Photocouplers Optically Isolation Amplifiers

TLP7920,TLP7920F

1. Applications

- Motor phase and rail current sensing
- Power inverter current and voltage sensing

2. General

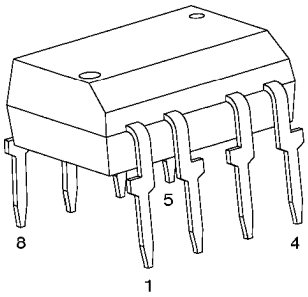
The TLP7920 and TLP7920F of isolation amplifiers is designed for current sensing in electronic motor drives. In a typical implementation, motor currents flow through an external resistor and the resulting analog voltage drop is sensed by the TLP7920 or TLP7920F.

3. Features

(1) Output side supply voltage: 3.0 to 5.5 V
(2) Output side supply current: 6.2 mA (typ.)
(3) Operating temperature range: -40 to 105 ℃
(4) Common-mode transient immunity: 15 kV/μs (min)

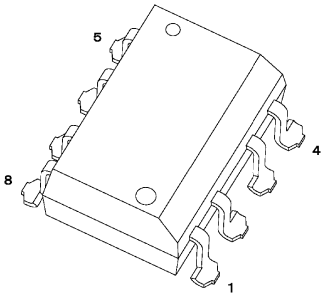
4. Packaging (Note)

TLP7920



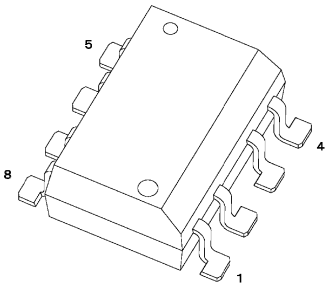
11-10C4S

TLP7920(LF1,TP1)



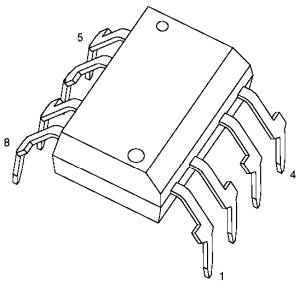
11-10C401S

TLP7920(LF5,TP5)



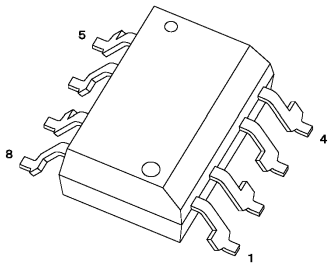
11-10C405S

TLP7920F



11-10C402S

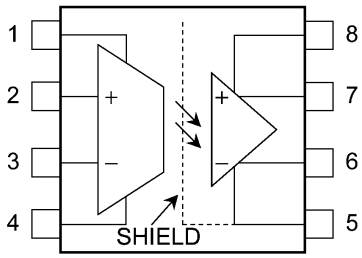
TLP7920F(LF4,TP4)



11-10C404S

Note: Through hole type: TLP7920, TLP7920F
Lead forming option: (LF1),(LF4),(LF5)
Taping option: (TP1),(TP4),(TP5)

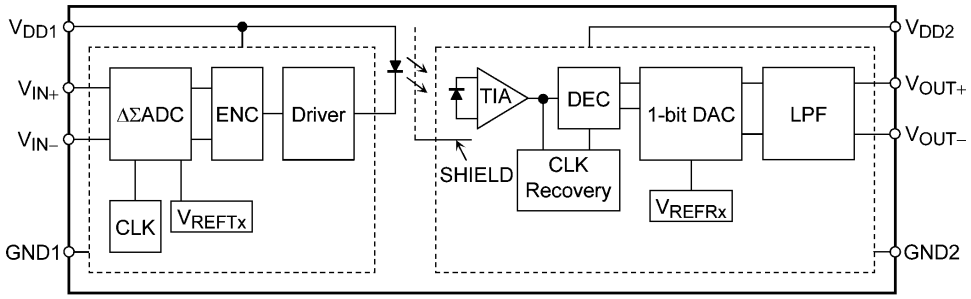
5. Pin Assignment



5.1. Pin Functions

Pin No.	Symbol	Description
1	V_{DD1}	Input side supply voltage
2	V_{IN+}	Positive input
3	V_{IN-}	Negative input
4	GND1	Input side ground
5	GND2	Output side ground
6	V_{OUT-}	Negative output
7	V_{OUT+}	Positive output
8	V_{DD2}	Output side supply voltage

6. Internal Circuit (Note)



Note: A 0.1 μF bypass capacitor must be connected between 1 and 4 pins and between 5 and 8 pins.

7. Principle of Operation

7.1. Mechanical Parameters

Characteristics	7.62-mm Pitch TLP7920	10.16-mm Pitch TLP7920F	Unit
Creepage distances	7.0 (min)	8.0 (min)	mm
Clearance	7.0 (min)	8.0 (min)	
Internal isolation thickness	0.4 (min)	0.4 (min)	

8. Absolute Maximum Ratings (Note) (Unless otherwise specified, T_a = 25 °C)

Characteristics		Symbol	Note	Rating	Unit
Supply Voltages		V_{DD1}, V_{DD2}		-0.5 to 6	V
Steady-state input voltages		V_{IN+}, V_{IN-}		-0.5 to 6	
Two-second transient input voltages		V_{IN+}, V_{IN-}		-6 to 6	
Output voltages		V_{OUT+}, V_{OUT-}		-0.5 to 6	
Operating temperature		T_{opr}		-40 to 105	°C
Storage temperature		T_{stg}		-55 to 125	
Lead soldering temperature	(10 s)	T_{sol}	(Note 1)	260	
Isolation voltage	AC, 60 s, R.H. ≤ 60 %	BV_S	(Note 2)	5000	Vrms

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: Ceramic capacitors (0.1 μF) should be connected between 1 and 4 pins and between 5 and 8 pins to stabilize the operation. Otherwise, this photocoupler may not switch properly. The bypass capacitors should be placed as close as possible to each pin.

Note 1: ≥ 2 mm below seating plane.

Note 2: This device is considered as a two-terminal device: Pins 1, 2, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

9. Recommended Operating Conditions (Note)

Characteristics	Symbol	Note	Min	Typ.	Max	Unit
Input side supply voltage	V_{DD1}		4.5	5	5.5	V
Output side supply voltage	V_{DD2}		3.0	—	5.5	
Analog input voltage	V_{IN+}, V_{IN-}	(Note 1), (Note 2)	-200	—	200	mV
Ambient temperature	T_a		-40	—	105	°C

Note: The recommended operating conditions are given as a design guide necessary to obtain the intended performance of the device. Each parameter is an independent value. When creating a system design using this device, the electrical characteristics specified in this datasheet should also be considered.

Note 1: FSR = ±300 mV

Note 2: When either V_{IN+} or V_{IN-} or both are equal to or greater than V_{DD1} - 2 V (e.g., if V_{DD1} = 5 V, when V_{IN+} and/or V_{IN-} are equal to or greater than 5 V - 2 V = 3 V), isolation amplifiers go into one of the test modes. Do not raise either V_{IN+} or V_{IN-} above this voltage to keep the device in functional mode.

10. Electrical Characteristics

10.1. DC Characteristics (Unless otherwise specified, T_a = -40 to 105 °C, V_{DD1} = 4.5 to 5.5 V, V_{DD2} = 3.0 to 5.5 V, V_{IN+} = -200 to 200 mV, V_{IN-} = 0 V)

Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Input offset voltage	V_{OS}		T_a = 25 °C	-0.7	0.73	2.1	mV
Input offset voltage drift vs ambient temperature	$\lvert dV_{OS}/dT_a \rvert$			—	3	10	μV/°C
Input offset voltage drift vs input side supply voltage	$\lvert dV_{OS}/dV_{DD1} \rvert$			—	120	—	μV/V
Gain (Rank B)	G_0	(Note 1)	T_a = 25 °C	—	—	—	V/V
Gain (Rank A)	G_1	(Note 1)	T_a = 25 °C	—	—	—	
Gain (None)	G_3	(Note 1)	T_a = 25 °C	—	—	—	
Gain drift vs ambient temperature	$\lvert dG/dT_a \rvert$			—	0.00012	—	V/V/°C
V_{OUT} non-linearity (±200 mV)	NL_{200}	(Note 2)	V_{IN+} = -200 to 200 mV, T_a = 25 °C	—	0.04	0.13	%
V_{OUT} non-linearity (±200 mV) drift vs ambient temperature	$\lvert dNL_{200}/dT_a \rvert$			—	0.00007	—	%/°C
V_{OUT} non-linearity (±100 mV)	NL_{100}	(Note 2)	V_{IN+} = -100 to 100 mV, T_a = 25 °C	—	0.02	0.06	%
High-level output voltage	V_{OH}		V_{IN+} = 400 mV, T_a = 25 °C	—	2.497	—	V
Low-level output voltage	V_{OL}		V_{IN+} = -400 mV, T_a = 25 °C	—	0.0009	—	
Input common-mode rejection ratio	$CMRR_{IN}$			—	80	—	dB
Input bias current	I_{IN+}		V_{IN+} = 0 V, T_a = 25 °C	-1	-0.055	—	μA
Input side supply current (V_{DD1})	I_{DD1}		V_{IN+} = 0 V	—	8.6	12	mA
Output side supply current (V_{DD2})	I_{DD2}		V_{IN+} = 0 V	—	6.2	10	mA
Equivalent input resistance	R_{IN}			—	78	—	kΩ

Note 1: See Chapter 10.1.1 for gain rank values.

Note 2: The slope of the optimum line is derived by the method of least squares between differential input voltage (V_{IN+} - V_{IN-}) and differential output voltage (V_{OUT+} - V_{OUT-}). Nonlinearity is defined as a fraction of the half of the peak-to-peak value of differential output voltage deviation divided by the full-scale differential output voltage (OVR).

10.1.1. Gain Rank (Note) (Unless otherwise specified, T_a = 25 °C)

Rank	Gain Rank Marking	Gain (Min)	Gain (Typ.)	Gain (Max)	Unit
None (±3 %)	Blank, A, B	7.95	8.2	8.44	V/V
Rank A (±1 %)	A, B	8.12	8.2	8.28	
Rank B (±0.5 %)	B	8.16	8.2	8.24	

Note: The gain is defined as the slope of the optimum line derived by the method of least squares between differential input voltage (V_{IN+} - V_{IN-}) and differential output voltage (V_{OUT+} - V_{OUT-}) in the recommended voltage range.

Note: Specify both the part number and a rank in this format when ordering.
Example: TLP7920(B
For safety standard certification, however, specify the part number alone.
Example: TLP7920(B → TLP7920

10.2. AC Characteristics (Note) (Unless otherwise specified, T_a = -40 to 105 °C, V_{DD1} = 4.5 to 5.5 V, V_{DD2} = 3.0 to 5.5 V)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
V_{OUT} bandwidth (-3 dB)	f_{-3dB}	V_{IN+} = 400 mV_{p-p}, sine wave	140	230	—	kHz
V_{IN} to V_{OUT} propagation delay time (10 %-10 %)	t_{pD10}	V_{IN+} = 0 to 200 mV/μs step C_L = 15 pF	—	1.9	2.3	μs
V_{IN} to V_{OUT} propagation delay time (50 %-50 %)	t_{pD50}		—	2.3	2.6	
V_{IN} to V_{OUT} propagation delay time (90 %-90 %)	t_{pD90}		—	2.8	3.3	
V_{OUT} rise time	t_r		—	1.7	—	
V_{OUT} fall time	t_f		—	1.7	—	
Common-mode transient immunity	CMTI	V_{CM} = 1 kV, T_a = 25 °C	15	20	—	kV/μs

Note: All typical values are at T_a = 25 °C.
C_L is approximately 15 pF which includes probe and stray wiring capacitance.

11. Isolation Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Total capacitance (input to output)	C_S	(Note 1)	V_S = 0 V, f = 1 MHz	—	1.0	—	pF
Isolation resistance	R_S	(Note 1)	V_S = 500 V, R.H. ≤ 60 %	1×10^{12}	10^{14}	—	Ω
Isolation voltage	BV_S	(Note 1)	AC, 60 s	5000	—	—	Vrms
			AC, 1 s in oil	—	10000	—	
			DC, 60 s in oil	—	10000	—	Vdc

Note 1: This device is considered as a two-terminal device: Pins 1, 2, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

12. Land Pattern Dimensions (for reference only)

Unit : mm

TLP7920(LF1,TP1),TLP7920(LF5,TP5)

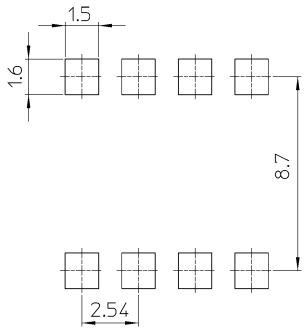


Fig. 12.1 Lead forming and taping option (LF1), (TP1), (LF5), (TP5)

TLP7920F(LF4,TP4)

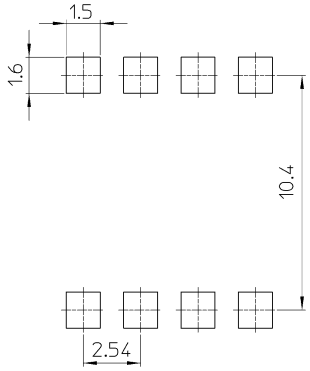
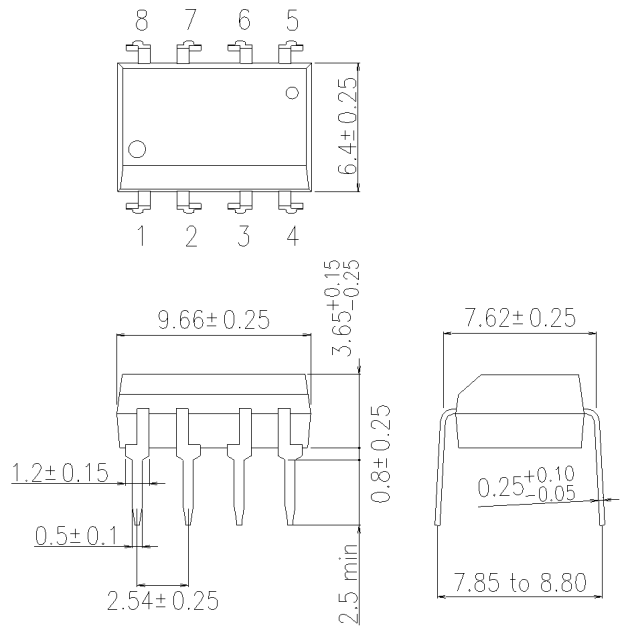


Fig. 12.2 Lead forming and taping option (LF4), (TP4)

Package Dimensions

Unit: mm

TLP7920



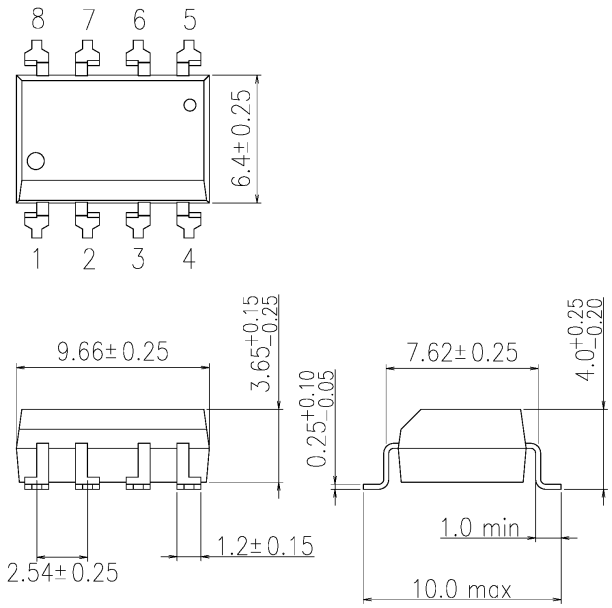
Weight: 0.54 g (typ.)

Package Name(s)
TOSHIBA: 11-10C4S

Package Dimensions

Unit: mm

TLP7920(LF1,TP1)



Weight: 0.53 g (typ.)

Package Name(s)
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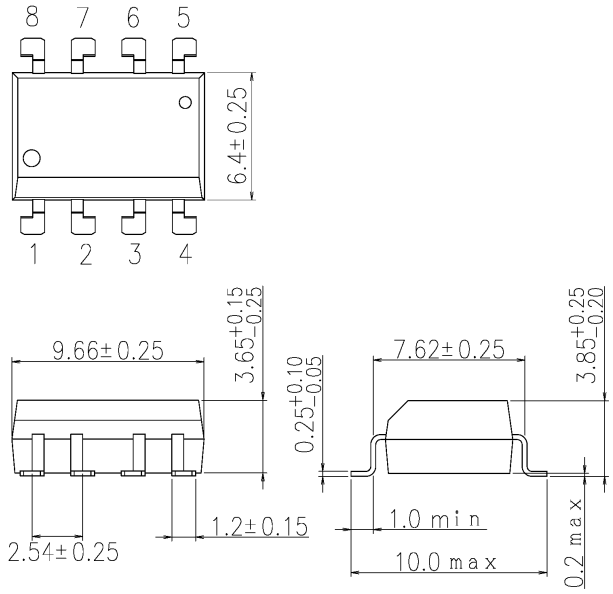
Package Dimensions

Unit: mm

TLP7920(LF5,TP5)



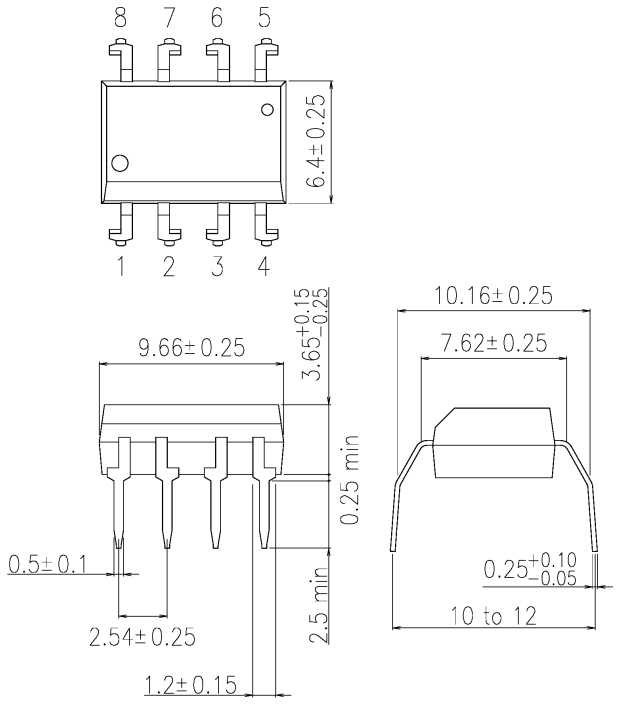
Weight: 0.53 g (typ.)

Package Name(s)
TOSHIBA: 11-10C405S

Package Dimensions

Unit: mm

TLP7920F



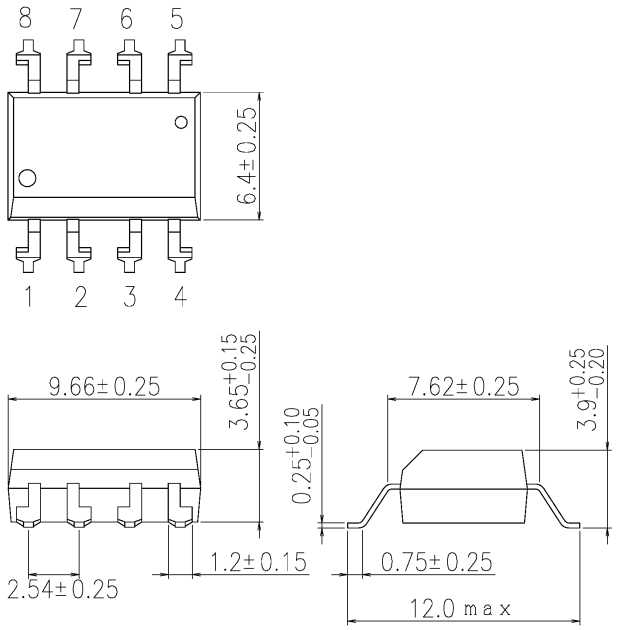
Weight: 0.54 g (typ.)

Package Name(s)
TOSHIBA: 11-10C402S
Nickname: DIP8

Package Dimensions

Unit: mm

TLP7920F(LF4,TP4)



Weight: 0.53 g (typ.)

Package Name(s)
TOSHIBA: 11-10C404S

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