

# TLX9378

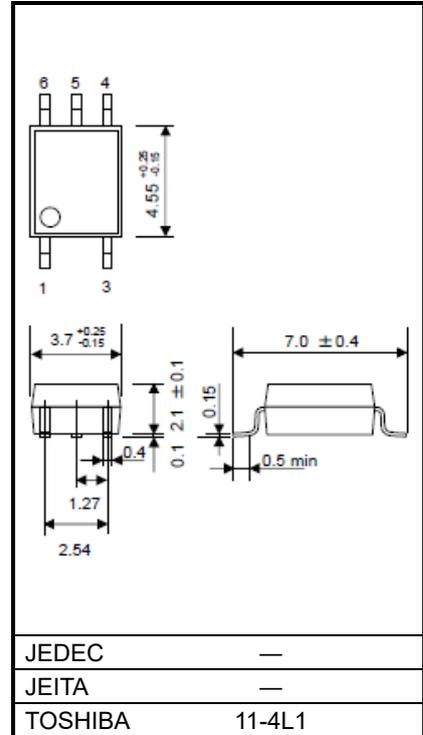
○ HEV (Hybrid Electric Vehicle) and EV (Electric Vehicle) Applications

The Toshiba TLX9378 consists of an infrared LED and integrated high gain, high-speed photodetector. The TLX9378 is housed in the SO6 package. The output stage is an open collector type.

The photodetector has an internal Faraday shield that provides a guaranteed common-mode transient immunity of 15 kV/μs. TLX9378 guarantees minimum and maximum of propagation delay time, switching speed dispersion, and high common mode transient immunity. Therefore TLX9378 is suitable for isolation interface between IPM (Intelligent Power Module) in motor control application.

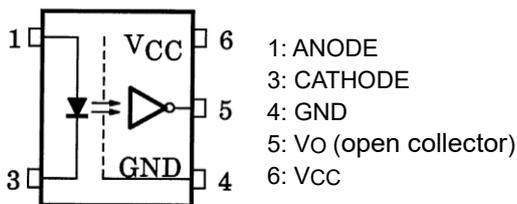
- Input current logic LOW output : 5 mA (max)
- Switching Speed : 10 MBd (typ.)
- Common mode transient immunity : 15 kV/μs (min)
- Operating Temperature : -40 to 125 °C
- Isolation voltage : 3750 Vrms (min)
- AEC-Q101 qualified

Unit: mm

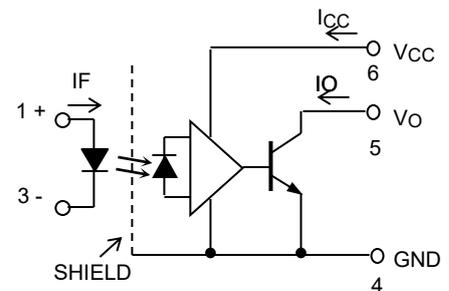


Weight: 0.08 g (typ.)

### Pin Configuration



### Schematic



### Truth Table

Input	LED	Output
H	ON	L
L	OFF	H

A ceramic capacitor (0.1 μF) should be connected from pin 6 (VCC) to pin 4 (GND) to stabilize the operation of the high gain linear amplifier. Failure to provide the bypass may impair the switching property. The total lead length between capacitor and coupler should not exceed 1 cm.

**Absolute Maximum Ratings (Note) (Unless otherwise specified, Ta = 25°C)**

Characteristic		Symbol	Rating	Unit
LED	Forward Current	I <sub>F</sub>	25	mA
	Forward Current (Ta=125°C)	I <sub>F</sub>	15	mA
	Forward Current Derating (Ta ≥ 70°C)	ΔI <sub>F</sub> /°C	-0.18	mA/°C
	Peak Transient Forward Current (Note 1)	I <sub>FPT</sub>	1	A
	Input Power Dissipation	PD	50	mW
	Reverse Voltage	V <sub>R</sub>	5	V
DETECTOR	Output Current	I <sub>O</sub>	25	mA
	Output Voltage	V <sub>O</sub>	6	V
	Supply Voltage (Note 2)	V <sub>CC</sub>	6	V
	Output Power Dissipation	P <sub>O</sub>	40	mW
Storage Temperature Range		T <sub>stg</sub>	-55 to 150	°C
Operating Temperature Range		T <sub>opr</sub>	-40 to 125	°C
Lead Soldering Temperature (10 s)		T <sub>sol</sub>	260	°C
Isolation Voltage (AC,60 s.,R.H.≤ 60%) (Note 3)		BVS	3750	V <sub>rms</sub>

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook (“Handling Precautions”/“Derating Concept and Methods”) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: Pulse width ≤ 1 μs, 300 pps

Note 2: 60 s. (max)

Note 3: This device is considered as a two terminal device: Pins 1 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

**Recommended Operating Conditions (Note)**

Characteristic	Symbol	Min	Typ.	Max	Unit
Low level input voltage	V <sub>FL</sub>	-3.0	0	1.0	V
High level input current	I <sub>FHL</sub>	-	10	15	mA
Supply Voltage	V <sub>CC</sub>	4.5	5	5.5	V
Operating Temperature (Note 1)	T <sub>opr</sub>	-40	-	125	°C

Note: Recommended operating conditions are given as a design guideline to obtain expected performance of the device. Additionally, each item is an independent guideline respectively. In developing designs using this product, please confirm specified characteristics shown in this document.

Note 1: This item denotes operating range, not meaning of recommended operating conditions.

## Electrical Characteristics

(Unless otherwise specified,  $T_a = -40$  to  $125^\circ\text{C}$ ,  $V_{CC} = 4.5$  to  $5.5\text{V}$ )

Characteristic	Symbol	Test Condition	Min	Typ.	Max	Unit
Forward voltage	$V_F$	$I_F = 10\text{ mA}$ , $T_a = 25^\circ\text{C}$	1.45	—	1.75	V
		$I_F = 10\text{ mA}$	1.35	—	1.9	
Reverse current	$I_R$	$V_R = 3\text{ V}$ , $T_a = 25^\circ\text{C}$	—	—	10	$\mu\text{A}$
Capacitance between terminals	$C_T$	$V_F = 0\text{ V}$ , $f = 1\text{ MHz}$ , $T_a = 25^\circ\text{C}$	—	45	—	pF
High level output current	$I_{OH}$	$V_F = 1.0\text{V}$ , $V_O = 5.5\text{V}$ , $T_a = 25^\circ\text{C}$	—	—	10	$\mu\text{A}$
		$V_F = 1.0\text{V}$ , $V_O = 5.5\text{V}$	—	—	50	$\mu\text{A}$
Low level output voltage	$V_{OL}$	$I_F = 5\text{ mA}$ , $I_{OL} = 5\text{ mA}$ (Sinking)	—	—	0.6	V
Input current logic LOW output	$I_{FHL}$	$I_{OL} = 5\text{ mA}$ (Sinking), $V_O = 0.6\text{ V}$	—	—	5	mA
Output current	$I_O$	$I_F = 10\text{ mA}$ , $V_O = 0.6\text{V}$	5.0	—	—	mA
High level supply current	$I_{CCH}$	$I_F = 0\text{ mA}$	—	—	1.3	mA
Low level supply current	$I_{CCL}$	$I_F = 10\text{ mA}$	—	—	1.3	mA

## Isolation Characteristics ( $T_a = 25^\circ\text{C}$ )

Characteristic	Symbol	Test Conditions	Min	Typ.	Max	Unit
Capacitance input to output	$C_S$	$V = 0\text{ V}$ , $f = 1\text{ MHz}$	—	0.8	—	pF
Isolation resistance	$R_S$	R.H. $\leq 60\%$ , $V_S = 500\text{ V}$	$10^{12}$	$10^{14}$	—	$\Omega$
Isolation voltage	$BV_S$	AC, 60 s	3750	—	—	$V_{rms}$

Note : This device is considered as a two terminal device: Pins 1 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

## Switching Characteristics

(Note)(Unless otherwise specified, Ta = -40 to 125°C, Vcc=5V)

Characteristic	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit	
Propagation delay time (H→L)	t <sub>pHL</sub>	1	I <sub>F</sub> =0→10 mA	R <sub>L</sub> = 1.9 kΩ C <sub>L</sub> = 15 pF (Note1)	—	50	100	ns
Propagation delay time (L→H)	t <sub>pLH</sub>		I <sub>F</sub> =10→0 mA		—	45	100	
Propagation Delay Skew (Note 4)	t <sub>psk</sub>		I <sub>F</sub> =10 mA, R <sub>L</sub> = 1.9 kΩ C <sub>L</sub> = 15 pF (Note1)		—	—	40	
Switching Time Dispersion between ON and OFF	t <sub>pHL</sub> -t <sub>pLH</sub>				—	—	30	
Fall Time (90 – 10 %)	t <sub>f</sub>		I <sub>F</sub> =0→10 mA	R <sub>L</sub> = 1.9 kΩ C <sub>L</sub> = 15 pF (Note1)	—	30	—	
Rise Time (10 – 90 %)	t <sub>r</sub>		I <sub>F</sub> =10→0 mA		—	90	—	
Common mode transient immunity at high output level (Note 2)	CMH	2	V <sub>CM</sub> = 1500 Vp-p, I <sub>F</sub> = 0 mA, V <sub>O</sub> (min) = 2.0 V, Ta = 25°C		15000	—	—	V/μs
Common mode transient Immunity at low output level (Note 3)	CML		V <sub>CM</sub> = 1500 Vp-p, I <sub>F</sub> = 10 mA, V <sub>O</sub> (max) = 0.8 V, Ta = 25°C		-15000	—	—	V/μs

Note: All typical values are at Ta = 25°C, VCC = 5 V.

Note: A ceramic capacitor (0.1 μF) should be connected from pin 6 (VCC) to pin 4 (GND) to stabilize the operation of the high gain linear amplifier. Failure to provide the bypass may impair the switching property.

The total lead length between capacitor and coupler should not exceed 1 cm.

Note 1: f = 5 MHz, duty = 50%, input current t<sub>r</sub> = t<sub>f</sub> = 5 ns or less,

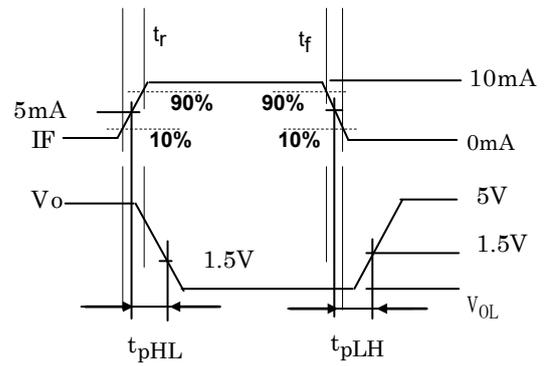
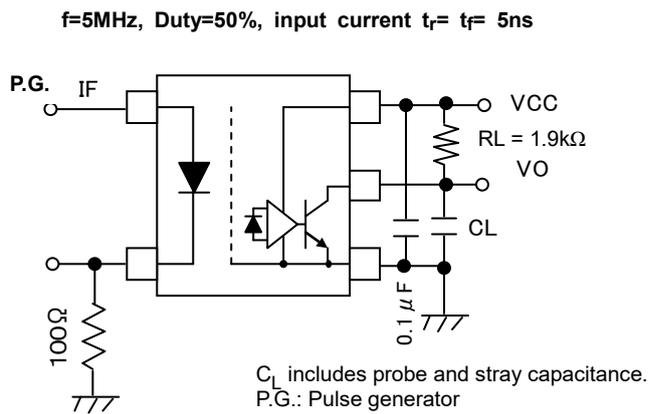
C<sub>L</sub> is less than 15 pF which includes probe and Jig/stray wiring capacitance.

Note 2: CMH 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<sub>O</sub> > 2.0 V)

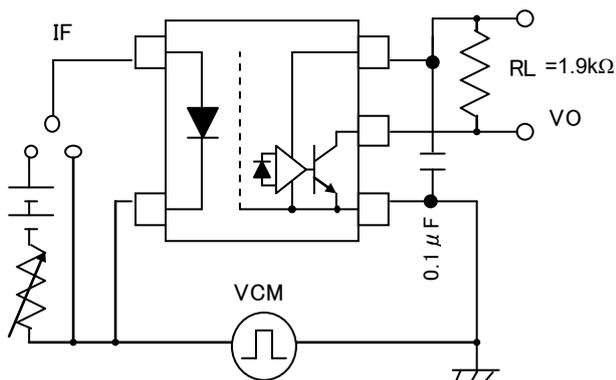
Note 3: CML is the maximum rate of fall of the common mode voltage that can be sustained with the output voltage in the logic low state (V<sub>O</sub> < 0.8 V).

Note 4: Propagation delay skew is defined as the difference between the largest and smallest propagation delay times (i.e. t<sub>pHL</sub> or t<sub>pLH</sub>) of multiple samples. Evaluations of these samples are conducted under identical test conditions (supply voltage, input current, temperature, etc).

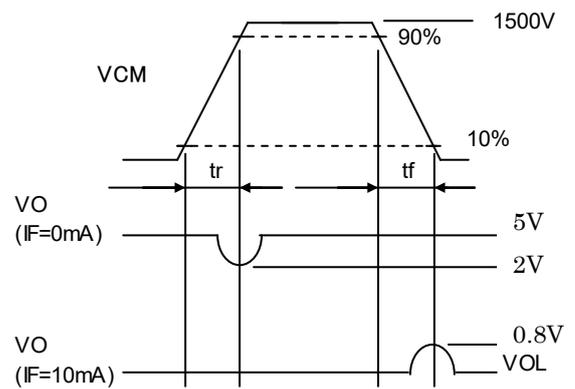
## Test Circuit 1: $t_{pHL}$ , $t_{pLH}$ , $|t_{pHL}-t_{pLH}|$



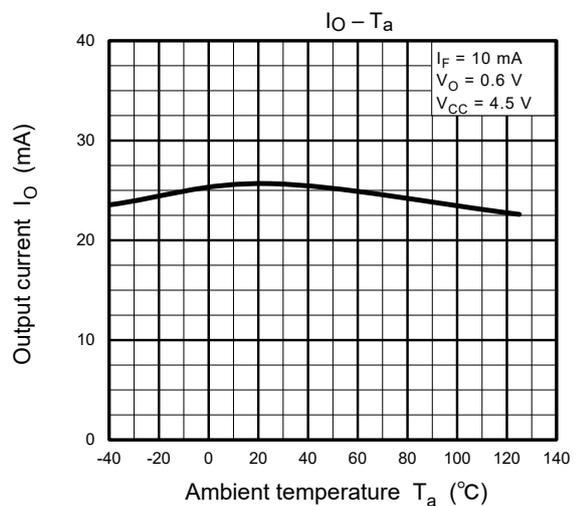
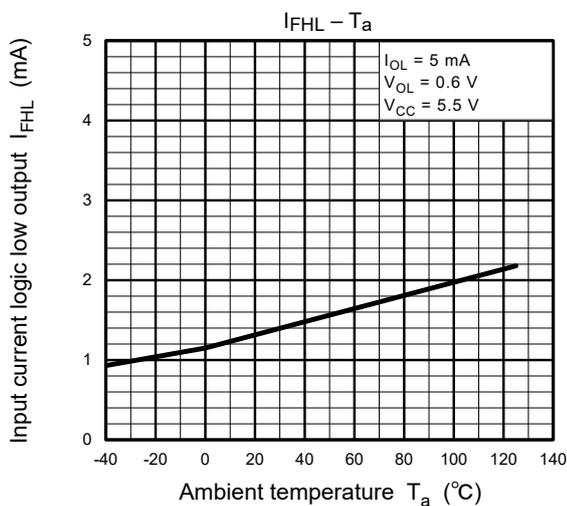
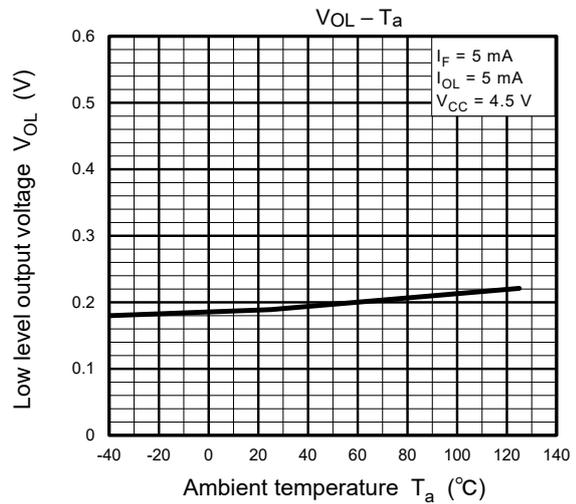
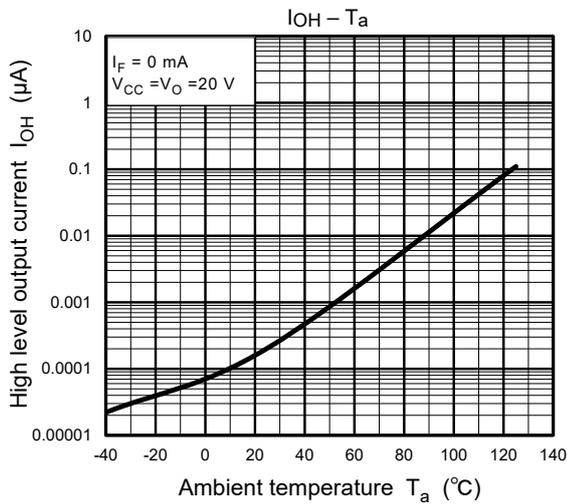
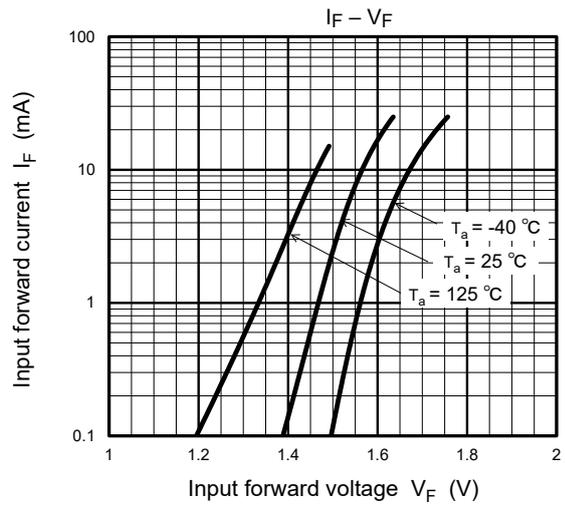
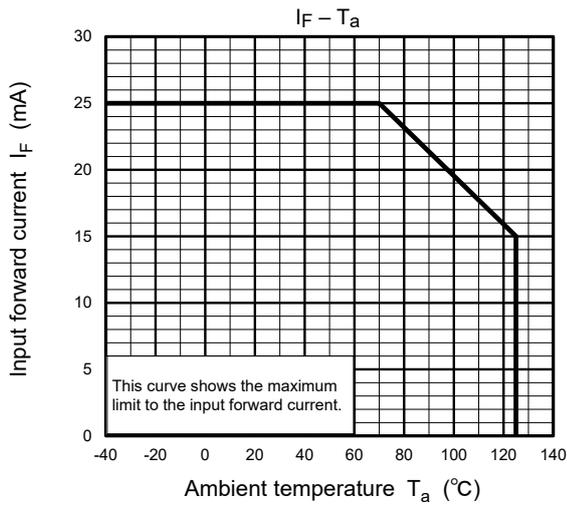
## Test Circuit 2: $CM_H$ , $CM_L$

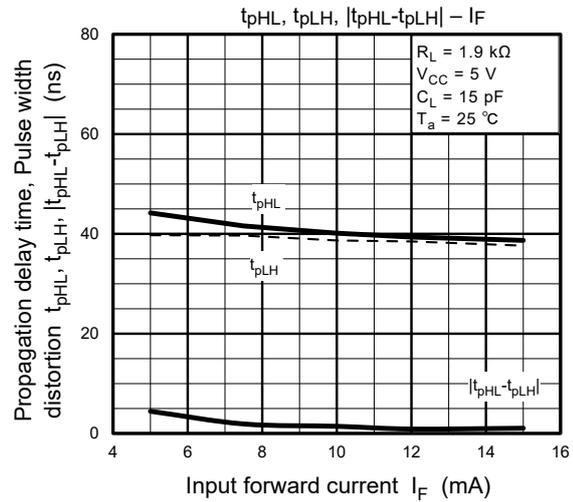
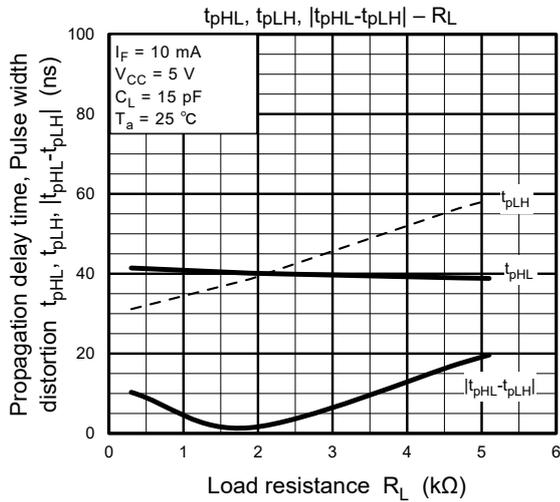
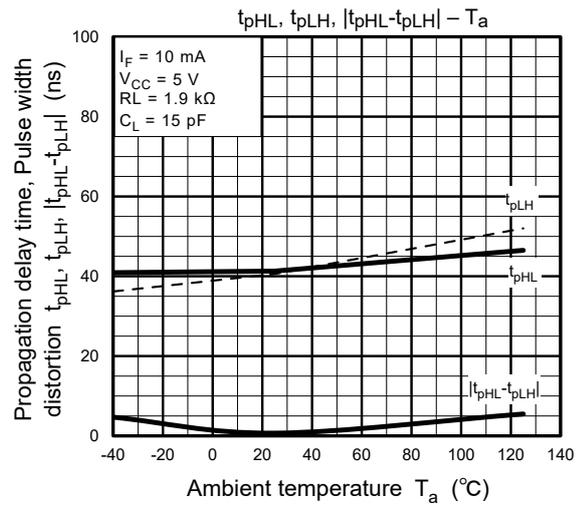
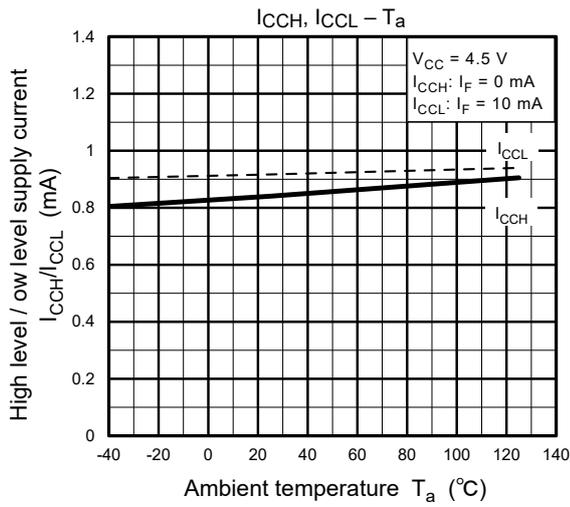


$$CM_H = \frac{1200(V)}{t_r(\mu s)} \quad CM_L = \frac{1200(V)}{t_f(\mu s)}$$



## Characteristics Curves (Note)





Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

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