

## High Speed Optocoupler, Single and Dual, 10 MBd



### DESCRIPTION

The 6N137, VO2601, and VO2611 are single channel 10 MBd optocouplers utilizing a high efficient input LED coupled with an integrated optical photodiode IC detector. The detector has an open drain NMOS-transistor output, providing less leakage compared to an open collector Schottky clamped transistor output. The VO2630, VO2631, and VO4661 are dual channel 10 MBd optocouplers. For the single channel type, an enable function on pin 7 allows the detector to be strobed. The internal shield provides a guaranteed common mode transient immunity of 5 kV/μs for the VO2601 and VO2631 and 15 kV/μs for the VO2611 and VO4661. The use of a 0.1 μF bypass capacitor connected between pin 5 and 8 is recommended.

### FEATURES

- Choice of CMR performance of 15 kV/μs, 5 kV/μs, and 1000 V/μs
- High speed: 10 MBd typical
- +5 V CMOS compatibility
- Pure tin leads
- Guaranteed AC and DC performance over temperature
- Meets IEC 60068-2-42 (SO<sub>2</sub>) and IEC 60068-2-43 (H<sub>2</sub>S) requirements
- Low input current capability of 5 mA
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



RoHS COMPLIANT

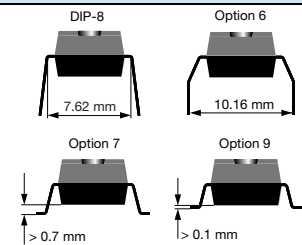
### APPLICATIONS

- Microprocessor system interface
- PLC, ATE input / output isolation
- Computer peripheral interface
- Digital fieldbus isolation: CC-link, DeviceNet, profibus, SDS
- High speed A/D and D/A conversion
- AC plasma display panel level shifting
- Multiplexed data transmission
- Digital control power supply
- Ground loop elimination, noise isolation

### AGENCY APPROVALS

- UL1577
- cUL
- DIN EN 60747-5-5 (VDE 0884-5) available with option 1
- BS EN 60950-1
- CQC GB8898-2011, GB4943.1-2011

### ORDERING INFORMATION



AGENCY CERTIFIED/PACKAGE	CHANNELS 1			CHANNELS 2		
	CMR (V/μs)			CMR (V/μs)		
	1000	5000	15 000	1000	5000	15 000
<b>BSI, UL, cUL</b>						
DIP-8	6N137	VO2601	VO2611	VO2630	VO2631	VO4661
DIP-8, 400 mil (option 6)	6N137-X006	VO2601-X006	VO2611-X006	VO2630-X006	VO2631-X006	VO4661-X006
SMD-8 (option 7)	6N137-X007T	VO2601-X007T	VO2611-X007T	VO2630-X007T	VO2631-X007T	VO4661-X007T
SMD-8 (option 9)	6N137-X009T	-	-	VO2630-X009T	-	-
<b>VDE, BSI, UL, cUL</b>	<b>1000</b>	<b>5000</b>	<b>15 000</b>	<b>1000</b>	<b>5000</b>	<b>15 000</b>
DIP-8, 400 mil (option 6)	-	VO2601-X016	VO2611-X016	-	VO2631-X016	-
SMD-8 (option 7)	-	VO2601-X017T	VO2611-X017T	-	VO2631-X017T	-



TRUTH TABLE (positive logic)		
LED	ENABLE	OUTPUT
On	H	L
Off	H	H
On	L	H
Off	L	H
On	NC	L
Off	NC	H

ABSOLUTE MAXIMUM RATINGS (T <sub>amb</sub> = 25 °C, unless otherwise specified)				
PARAMETER	CONDITIONS	SYMBOL	VALUE	UNIT
<b>INPUT</b>				
Average forward current (single channel)		I <sub>F</sub>	20	mA
Average forward current (per channel for dual channel)		I <sub>F</sub>	15	mA
Reverse input voltage		V <sub>R</sub>	5	V
Enable input voltage		V <sub>E</sub>	V <sub>CC</sub> + 0.5 V	V
Enable input current		I <sub>E</sub>	5	mA
Surge current	t = 100 μs	I <sub>FSM</sub>	200	mA
Output power dissipation (single channel)		P <sub>diss</sub>	35	mW
Output power dissipation (per channel for dual channel)		P <sub>diss</sub>	25	mW
<b>OUTPUT</b>				
Supply voltage	1 min maximum	V <sub>CC</sub>	7	V
Output current		I <sub>O</sub>	50	mA
Output voltage		V <sub>O</sub>	7	V
Output power dissipation (single channel)		P <sub>diss</sub>	85	mW
Output power dissipation (per channel for dual channel)		P <sub>diss</sub>	60	mW
<b>COUPLER</b>				
Storage temperature		T <sub>stg</sub>	-55 to +150	°C
Operating temperature		T <sub>amb</sub>	-40 to +100	°C
Lead solder temperature	for 10 s		260	°C
Solder reflow temperature			260	°C

Note

- 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.

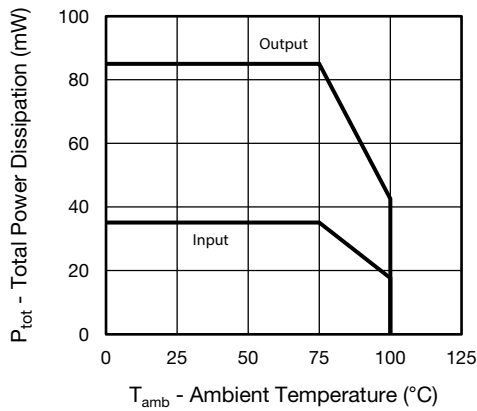


Fig. 1 - Total Power Dissipation vs. Ambient Temperature (single channel)

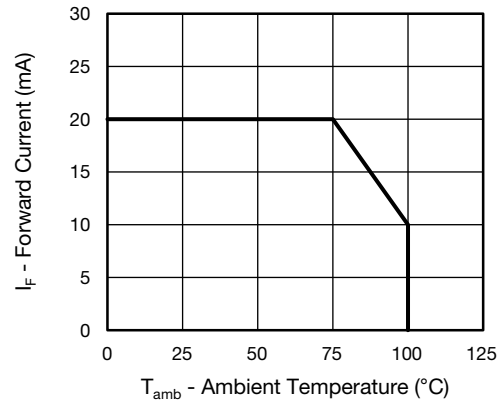


Fig. 3 - Forward Current vs. Ambient Temperature (single channel)

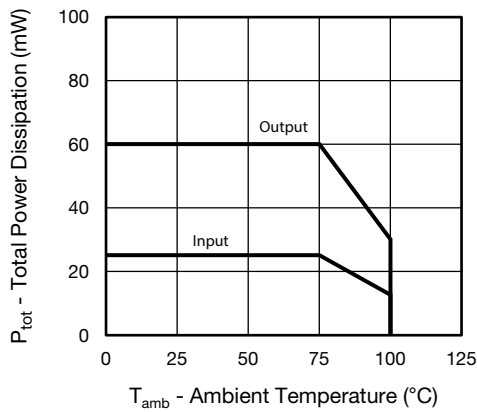


Fig. 2 - Total Power Dissipation vs. Ambient Temperature (dual channel)

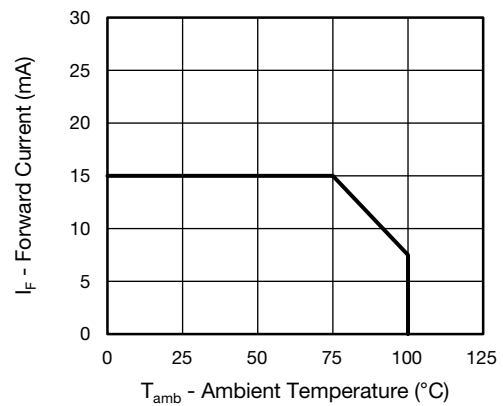


Fig. 4 - Forward Current vs. Ambient Temperature (dual channel)

RECOMMENDED OPERATING CONDITIONS					
PARAMETER	TEST CONDITION	SYMBOL	MIN.	MAX.	UNIT
Operating temperature		T <sub>amb</sub>	-40	100	°C
Supply voltage		V <sub>CC</sub>	4.5	5.5	V
Input current low level		I <sub>FL</sub>	0	250	μA
Input current high level		I <sub>FH</sub>	5	15	mA
Logic high enable voltage		V <sub>EH</sub>	2	V <sub>CC</sub>	V
Logic low enable voltage		V <sub>EL</sub>	0	0.8	V
Output pull up resistor		R <sub>L</sub>	330	4K	Ω
Fanout	R <sub>L</sub> = 1 kΩ	N	-	5	-



<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>						
Input forward voltage	$I_F = 10\text{ mA}$	$V_F$	1.1	1.4	1.7	V
Reverse current	$V_R = 5\text{ V}$	$I_R$	-	0.01	10	$\mu\text{A}$
Input capacitance	$f = 1\text{ MHz}, V_F = 0\text{ V}$	$C_I$	-	55	-	pF
<b>OUTPUT</b>						
High level supply current (single channel)	$V_E = 0.5\text{ V}, I_F = 0\text{ mA}$	$I_{CCH}$	-	4.1	7	mA
	$V_E = V_{CC}, I_F = 0\text{ mA}$	$I_{CCH}$	-	3.3	6	mA
High level supply current (dual channel)	$I_F = 0\text{ mA}$	$I_{CCH}$	-	6.5	12	mA
Low level supply current (single channel)	$V_E = 0.5\text{ V}, I_F = 10\text{ mA}$	$I_{CCL}$	-	4	7	mA
	$V_E = V_{CC}, I_F = 10\text{ mA}$	$I_{CCL}$	-	3.3	6	mA
Low level supply current (dual channel)	$I_F = 10\text{ mA}$	$I_{CCL}$	-	6.5	12	mA
High level output current	$V_E = 2\text{ V}, V_{CC} = 5.5\text{ V}, I_F = 250\text{ }\mu\text{A}$	$I_{OH}$	-	0.002	1	$\mu\text{A}$
Low level output voltage	$V_E = 2\text{ V}, I_F = 5\text{ mA}, I_{OL}(\text{sinking}) = 13\text{ mA}$	$V_{OL}$	-	0.2	0.6	V
Input threshold current	$V_E = 2\text{ V}, V_{CC} = 5.5\text{ V}, I_{OL}(\text{sinking}) = 13\text{ mA}$	$I_{TH}$	-	2.4	5	mA
High level enable current	$V_E = 2\text{ V}$	$I_{EH}$	-	-0.6	-1.6	mA
Low level enable current	$V_E = 0.5\text{ V}$	$I_{EL}$	-	-0.8	-1.6	mA
High level enable voltage		$V_{EH}$	2	-	-	V
Low level enable voltage		$V_{EL}$	-	-	0.8	V

**Note**

- Minimum and maximum values are testing requirements. Typical values are characteristics of the device and are the result of engineering evaluation. Typical values are for information only and are not part of the testing requirements.

<b>SWITCHING CHARACTERISTICS</b>						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Propagation delay time to high output level	$R_L = 350\text{ }\Omega, C_L = 15\text{ pF}$	$t_{PLH}$	20	48	75 <sup>(1)</sup>	ns
		$t_{PLH}$	-	-	100	ns
Propagation delay time to low output level	$R_L = 350\text{ }\Omega, C_L = 15\text{ pF}$	$t_{PHL}$	25	50	75 <sup>(1)</sup>	ns
		$t_{PHL}$	-	-	100	ns
Pulse width distortion	$R_L = 350\text{ }\Omega, C_L = 15\text{ pF}$	$ t_{PHL} - t_{PLH} $	-	2.9	35	ns
Propagation delay skew	$R_L = 350\text{ }\Omega, C_L = 15\text{ pF}$	$t_{PSK}$	-	8	40	ns
Output rise time (10 % to 90 %)	$R_L = 350\text{ }\Omega, C_L = 15\text{ pF}$	$t_r$	-	23	-	ns
Output fall time (90 % to 10 %)	$R_L = 350\text{ }\Omega, C_L = 15\text{ pF}$	$t_f$	-	7	-	ns
Propagation delay time of enable from $V_{EH}$ to $V_{EL}$	$R_L = 350\text{ }\Omega, C_L = 15\text{ pF}, V_{EL} = 0\text{ V}, V_{EH} = 3\text{ V}$	$t_{ELH}$	-	12	-	ns
Propagation delay time of enable from $V_{EL}$ to $V_{EH}$	$R_L = 350\text{ }\Omega, C_L = 15\text{ pF}, V_{EL} = 0\text{ V}, V_{EH} = 3\text{ V}$	$t_{EHL}$	-	11	-	ns

**Notes**

- Over recommended temperature ( $T_{amb} = -40\text{ }^{\circ}\text{C}$  to  $+100\text{ }^{\circ}\text{C}$ ),  $V_{CC} = 5\text{ V}, I_F = 7.5\text{ mA}$  unless otherwise specified. All typicals at  $T_{amb} = 25\text{ }^{\circ}\text{C}, V_{CC} = 5\text{ V}$ .
- (1) 75 ns applies to the 6N137 only, a JEDEC® registered specification

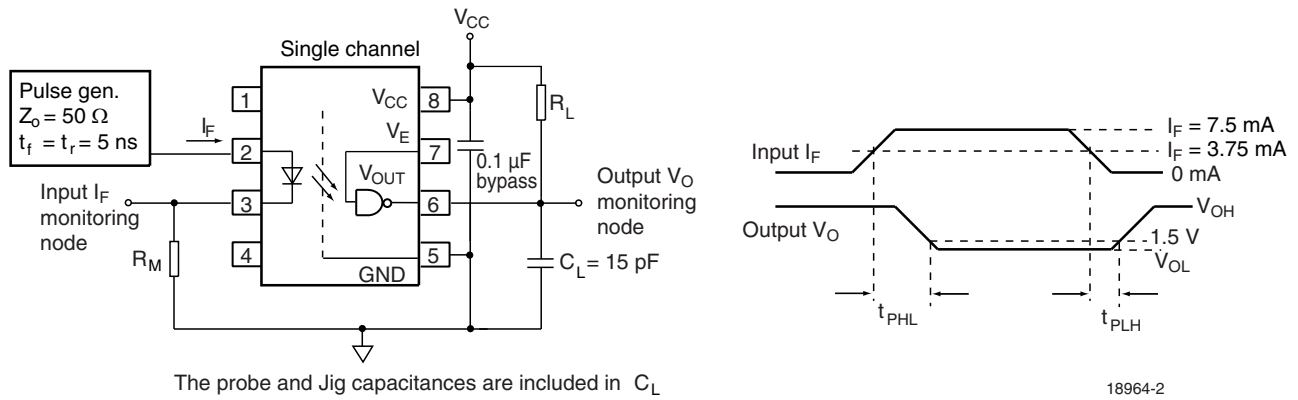


Fig. 5 - Single Channel Test Circuit for  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_r$  and  $t_f$

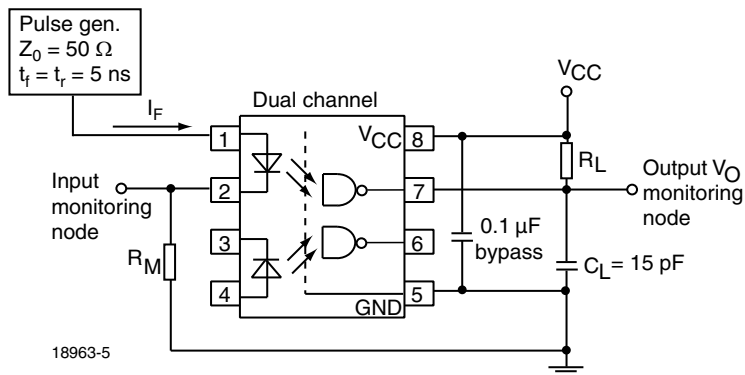


Fig. 6 - Dual Channel Test Circuit for  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_r$  and  $t_f$

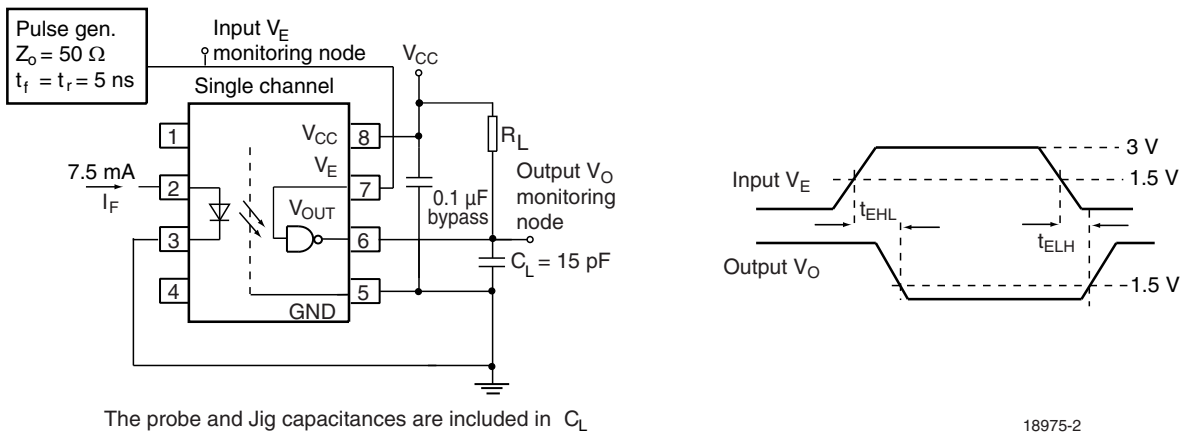


Fig. 7 - Single Channel Test Circuit for  $t_{EHL}$  and  $t_{ELH}$

COMMON MODE TRANSIENT IMMUNITY ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Common mode transient immunity	$ V_{CM}  = 10\text{ V}$ , $V_{CC} = 5\text{ V}$ , $I_F = 0\text{ mA}$ , $V_{O(min.)} = 2\text{ V}$ , $R_L = 350\text{ }\Omega$ , $T_{amb} = 25\text{ }^{\circ}\text{C}$ (1)	$ CM_H $	1000			$\text{V}/\mu\text{s}$
	$ V_{CM}  = 50\text{ V}$ , $V_{CC} = 5\text{ V}$ , $I_F = 0\text{ mA}$ , $V_{O(min.)} = 2\text{ V}$ , $R_L = 350\text{ }\Omega$ , $T_{amb} = 25\text{ }^{\circ}\text{C}$ (2)	$ CM_H $	5000	10 000		$\text{V}/\mu\text{s}$
	$ V_{CM}  = 1\text{ kV}$ , $V_{CC} = 5\text{ V}$ , $I_F = 0\text{ mA}$ , $V_{O(min.)} = 2\text{ V}$ , $R_L = 350\text{ }\Omega$ , $T_{amb} = 25\text{ }^{\circ}\text{C}$ (3)	$ CM_H $	15 000	25 000		$\text{V}/\mu\text{s}$
	$ V_{CM}  = 10\text{ V}$ , $V_{CC} = 5\text{ V}$ , $I_F = 7.5\text{ mA}$ , $V_{O(max.)} = 0.8\text{ V}$ , $R_L = 350\text{ }\Omega$ , $T_{amb} = 25\text{ }^{\circ}\text{C}$ (1)	$ CM_L $	1000			$\text{V}/\mu\text{s}$
	$ V_{CM}  = 50\text{ V}$ , $V_{CC} = 5\text{ V}$ , $I_F = 7.5\text{ mA}$ , $V_{O(max.)} = 0.8\text{ V}$ , $R_L = 350\text{ }\Omega$ , $T_{amb} = 25\text{ }^{\circ}\text{C}$ (2)	$ CM_L $	5000	10 000		$\text{V}/\mu\text{s}$
	$ V_{CM}  = 1\text{ kV}$ , $V_{CC} = 5\text{ V}$ , $I_F = 7.5\text{ mA}$ , $V_{O(max.)} = 0.8\text{ V}$ , $R_L = 350\text{ }\Omega$ , $T_{amb} = 25\text{ }^{\circ}\text{C}$ (3)	$ CM_L $	15 000	25 000		$\text{V}/\mu\text{s}$

**Notes**

- (1) For 6N137 and VO2630  
 (2) For VO2601 and VO2631  
 (3) For VO2611 and VO4661

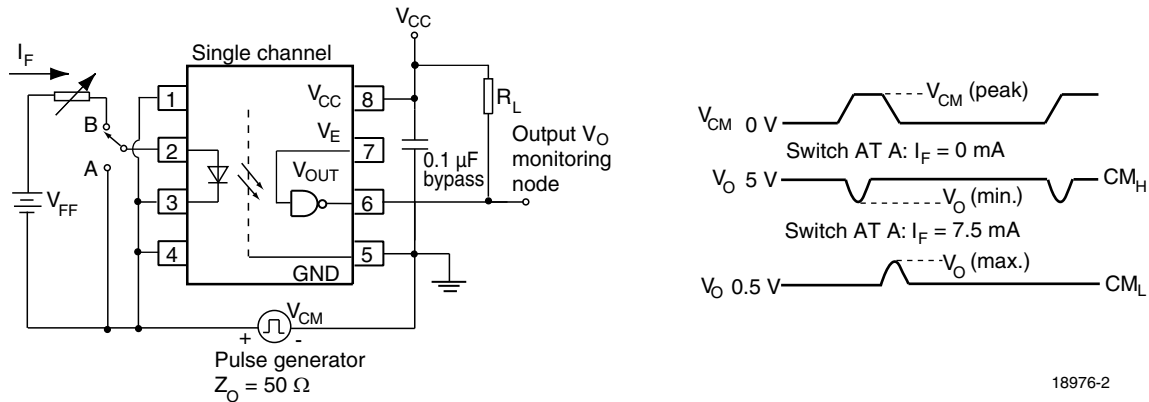


Fig. 8 - Single Channel Test Circuit for Common Mode Transient Immunity



Fig. 9 - Dual Channel Test Circuit for Common Mode Transient Immunity



SAFETY AND INSULATION RATINGS				
PARAMETER	TEST CONDITION	SYMBOL	VALUE	UNIT
Climatic classification	According to IEC 68 part 1		55 / 100 / 21	
Pollution degree	According to DIN VDE 0109		2	
Comparative tracking index	Insulation group IIIa	CTI	175	
Maximum rated withstanding isolation voltage	According to UL1577, t = 1 min	V <sub>ISO</sub>	5300	V <sub>RMS</sub>
Maximum transient isolation voltage	According to DIN EN 60747-5-5	V <sub>IOTM</sub>	8000	V <sub>peak</sub>
Maximum repetitive peak isolation voltage	According to DIN EN 60747-5-5	V <sub>IORM</sub>	890	V <sub>peak</sub>
Isolation resistance	T <sub>amb</sub> = 25 °C, V <sub>IO</sub> = 500 V	R <sub>IO</sub>	≥ 10 <sup>12</sup>	Ω
	T <sub>amb</sub> = 100 °C, V <sub>IO</sub> = 500 V	R <sub>IO</sub>	≥ 10 <sup>11</sup>	Ω
Output safety power		P <sub>SO</sub>	500	mW
Input safety current		I <sub>SI</sub>	300	mA
Input safety temperature		T <sub>S</sub>	175	°C
Creepage distance	DIP-8		≥ 7	mm
Clearance distance			≥ 7	mm
Creepage distance	DIP-8, 400 mil (option 6)		≥ 8	mm
Clearance distance			≥ 8	mm
Creepage distance	SMD-8 (option 7)		≥ 8	mm
Clearance distance			≥ 8	mm
Creepage distance	SMD-8 (option 9)		≥ 8	mm
Clearance distance			≥ 8	mm
Insulation thickness		DTI	≥ 0.4	mm

**Note**

- As per IEC 60747-5-5, § 7.4.3.8.2, this optocoupler is 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<sub>amb</sub> = 25 °C, unless otherwise specified)

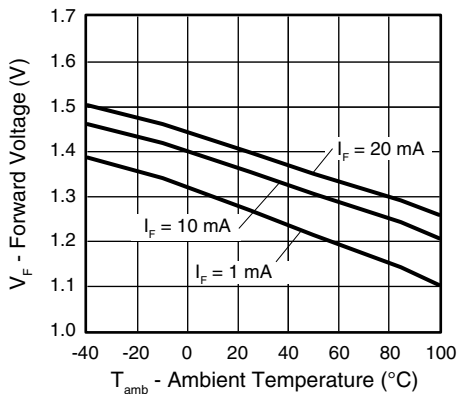


Fig. 10 - Forward Voltage vs. Ambient Temperature



Fig. 11 - Forward Voltage vs. Forward Current



Fig. 12 - Reverse Current vs. Ambient Temperature



Fig. 15 - Input Threshold On Current vs. Ambient Temperature

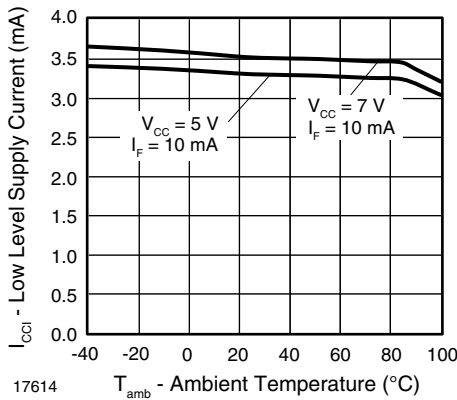


Fig. 13 - Low Level Supply Current vs. Ambient Temperature

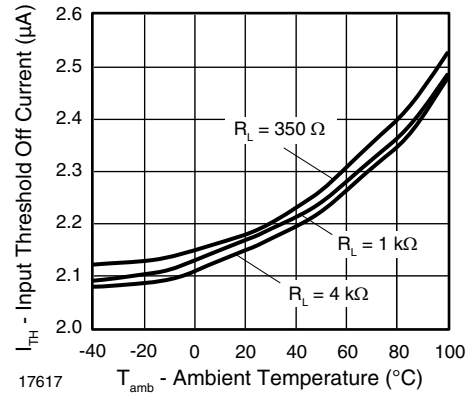


Fig. 16 - Input Threshold Off Current vs. Ambient Temperature

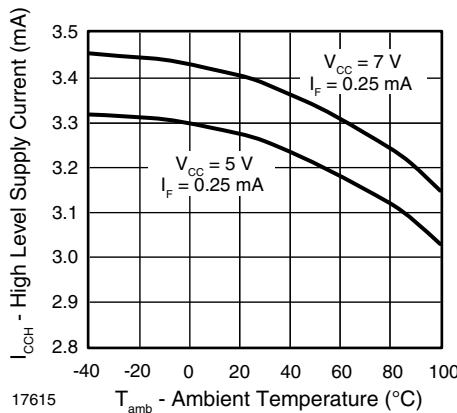


Fig. 14 - High Level Supply Current vs. Ambient Temperature

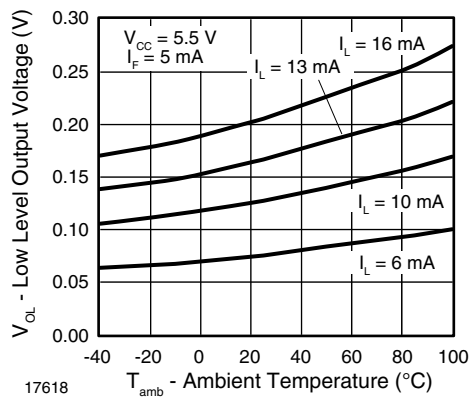


Fig. 17 - Low Level Output Voltage vs. Ambient Temperature



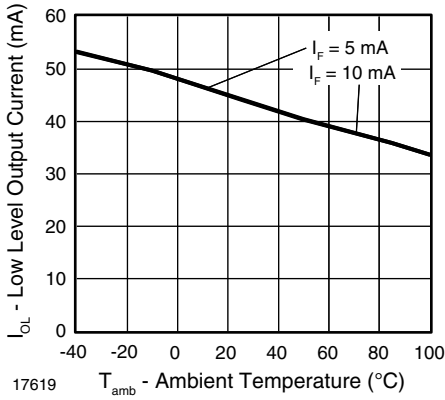


Fig. 18 - Low Level Output Current vs. Ambient Temperature



Fig. 21 - Propagation Delay vs. Ambient Temperature

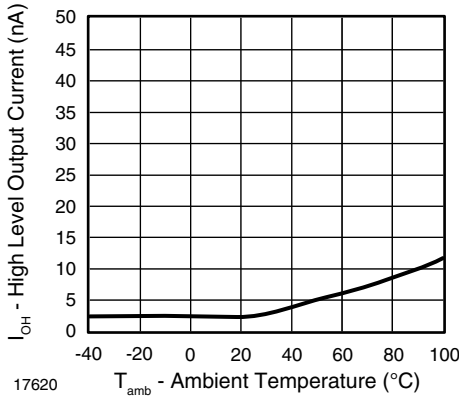


Fig. 19 - High Level Output Current vs. Ambient Temperature

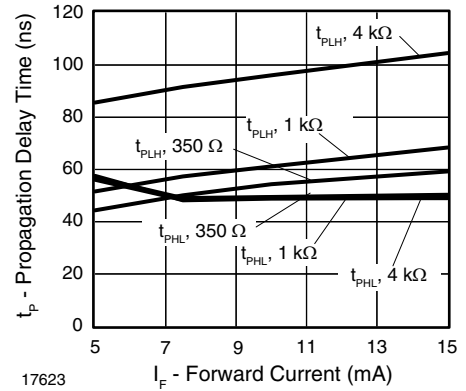


Fig. 22 - Propagation Delay vs. Forward Current

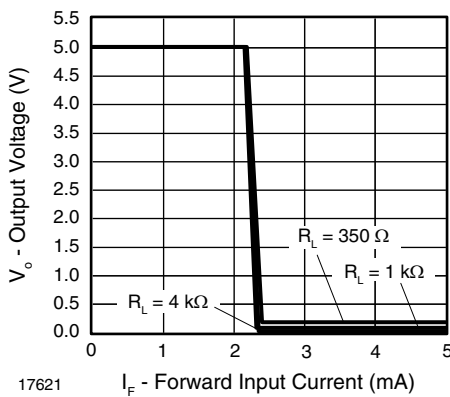


Fig. 20 - Output Voltage vs. Forward Input Current



Fig. 23 - Pulse Width Distortion vs. Ambient Temperature

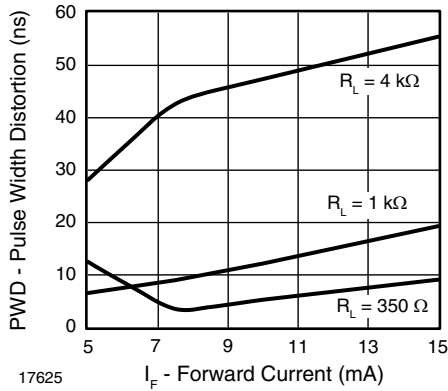


Fig. 24 - Pulse Width Distortion vs. Forward Current

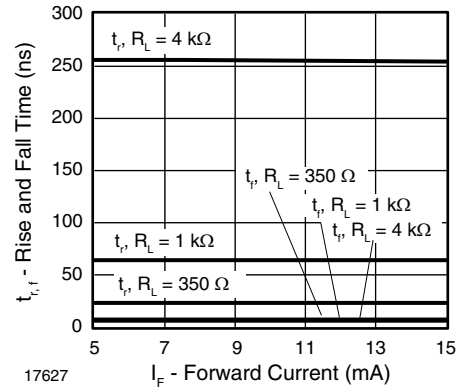


Fig. 26 - Rise and Fall Time vs. Forward Current

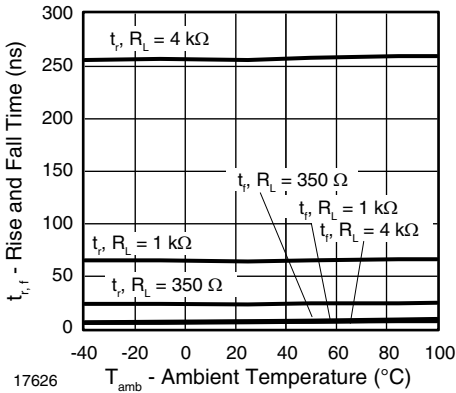


Fig. 25 - Rise and Fall Time vs. Ambient Temperature

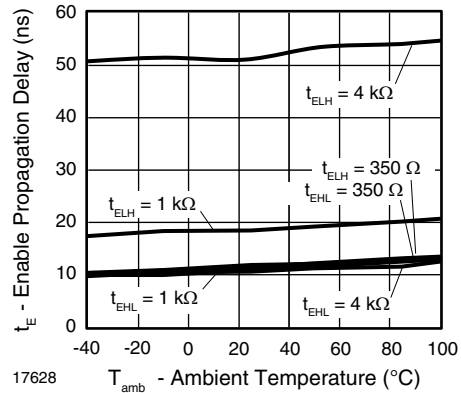
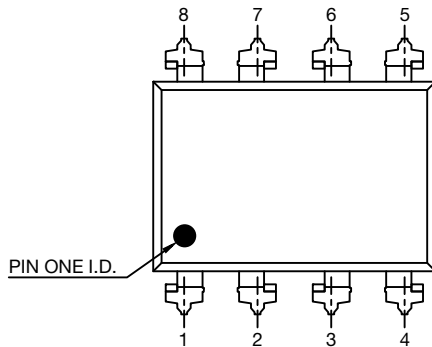
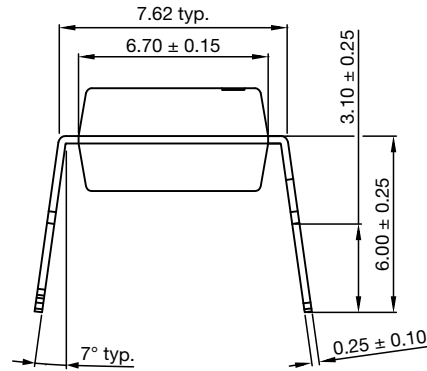
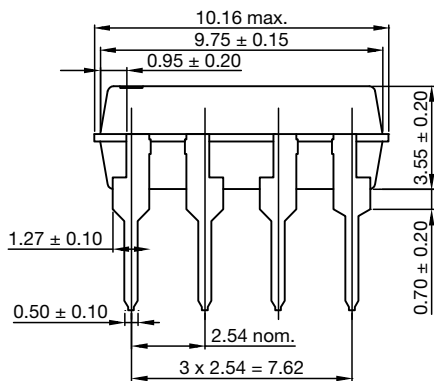


Fig. 27 - Enable Propagation Delay vs. Ambient Temperature

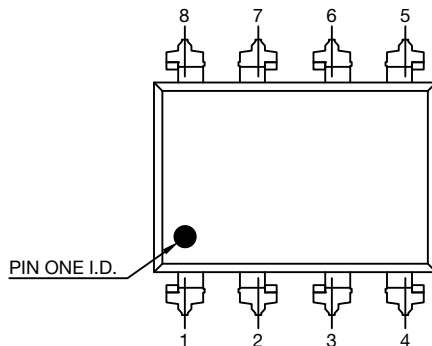
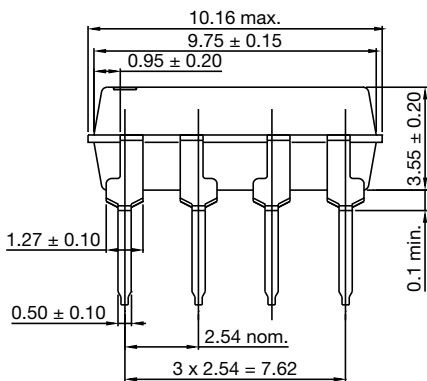


**PACKAGE DIMENSIONS** (in millimeters)

**DIP-8**

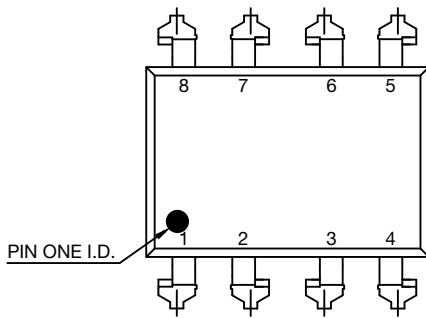


**DIP-8, 400 mil (option 6)**





SMD-8 (option 7)



SMD-8 (option 9)



**PACKAGE MARKING**

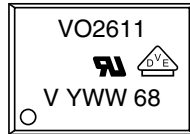


Fig. 28 - Example of VO2611-X017T

**Notes**

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

**PACKING INFORMATION** (in millimeters)

**Tube**

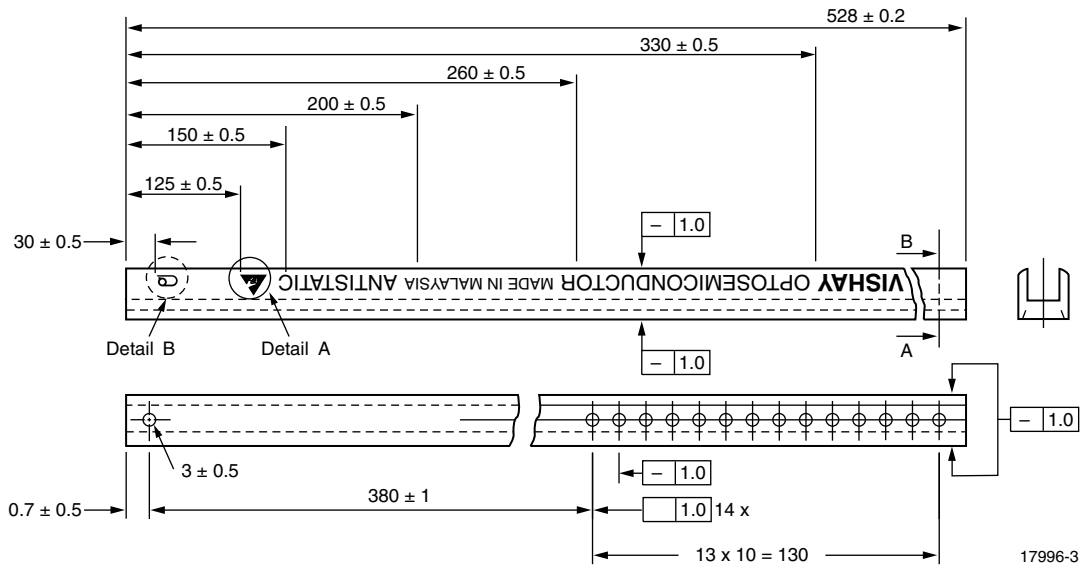


Fig. 29 - Shipping Tube Specifications for DIP-8 Packages

DEVICES PER TUBS			
TYPE	UNITS/TUBE	TUBES/BOX	UNITS/BOX
DIP-8	50	40	2000

**DIP-8**

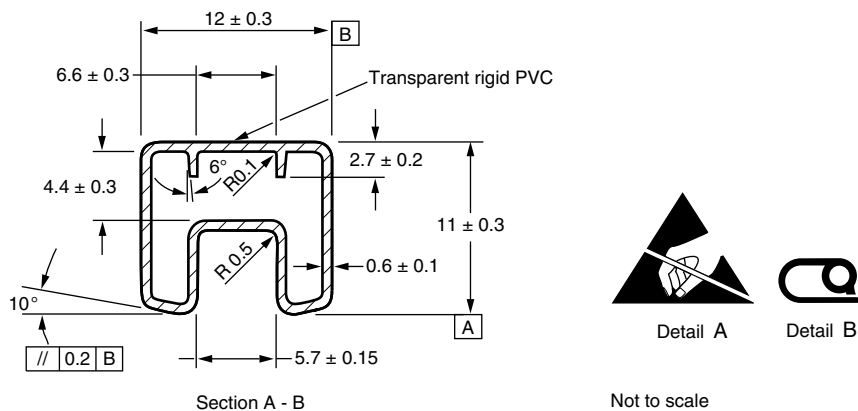


Fig. 30 - Tube Shipping Medium

DIP-8, 400 mil (option 6)

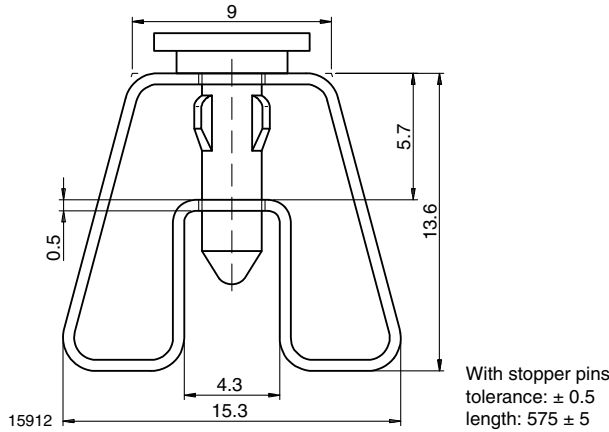
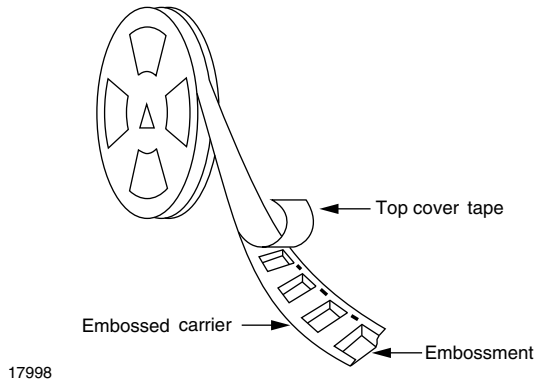


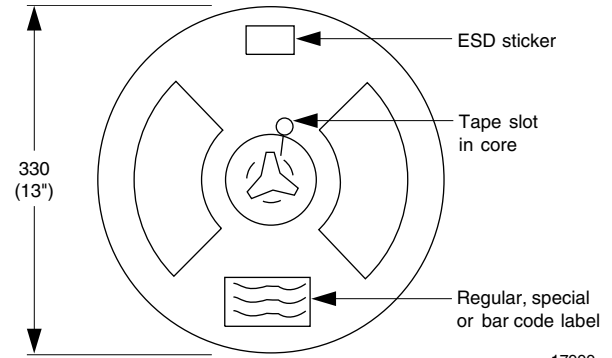
Fig. 31 - Tube Shipping Medium

Tape and Reel



17998

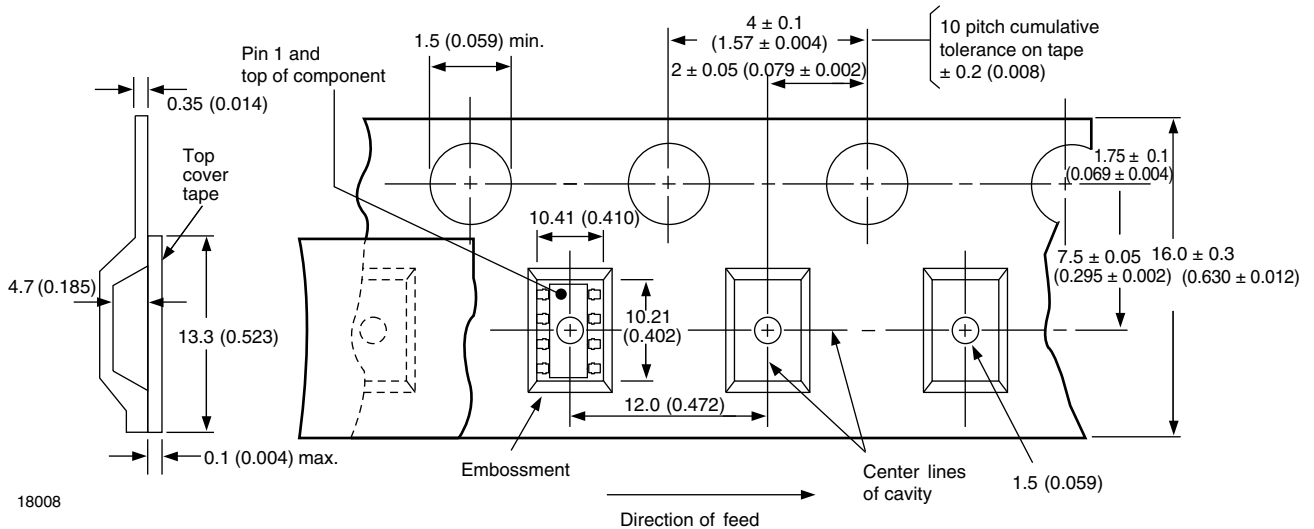
Fig. 32 - Tape and Reel Shipping Medium



17999

Fig. 33 - Tape and Reel Shipping Medium

SMD-8 (option 7)



18008

Fig. 34 - Tape and Reel Packing (1000 pieces on Reel)

SMD-8 (option 9)

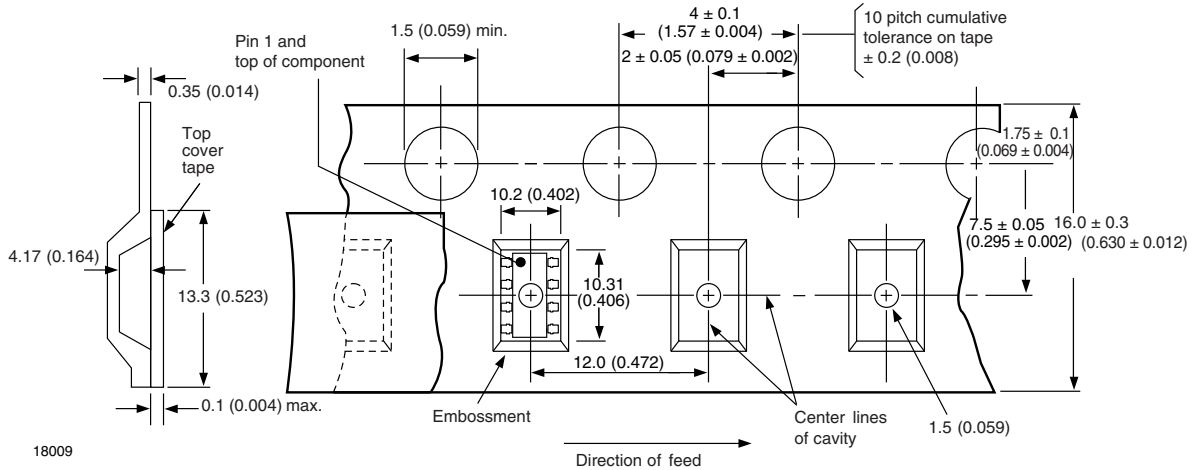


Fig. 35 - Tape and Reel Shipping Medium

SOLDER PROFILES

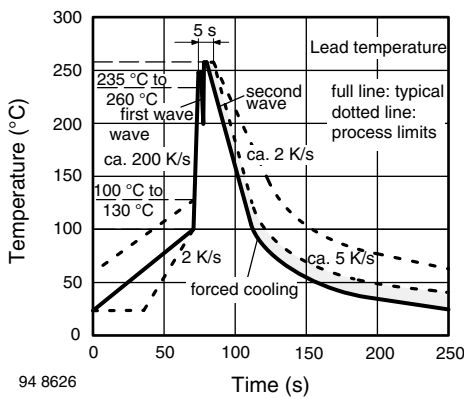


Fig. 36 - Wave Soldering Double Wave Profile According to J-STD-020 for DIP Devices

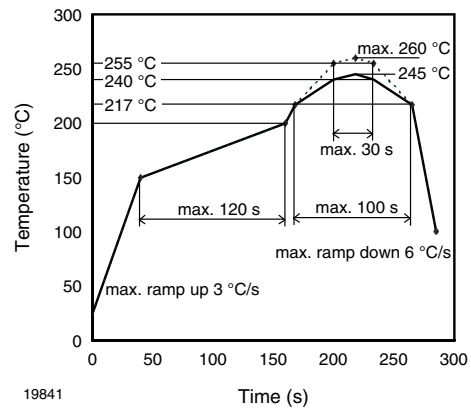


Fig. 37 - Lead (Pb)-free Reflow Solder Profile According to J-STD-020 for SMD Devices

HANDLING AND STORAGE CONDITIONS

ESD level: HBM class 2

Floor life: unlimited

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

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



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