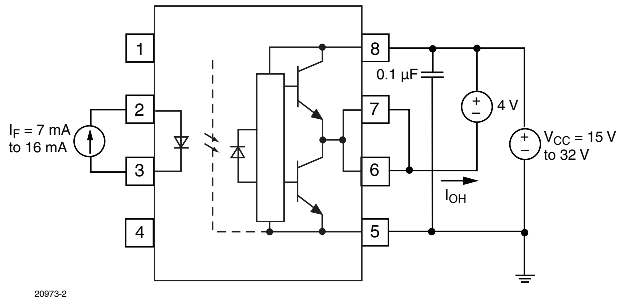


Fig. 1 - I_{OH} Test Circuit

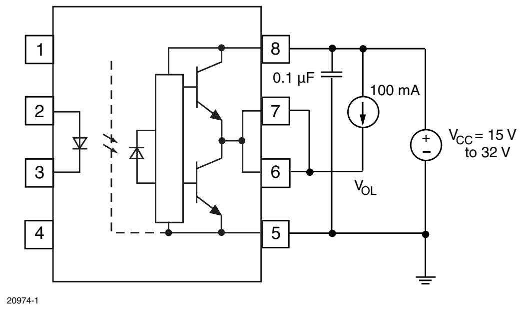


Fig. 4 - V_{OL} Test Circuit

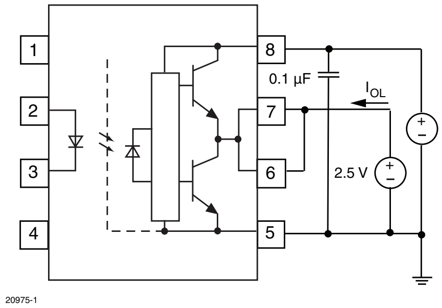


Fig. 2 - I_{OL} Test Circuit

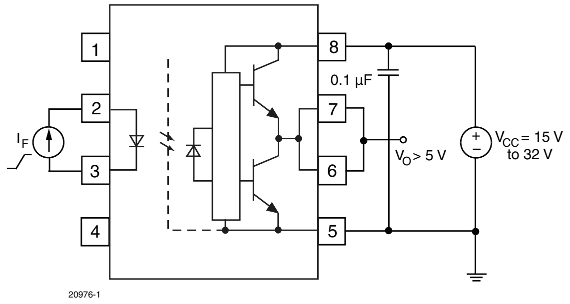


Fig. 5 - I_{FLH} Test Circuit

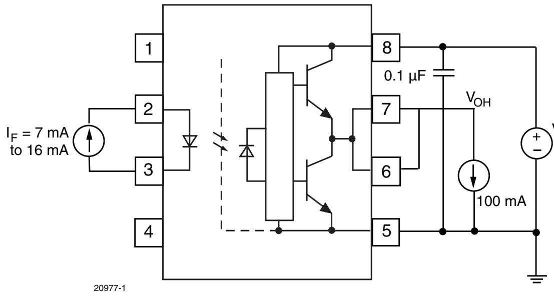


Fig. 3 - V_{OH} Test Circuit

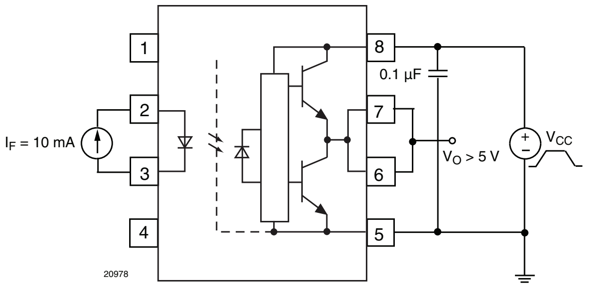


Fig. 6 - UVLO Test Circuit

SWITCHING CHARACTERISTICS

PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Propagation delay time to logic low output (1)	R_g = 10 Ω, C_g = 10 nF, f = 10 kHz, duty cycle = 50 %	t_{PHL}	0.1		0.4	µs
Propagation delay time to logic high output (1)	R_g = 10 Ω, C_g = 10 nF, f = 10 kHz, duty cycle = 50 %	t_{PLH}	0.1		0.4	µs
Pulse width distortion (2)	R_g = 10 Ω, C_g = 10 nF, f = 10 kHz, duty cycle = 50 %	PWD			0.2	µs
Rise time	R_g = 10 Ω, C_g = 10 nF, f = 10 kHz, duty cycle = 50 %	t_r		0.1		µs

SWITCHING CHARACTERISTICS						
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
Fall time	$R_g = 10\ \Omega$, $C_g = 10$ nF, f = 10 kHz, duty cycle = 50 %	t_f		0.1		µs
UVLO turn on delay	$V_O > 5$ V, $I_F = 10$ mA	$T_{UVLO-ON}$		0.8		µs
UVLO turn off delay	$V_O < 5$ V, $I_F = 10$ mA	$T_{UVLO-OFF}$		0.6		µs

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.

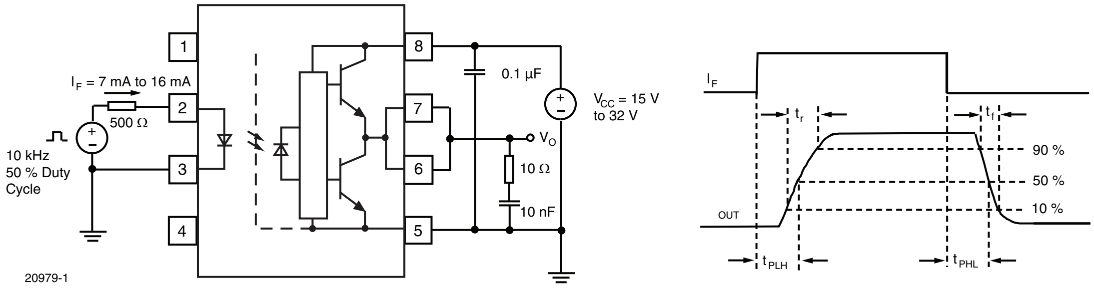


Fig. 7 - t_{PLH}, t_{PHL}, t_r and t_f Test Circuit and Waveforms

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

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., $V_O > 15$ 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., $V_O < 1$ V).

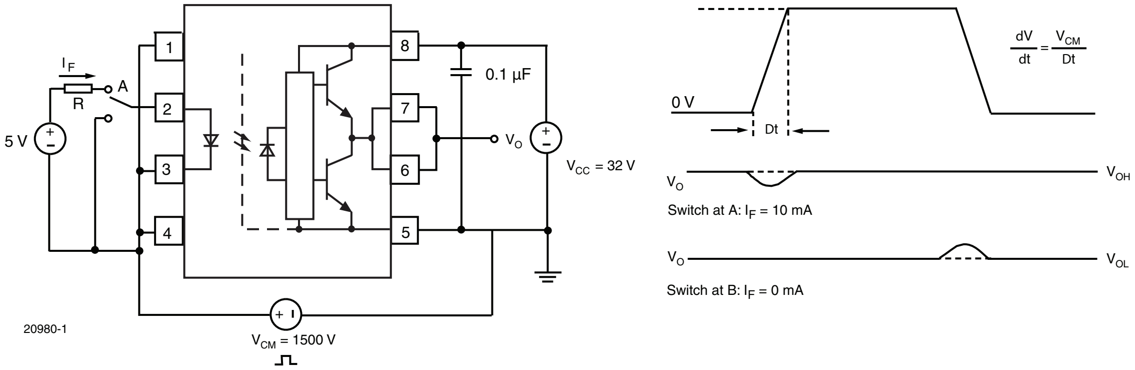


Fig. 8 - CMR Test Circuit and Waveforms

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	mW
Safety rating - input current		I_{SI}			300	mA
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 °C, unless otherwise specified)

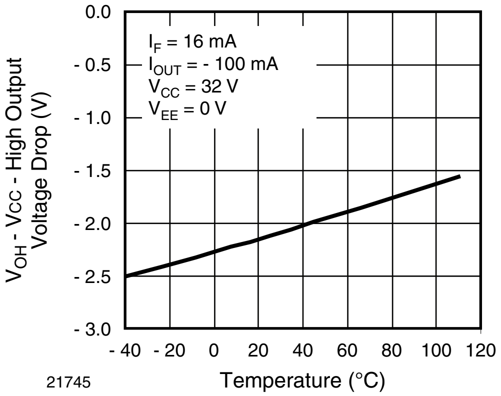


Fig. 9 - High Output Voltage Drop vs. Temperature

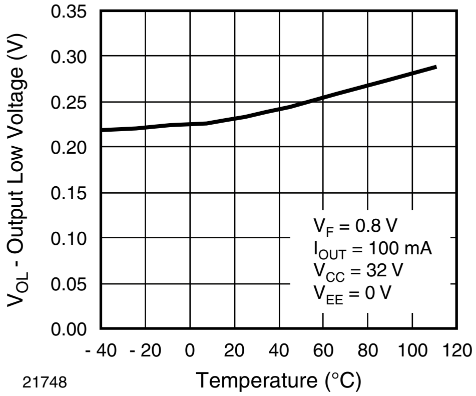


Fig. 11 - Output Low Voltage vs. Temperature

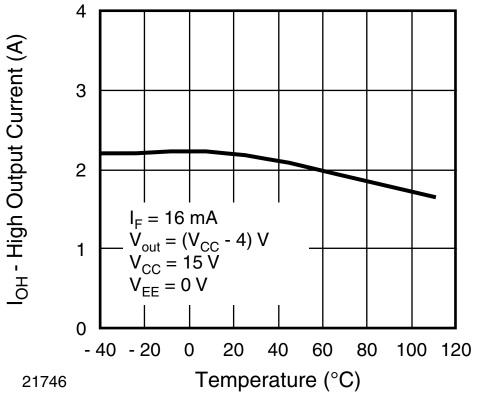


Fig. 10 - High Output Current vs. Temperature

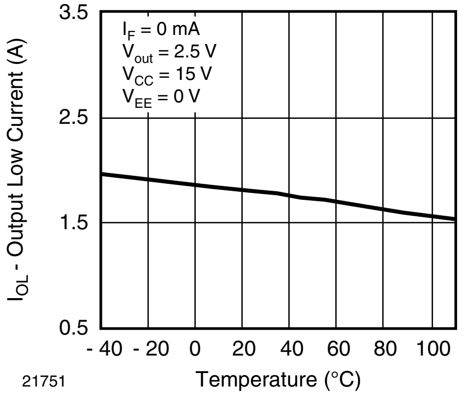


Fig. 12 - Output Low Current vs. Temperature

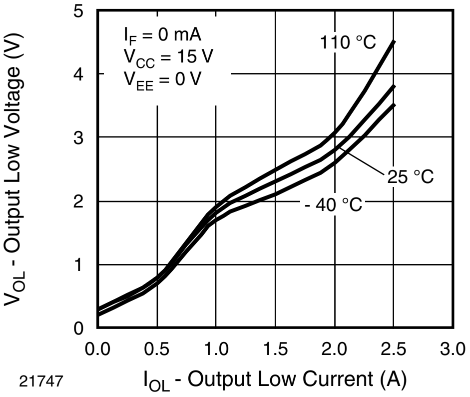


Fig. 13 - Output Low Voltage vs. Output Low Current

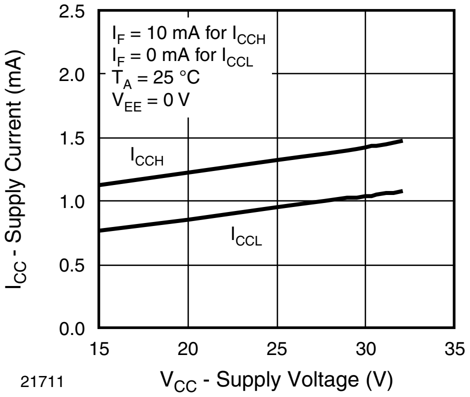


Fig. 16 - Supply Current vs. Supply Voltage

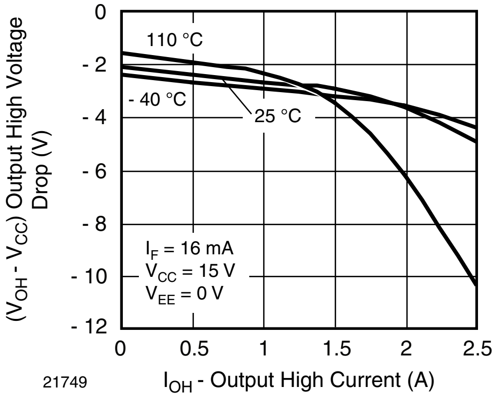


Fig. 14 - Output High Voltage Drop vs. Output High Current

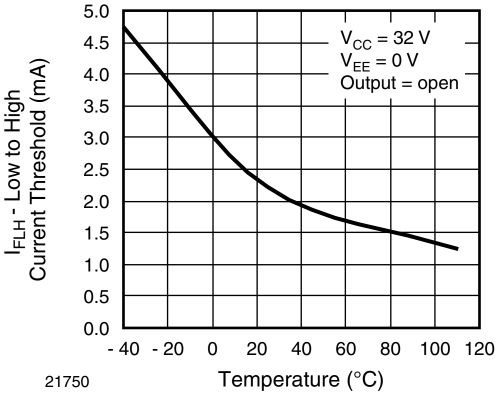


Fig. 17 - Low to High Current Threshold vs. Temperature

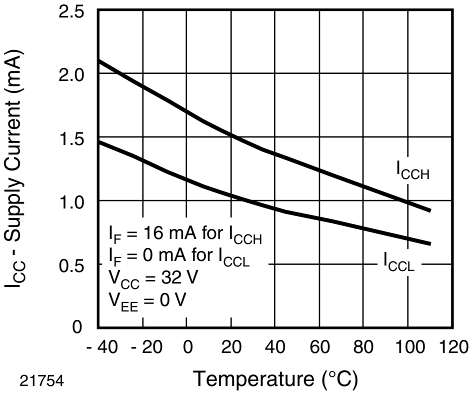


Fig. 15 - Supply Current vs. Temperature

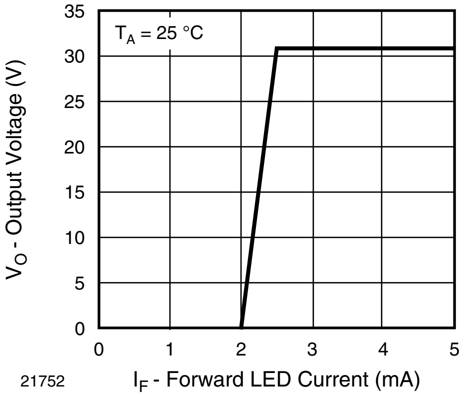


Fig. 18 - Transfer Characteristics

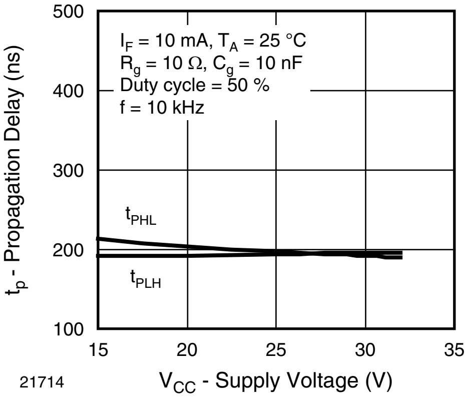


Fig. 19 - Propagation Delay vs. Supply Voltage

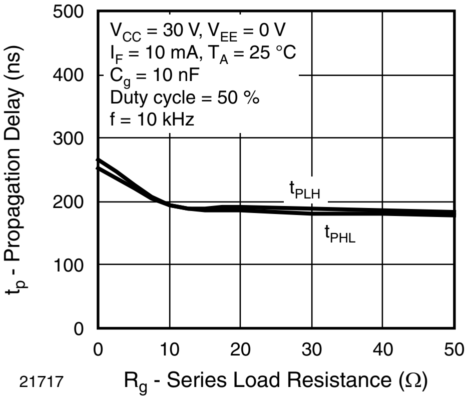


Fig. 22 - Propagation Delay vs. Series Load Resistance

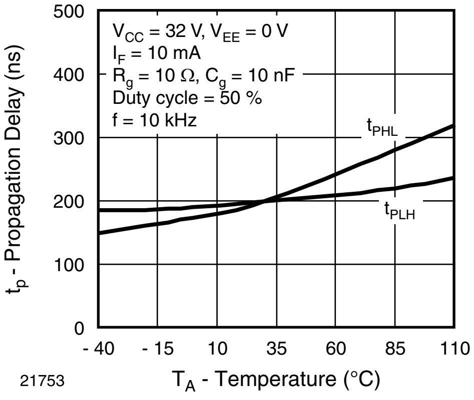


Fig. 20 - Propagation Delay vs. Temperature

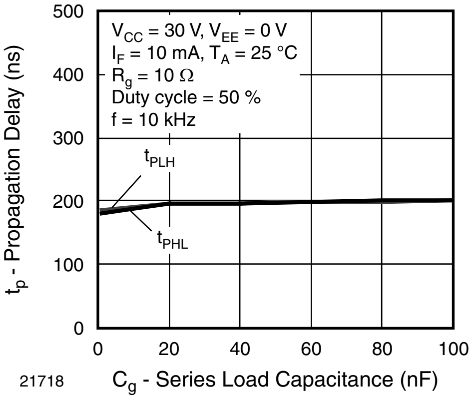


Fig. 23 - Propagation Delay vs. Series Load Capacitance

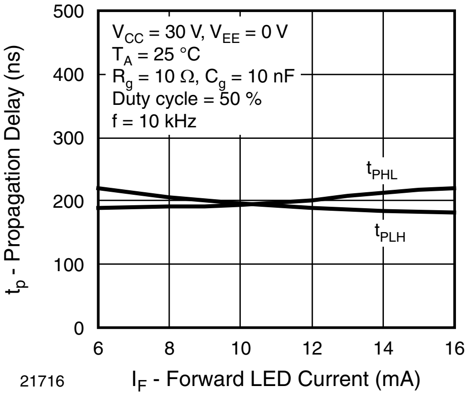
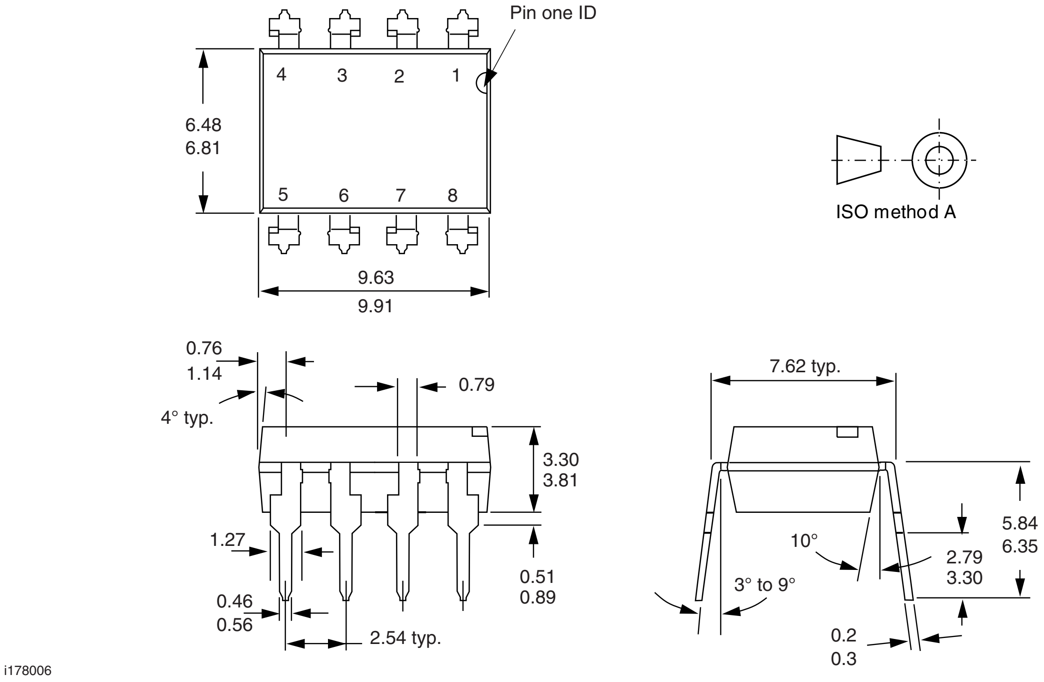
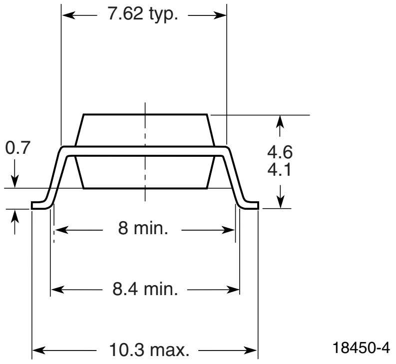


Fig. 21 - Propagation Delay vs. Forward LED Current

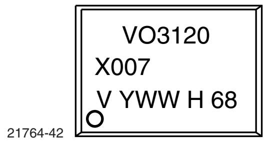
PACKAGE DIMENSIONS in millimeters



Option 7



PACKAGE MARKING



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