

To our customers,

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## Old Company Name in Catalogs and Other Documents

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Renesas Electronics website: <http://www.renesas.com>

April 1<sup>st</sup>, 2010  
Renesas Electronics Corporation

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# PHOTOCOUPLER

# PS9821-1,-2

## HIGH CMR, 15 Mbps OPEN COLLECTOR OUTPUT TYPE

## 8-PIN SSOP (SO-8)

## 3.3 V HIGH-SPEED PHOTOCOUPLER

—NEPOC Series—

### DESCRIPTION

The PS9821-1 and PS9821-2 are active-low type high-speed photocouplers that use a GaAlAs light-emitting diode on the input side and a photodetector IC that includes a photodiode and a signal processor on the same chip on the output side.

The PS9821-1, -2 are designed specifically for high common mode transient immunity (CMR) and low pulse width distortion, PS9821-2 is suitable for high density applications.

### FEATURES

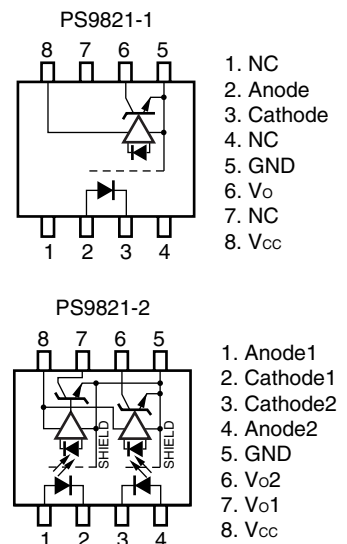
- Low power consumption ( $V_{CC} = 3.3\text{ V}$ )
- Pulse width distortion ( $|t_{PHL} - t_{PLH}| = 35\text{ ns MAX.}$ )
- High common mode transient immunity ( $CMH, CML = \pm 15\text{ kV}/\mu\text{s MIN.}$ )
- 40% reduction of mounting area (5-pin SOP  $\times$  2)
- High-speed (15 Mbps)
- High isolation voltage ( $BV = 2\ 500\text{ Vr.m.s.}$ )
- Open collector output
- Ordering number of tape product : PS9821-1-F3, F4: 1 500 pcs/reel  
: PS9821-2-F3, F4: 1 500 pcs/reel
- Pb-Free product
- Safety standards
  - UL approved: File No. E72422
  - DIN EN60747-5-2 (VDE0884 Part2) approved No.40008347 (option)

### APPLICATIONS

- Measurement equipment
- PDP
- FA Network

### PIN CONNECTION

(Top View)

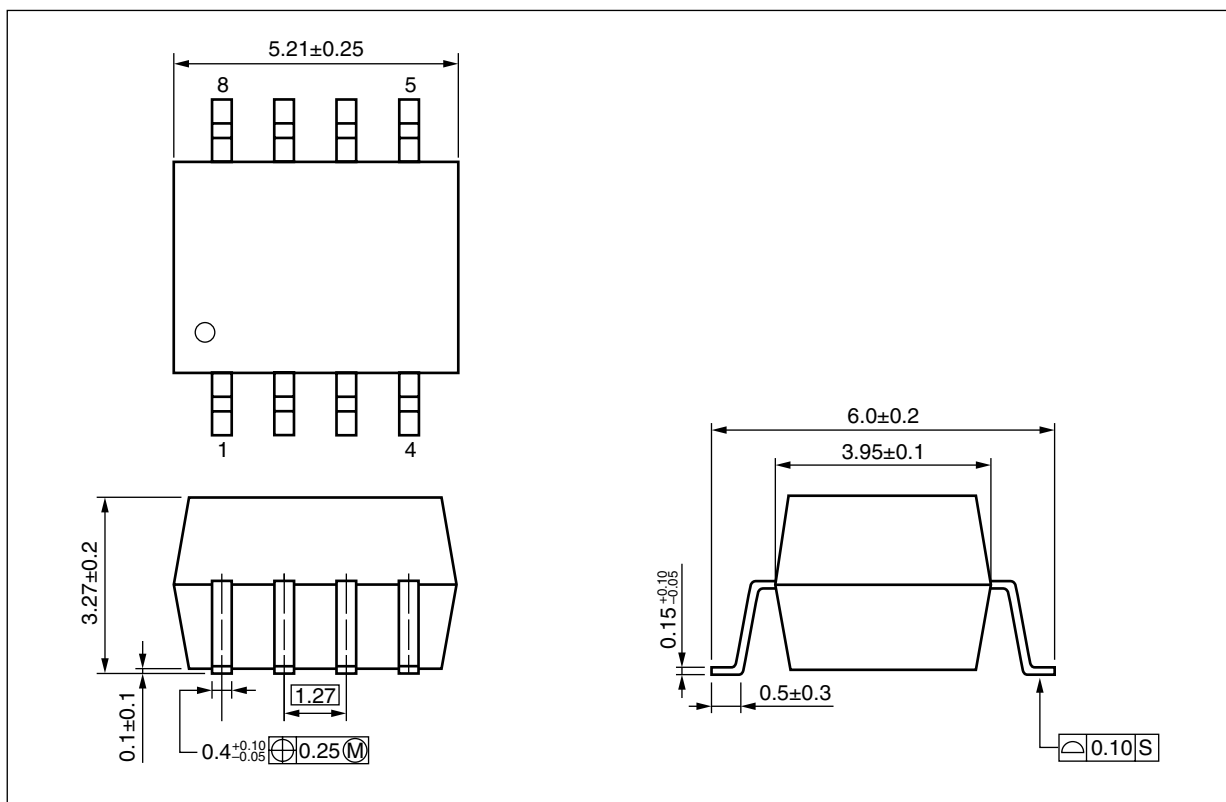


### TRUTH TABLE

LED	Output
ON	L
OFF	H

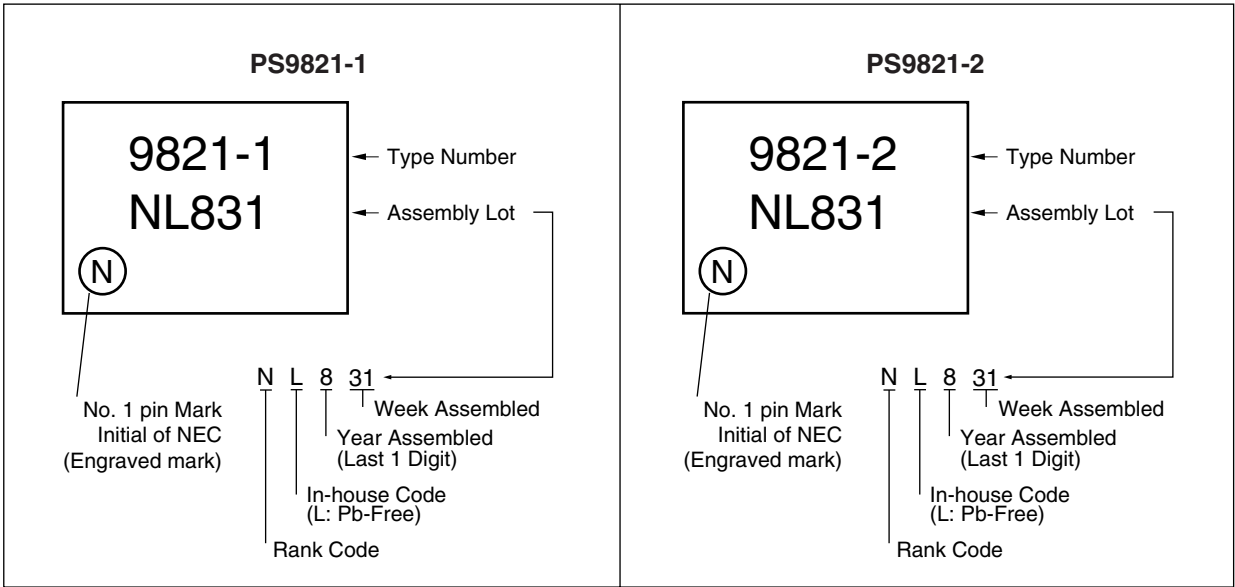
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<R> PACKAGE DIMENSIONS (UNIT: mm)

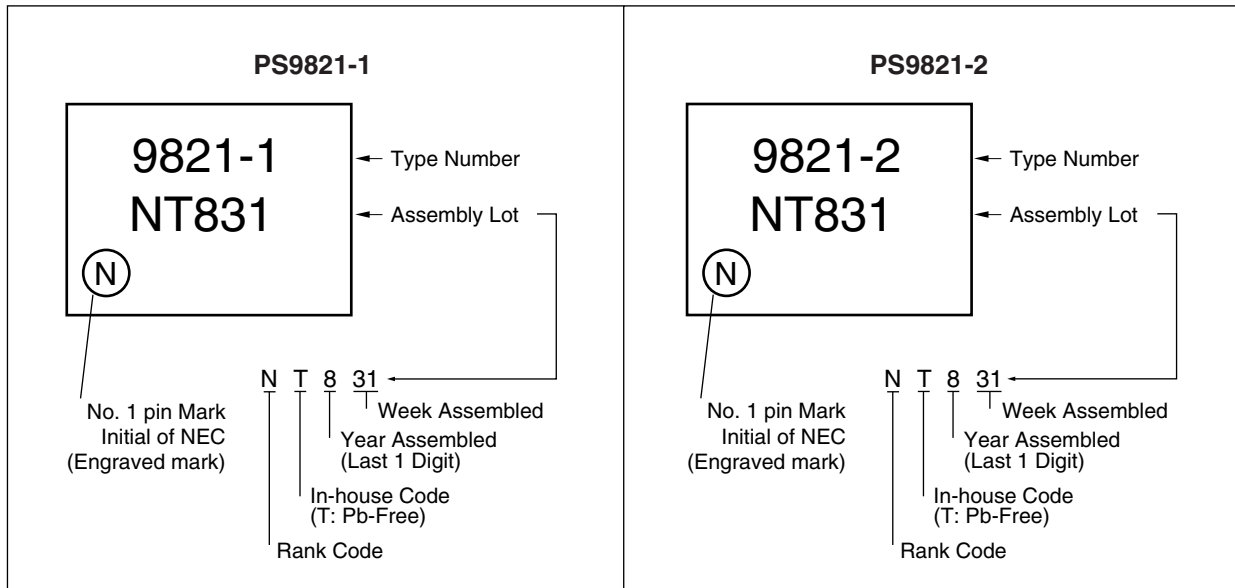


<R> MARKING EXAMPLE

SnBi PLATING



Ni/Pd/Au PLATING



<R> ORDERING INFORMATION

Part Number	Order Number	Solder Plating Specification	Packing Style	Safety Standards Approval	Application Part Number <sup>*1</sup>
PS9821-1	PS9821-1-A	Pb-Free (SnBi)	20 pcs (Tape 20 pcs cut)	Standard products (UL approved)	PS9821-1
PS9821-1-F3	PS9821-1-F3-A		Embossed Tape 1 500 pcs/reel		
PS9821-1-F4	PS9821-1-F4-A				
PS9821-2	PS9821-2-A		20 pcs (Tape 20 pcs cut)		PS9821-2
PS9821-2-F3	PS9821-2-F3-A		Embossed Tape 1 500 pcs/reel		
PS9821-2-F4	PS9821-2-F4-A				
PS9821-1-V	PS9821-1-V-A		20 pcs (Tape 20 pcs cut)	DIN EN60747-5-2 (VDE0884 Part2) approved (Option)	PS9821-1
PS9821-1-V-F3	PS9821-1-V-F3-A		Embossed Tape 1 500 pcs/reel		
PS9821-1-V-F4	PS9821-1-V-F4-A				
PS9821-2-V	PS9821-2-V-A		20 pcs (Tape 20 pcs cut)		PS9821-2
PS9821-2-V-F3	PS9821-2-V-F3-A		Embossed Tape 1 500 pcs/reel		
PS9821-2-V-F4	PS9821-2-V-F4-A				
PS9821-1	PS9821-1-AX	Pb-Free (Ni/Pd/Au)	20 pcs (Tape 20 pcs cut)	Standard products (UL approved)	PS9821-1
PS9821-1-F3	PS9821-1-F3-AX		Embossed Tape 1 500 pcs/reel		
PS9821-1-F4	PS9821-1-F4-AX				
PS9821-2	PS9821-2-AX		20 pcs (Tape 20 pcs cut)		PS9821-2
PS9821-2-F3	PS9821-2-F3-AX		Embossed Tape 1 500 pcs/reel		
PS9821-2-F4	PS9821-2-F4-AX				
PS9821-1-V	PS9821-1-V-AX		20 pcs (Tape 20 pcs cut)	DIN EN60747-5-2 (VDE0884 Part2) approved (Option)	PS9821-1
PS9821-1-V-F3	PS9821-1-V-F3-AX		Embossed Tape 1 500 pcs/reel		
PS9821-1-V-F4	PS9821-1-V-F4-AX				
PS9821-2-V	PS9821-2-V-AX		20 pcs (Tape 20 pcs cut)		PS9821-2
PS9821-2-V-F3	PS9821-2-V-F3-AX		Embossed Tape 1 500 pcs/reel		
PS9821-2-V-F4	PS9821-2-V-F4-AX				

\*1 For the application of the Safety Standard, following part number should be used.

**ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C, unless otherwise specified)**

Parameter		Symbol	Ratings		Unit
			PS9821-1	PS9821-2	
Diode	Forward Current	I <sub>F</sub>	20 <sup>*1</sup>	15 <sup>*2</sup>	mA
	Reverse Voltage	V <sub>R</sub>	5		V/ch
Detector	Supply Voltage	V <sub>CC</sub>	7		V
	Output Voltage	V <sub>O</sub>	7		V/ch
	Output Current	I <sub>O</sub>	25		mA/ch
	Power Dissipation <sup>*3</sup>	P <sub>C</sub>	40		mW/ch
Isolation Voltage <sup>*4</sup>		BV	2 500		Vr.m.s.
Operating Ambient Temperature		T <sub>A</sub>	-40 to +85		°C
Storage Temperature		T <sub>stg</sub>	-55 to +125		°C

\*1 Reduced to 0.3 mA/°C at T<sub>A</sub> = 60°C or more.

\*2 Reduced to 0.1 mA/°C at T<sub>A</sub> = 60°C or more.

\*3 Applies to output pin V<sub>O</sub> (collector pin). Reduced to 1.5 mW/°C at T<sub>A</sub> = 65°C or more.

\*4 AC voltage for 1 minute at T<sub>A</sub> = 25°C, RH = 60% between input and output.

Pins 1-4 shorted together, 5-8 shorted together.

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Low Level Input Voltage	V <sub>FL</sub>	0		0.8	V
High Level Input Current	I <sub>FH</sub>	6.3	10	12.5	mA
Supply Voltage	V <sub>CC</sub>	2.7		3.6	V
Pull-up Resistance	R <sub>L</sub>	330		4 k	Ω
TLL (R <sub>L</sub> = 1.0 kΩ, loads)	N			5	

**ELECTRICAL CHARACTERISTICS (1/2) (T<sub>A</sub> = -40 to +85°C, unless otherwise specified)**

Parameter		Symbol	Conditions	MIN.	TYP. <sup>*1</sup>	MAX.	Unit
Diode	Forward Voltage	V <sub>F</sub>	I <sub>F</sub> = 10 mA, T <sub>A</sub> = 25°C	1.4	1.65	1.8	V
	Reverse Current	I <sub>R</sub>	V <sub>R</sub> = 3.0 V, T <sub>A</sub> = 25°C			10	μA
	Terminal Capacitance	C <sub>i</sub>	V <sub>F</sub> = 0 V, f = 1 MHz, T <sub>A</sub> = 25°C		30		pF
Detector	High Level Output Current	I <sub>OH</sub>	V <sub>CC</sub> = V <sub>O</sub> = 3.3 V, I <sub>F</sub> = 0.8 mA		1	80	μA
			V <sub>CC</sub> = V <sub>O</sub> = 5.5 V, I <sub>F</sub> = 0.8 mA		1 <sup>*2</sup>		
	Low Level Output Voltage <sup>*3</sup>	V <sub>OL</sub>	V <sub>CC</sub> = 3.3 V, I <sub>F</sub> = 5.0 mA, I <sub>OL</sub> = 13 mA		0.2	0.6	V
			V <sub>CC</sub> = 5.5 V, I <sub>F</sub> = 5.0 mA, I <sub>OL</sub> = 13 mA		0.2 <sup>*2</sup>		
	High Level Supply Current (PS9821-1)	I <sub>OCH</sub>	V <sub>CC</sub> = 3.3 V, I <sub>F</sub> = 0 mA, V <sub>O</sub> = open		4	7	mA
			V <sub>CC</sub> = 5.5 V, I <sub>F</sub> = 0 mA, V <sub>O</sub> = open		5 <sup>*2</sup>		
	High Level Supply Current (PS9821-2)		V <sub>CC</sub> = 3.3 V, I <sub>F</sub> = 0 mA, V <sub>O</sub> = open		8	14	
			V <sub>CC</sub> = 5.5 V, I <sub>F</sub> = 0 mA, V <sub>O</sub> = open		10 <sup>*2</sup>		
	Low Level Supply Current (PS9821-1)	I <sub>OCL</sub>	V <sub>CC</sub> = 3.3 V, I <sub>F</sub> = 10 mA, V <sub>O</sub> = open		7	10	
			V <sub>CC</sub> = 5.5 V, I <sub>F</sub> = 10 mA, V <sub>O</sub> = open		9 <sup>*2</sup>		
	Low Level Supply Current (PS9821-2)		V <sub>CC</sub> = 3.3 V, I <sub>F</sub> = 10 mA, V <sub>O</sub> = open		14	20	
			V <sub>CC</sub> = 5.5 V, I <sub>F</sub> = 10 mA, V <sub>O</sub> = open		18 <sup>*2</sup>		
Coupled	Threshold Input Current (H → L)	I <sub>FHL</sub>	V <sub>CC</sub> = 3.3 V, V <sub>O</sub> = 0.8 V, R <sub>L</sub> = 350 Ω		2.5	5	mA
			V <sub>CC</sub> = 5 V, V <sub>O</sub> = 0.8 V, R <sub>L</sub> = 350 Ω		2.5 <sup>*2</sup>		
	Isolation Resistance	R <sub>I-O</sub>	V <sub>I-O</sub> = 1 kV <sub>DC</sub> , RH = 40 to 60%, T <sub>A</sub> = 25°C	10 <sup>11</sup>			Ω
	Insulation Resistance (Input-Input), (PS9821-2)	R <sub>I-I</sub>	V <sub>I-I</sub> = 1 kV <sub>DC</sub> , RH = 40 to 60%, T <sub>A</sub> = 25°C	10 <sup>10</sup>			Ω
	Isolation Capacitance	C <sub>I-O</sub>	V = 0 V, f = 1 MHz, T <sub>A</sub> = 25°C		0.6		pF
	Insulation Capacitance (Input-Input), (PS9821-2)	C <sub>I-I</sub>	V = 0 V, f = 1 MHz, T <sub>A</sub> = 25°C		0.3		pF
	Propagation Delay Time (H → L) <sup>*4</sup>	t <sub>PHL</sub>	T <sub>A</sub> = 25°C		45	75	ns
			V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA			100	
			V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA		38 <sup>*2</sup>		
	Propagation Delay Time (L → H) <sup>*4</sup>	t <sub>PLH</sub>	T <sub>A</sub> = 25°C		50	75	
			V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA			100	
			V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA		43 <sup>*2</sup>		
	Rise Time	t <sub>r</sub>	V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA		20		
			V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA		20 <sup>*2</sup>		
	Fall Time	t <sub>f</sub>	V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA		5		
			V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA		5 <sup>*2</sup>		
	Pulse Width Distortion (PWD) <sup>*4</sup>	t <sub>PLH</sub> - t <sub>PHL</sub>	V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA		5	35	
			V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA		5 <sup>*2</sup>		
	Propagation Delay Skew	t <sub>PSK</sub>	V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA			40	



**ELECTRICAL CHARACTERISTICS (2/2) ( $T_A = -40$  to  $+85^\circ\text{C}$ , unless otherwise specified)**

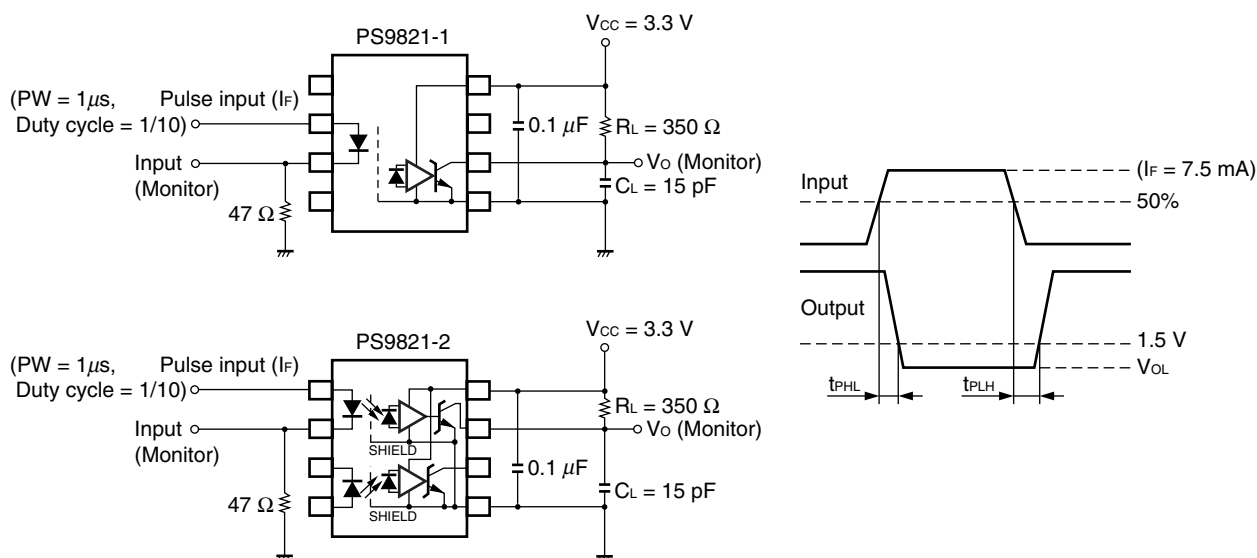
Parameter	Symbol	Conditions	MIN.	TYP.*1	MAX.	Unit
Coupled	Common Mode Transient Immunity at High Level Output <sup>*5</sup>	$V_{CC} = 3.3\text{ V}$ , $R_L = 350\ \Omega$ , $T_A = 25^\circ\text{C}$ , $I_F = 0\text{ mA}$ , $V_O > 2\text{ V}$ , $V_{CM} = 1\text{ kV}$	15	20		$\text{kV}/\mu\text{s}$
		$V_{CC} = 5\text{ V}$ , $R_L = 350\ \Omega$ , $T_A = 25^\circ\text{C}$ , $I_F = 0\text{ mA}$ , $V_O > 2\text{ V}$ , $V_{CM} = 1\text{ kV}$		20 <sup>*2</sup>		
	Common Mode Transient Immunity at Low Level Output <sup>*5</sup>	$V_{CC} = 3.3\text{ V}$ , $R_L = 350\ \Omega$ , $T_A = 25^\circ\text{C}$ , $I_F = 7.5\text{ mA}$ , $V_O < 0.8\text{ V}$ , $V_{CM} = 1\text{ kV}$	15	20		
		$V_{CC} = 5\text{ V}$ , $R_L = 350\ \Omega$ , $T_A = 25^\circ\text{C}$ , $I_F = 7.5\text{ mA}$ , $V_O < 0.8\text{ V}$ , $V_{CM} = 1\text{ kV}$		20 <sup>*2</sup>		

\*1 Typical values at  $T_A = 25^\circ\text{C}$

\*2 These values are reference values.

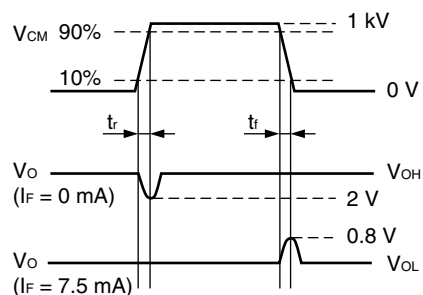
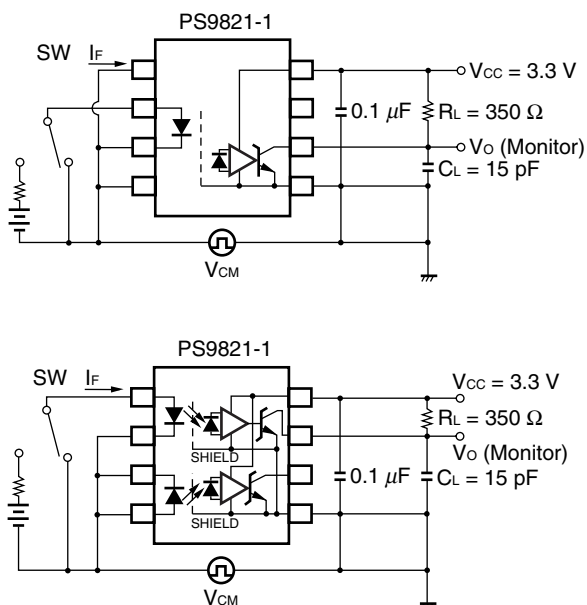
\*3 Because  $V_{OL}$  of 2 V or more may be output when LED current input and when output supply of  $V_{CC} = 2.6\text{ V}$  or less, it is important to confirm the characteristics (operation with the power supply on and off) during design, before using this device.

\*4 Test circuit for propagation delay time



**Remark**  $C_L$  includes probe and stray wiring capacitance.

\*5 Test circuit for common mode transient immunity

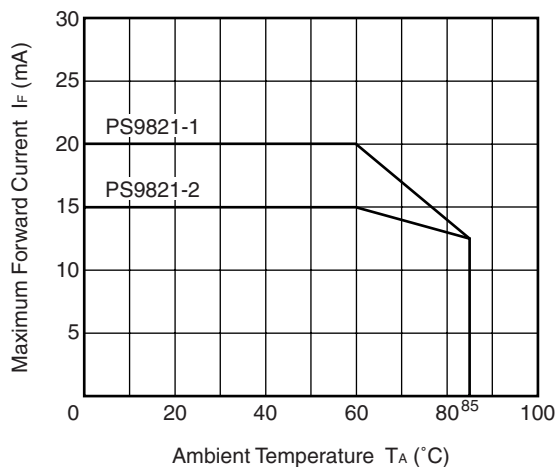


**USAGE CAUTIONS**

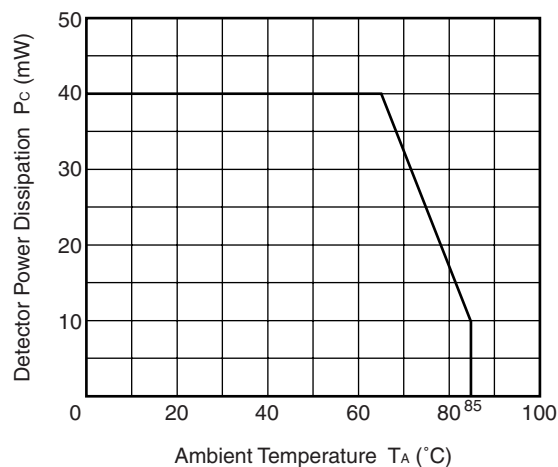
1. This product is weak for static electricity by designed with high-speed integrated circuit so protect against static electricity when handling.
2. By-pass capacitor of  $0.1 \mu\text{F}$  is used between  $V_{CC}$  and GND near device. Also, ensure that the distance between the leads of the photocoupler and capacitor is no more than 10 mm.
3. Avoid storage at a high temperature and high humidity.

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

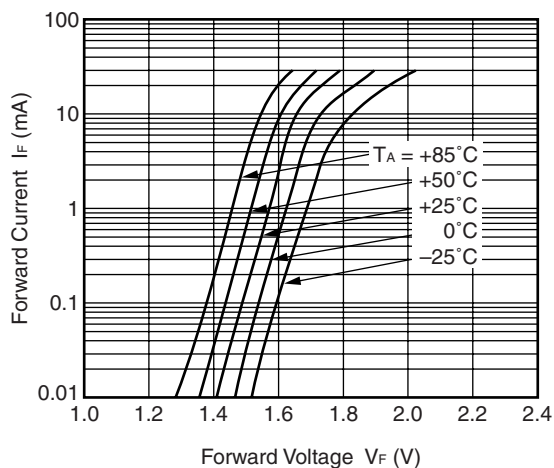
**MAXIMUM FORWARD CURRENT vs. AMBIENT TEMPERATURE**



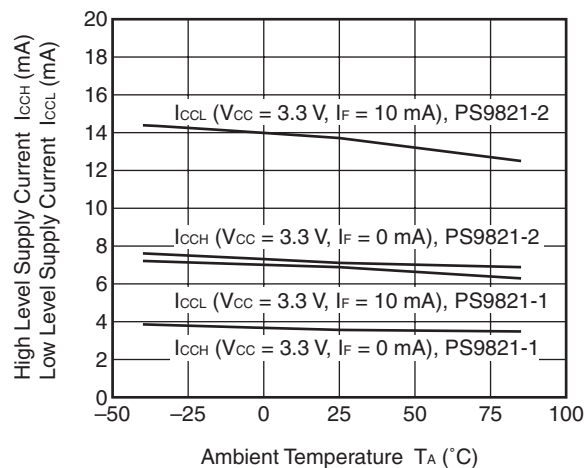
**DETECTOR POWER DISSIPATION vs. AMBIENT TEMPERATURE**



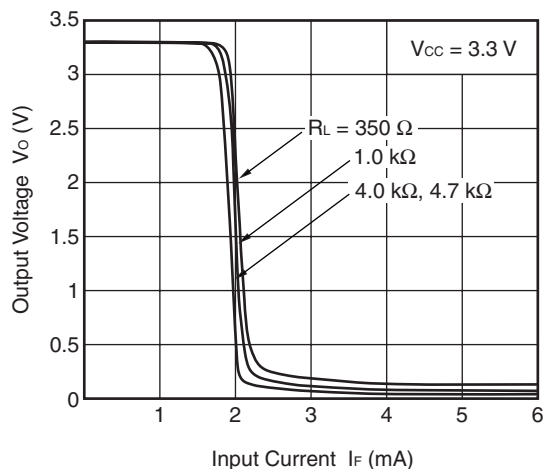
**FORWARD CURRENT vs. FORWARD VOLTAGE**



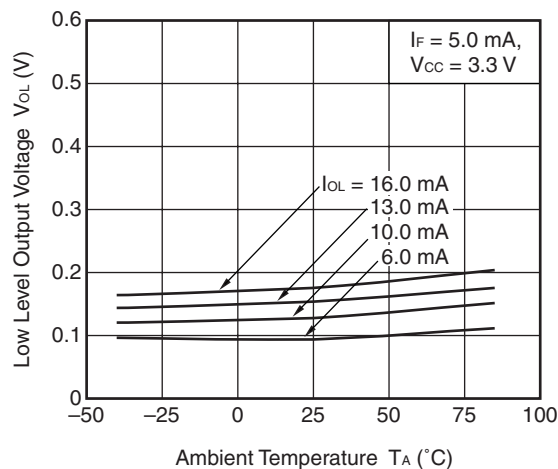
**SUPPLY CURRENT vs. AMBIENT TEMPERATURE**



**OUTPUT VOLTAGE vs. INPUT CURRENT**

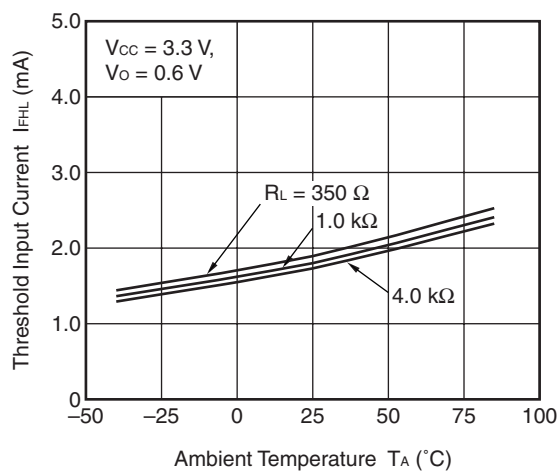


**LOW LEVEL OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE**

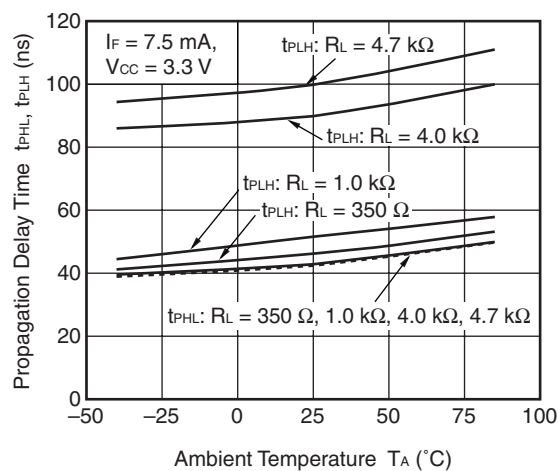


**Remark** The graphs indicate nominal characteristics.

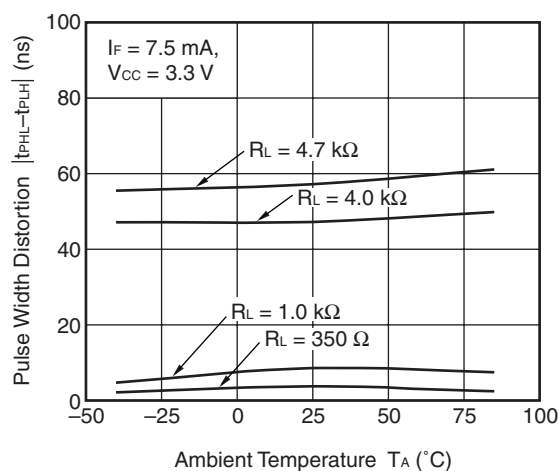
THRESHOLD INPUT CURRENT vs.  
AMBIENT TEMPERATURE



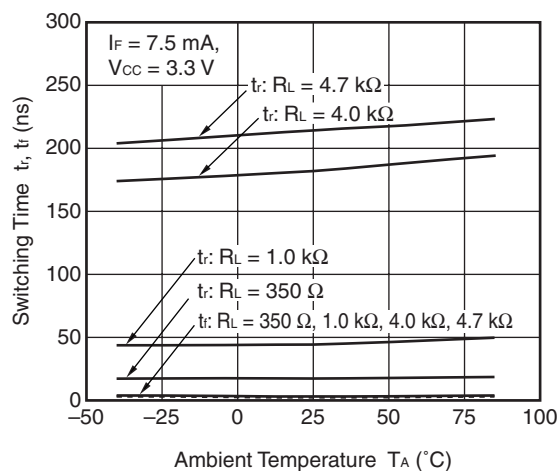
PROPAGATION DELAY TIME vs.  
AMBIENT TEMPERATURE



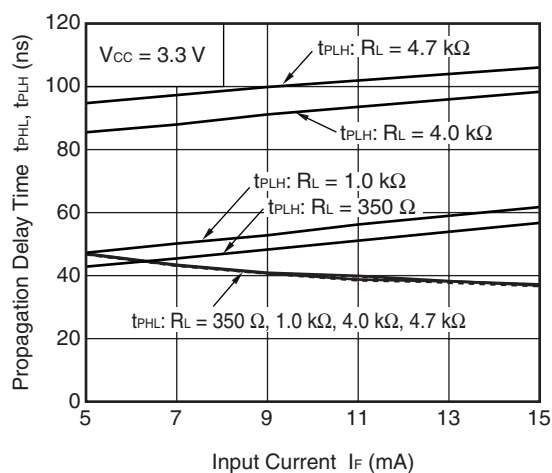
PULSE WIDTH DISTORTION vs.  
AMBIENT TEMPERATURE



SWITCHING TIME vs.  
AMBIENT TEMPERATURE



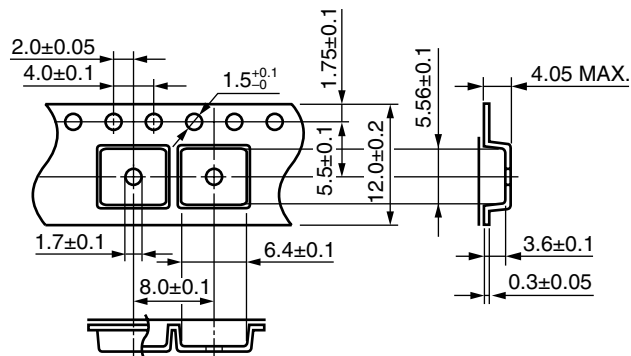
PROPAGATION DELAY TIME vs.  
INPUT CURRENT



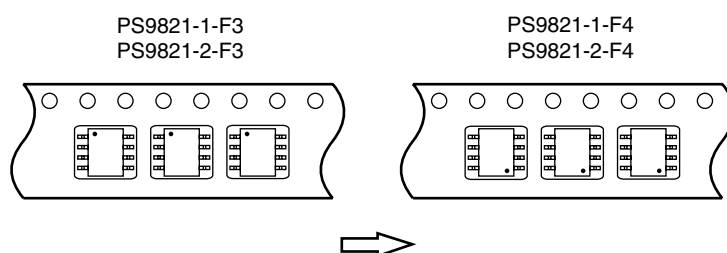
**Remark** The graphs indicate nominal characteristics.

TAPING SPECIFICATIONS (UNIT: mm)

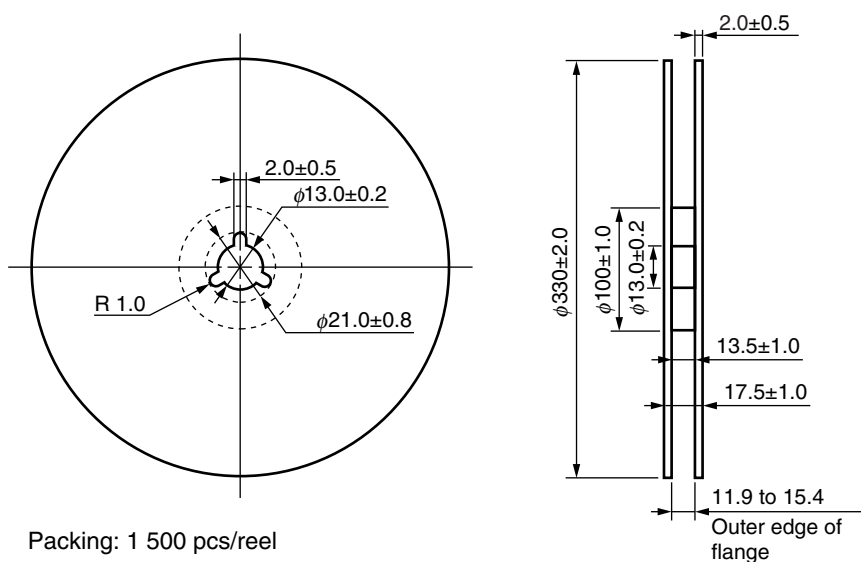
Outline and Dimensions (Tape)



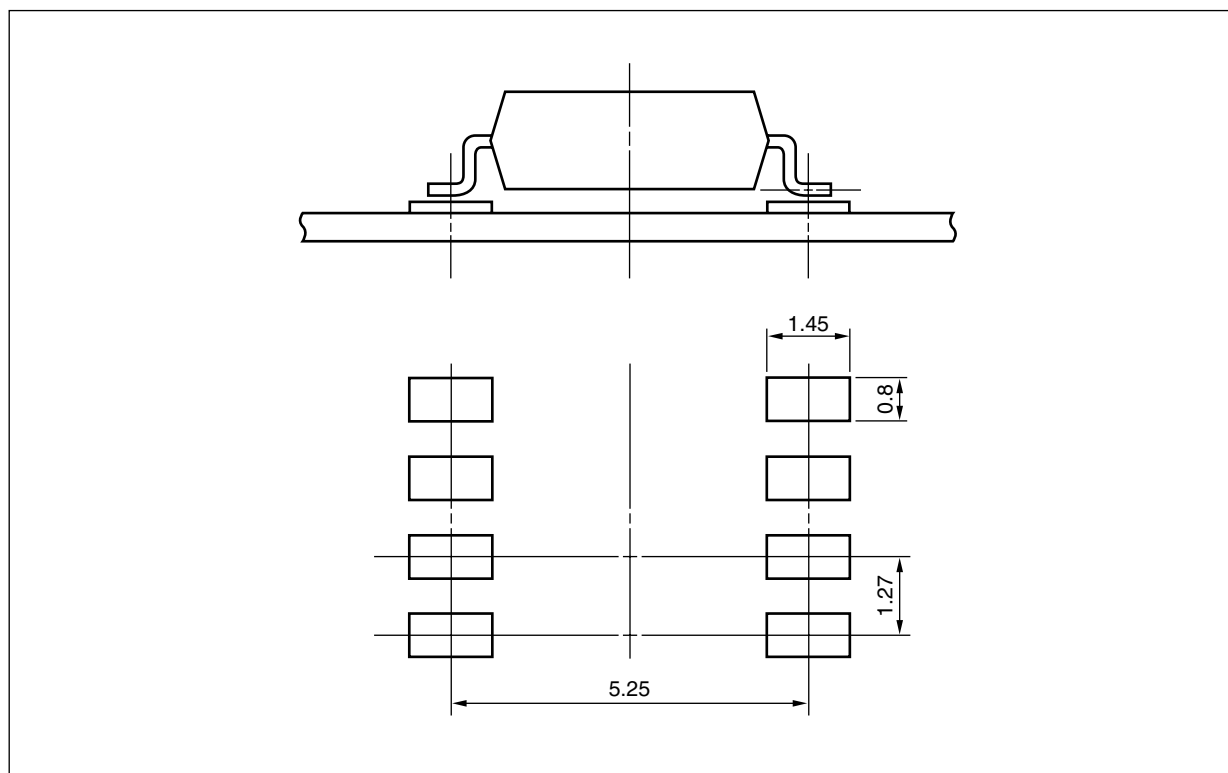
Taping Direction



Outline and Dimensions (Reel)



RECOMMENDED MOUNT PAD DIMENSIONS (UNIT: mm)



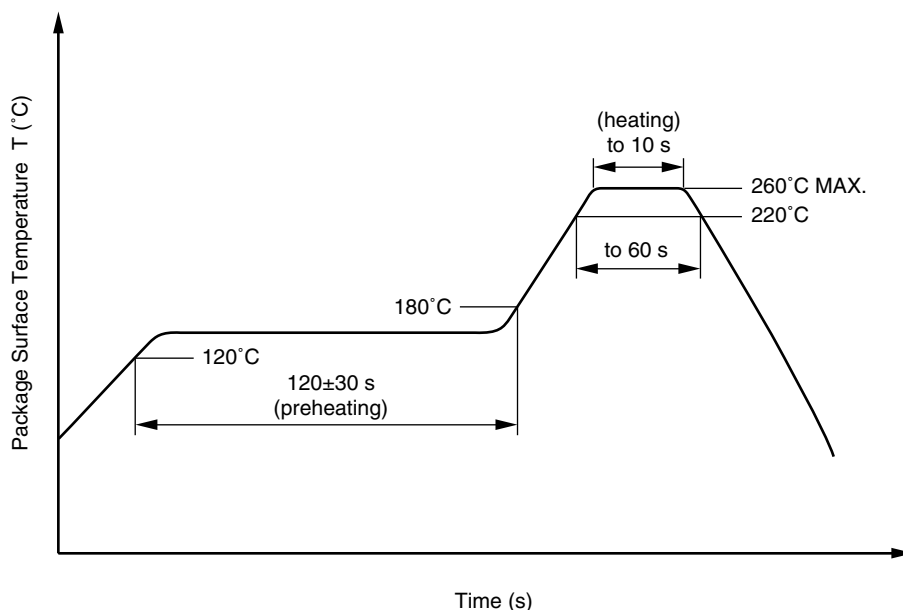
## NOTES ON HANDLING

### 1. Recommended soldering conditions

#### (1) Infrared reflow soldering

- Peak reflow temperature 260°C or below (package surface temperature)
- Time of peak reflow temperature 10 seconds or less
- Time of temperature higher than 220°C 60 seconds or less
- Time to preheat temperature from 120 to 180°C 120±30 s
- Number of reflows Three
- Flux Rosin flux containing small amount of chlorine (The flux with a maximum chlorine content of 0.2 Wt% is recommended.)

Recommended Temperature Profile of Infrared Reflow



#### (2) Wave soldering

- Temperature 260°C or below (molten solder temperature)
- Time 10 seconds or less
- Preheating conditions 120°C or below (package surface temperature)
- Number of times One (Allowed to be dipped in solder including plastic mold portion.)
- Flux Rosin flux containing small amount of chlorine (The flux with a maximum chlorine content of 0.2 Wt% is recommended.)

#### (3) Soldering by soldering iron

- Peak temperature (lead part temperature) 350°C or below
- Time (each pins) 3 seconds or less
- Flux Rosin flux containing small amount of chlorine (The flux with a maximum chlorine content of 0.2 Wt% is recommended.)

(a) Soldering of leads should be made at the point 1.5 to 2.0 mm from the root of the lead.

(b) Please be sure that the temperature of the package would not be heated over 100°C.

**(4) Cautions**

- Fluxes

Avoid removing the residual flux with freon-based and chlorine-based cleaning solvent.

**2. Cautions regarding noise**

Be aware that when voltage is applied suddenly between the photocoupler's input and output or between collector-emitters at startup, the output transistor may enter the on state, even if the voltage is within the absolute maximum ratings.

**USAGE CAUTIONS**

1. Protect against static electricity when handling.
2. Avoid storage at a high temperature and high humidity.



<R> SPECIFICATION OF VDE MARKS LICENSE DOCUMENT

Parameter	Symbol	Speck	Unit
Application classification (DIN EN 60664-1 VDE0110 Part 1) for rated line voltages $\leq 300$ Vr.m.s. for rated line voltages $\leq 600$ Vr.m.s.		IV III	
Climatic test class (DIN EN 60664-1 VDE0110)		55/100/21	
Dielectric strength maximum operating isolation voltage Test voltage (partial discharge test, procedure a for type test and random test) $U_{pr} = 1.5 \times U_{IORM}$ , $P_d < 5$ pC	$U_{IORM}$ $U_{pr}$	566 849	$V_{peak}$ $V_{peak}$
Test voltage (partial discharge test, procedure b for all devices) $U_{pr} = 1.875 \times U_{IORM}$ , $P_d < 5$ pC	$U_{pr}$	1 061	$V_{peak}$
Highest permissible overvoltage	$U_{TR}$	4 000	$V_{peak}$
Degree of pollution (DIN EN 60664-1 VDE0110 Part 1)		2	
Clearance distance		>4.0	mm
Creepage distance		>4.0	mm
Comparative tracking index (DIN IEC 112/VDE 0303 Part 1)	CTI	175	
Material group (DIN EN 60664-1 VDE0110 Part 1)		III a	
Storage temperature range	$T_{stg}$	-55 to +125	°C
Operating temperature range	$T_A$	-40 to +85	°C
Isolation resistance, minimum value $V_{IO} = 500$ V dc at $T_A = 25^\circ\text{C}$ $V_{IO} = 500$ V dc at $T_A$ MAX. at least $100^\circ\text{C}$	$R_{is}$ MIN. $R_{is}$ MIN.	$10^{12}$ $10^{11}$	$\Omega$ $\Omega$
Safety maximum ratings (maximum permissible in case of fault, see thermal derating curve) Package temperature Current (input current $I_F$ , $P_{si} = 0$ ) Power (output or total power dissipation) Isolation resistance $V_{IO} = 500$ V dc at $T_A = T_{si}$	$T_{si}$ $I_{si}$ $P_{si}$ $R_{is}$ MIN.	150 150 600 $10^9$	°C mA mW $\Omega$

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M8E 02.11-1

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