

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 delta-sigma ($\Delta\Sigma$) modulator converts an analog input signal into a high-speed data stream with galvanic isolation based on optical coupling technology.

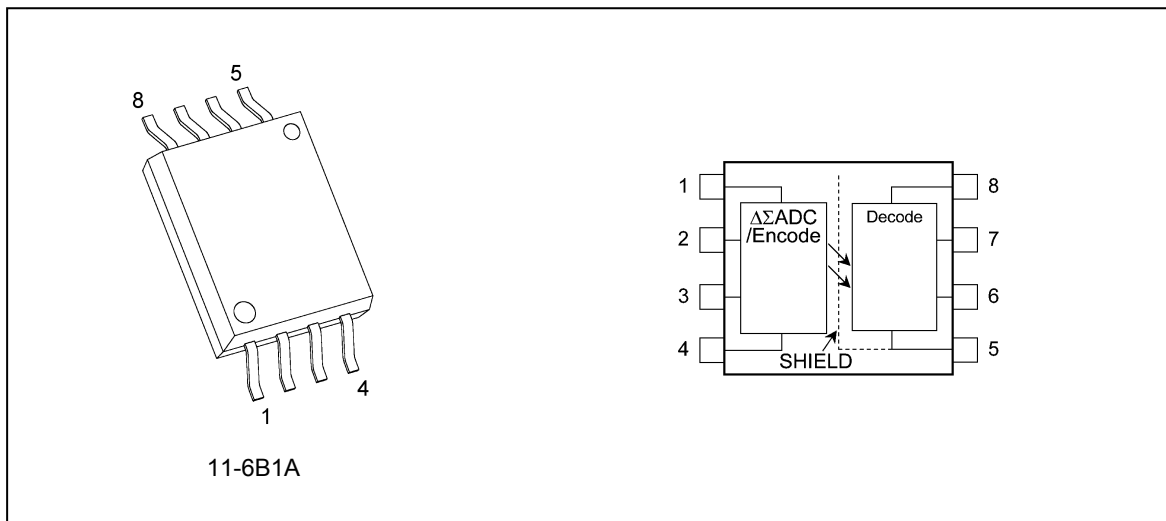
3. Features

- (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 °C
- (6) Common-mode transient immunity: 15 kV/ μ s (min)
- (7) Safety standards
 - UL-recognized: UL 1577, File No.E67349
 - cUL-recognized: CSA Component Acceptance Service No.5A File No.E67349
 - VDE-approved: EN 60747-5-5, EN 62368-1 (**Note 1**)
 - CQC-approved: GB4943.1, GB8898 Japan Factory

Note 1: When a VDE approved type is needed, please designate the **Option (D4)**.

Start of commercial production
2016-01

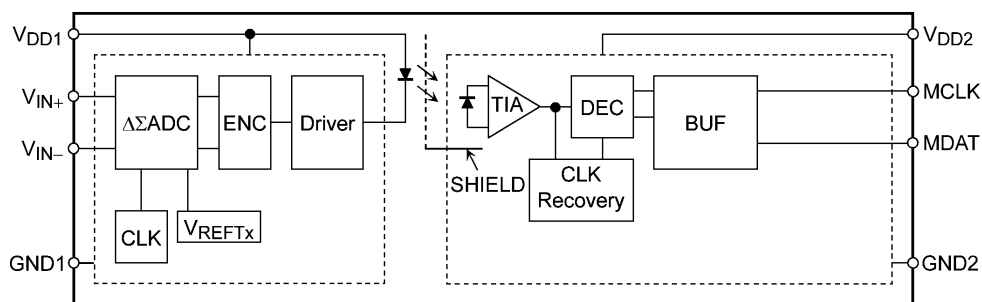
4. Packaging and Pin Assignment



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 |

5. Internal Circuit (Note)



Note: A 0.1- μ F 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 | Size | 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, $T_a = 25\text{ }^\circ\text{C}$)

| 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 $V_{DD1} + 0.5$ | V |
| Two-second transient input voltages | V_{IN+}, V_{IN-} | | -6 to $V_{DD1} + 0.5$ | V |
| Input power dissipation | P_D | | 72 | mW |
| Input power dissipation derating ($T_a \geq 110.6^\circ\text{C}$) | $\Delta P_D/\Delta T_a$ | | -5.0 | mW/ $^\circ\text{C}$ |
| Digital output voltage | MCLK, MDAT | | -0.5 to 6 | V |
| Output power dissipation | P_O | | 48 | mW |
| Output power dissipation derating ($T_a \geq 115.4^\circ\text{C}$) | $\Delta P_O/\Delta T_a$ | | -5.0 | mW/ $^\circ\text{C}$ |
| Operating temperature | T_{opr} | | -40 to 105 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | | -55 to 125 | $^\circ\text{C}$ |
| Lead soldering temperature (10 s) | T_{sol} | (Note 1) | 260 | $^\circ\text{C}$ |
| Isolation voltage (AC, 60 s, R.H. $\leq 60\%$) | 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 | V |
| Analog input voltage | V_{IN+}, V_{IN-} | (Note 1), (Note 2) | -200 | — | 200 | mV |
| Ambient temperature | T_a | | -40 | — | 105 | $^\circ\text{C}$ |

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 data sheet 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.

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 | $ dV_{OS}/dT_a $ | | — | 1.2 | 3 | $\mu\text{V}/^\circ\text{C}$ |
| Input offset voltage drift vs input side supply voltage | $ dV_{OS}/dV_{DD1} $ | | — | 150 | — | $\mu\text{V}/\text{V}$ |
| Internal reference voltage | V_{REF} | | — | 320 | — | mV |
| Gain error | G_E | $T_a = 25$ °C | -1 | 0.1 | 1 | % |
| | | $T_a = -40$ 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 |
| | | $V_{IN+} = 0$ V, $V_{DD2} = 5$ V | — | 4.9 | 8 | |
| 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 |
| | | $I_{OUT} = -200$ μA , $V_{DD2} = 5$ V | 4.8 | 4.9 | — | |
| Equivalent input resistance | R_{IN} | | — | 80 | — | k Ω |

Note: Tested with a Sinc³ 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.

10. 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 | — | ns |
| Common-mode transient immunity | CMTI | $V_{CM} = 1$ kV, $T_a = 25$ °C | 15 | 20 | — | kV/ μ s |

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 % | 10^{12} | 10^{14} | — | Ω |
| Isolation voltage | BV_S | (Note 1) | AC, 60 s | 5000 | — | — | Vrms |

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. 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)

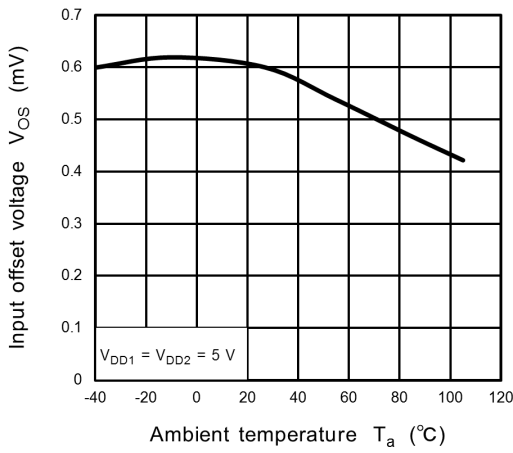


Fig. 12.1 $V_{OS} - T_a$

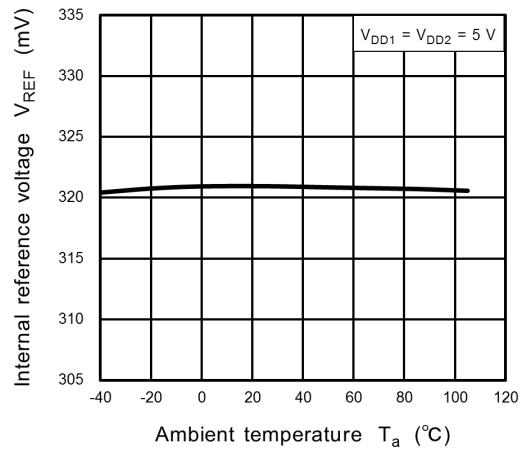


Fig. 12.2 $V_{REF} - T_a$

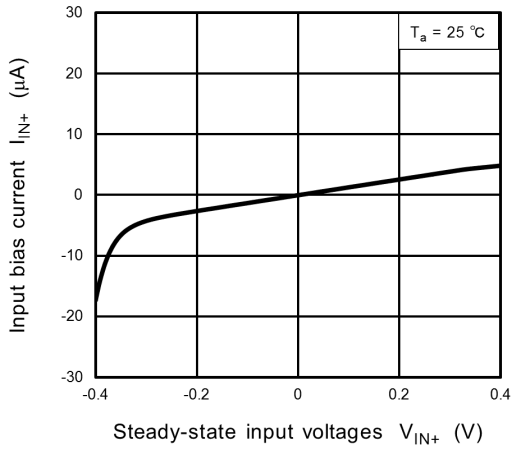


Fig. 12.3 $V_{IN+} - I_{IN+}$

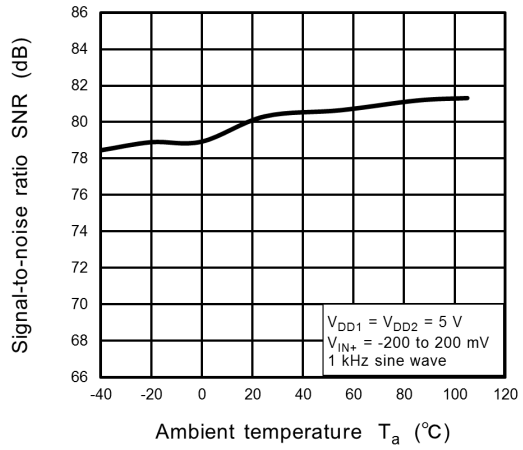


Fig. 12.4 $SNR - T_a$

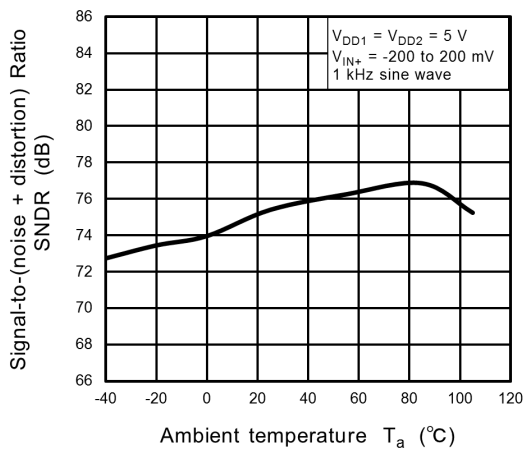


Fig. 12.5 $SNDR - T_a$

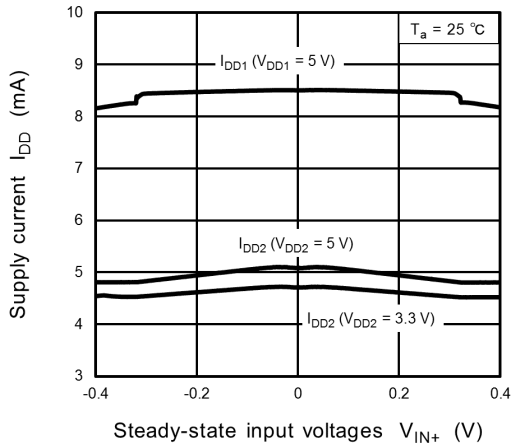


Fig. 12.6 $I_{DD} - V_{IN+}$

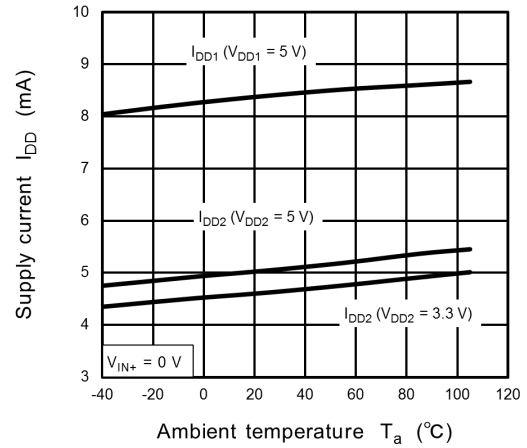


Fig. 12.7 $I_{DD} - T_a$

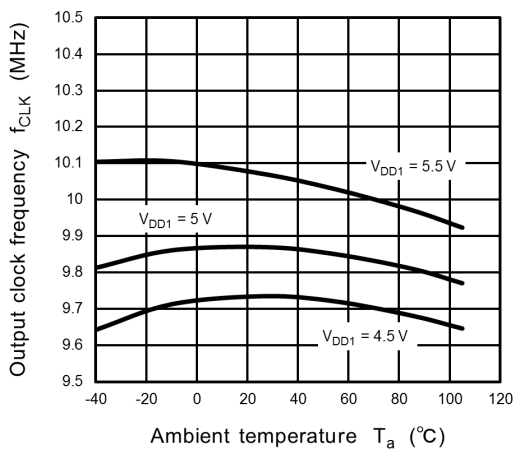


Fig. 12.8 $f_{CLK} - T_a$

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

13. Soldering and Storage

13.1. Precautions for Soldering

The soldering temperature should be controlled as closely as possible to the conditions shown below, irrespective of whether a soldering iron or a reflow soldering method is used.

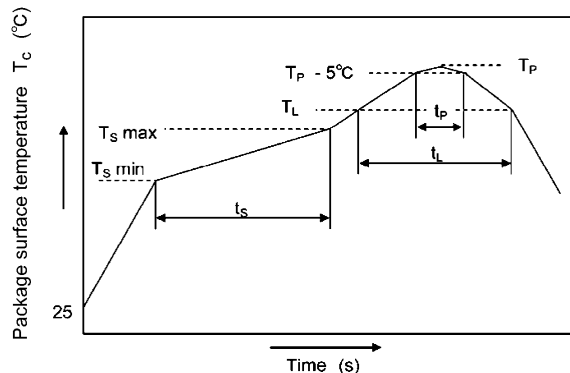
- When using soldering reflow.

The soldering temperature profile is based on the package surface temperature.

(See the figure shown below, which is based on the package surface temperature.)

Reflow soldering must be performed once or twice.

The mounting should be completed with the interval from the first to the last mountings being 2 weeks.



| | Symbol | Min | Max | Unit |
|--|--------|-----|-----|------|
| Preheat temperature | T_s | 150 | 200 | °C |
| Preheat time | t_s | 60 | 120 | s |
| Ramp-up rate (T_L to T_P) | | | 3 | °C/s |
| Liquidus temperature | T_L | 217 | | °C |
| Time above T_L | t_L | 60 | 150 | s |
| Peak temperature | T_P | | 260 | °C |
| Time during which T_c is between ($T_P - 5$) and T_P | t_p | | 30 | s |
| Ramp-down rate (T_P to T_L) | | | 6 | °C/s |

An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- When using soldering flow
Preheat the device at a temperature of 150 °C (package surface temperature) for 60 to 120 seconds.
Mounting condition of 260 °C within 10 seconds is recommended.
Flow soldering must be performed once.
- When using soldering Iron
Complete soldering within 10 seconds for lead temperature not exceeding 260 °C or within 3 seconds not exceeding 350 °C
Heating by soldering iron must be done only once per lead.

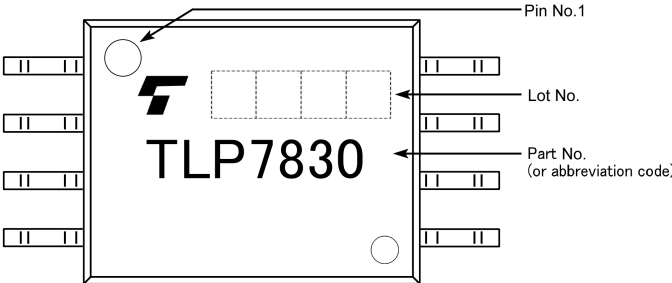
13.2. Precautions for General Storage

- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.
- Do not store the products in locations with poisonous gases (especially corrosive gases) or in dusty conditions.
- Store the products in locations with minimal temperature fluctuations. Rapid temperature changes during storage can cause condensation, resulting in lead oxidation or corrosion, which will deteriorate the solderability of the leads.
- When restoring devices after removal from their packing, use anti-static containers.
- Do not allow loads to be applied directly to devices while they are in storage.
- If devices have been stored for more than two years under normal storage conditions, it is recommended that you check the leads for ease of soldering prior to use.

14. Land Pattern Dimensions (for reference only)



15. Marking



16. EN 60747-5-5 Option (D4) Specification

- Part number: TLP7830 (**Note 1**)
- The following part naming conventions are used for the devices that have been qualified according to option (D4) of EN 60747.

Example: TLP7830(D4-TP4,E)

D4: EN 60747 option

TP4: Tape type

E: [[G]]/RoHS COMPATIBLE (**Note 2**)

Note 1: Use TOSHIBA standard type number for safety standard application.

e.g., TLP7830(D4-TP4,E → TLP7830

Note 2: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.

RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

| Description | Symbol | Rating | Unit |
|--|--|---|----------------|
| Application classification for rated mains voltage ≤ 600 Vrms for rated mains voltage ≤ 1000 Vrms | | I-IV I-III | — |
| Climatic classification | | 40 / 105 / 21 | — |
| Pollution degree | | 2 | — |
| Maximum operating insulation voltage | VIORM | 1414 | Vpeak |
| Input to output test voltage, Method A $V_{pr} = 1.6 \times VIORM$, type and sample test $t_p = 10$ s, partial discharge < 5 pC | Vpr | 2262 | Vpeak |
| Input to output test voltage, Method B $V_{pr} = 1.875 \times VIORM$, 100 % production test $t_p = 1$ s, partial discharge < 5 pC | Vpr | 2652 | Vpeak |
| Highest permissible overvoltage (transient overvoltage, $t_{pr} = 60$ s) | VTR | 8000 | Vpeak |
| Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve) current (input current IF, $P_{so} = 0$) power (output or total power dissipation) temperature | I _{si} P _{so} T _s | 300 700 150 | mA mW °C |
| Insulation resistance V _{IO} = 500 V, T _a = 25 °C V _{IO} = 500 V, T _a = 100 °C V _{IO} = 500 V, T _a = T _s | R _{si} | $\geq 10^{12}$ $\geq 10^{11}$ $\geq 10^9$ | Ω |

Fig. 16.1 EN 60747 Insulation Characteristics

| | | |
|------------------------------|-----|--------|
| Minimum creepage distance | Cr | 8.0 mm |
| Minimum clearance | Cl | 8.0 mm |
| Minimum insulation thickness | ti | 0.4 mm |
| Comparative tracking index | CTI | 500 |

Fig. 16.2 Insulation Related Specifications (Note)

Note: This photocoupler is suitable for **safe electrical isolation** only within the safety limit data. Maintenance of the safety data shall be ensured by means of protective circuits.



Fig. 16.3 Marking on Packing

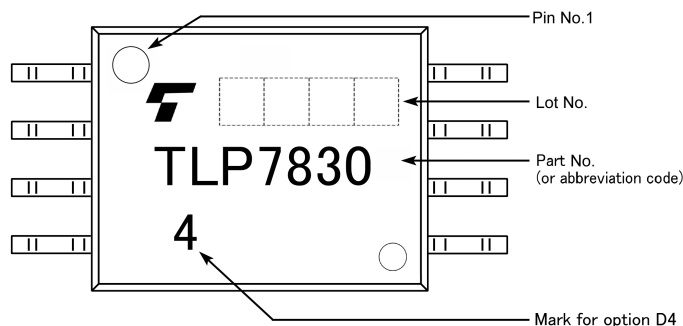


Fig. 16.4 Marking Example (Note)

Note: The above marking is applied to the photocouplers that have been qualified according to option (D4) of EN 60747.

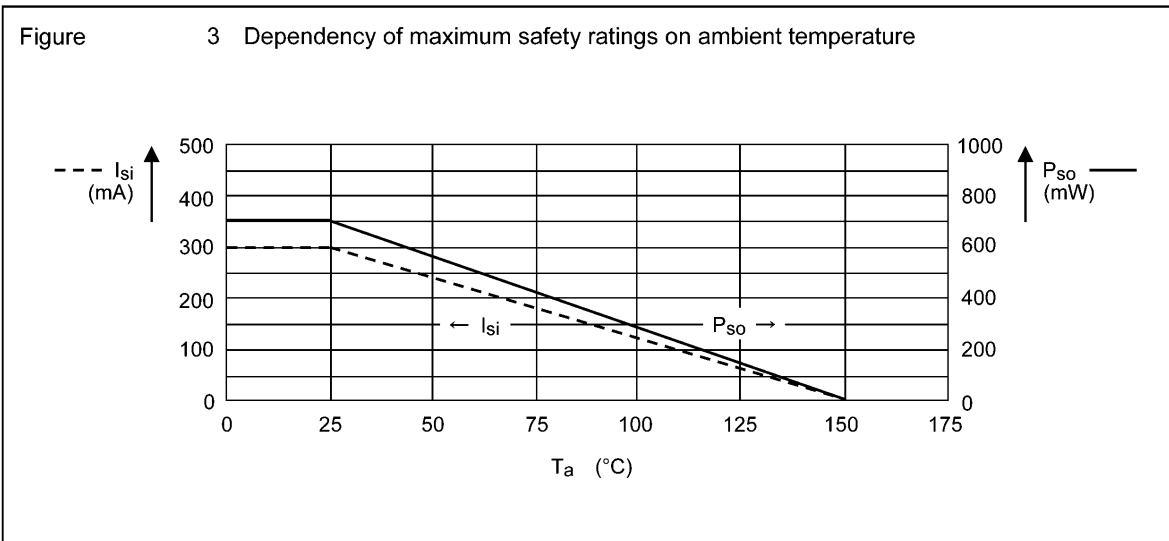
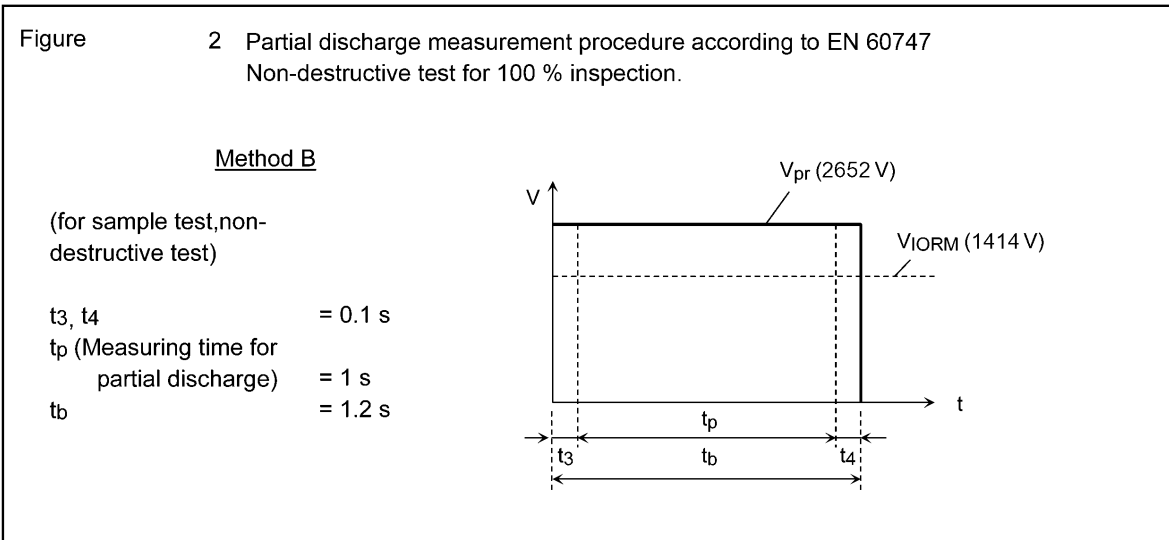
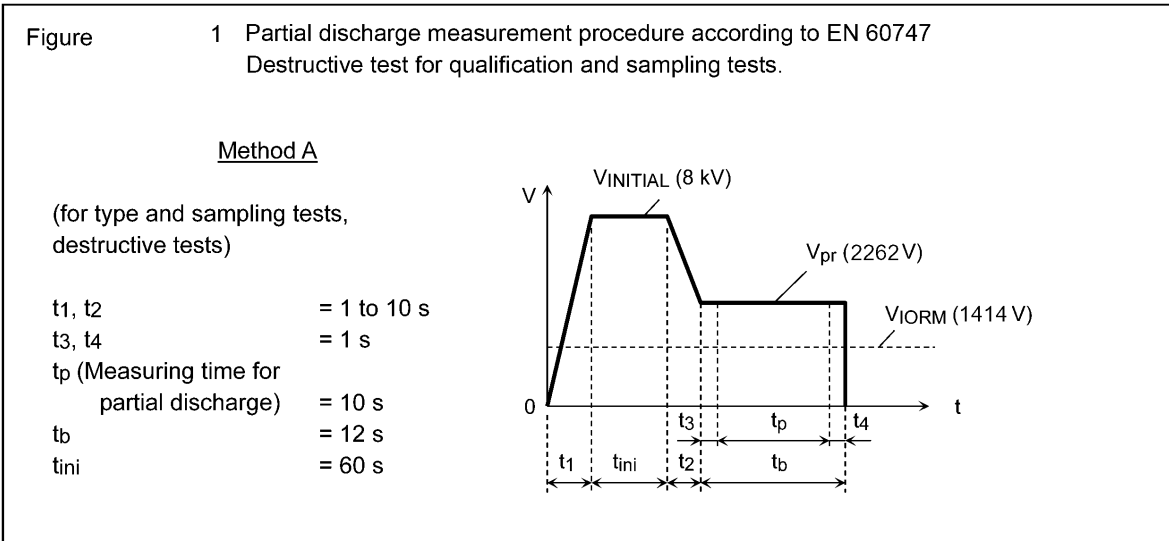


Fig. 16.5 Measurement Procedure

17. Ordering Information

When placing an order, please specify the part number, tape type and quantity as shown in the following example.

Example) TLP7830(TP4,E 1500 pcs

Part number: TLP7830

Tape type: TP4

[[G]]/RoHS COMPATIBLE: E (**Note 1**)

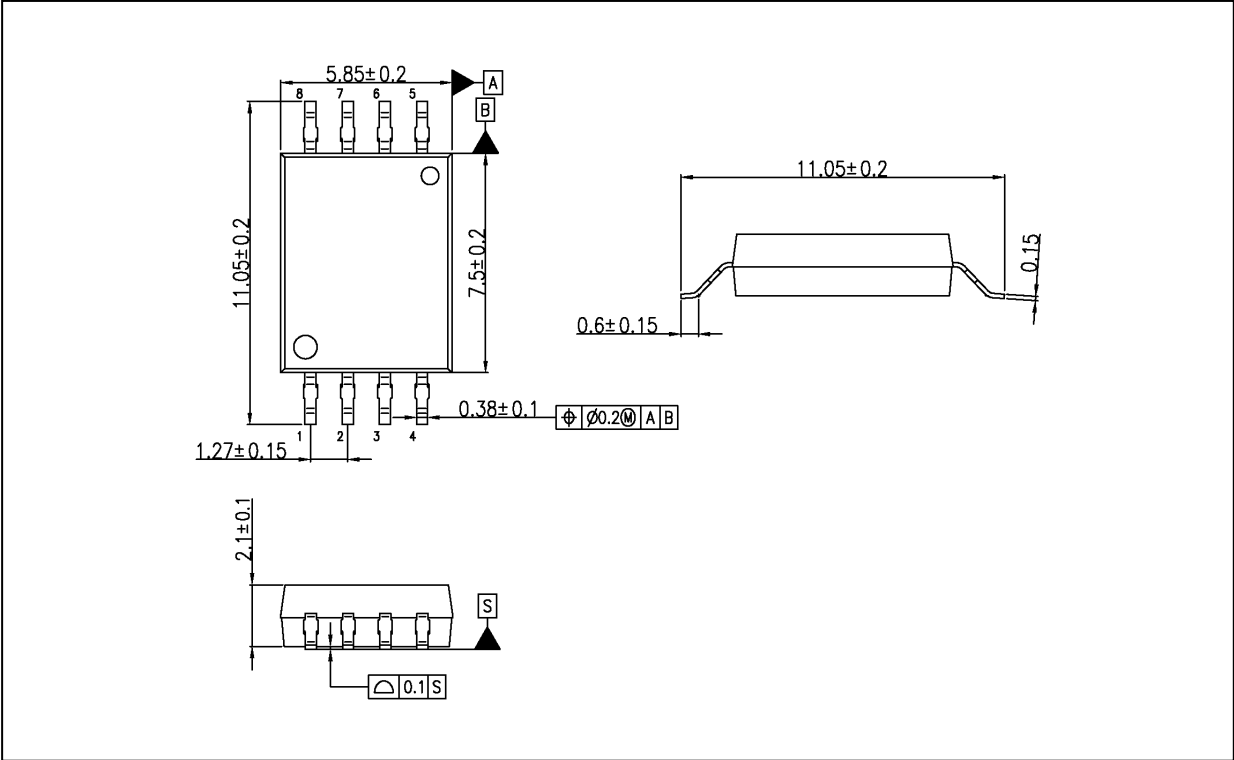
Quantity (must be a multiple of 1500): 1500 pcs

Note 1: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.

RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Package Dimensions

Unit: mm



Weight: 0.205 g (typ.)

| Package Name(s) |
|------------------|
| TOSHIBA: 11-6B1A |

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