Photocouplers Optically Isolated Delta-Sigma Modulator

TLP7830

1. Applications

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

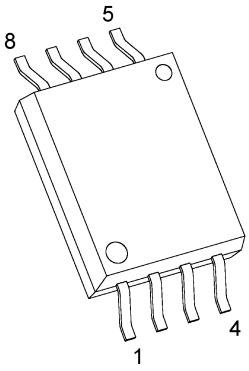
2. General

The TLP7830 is a 1-bit, second-order sigma-delta (∑-Δ) modulator converts an analog input signal into a high-speed data stream with galvanic isolation based on optical coupling technology.

3. Features

(1) Output clock frequency: 10 MHz (typ.)
(2) 16 bits resolution no missing codes [ENOB:12 bits(typ.)]
(3) Integral non-linearity: 4 LSB (typ.)
(4) Input offset voltage: 0.6 mV (typ.)
(5) Operating temperature range: -40 to 105 ℃
(6) Common-mode transient immunity: 15 kV/μs (min)

4. Packaging and Pin Assignment



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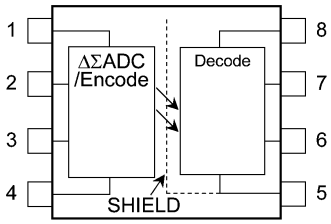

4.1. Pin Assignment

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	MDAT	Modulator data output
7	MCLK	Modulator clock output
8	V_{DD2}	Output side supply voltage

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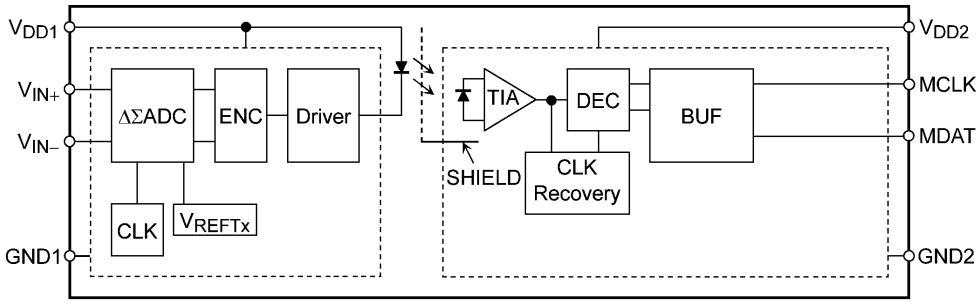
5. Internal Circuit (Note)



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

6. Principle of Operation

6.1. Mechanical Parameters

Characteristics	SO8L	Unit
Height	2.3 (Max)	mm
Creepage distances	8.0 (Min)	
Clearance	8.0 (Min)	
Internal isolation thickness	0.4 (Min)	

7. 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	
Digital output voltage		MCLK, MDAT		-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.

8. 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	—	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 = ±320 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.

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9. Electrical Characteristics

9.1. DC Characteristics (Note) (Unless otherwise specified, T_a = -40 to 105 °C, V_{DD1} = 4.5 to 5.5 V, V_{DD2} = 3 to 5.5 V, V_{IN+} = -200 to 200 mV, V_{IN-} = 0 V)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Integral non-linearity	INL	T_a = -40 to 85 °C	-15	4	15	LSB
		T_a = 105 °C	-25	4	25	
Differential non-linearity	DNL		-0.9	0.5	0.9	LSB
Input offset voltage	V_{OS}		-1.0	0.6	2.0	mV
Input offset voltage drift vs ambient temperature	$\lvert dV_{OS}/dT_a \rvert$		—	1.2	3	μV/°C
Input offset voltage drift vs input side supply voltage	$\lvert dV_{OS}/dV_{DD1} \rvert$		—	150	—	μV/V
Internal Reference Voltage	V_{REF}		—	320	—	mV
Gain error	G_E	T_a = 25 °C	-1	0.1	1	%
Gain error	G_E	T_a = -40 to 105 °C	-2	0.1	2	%
Input common-mode rejection ratio	$CMRR_{IN}$		—	74	—	dB
Signal-to-noise ratio	SNR	V_{IN+} = 400 mV_{p-p}, 1 kHz sine wave	68	80	—	dB
Signal-to-(noise + distortion) Ratio	SNDR		65	75	—	dB
Effective number of bits	ENOB		—	12	—	bits
Total harmonic distortion	THD		—	-78	—	dB
Input side supply current (V_{DD1})	I_{DD1}	V_{IN+} = 0 V	—	8.5	12	mA
Output side supply current (V_{DD2})	I_{DD2}	V_{IN+} = 0 V, V_{DD2} = 3.3 V	—	4.6	7	mA
	I_{DD2}	V_{IN+} = 0 V, V_{DD2} = 5 V	—	4.9	8	mA
Low-level output voltage	V_{OL}	I_{OUT} = 200 μA	—	0.03	0.05	V
High-level output voltage	V_{OH}	I_{OUT} = -200 μA, V_{DD2} = 3.3 V	3.1	3.2	—	V
	V_{OH}	I_{OUT} = -200 μA, V_{DD2} = 5 V	4.8	4.9	—	V
Output short-circuit current	I_{OSC}		—	11	—	mA
Equivalent input resistance	R_{IN}		—	77	—	kΩ

Note: Tested with a $Sinc^3$ filter with a decimation ratio of 256 (with the decimation filter output configured to 16 bits).

Note: All typical values are at V_{DD1} = 5 V, V_{DD2} = 5 V, T_a = 25 °C, unless otherwise noted.

9.2. AC Characteristics (Note) (Unless otherwise specified, T_a = -40 to 105 °C, V_{DD1} = 4.5 to 5.5 V, V_{DD2} = 3 to 5.5 V)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output clock frequency	f_{CLK}		8.5	10	11.5	MHz
Access time after MCLK rising edge	t_a	C_L = 15 pF	—	33	45	ns
Hold time after MCLK rising edge	t_h		10	24	—	
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.

10. 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.

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11. Characteristics Curves (Note)

V_{IN-} = 0 V. Tested with a Sinc³ filter with a decimation ratio of 256 (with the decimation filter output configured to 16 bits)

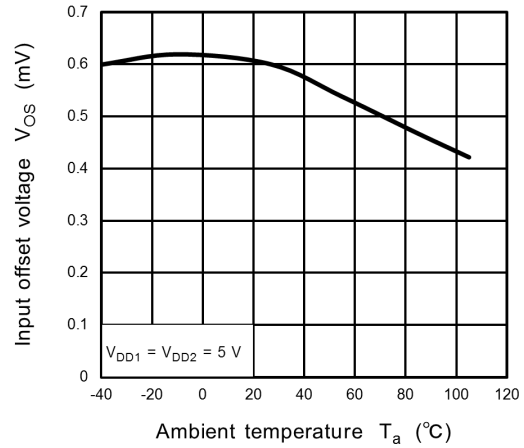


Fig. 11.1 V_{OS} - T_a

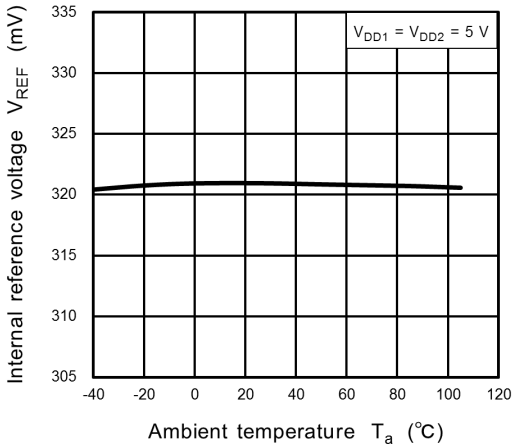


Fig. 11.2 V_{REF} - T_a

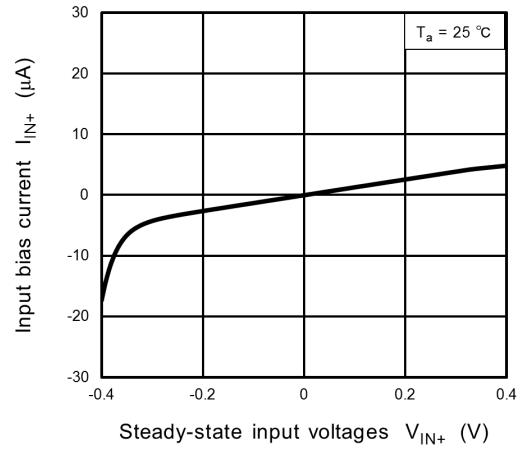


Fig. 11.3 V_{IN+} - I_{IN+}

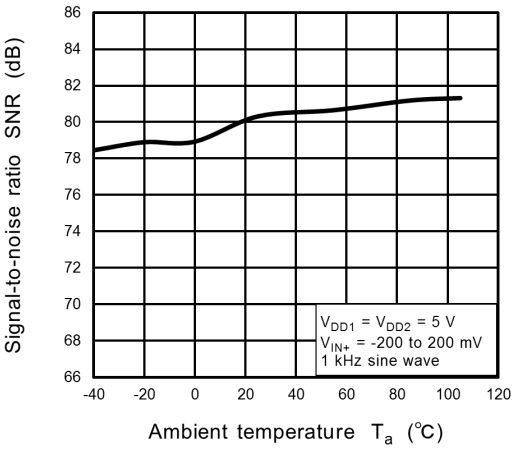


Fig. 11.4 SNR - T_a

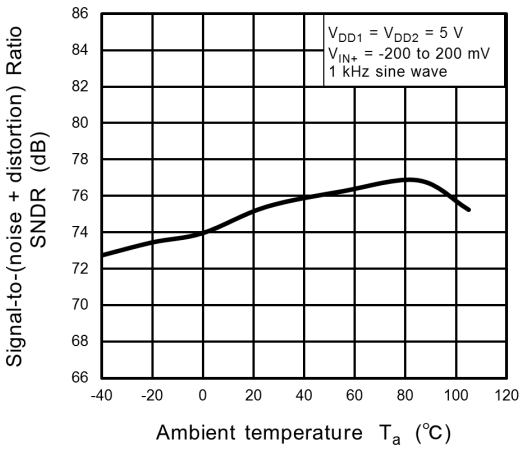


Fig. 11.5 SNDR - T_a

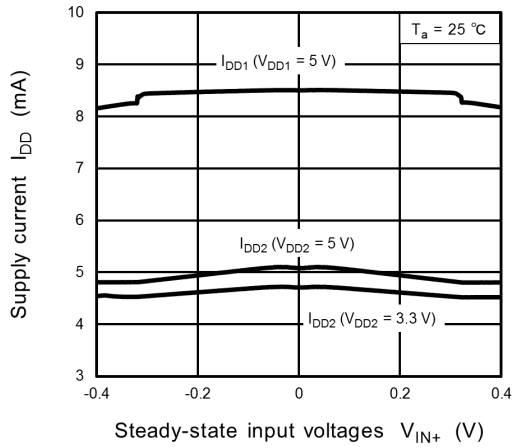


Fig. 11.6 I_{DD} - V_{IN+}

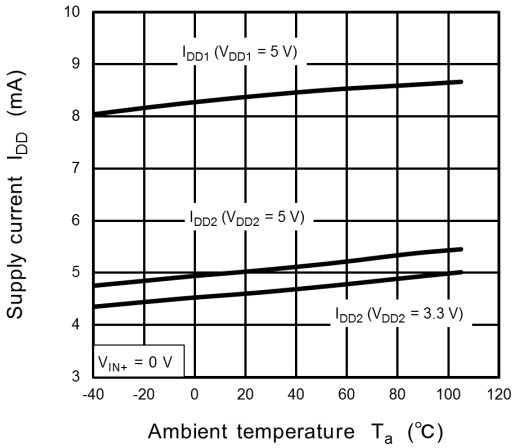


Fig. 11.7 I_{DD} - T_a

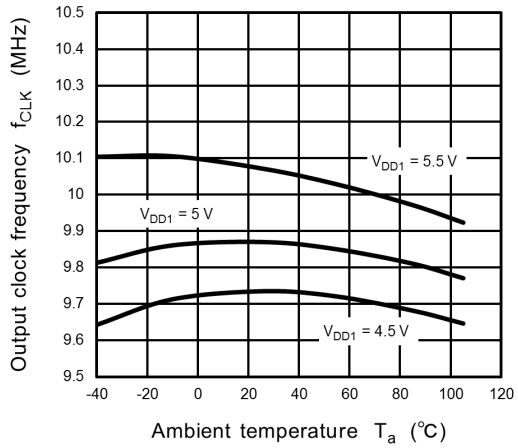
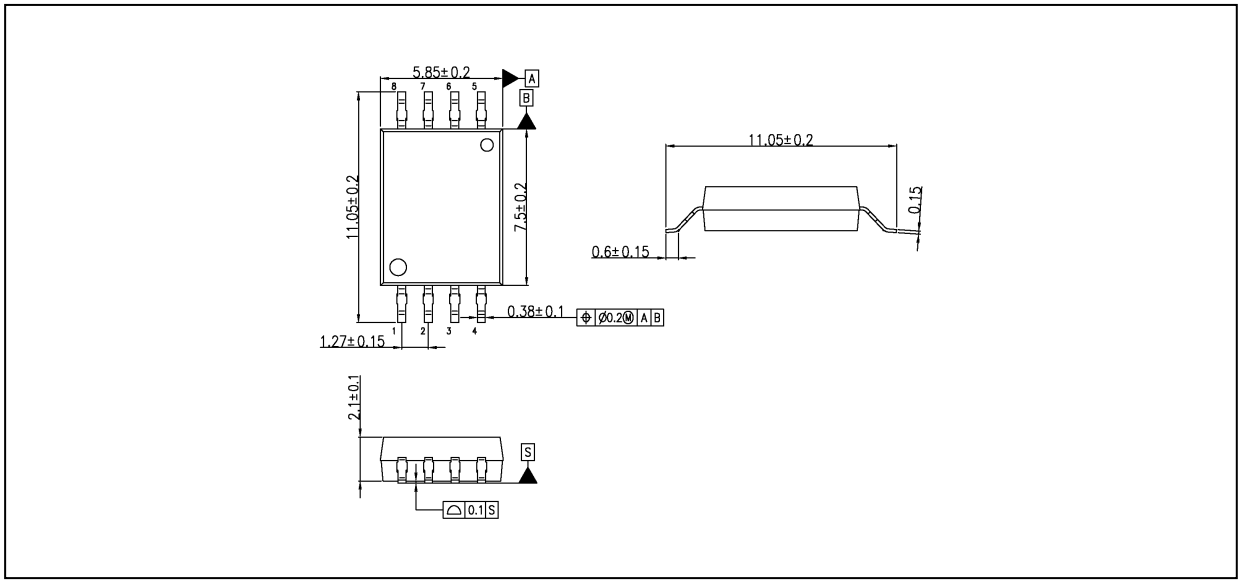


Fig. 11.8 f_{CLK} - T_a

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

Package Dimensions

Unit: mm



Weight: 0.205 g (typ.)

Package Name(s)
TOSHIBA: 11-6B1A

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