

TOSHIBA PHOTOCOUPLER IRLED & PHOTO-IC

# TLX9304

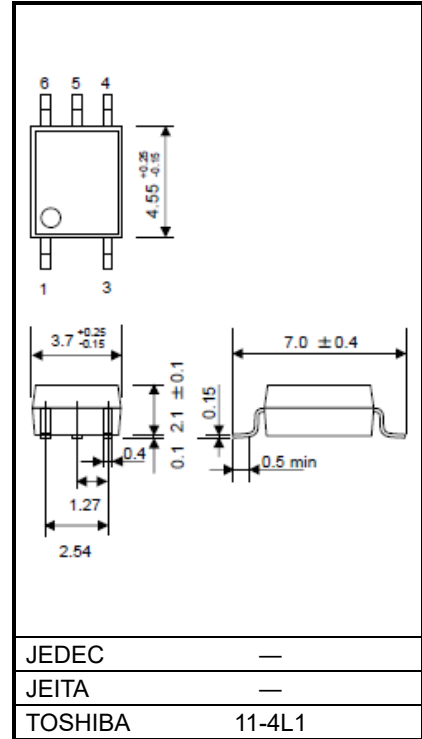
- Inverter control applications in Automotive Equipment
- Interface of IPM (Intelligent Power Module)
- HEV (Hybrid Electric Vehicle) and EV (Electric Vehicle) Applications

The Toshiba TLX9304 consists of an infrared LED and integrated high gain, high-speed photodetector. The TLX9304 is housed in the SO6 package. The output stage is an open collector type.

The photodetector has an internal Faraday shield that provides a common-mode transient immunity of 15 kV/μs. TLX9304 realizes minimum and maximum of propagation delay time, switching speed dispersion, and high common mode transient immunity. Therefore TLX9304 is suitable for isolation interface between IPM (Intelligent Power Module) in motor control application.

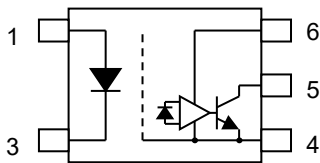
- Isolation voltage : 3750 Vrms (min)
- Common mode transient immunity : 15 kV/μs (min)  
@VCM = 1500 V
- Propagation delay time (tpHL/tpLH): tpHL = 400 ns (max)  
tpLH = 550 ns (max)
- Switching Time Dispersion(tpLH-tpHL): 400 ns (max)
- It becomes TTL compatible by connecting the resistance.
- AEC-Q101 qualified

Unit: mm



Weight: 0.08 g (typ.)

### Pin Configuration

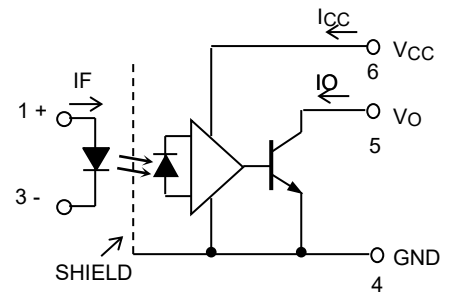


- 1: ANODE
- 3: CATHODE
- 4: GND
- 5: Vo (Output)
- 6: VCC

### Truth Table

Input	LED	Output
H	ON	L
L	OFF	H

### Schematic



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

## Absolute Maximum Ratings (Note) (Ta = 25 °C, unless otherwise specified)

Characteristic		Symbol	Rating	Unit
LED	DC Forward Current	$I_F$	25	mA
	DC Forward Current (Ta=125°C)	$I_F$	15	mA
	DC Forward Current Derating (Ta ≥ 85°C)	$\Delta I_F / ^\circ C$	-0.25	mA/°C
	Peak Transient Forward Current (Note 1)	$I_{FPT}$	1	A
	Input Power Dissipation	$P_D$	50	mW
	DC Reverse Voltage	$V_R$	5	V
DETECTOR	Output Current	$I_O$	15	mA
	Peak Output Current	$I_{OP}$	30	mA
	Output Voltage	$V_O$	-0.5 to 30	V
	Supply Voltage	$V_{CC}$	-0.5 to 30	V
	Output Power Dissipation	$P_O$	100	mW
	Output Power Dissipation Derating (Ta ≥ 85°C)	$\Delta P_O / ^\circ C$	-1.83	mW/°C
Operating Temperature Range		$T_{opr}$	-40 to 125	°C
Storage Temperature Range		$T_{stg}$	-55 to 150	°C
Lead Soldering Temperature (10 s)		$T_{sol}$	260	°C
Isolation Voltage (R.H. ≤ 60%, AC, 60 s.) (Note 2)		$BV_S$	3750	$V_{rms}$

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: This device is considered as 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
Supply Voltage	$V_{CC}$	4.5	-	20	V
Output Voltage	$V_O$	-	-	$V_{CC}$	V
Forward Current	$I_F$	-	10	15	mA
Operating Temperature (Note 1)	$T_{opr}$	-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: Denotes the operating range, not the recommended operating condition.

## Electrical Characteristics (Note)

(Unless otherwise specified,  $T_a = -40$  to  $125\text{ }^\circ\text{C}$ ,  $V_{CC} = 4.5$  to  $20\text{ V}$ )

Characteristic	Symbol	Test Condition	Min	Typ.	Max	Unit
Input Forward voltage	$V_F$	$I_F = 10\text{ mA}$ , $T_a = 25\text{ }^\circ\text{C}$	1.45	1.56	1.75	V
		$I_F = 10\text{ mA}$	1.35	—	1.9	
Input Reverse current	$I_R$	$V_R = 5\text{ V}$ , $T_a = 25\text{ }^\circ\text{C}$	—	—	10	$\mu\text{A}$
Input Capacitance between terminals	$C_T$	$V_F = 0\text{ V}$ , $f = 1\text{ MHz}$ , $T_a = 25\text{ }^\circ\text{C}$	—	45	—	pF
High level output current	$I_{OH}$	$I_F = 0\text{ mA}$ , $V_O = 20\text{ V}$	—	—	50	$\mu\text{A}$
Low level output voltage	$V_{OL}$	$I_F = 10\text{ mA}$ , $I_O = 2.4\text{ mA}$	—	0.3	0.6	V
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
Input current logic LOW output	$I_{FHL}$	$I_O = 0.75\text{ mA}$ , $V_O < 0.8\text{ V}$	—	1	5	mA
Input voltage logic HIGH output	$V_{FLH}$	$I_O = 0.75\text{ mA}$ , $V_O > 2.0\text{ V}$	0.8	—	—	V
Output current	$I_O$	$I_F = 10\text{ mA}$ , $V_O = 0.6\text{ V}$	4.0	—	—	mA

Note: All typical values at  $V_{CC} = 5\text{ V}$  and  $T_a = 25\text{ }^\circ\text{C}$ .

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

Characteristic	Symbol	Test Condition	Min	Typ.	Max	Unit
Stray Capacitance (input to output)	$C_S$	$V_S = 0\text{ V}$ , $f = 1\text{ MHz}$	—	0.5	—	pF
Isolation resistance	$R_S$	$V_S = 500\text{ V}$ , R.H. $\leq 60\%$	$10^{12}$	$10^{14}$	—	$\Omega$
Isolation voltage	$BV_S$	AC, 60 s	3750	—	—	V <sub>rms</sub>

Note : This device is considered as 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, $T_a = -40$ to $125\text{ }^\circ\text{C}$ )

Characteristic	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit		
Propagation delay time (H→L)	$t_{pHL}(1)$	Fig.1	$I_F = 10\text{ mA}$ , $R_L = 4.7\text{ k}\Omega$ $V_{CC} = 5\text{ V}$	$C_L = 100\text{ pF}$	30	100	400	ns	
				$C_L = 10\text{ pF}$	—	90	—		
Propagation delay time (L→H)	$t_{pLH}(1)$			$C_L = 100\text{ pF}$	200	300	550		
				$C_L = 10\text{ pF}$	—	140	—		
Switching Time Dispersion between ON and OFF	$ t_{pLH} - t_{pHL} (1)$					0	200		400
Propagation Delay Skew (Note 1)	$t_{psk}(1)$				-50	200	450		
Propagation delay time (H→L)	$t_{pHL}(2)$		Fig.2	$I_F = 10\text{ mA}$ , $R_L = 20\text{ k}\Omega$ $V_{CC} = 15\text{ V}$	$C_L = 100\text{ pF}$	30	150	400	ns
					$C_L = 10\text{ pF}$	—	100	—	
Propagation delay time (L→H)	$t_{pLH}(2)$				$C_L = 100\text{ pF}$	200	350	550	
					$C_L = 10\text{ pF}$	—	150	—	
Switching Time Dispersion between ON and OFF	$ t_{pLH} - t_{pHL} (2)$					0	200	400	
Propagation Delay Skew (Note 1)	$t_{psk}(2)$			-50	200	450			
Common mode transient immunity at high output level (Note 2)	$CM_H$	Fig.2	$V_{CC} = 15\text{ V}$ , $C_L = 100\text{ pF}$ , $V_{CM} = 1500\text{ V}_{p-p}$ , $I_F = 0\text{ mA}$ , $R_L = 20\text{ k}\Omega$ , $T_a = 25^\circ\text{C}$	15	—	—	kV/ $\mu\text{s}$		
Common mode transient immunity at low output level (Note 2)	$CM_L$			-15	—	—	kV/ $\mu\text{s}$		

Note: All typical values at  $V_{CC} = 5\text{ V}$  and  $T_a = 25^\circ\text{C}$ .

Note 1: The propagation delay skew,  $t_{psk}$ , is equal to the magnitude of the worst-case difference in  $t_{pHL}$  and/or  $t_{pLH}$  that will be seen between units at the same given conditions (supply voltage, input current, temperature, etc).

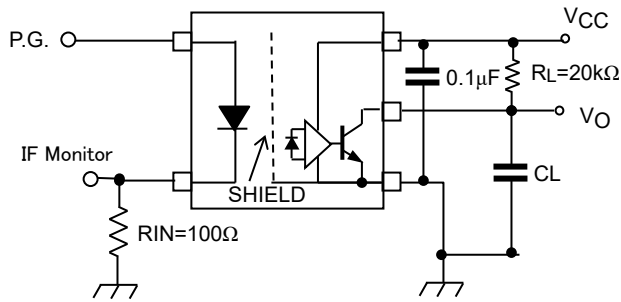
Note 2:  $CM_H$  is the maximum rate of rise of the common mode voltage that can be sustained with the output voltage in the logic high state ( $V_O > 11\text{ V}$ )

$CM_L$  is the maximum rate of fall of the common mode voltage that can be sustained with the output voltage in the logic low state ( $V_O < 1.0\text{ V}$ ).

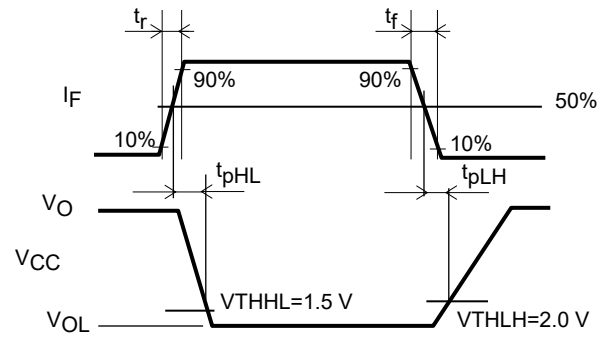
**Fig. 1:  $t_{pHL}$ ,  $t_{pLH}$**

$I_F = 10\text{mA (P.G)}$

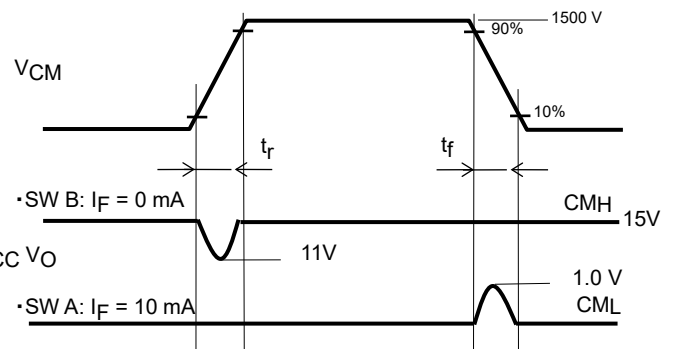
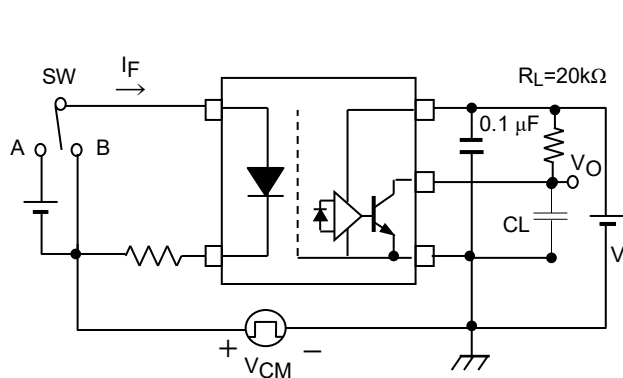
$(f = 10\text{kHz, duty} = 10\%, t_r = t_f = 5\text{ns})$



$C_L$  includes probe and stray capacitance.  
P.G.: Pulse generator

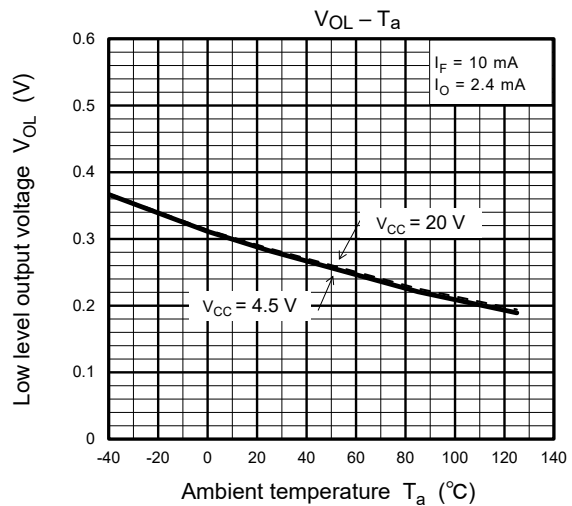
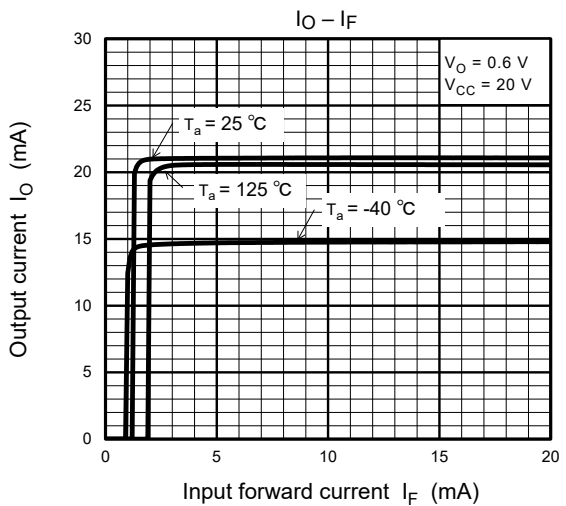
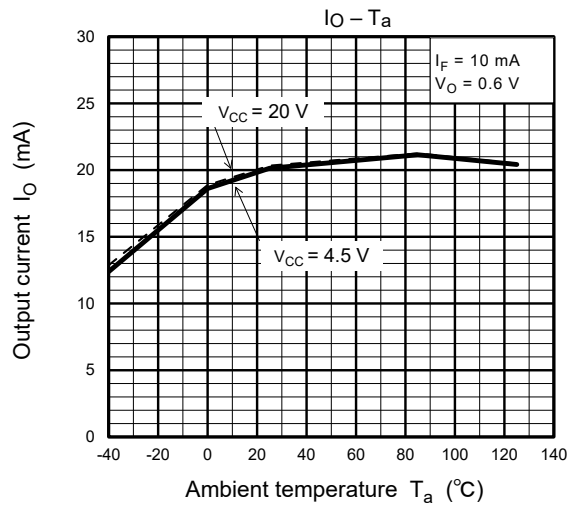
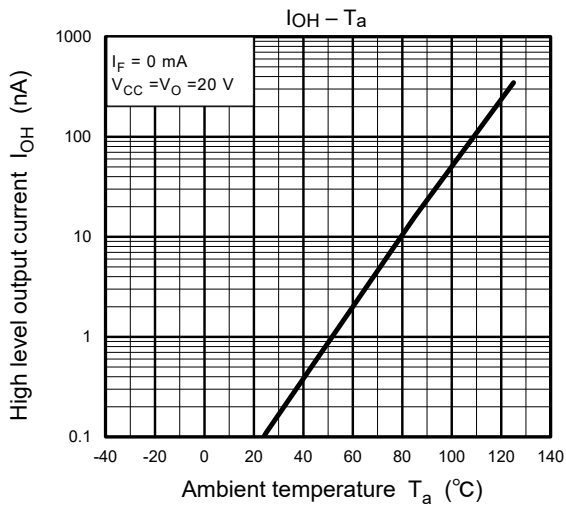
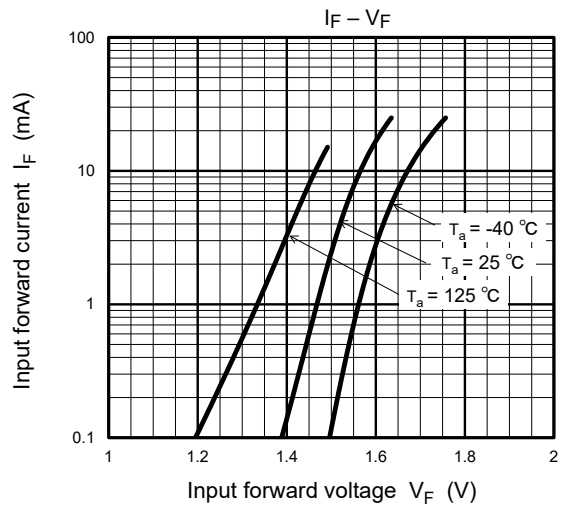
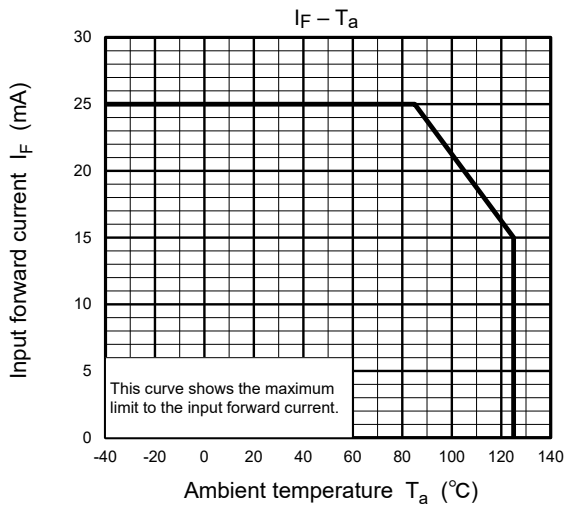


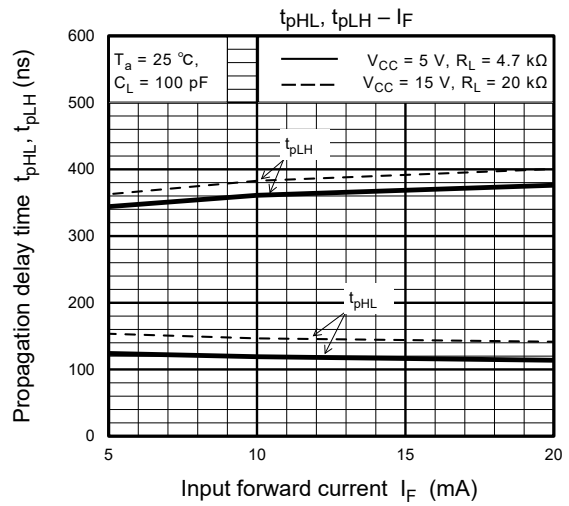
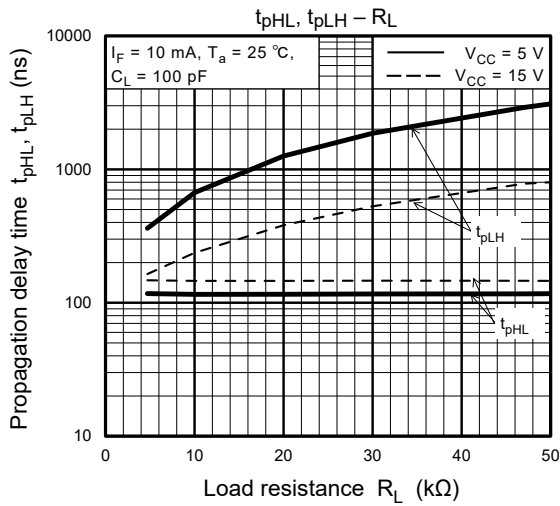
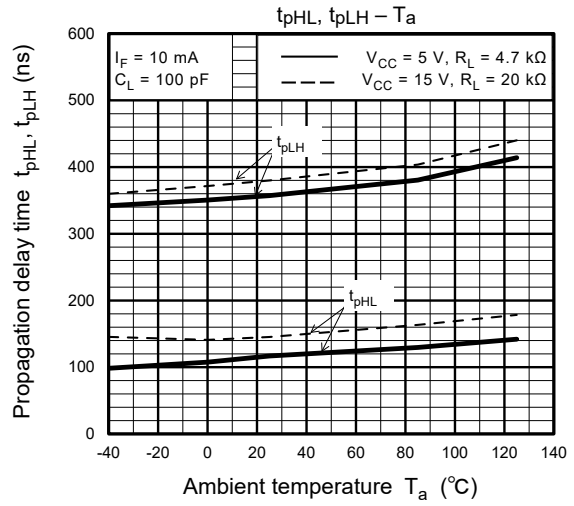
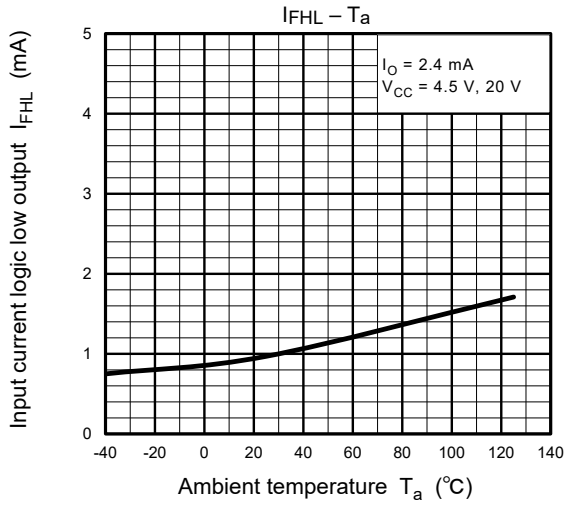
**Fig. 2:  $C_{MH}$ ,  $C_{ML}$**



$$C_{MH} = \frac{1200(V)}{t_r(\mu s)} \quad C_{ML} = -\frac{1200(V)}{t_f(\mu s)}$$

## 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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