

TIOL112 および TIOL112x IO-Link デバイス・トランシーバ、低残留電圧、および小型パッケージのサージ保護機能内蔵

1 特長

- 電源電圧: 7V~36V
- PNP、NPN、または IO-Link を構成可能な出力
 - IEC 61131-9 COM1、COM2、COM3 のデータ・レートをサポート
- 機能安全対応
 - 機能安全システムの設計に役立つ資料を利用可能
- TIOL111(x) とピン互換でさらに性能向上
 - 低い残留電圧: 200mA で 0.5V (標準値)
 - アクティブ・ドライバの電流制限機能
 - パッケージの放熱性能向上
 - ドライバのスルーレートを下げてオーバーシュートを低減: 750ns (最大値)
- 堅牢なシステムのための保護機能を内蔵
 - ドライバの過電流制限を設定可能: 50mA~350mA
 - L+、CQ、L- で最大 65V のアクティブな逆極性保護
 - 過電流、過熱、UVLO フォルトのフォルト・インジケータ
 - 誘導性負荷に対する安全で高速な消磁
 - 拡張周囲温度動作範囲: -40°C~125°C
- L+ および CQ に EMC 保護を搭載
 - ±8kV IEC 61000-4-2 ESD 接触放電
 - ±4kV IEC 61000-4-4 電気的高速過渡
 - ±1.2kV/500Ω の IEC 61000-4-5 サージ
- 大容量負荷駆動能力
- 2μA 未満の CQ リーク電流
- 1.5mA 未満の無信号時電流
- 最大電流 20mA 対応の LDO オプションを搭載
 - TIOL1123: 3.3V LDO
 - TIOL1125: 5V LDO
 - TIOL1123L (YAH): 3.3V/5V の出力を選択可能
- リモート・ウェークアップ通知およびウェークアップ発生
- スペースを節約する小型のパッケージ・オプション
 - 3mm × 3mm の 10 ピン VSON パッケージ: TIOL111 とピン互換
 - 2.45mm x 1.7mm の DSBGA パッケージ

2 アプリケーション

- フィールド・トランスミッタおよびアクチュエータ
- ファクトリ・オートメーション
- プロセス・オートメーション
- リモート IO の IO-link PHY

3 概要

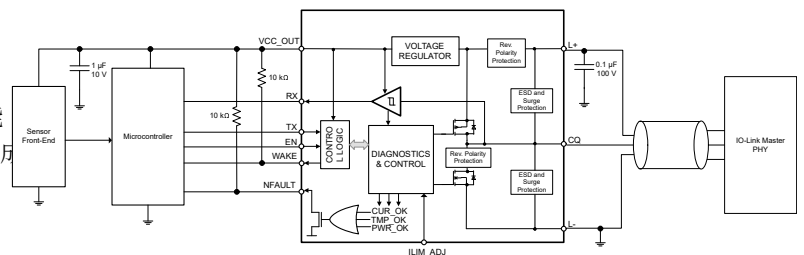
TIOL112(x) ファミリのトランシーバには、産業用の双方向ポイント・ツー・ポイント通信向けに IO-Link インターフェイスが実装されています。このデバイスが 3 線式のインターフェイス経由で IO-Link マスタに接続されているとき、マスタは通信を開始してリモート・ノードとデータを交換でき、TIOL112(x) はこの通信の完全な物理層として機能します。

これらのデバイスは、最大 1.2kV (500Ω) の IEC 61000-4-5 サージに耐えることができ、また、逆極性保護を内蔵しています。ピンによりプログラム可能なインターフェイスを使って、コントローラ回路と容易に接続できます。出力電流制限は、外付けの抵抗を使用して構成できます。TIOL112(x) はウェークアップ・パルスを生成するように構成することができ、IO-Link のマスター・アプリケーションで使用できます。低電圧、過電流、過熱状態に対するフォルト通知および内部保護機能を備えています。

デバイス情報

| 部品番号 | パッケージ ⁽¹⁾ | 本体サイズ (公称) |
|----------|----------------------|-----------------|
| TIOL112 | VSON (10) | 3.00mm × 3.00mm |
| TIOL1123 | | |
| TIOL1125 | | |
| TIOL112 | DSBGA (12) | 2.45mm × 1.70mm |
| TIOL1123 | | |

(1) 利用可能なデバイスについては、このデータシートの末尾にある注文情報を参照してください。



代表的なアプリケーションの図



Table of Contents

| | | | |
|---|----|---|-----------|
| 1 特長..... | 1 | 8.2 Functional Block Diagrams..... | 13 |
| 2 アプリケーション..... | 1 | 8.3 Feature Description..... | 14 |
| 3 概要..... | 1 | 8.4 Device Functional Modes..... | 21 |
| 4 Revision History..... | 2 | 9 Application and Implementation..... | 22 |
| 5 Pin Configuration and Functions..... | 3 | 9.1 Application Information..... | 22 |
| 6 Specifications..... | 5 | 9.2 Typical Application..... | 22 |
| 6.1 Absolute Maximum Ratings..... | 5 | 9.3 Power Supply Recommendations..... | 26 |
| 6.2 ESD Ratings..... | 5 | 9.4 Layout..... | 26 |
| 6.3 ESD Ratings - IEC Specifications..... | 5 | 10 Device and Documentation Support..... | 27 |
| 6.4 Recommended Operating Conditions..... | 5 | 10.1 Receiving Notification of Documentation Updates.. | 27 |
| 6.5 Thermal Information..... | 6 | 10.2 サポート・リソース..... | 27 |
| 6.6 Electrical Characteristics..... | 6 | 10.3 Trademarks..... | 27 |
| 6.7 Switching Characteristics..... | 8 | 10.4 静電気放電に関する注意事項..... | 27 |
| 6.8 Typical Characteristics..... | 9 | 10.5 用語集..... | 27 |
| 7 Parameter Measurement Information..... | 10 | 11 Mechanical, Packaging, and Orderable Information..... | 27 |
| 8 Detailed Description..... | 13 | | |
| 8.1 Overview..... | 13 | | |

4 Revision History

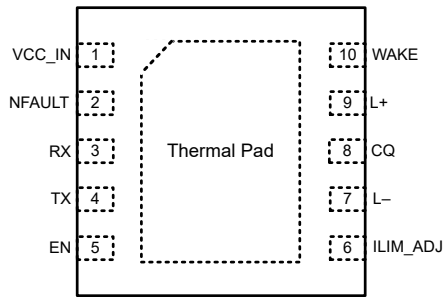
| Changes from Revision C (January 2023) to Revision D (March 2023) | Page |
|---|------|
| • Added the package outline and land pattern images for the YAH (DSBGA) 12-pin package..... | 27 |

| Changes from Revision B (December 2022) to Revision C (January 2023) | Page |
|--|------|
| • 「製品情報」表で DSBGA パッケージの事前情報の注記を削除..... | 1 |

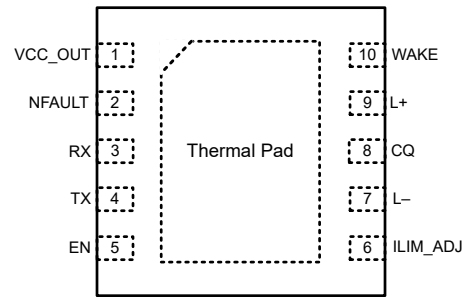
| Changes from Revision A (April 2022) to Revision B (December 2022) | Page |
|--|------|
| • Removed the conditional note 2 from the <i>IEC Ratings - ESD Specifications</i> table that specified 4.5kV when EN=TX=HIGH | 5 |
| • Changed the description of $I_{(VCC_OUT)}$ from: (TIOL112L only) to: TIOL1123(L), TIOL1125 only in the <i>Recommended Operating Conditions</i> table..... | 5 |
| • Changed 図 6-4 and 図 6-6 | 9 |
| • Added application curves Figure 9-6 and Figure 9-7 showing inductive load demagnetization..... | 25 |

| Changes from Revision * (February 2022) to Revision A (April 2022) | Page |
|--|------|
| • 「デバイス情報」表で VSON パッケージの TIOL112 および TIOL1125 から事前情報の注記を削除..... | 1 |

5 Pin Configuration and Functions



**图 5-1. TIOL112
DRC (VSON), 10-Pin
(Top View)**



**图 5-2. TIOL1123, TIOL1125
DRC (VSON), 10-Pin
(Top View)**

表 5-1. Pin Functions (VSON Package)

| PIN NO | PIN NAME | | TYPE | DESCRIPTION |
|--------|-------------|----------------------|------|--|
| | TIOL112 | TIOL1123 TIOL1125 | | |
| 1 | VCC_IN | VCC_OUT | P | VCC_IN (TIOL112): External 3.3-V or 5-V logic supply input pin. VCC_OUT (TIOL1123, TIOL1125): 3.3-V or 5-V linear regulator output |
| 2 | NFAULT | NFAULT | O | Fault indicator output signal to the microcontroller. A low level indicates either an over-current, an undervoltage supply or an overtemperature condition. |
| 3 | RX | RX | O | Receive data output to the local microcontroller |
| 4 | TX | TX | I | Transmit data input from the local microcontroller. No effect if EN is low. Logic high sets low-side switch. Logic low sets high-side switch. Weak internal pull-up. |
| 5 | EN | EN | I | Driver enable input signal from the local microcontroller. Logic low sets the CQ output at Hi-Z. Weak internal pull-down. |
| 6 | ILIM_ADJ | ILIM_ADJ | I | Input for current limit adjustment. Connect resistor R_{SET} between ILIM_ADJ and L-. |
| 7 | L- | L- | GND | IO-Link ground potential |
| 8 | CQ | CQ | I/O | IO-Link data signal (bidirectional) |
| 9 | L+ | L+ | P | IO-Link supply voltage (24 V nominal) |
| 10 | WAKE | WAKE | O | Wake-up indicator to the local microcontroller. Open-drain output, connect this pin via pull-up resistor to VCC_IN/OUT. |
| | Thermal Pad | Thermal Pad | — | Connect to L- for optimal thermal and electrical performance |

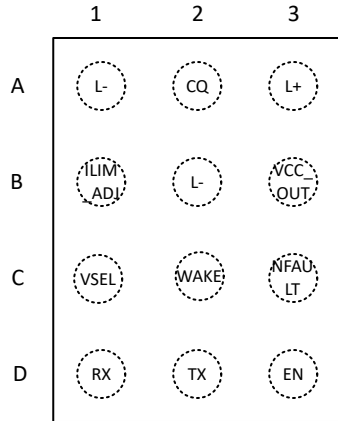


图 5-3. TIOL1123L YAH (DSBGA), 12-Pin (Top View)

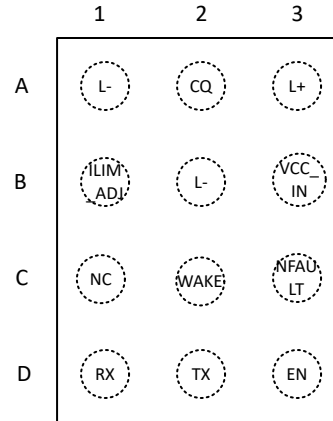


图 5-4. TIOL112 YAH (DSBGA), 12-Pin (Top View)

表 5-2. Pin Functions (DSBGA)

| PIN NO | PIN NAME | | TYPE | DESCRIPTION |
|--------|----------|-----------|------|--|
| | TIOL112 | TIOL1123L | | |
| B3 | VCC_IN | VCC_OUT | P | VCC_IN (TIOL112): External 3.3-V or 5-V logic supply input pin. VCC_OUT (TIOL1123): 3.3-V or 5-V linear regulator output |
| C3 | NFAULT | NFAULT | O | Fault indicator output signal to the microcontroller. A low level indicates either an over-current, an undervoltage supply or an overtemperature condition. |
| D1 | RX | RX | O | Receive data output to the local controller |
| D2 | TX | TX | I | Transmit data input from the local controller. No effect if EN is low. Logic high sets low-side switch. Logic low sets high-side switch. Weak internal pull-up. |
| D3 | EN | EN | I | Driver enable input signal from the local controller. Logic low sets the CQ output at Hi-Z. Weak internal pull-down. |
| B1 | ILIM_ADJ | ILIM_ADJ | O | Input for current limit adjustment. Connect resistor R_{SET} between ILIM_ADJ and L-. |
| A1, B2 | L- | L- | GND | IO-Link ground potential |
| A2 | CQ | CQ | I/O | IO-Link data signal (bidirectional) |
| A3 | L+ | L+ | P | IO-Link supply voltage (24 V nominal) |
| C1 | NC | VSEL | I | TIOL112 (NC): Leave floating. Do not connect. TIOL1123 (VSEL): Connect to GND for 5V LDO output. Please leave this pin floating for 3.3V LDO output. VSEL has an internal pull-up of 1 M Ω |
| C2 | WAKE | WAKE | O | Wake-up indicator to the local controller. Open-drain output, connect this pin via pull-up resistor to VCC_IN/OUT. |

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

| | | MIN | MAX | UNIT |
|---------------------------------------|--|------|-----------------------------|------|
| Supply voltage | Steady state voltage for L+ and CQ | -65 | 65 | V |
| | Transient pulse width < 100 μs for L+ and CQ | -70 | 70 | V |
| Voltage difference | $ V_{(L+)} - V_{(CQ)} $ | | 65 | V |
| Logic supply voltage (TIOL112) | VCC_IN | -0.3 | 6 | V |
| Input logic voltage | TX, EN, VSEL | -0.3 | $\min(V_{CC_IN} + 0.3, 6)$ | V |
| Output current | RX, WAKE, NFAULT | -5 | 5 | mA |
| Storage temperature, T _{stg} | | -55 | 170 | °C |

- (1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute maximum ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If briefly operating outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not sustain damage, but it may not be fully functional. Operating the device in this manner may affect device reliability, functionality, performance, and shorten the device lifetime. All voltages are with reference to the L- pin, unless otherwise specified.

6.2 ESD Ratings

| | | | VALUE | UNIT |
|--------------------|-------------------------|---|-------|------|
| V _(ESD) | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾ | ±4000 | V |
| V _(ESD) | Electrostatic discharge | Charged Device Model (CDM), per ANSI/ESDA/JEDEC JS-002 ⁽²⁾ | ±750 | V |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 ESD Ratings - IEC Specifications

| | | | VALUE | UNIT |
|--------------------|-------------------------|--|--------|------|
| V _(ESD) | Electrostatic discharge | IEC 61000-4-2 ESD (Contact Discharge), L+, CQ and L- ⁽¹⁾ | ±8,000 | V |
| | Electrostatic discharge | IEC 61000-4-5, 1.2 μs/50 μs Surge with 500 Ω in series, L+, CQ and L- ⁽¹⁾ | ±1,200 | |
| | Electrostatic discharge | IEC 61000-4-4 EFT (Fast transient or burst), L+, CQ and L- ⁽¹⁾ | ±4,000 | |

- (1) Minimum 100-nF capacitor is required between L+ and L-. Minimum 1-μF capacitor is required between VCC_IN/VCC_OUT and L-.

6.4 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

| | | MIN | NOM | MAX | UNIT |
|------------------------|---|---------------------|-----|-----|------|
| V _(L+) | Supply voltage | 7 | 24 | 36 | V |
| V _(VCC_IN) | Logic level input voltage (TIOL112 only) | 3.3 V configuration | 3.3 | 3.6 | V |
| | | 5 V configuration | 4.5 | 5.5 | V |
| R _{SET} | External resistor for CQ current limit | 0 | | 110 | kΩ |
| 1/t _{BIT} | Data rate (Communication mode) | | | 250 | kbps |
| I _(VCC_OUT) | LDO output current (TIOL1123(L), TIOL1125 only) | | | 20 | mA |
| T _A | Operating ambient temperature | -40 | | 125 | °C |
| T _J | Junction temperature | | | 150 | °C |

6.5 Thermal Information

| THERMAL METRIC ⁽¹⁾ | | TIOL112, TIOL1123, TIOL1125 | TIOL112, TIOL1123L | UNIT |
|-------------------------------|--|-----------------------------------|--------------------|------|
| | | DRC (10 Pins) | YAH (12 Pins) | |
| R _{θJA} | Junction-to-ambient thermal resistance | 45.9 | 79.3 | °C/W |
| R _{θJC(top)} | Junction-to-case (top) thermal resistance | 45.9 | 0.3 | °C/W |
| R _{θJB} | Junction-to-board thermal resistance | 17.9 | 19.5 | °C/W |
| ψ _{JT} | Junction-to-top characterization parameter | 0.7 | 0.1 | °C/W |
| ψ _{JB} | Junction-to-board characterization parameter | 17.8 | 19.4 | °C/W |
| R _{θJC(bot)} | Junction-to-case (bottom) thermal resistance | 4.7 | N/A | °C/W |

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

6.6 Electrical Characteristics

Over recommended operating conditions and recommended free-air temperature range (unless otherwise noted). Typical values are at L₊ = 24 V, V_{VCC_IN} = 3.3 V, V_{VCC_OUT} = 3.3 V and T_A = 25 °C unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|---|---|-------------------------|------|-------------------------|------|
| POWER SUPPLIES (L+) | | | | | | |
| I _(L+) | Quiescent supply current | EN = LOW, no load | | 1 | 1.5 | mA |
| | | EN = HIGH, no load | | 2 | 2.95 | mA |
| LOGIC-LEVEL INPUTS (EN, TX, VSEL) | | | | | | |
| V _{IL} | Input logic low voltage | | | | 0.8 | V |
| V _{IH} | Input logic high voltage | | 2 | | | V |
| R _{PD} | Pull-down (EN) resistance | | | 100 | | kΩ |
| R _{PU} | Pull-up (TX) resistance | | | 200 | | kΩ |
| R _{PU} | Pull-up (VSEL) resistance | | | 1000 | | kΩ |
| CONTROL OUTPUTS (WAKE, NFAULT) | | | | | | |
| V _{OL} | Output logic low voltage | I _O = 4 mA | | | 0.5 | V |
| I _{OZ} | Output high impedance leakage | Output in Hi-Z, V _O = 0 V or VCC_IN/OUT | -1 | | 1 | μA |
| DRIVER OUTPUT (CQ) | | | | | | |
| R _{DS(ON)} | High-side driver on-resistance | | | 2.5 | 4.5 | Ω |
| V _{DS(ON)} | High-side driver residual voltage | I = 200 mA | | 0.5 | 0.9 | V |
| | | I = 100 mA | | 0.25 | 0.5 | V |
| R _{DS(ON)} | Low-side driver on-resistance | | | 2.5 | 4.5 | Ω |
| V _{DS(ON)} | Low-side driver residual voltage | I = 200 mA | | 0.5 | 0.9 | V |
| | | I = 100 mA | | 0.25 | 0.5 | V |
| I _{OZ(CQ)} | CQ leakage | EN = LOW, 0 ≤ V _(CQ) ≤ (V _(L+) - 0.1 V) | -2 | | 2 | μA |
| I _{LLM} | CQ load discharge current | EN = LOW, R _{SET} = 0 to 5 kΩ ⁽²⁾ , V _(CQ) ≥ 5 V | 5 | | 15 | mA |
| I _{O(LIM)} | Driver output current limit | R _{SET} = 110 kΩ; V _(CQ) = (V _(L+) - 3) V or 3 V | 35 | 50 | 70 | mA |
| | | R _{SET} = 10 kΩ | 300 | 350 | 400 | mA |
| | | R _{SET} = 0 to 5 kΩ ⁽²⁾ V _(CQ) = (V _(L+) - 3) V or 3 V T _J < T _(SDN) or t < 200 μs ⁽⁷⁾ | 500 | | | mA |
| | | (Fast-detect mode) R _{SET} = OPEN ⁽¹⁾ ; V _(CQ) = (V _(L+) - 3) V or 3 V | 260 | 330 | 400 | mA |
| RECEIVER INPUT (CQ) | | | | | | |
| V _(THH) | Input threshold "H" | V _(L+) > 18 V, EN = LOW | 10.5 | | 13 | V |
| V _(THL) | Input threshold "L" | | 8 | | 11.5 | V |
| V _(HYS) | Receiver Hysteresis (V _(THH) - V _(THL)) | | 0.75 | | | V |
| V _(THH) | Input threshold "H" | V _(L+) < 18 V, EN = LOW | See Note ⁽⁴⁾ | | See Note ⁽⁵⁾ | V |

6.6 Electrical Characteristics (continued)

Over recommended operating conditions and recommended free-air temperature range (unless otherwise noted). Typical values are at $V_{L+} = 24\text{ V}$, $V_{VCC_IN} = 3.3\text{ V}$, $V_{VCC_OUT} = 3.3\text{ V}$ and $T_A = 25\text{ }^\circ\text{C}$ unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-------------------------------|--|---|----------------------------|----------------------------|--------------|------------------|
| $V_{(THL)}$ | Input threshold "L" | | See Note (6) | | See Note (7) | V |
| $V_{(HYS)}$ | Receiver Hysteresis ($V_{(THH)} - V_{(THL)}$) | $V_{(L+)} < 18\text{ V}$, EN= LOW | | 0.75 | | V |
| V_{OL} | RX output low voltage | $I_{OL} = 4\text{ mA}$ | | | 0.4 | V |
| V_{OH} | RX output high voltage | $I_{OL} = -4\text{ mA}$ | | $V_{CC_IN}/$ $OUT-0.5$ | | V |
| PROTECTION CIRCUITS | | | | | | |
| $V_{(UVLO)}$ | L+ under voltage lockout | L+ falling; NFAULT = Hi-Z | 6 | 6.3 | | V |
| | | L+ rising; NFAULT = LOW | | 6.5 | 6.8 | V |
| $V_{(UVLO,HYS)}$ | L+ under voltage hysteresis | Rising to falling threshold | 200 | | | mV |
| $V_{(UVLO_IN)}$ | VCC_IN under voltage lockout (No LDO option) | VCC_IN falling; NFAULT = Hi-Z | | 2.3 | | V |
| | | VCC_IN rising; NFAULT = LOW | | 2.5 | | V |
| $V_{(UVLO,HYS)}$ | VCC_IN under voltage hysteresis (No LDO option) | Rising to falling threshold | | 190 | | mV |
| $T_{(WRN)}$ | Thermal warning | | 125 | | | $^\circ\text{C}$ |
| $T_{(SDN)}$ | Thermal shutdown | Die temperature T_J | 150 | 160 | | $^\circ\text{C}$ |
| $T_{(HYS)}$ | Thermal hysteresis for shutdown | | | 14 | | $^\circ\text{C}$ |
| $T_{(WRN)}$ | Thermal hysteresis for warning | Die temperature T_J | | 14 | | $^\circ\text{C}$ |
| I_{REV} | Leakage current in reverse polarity | EN=LOW, TX=x; $V_{(CQ)} < V_{(L-)}$ or $V_{(CQ)} > V_{(L+)}$, up to 36 V | | | 60 | μA |
| | | EN=LOW, TX=x; $V_{(CQ)} < V_{(L-)}$ or $V_{(CQ)} > V_{(L+)}$, up to 65 V | | | 110 | μA |
| | | EN = HIGH, TX = LOW; $V_{(CQ\text{ to }L+)} = 3\text{ V}$ | | | 640 | μA |
| | | EN = HIGH, TX = HIGH; $V_{(CQ\text{ to }L-)} = -3\text{ V}$ | | | 10 | μA |
| LINEAR REGULATOR (LDO) | | | | | | |
| $V_{(VCC_OUT)}$ | Voltage regulator output | TIOL1125, TIOL1123L (5V) | 4.75 | 5 | 5.25 | V |
| | | TIOL1123, TIOL1123L (3.3V) | 3.13 | 3.3 | 3.46 | V |
| $V_{(DROP)}$ | Voltage regulator drop-out voltage ($V_{(L+)} - V_{(VCC_OUT)}$) | $I_{CC} = 20\text{ mA}$ load current | TIOL1125, TIOL1123L (5V) | 0.75 | 1.9 | V |
| | | | TIOL1123, TIOL1123L (3.3V) | 0.75 | 2.3 | V |
| REG | Line regulation ($dV_{(VCC_OUT)}/dV_{(L+)}$) | $I_{(VCC_OUT)} = 1\text{ mA}$ | | | 1.7 | mV/V |
| L_{REG} | Load regulation ($dV_{(VCC_OUT)}/V_{(VCC_OUT)}$) | $V_{(L+)} = 24\text{ V}$, $I_{(VCC_OUT)} = 100\text{ }\mu\text{A}$ to 20 mA | | | 1% | |
| PSSR | Power Supply Rejection Ratio | 100 kHz, $I_{(VCC_OUT)} = 20\text{ mA}$ | | 40 | | dB |

- (1) Current fault indication will be active. Current fault auto recovery will be de-activated.
- (2) Current fault indication and current fault auto recovery will be de-activated.
- (3) If operating continuously with this current limit, ensure that the current through the device does not cause the T_J to be greater than $T_{(SDN)}$ for a given ambient temperature and thermal property of the system. For pulse durations $t < 200\text{ }\mu\text{s}$, the device can source or sink current of at least 500 mA across the recommended operating conditions. For YAH (DSBGA) package, this parameter is specified by design and characterization.
- (4) $V_{THH}(\text{min}) = 5\text{ V} + (11/18) [V_{(L+)} - 8\text{ V}]$
- (5) $V_{THH}(\text{max}) = 6.5\text{ V} + (13/18) [V_{(L+)} - 8\text{ V}]$
- (6) $V_{THL}(\text{min}) = 4\text{ V} + (8/18) [V_{(L+)} - 8\text{ V}]$
- (7) $V_{THL}(\text{max}) = 6\text{ V} + (11/18) [V_{(L+)} - 8\text{ V}]$

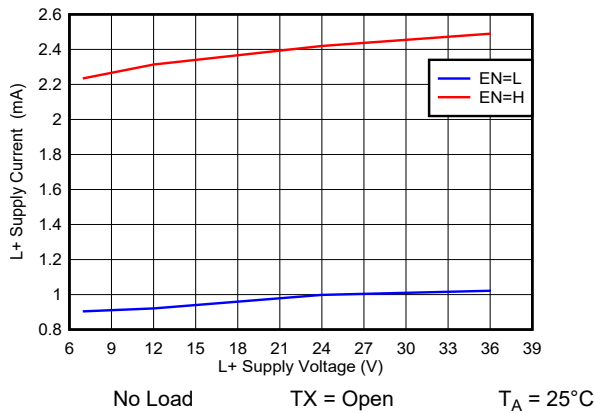
6.7 Switching Characteristics

Over recommended operating conditions and recommended free-air temperature range (unless otherwise noted). Typical values are at $L_+ = 24\text{ V}$, $V_{VCC_IN} = 3.3\text{ V}$, $V_{VCC_OUT} = 3.3\text{ V}$ and $T_A = 25\text{ }^\circ\text{C}$ unless otherwise specified.

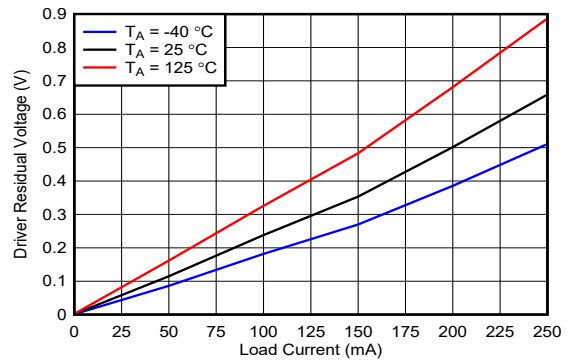
| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------------------|---|---|-----|-----|------|---------------|
| DRIVER | | | | | | |
| t_{PLH} , t_{PHL} | Driver propagation delay | | | 600 | 1200 | ns |
| $t_{P(\text{skew})}$ | Driver propagation delay skew. $t_{PLH} - t_{PHL}$ | See 7-1 See 7-2 | | 75 | | ns |
| t_{PZH} , t_{PZL} | Driver enable delay | See 7-3 | | | 4 | μs |
| t_{PHZ} , t_{PLZ} | Driver disable delay | $R_L = 2\text{ k}\Omega$ $C_L = 5\text{ nF}$ | | | 4 | μs |
| t_r , t_f | Driver output rise, fall time | $R_{(\text{SET})} = 10\text{ k}\Omega$ | 200 | | 700 | ns |
| $ t_r - t_f $ | Difference in rise and fall time | | | 50 | | ns |
| t_{WU1} | Wake-up recognition begin | | 45 | 60 | 75 | μs |
| t_{WU2} | Wake-up recognition end | | 85 | 100 | 145 | μs |
| t_{pWAKE} | Wake-up output delay | See 7-5 | | | 150 | μs |
| t_{SC} | Current fault blanking time | | 175 | 200 | | μs |
| t_{pSC} | Current fault indication delay | | | | 280 | μs |
| t_{WUL} | Wake output pulse duration on wake detection in EN=L mode | See 7-6 | 175 | 225 | 285 | μs |
| t_{SCEN} | Current fault driver re-enable wait time | | | 15 | | ms |
| $t_{(UVLO)}$ | CQ re-enable delay after UVLO ⁽¹⁾ | $V_{(UVLO)}$ rising threshold crossing time to CQ enable time | 10 | 30 | 50 | ms |
| RECEIVER | | | | | | |
| t_{ND} | Noise suppression time ⁽²⁾ | | | | 250 | ns |
| t_{PLH} , t_{PHL} | Receiver propagation delay | See 7-4 15-pF load on RX, | | 150 | 300 | ns |

- (1) CQ output remains Hi-Z for this time
- (2) Noise suppression time is defined as the permissible duration of a receive signal above/below the detection threshold without detection taking place.

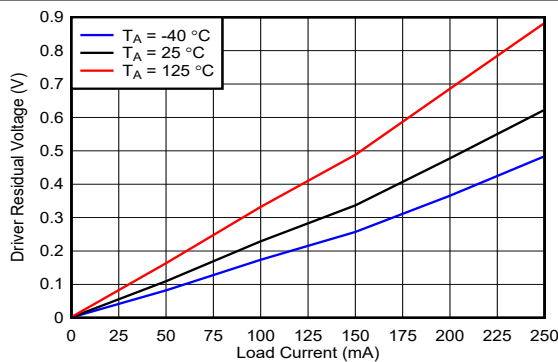
6.8 Typical Characteristics



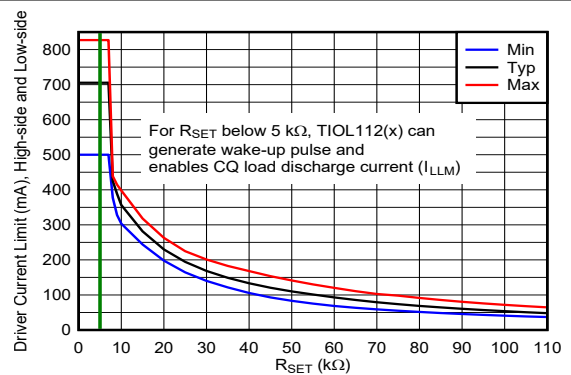
6-1. Supply Current vs Supply Voltage



6-2. Residual Voltage vs Load Current: High Side

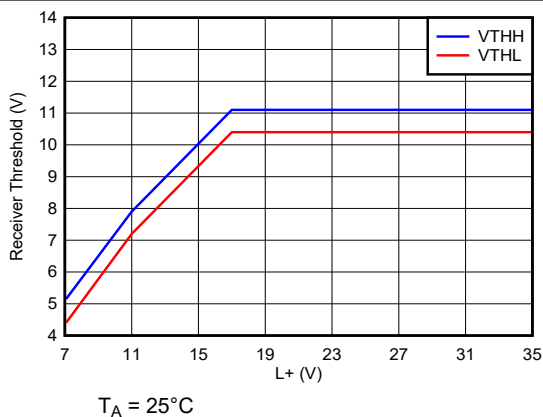


6-3. Residual Voltage vs Load Current: Low Side

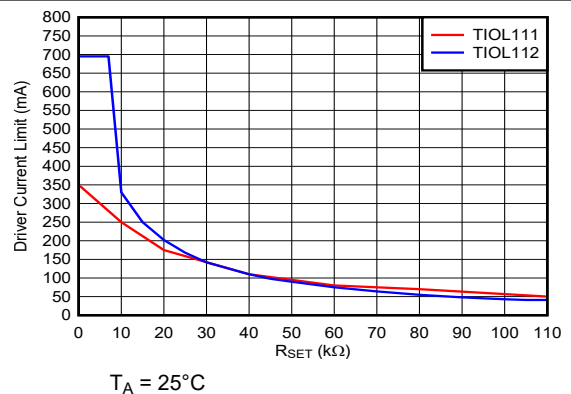


For R_{SET} in the 0-5 k Ω range, TIOL112(x) can source/sink 500 mA required for wake-up pulse generation in IO-link applications. For R_{SET} in the 0-5 k Ω range, TIOL112(x) also activates a pull-down current source (I_{LLM}) when the driver is disabled. Min and max curves specified by design and characterization across temperature and process variation. $T_A = 25^\circ\text{C}$ (typ curve)

6-4. Current Limit vs R_{SET}

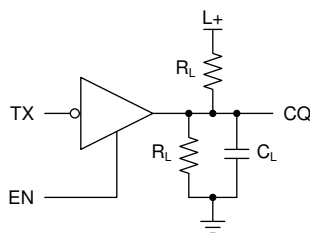


6-5. Receiver Threshold Boundaries



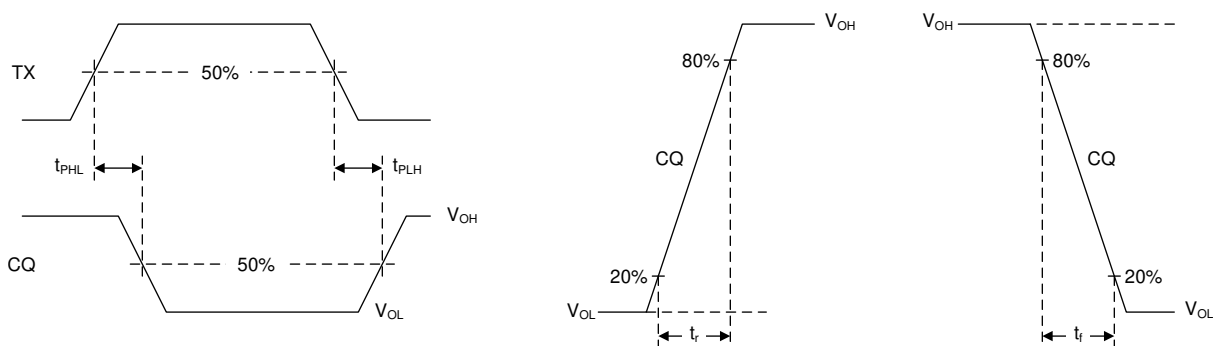
6-6. Current limit vs R_{SET} : TIOL112(x) vs TIOL111(x)

7 Parameter Measurement Information

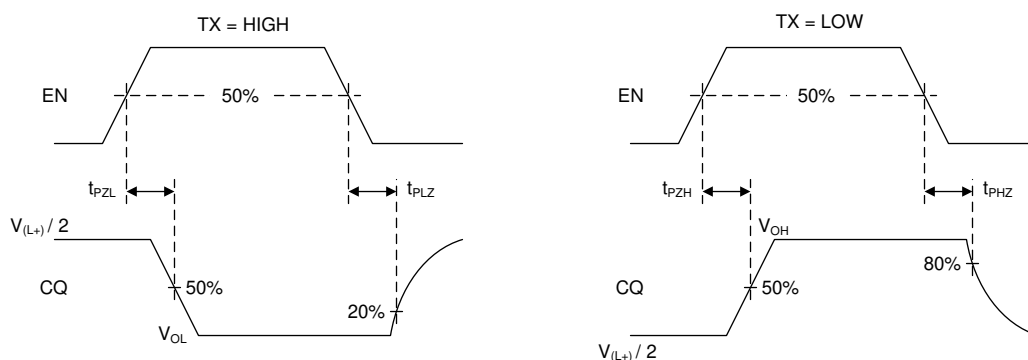


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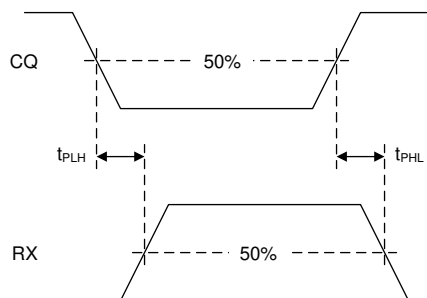
7-1. Test Circuit for Driver Switching



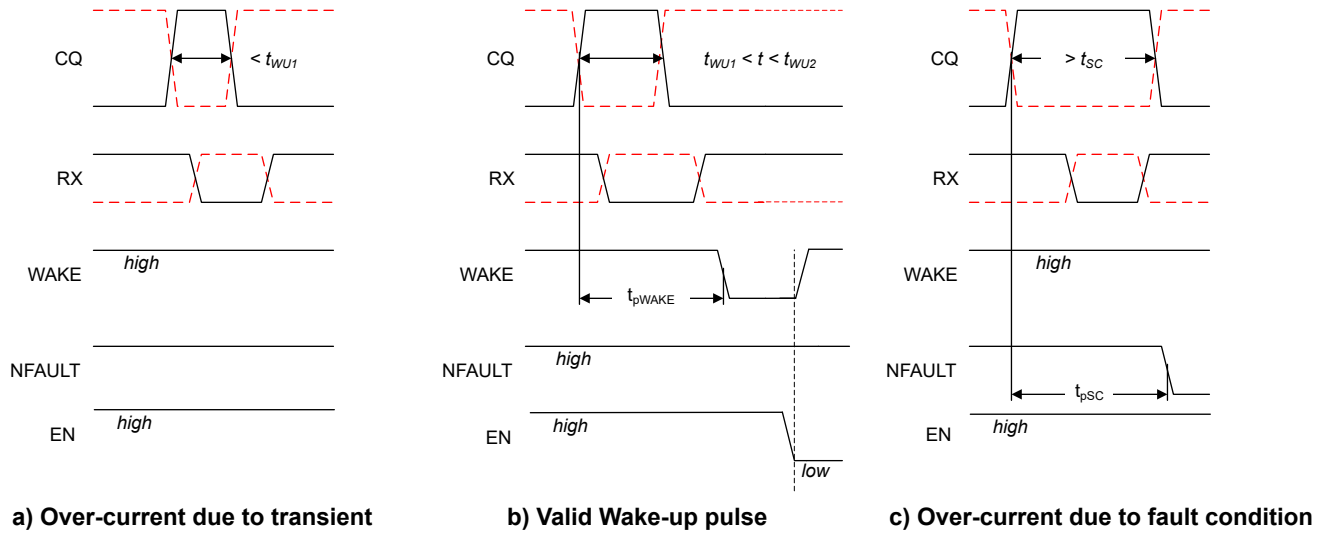
7-2. Waveforms for Driver Output Switching Measurements



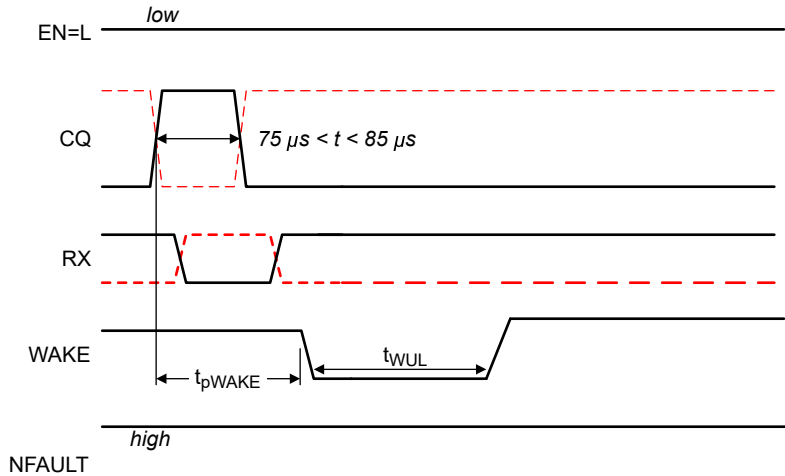
7-3. Waveforms for Driver Enable or Disable Time Measurements

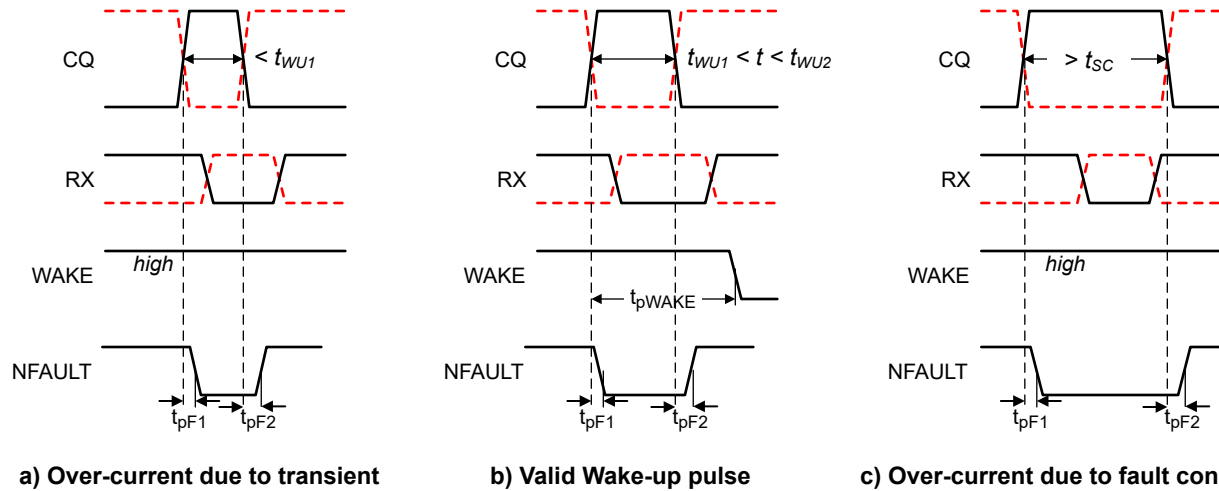


7-4. Receiver Switching Measurements



7-5. Overcurrent and Wake Conditions for EN = H and ILIM_ADJ = 10 kΩ to 110 kΩ, TX = H (Full Lines); and TX = L (Red Dotted Lines)





7-7. Overcurrent and Wake Conditions for EN = H and ILIM_ADJ is floating, TX = H (Full Lines); and TX = L (Red Dotted Lines)

8 Detailed Description

8.1 Overview

Figure 8-1 shows that the TIOL112 or TIOL112x driver output (CQ) can be used in either push-pull, high-side, or low-side configuration using the enable (EN) and transmit data (TX) input pins. The internal receiver converts the 24-V signal on the CQ line to standard logic levels on the receive data (RX) pin. A simple parallel interface is used to receive/transmit data and status information between the device and the local controller.

These devices have integrated IEC 61000-4-4/5 EFT and surge protection. In addition, tolerance to ± 70 -V transients enables flexibility to choose from a wider range of TVS diodes if an application requires higher levels of protection. These integrated robustness features will simplify the system level design by reducing external protection circuitry.

TIOL112 or TIOL112x transceivers implement protection features for overcurrent, overvoltage and over-temperature conditions. The devices also provide a current-limit setting of the driver output current using an external resistor.

The devices derive the low-voltage supply from the IO-Link L+ voltage (24 V nominal) via an internal linear regulator to provide power to the local controller and sensor circuitry.

8.2 Functional Block Diagrams

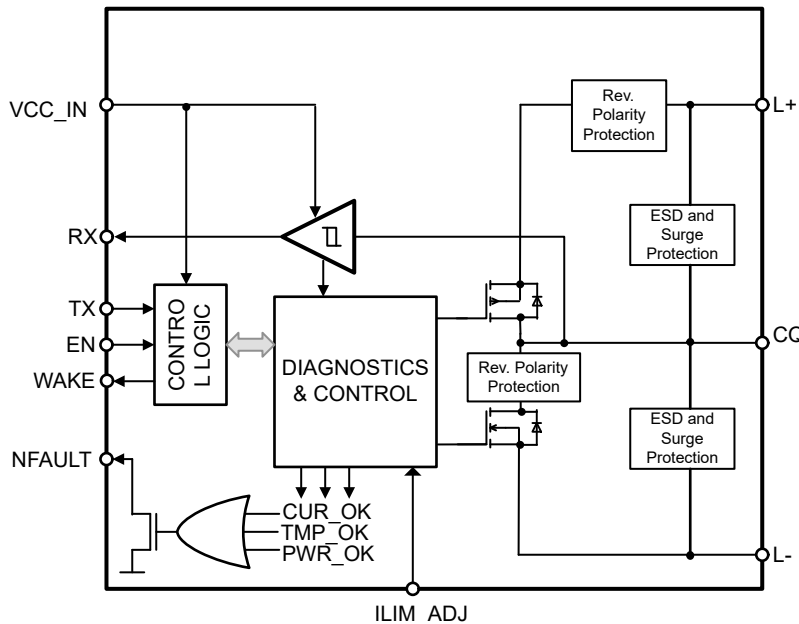
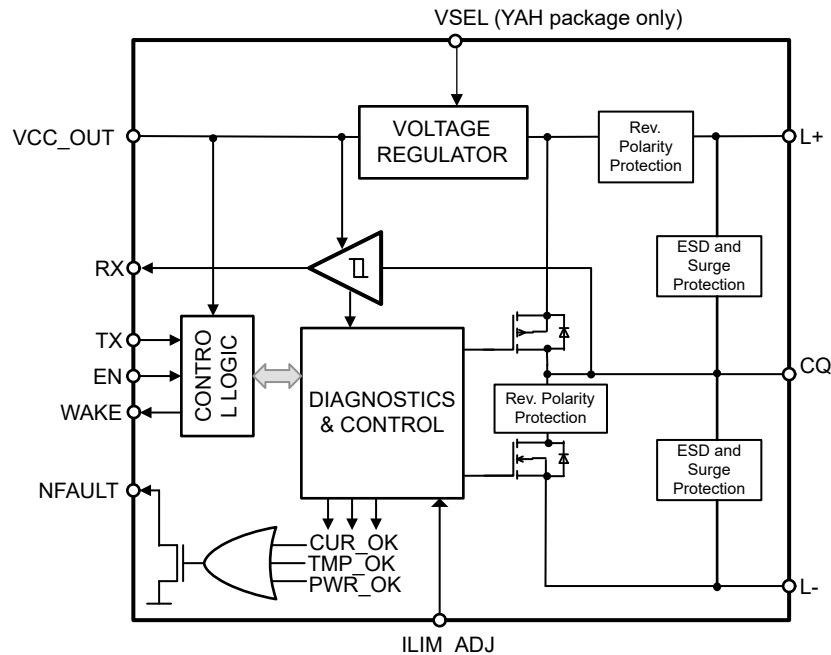


Figure 8-1. Block Diagram TIOL112



8-2. Block Diagram TIOL1123(L), TIOL1125

8.3 Feature Description

8.3.1 Wake-Up Detection

The TIOL112(x) may be operated in IO-Link mode or Standard Input / Output (SIO) mode. If the device is in SIO mode and the IO-link master node wants to initiate communication with the device node, the master drives the CQ line to the opposite of its present state, and will either sink or source the current (≥ 500 mA) for the wake-up duration (typically $80 \mu\text{s}$) depending on the CQ logic level as per the IO-Link specification. The TIOL112(x) detects this as a wake-up condition and communicates to the local microcontroller via the WAKE pin. The IO-Link communication specification requires the device node to switch to receive mode within $500 \mu\text{s}$ after receiving the wake-up signal.

For overcurrent conditions shorter or longer than a valid wake-up pulse, the WAKE pin remains in a high-impedance (inactive) state. This is illustrated in 7-5.

If the driver of TIOL112(x) is disabled ($\text{EN} = \text{L}$), any change in CQ logic level for duration $t_{\text{WU}1} < t < t_{\text{WU}2}$ is detected as a wake-up event and WAKE asserts low for the duration of t_{WUL} . This is illustrated in 7-6. Please refer to 表 8-4 for the summary of the conditions for Wake-Up detection.

8.3.2 Current Limit Configuration

The output current can be configured with an external resistor on ILIM_ADJ pin. The highest current limit setting with an external resistor of $10 \text{ k}\Omega$ provides a minimum of 300 mA over the operating temperature and voltage range.

Output disable due to current fault and current fault auto recovery features can be disabled by floating ILIM_ADJ pin. However, the current fault indication is still active in this configuration. This feature is useful when driving large capacitances.

When ILIM_ADJ pin is shorted to ground, the TIOL112(x) is configured to be in the IO-link master mode. In this mode, the TIOL112(x) can source or sink minimum of 500 mA to generate a wake-up request. In addition, the TIOL112(x) enables a small current sink of 5 mA (minimum). The current fault indication, output disable, and auto recovery features are disabled in this mode.

表 8-1. Current Limit Configuration

| ILIM_ADJ Pin Condition | CQ Current Limit (Min.) | NFAULT Indication During Current Fault | Output Disable and Auto Recovery |
|---|----------------------------|--|----------------------------------|
| R _{SET} resistor to L- (10 kΩ to 110 kΩ) | Variable (35 mA to 300 mA) | Yes | Yes |
| Connected to L- (R _{SET} 0 to 5 kΩ) | 500 mA | No | No |
| OPEN | 260 mA | Yes | No |

8.3.3 Current Fault Detection, Indication and Auto Recovery

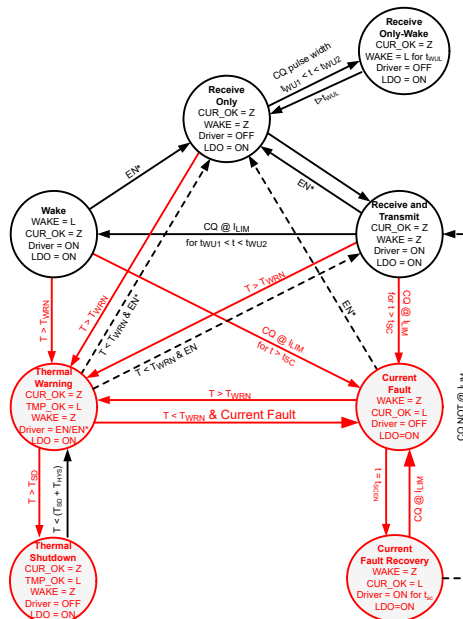
If the output current at CQ exceeds the internally-set current limit I_{O(LIM)} for a duration longer than t_{SC}, the NFAULT pin is driven logic low to indicate a fault condition. The output is turned off, but the LDO continues to function. The output periodically retries to check if the output is still in the over current condition. In this mode, the output is switched on for t_{SC} in t_{SCEN} intervals. Current fault auto recovery mode can be disabled by setting ILIM_ADJ = OPEN. See 表 8-5. Toggling EN will clear NFAULT.

8.3.4 Thermal Warning, Thermal Shutdown

If the die temperature exceeds T_(WRN), the NFAULT flag is held low indicating a potential over temperature problem. When the T_J exceeds T_(SDN), The output is disabled but the LDO remains operational. As soon as the temperature drops below the temperature threshold (and after T_(HYS)), the internal circuit re-enables the driver, subject to the state of the EN and TX pins.

8.3.5 Fault Reporting (NFAULT)

NFAULT is driven low if either a current fault condition is detected, die temperature has exceeded T_(WRN) or supply has dropped below the UVLO threshold. NFAULT returns to high-impedance as soon as all three fault conditions clear.



Note: NFAULT = [CUR_OK && PWR_OK && TMP_OK]

图 8-3. Device State Diagram

8.3.6 Transceiver Function Tables

表 8-2. Driver Function

| EN | TX | CQ | COMMENT |
|----------|----------|------|--|
| L / Open | X | Hi-Z | Device is in ready-to-receive state |
| H | L | H | CQ is sourcing current (high-side drive) |
| H | H / Open | L | CQ is sinking current (low-side drive) |

表 8-3. Receiver Function

| CQ VOLTAGE | RX | COMMENT |
|------------------------------------|----|---|
| $V_{(CQ)} < V_{(THL)}$ | H | Normal receive mode, input low |
| $V_{(THL)} < V_{(CQ)} < V_{(THH)}$ | ? | Indeterminate output, may be either high or low |
| $V_{(THH)} < V_{(CQ)}$ | L | Normal receive mode, input high |
| Open | ? | Indeterminate output, may be either high or low |

表 8-4. Wake-Up Function ($t_{WU1} < t < t_{WU2}$)

| EN | TX | CQ CURRENT | WAKE | COMMENT |
|----------|----------|----------------------------------|---------------------------|--|
| L / Open | X | X | Asserts low for t_{WUL} | Device asserts low for t_{WUL} if RX output changes high-to-low or low-to-high for $t_{WU1} < t < t_{WU2}$ |
| H | H / Open | $ I_{(CQ)} \geq 500 \text{ mA}$ | L | Device receives high-level wake-up request over the IO-Link bus |
| H | L | $ I_{(CQ)} \geq 500 \text{ mA}$ | L | Device receives low-level wake-up request over the IO-Link bus |

表 8-5. Current Limit Indicator Function ($t > t_{SC}$)

| EN | TX | CQ CURRENT | NFAULT | COMMENT |
|----------|----------|---------------------------|--------|---|
| H | H / Open | $ I_{(CQ)} > I_{O(LIM)}$ | L | CQ current exceeds the set limit for over t_{SC} |
| | | $ I_{(CQ)} < I_{O(LIM)}$ | Z | Normal operation |
| H | L | $ I_{(CQ)} > I_{O(LIM)}$ | L | CQ current exceeds the set limit for over t_{SC} |
| | | $ I_{(CQ)} < I_{O(LIM)}$ | Z | Normal operation |
| L / Open | X | X | Z | Driver is disabled, Current limit indicator is inactive |

注

Current limit indicator function is disabled when ILIM_ADJ is connected to GND (or $R_{SET} < 5 \text{ k}\Omega$)

8.3.7 The Integrated Voltage Regulator (LDO)

The TIOL1123 and TIOL1125 each have an integrated linear voltage regulator (LDO) which can supply power to external components. The voltage regulator is specified for L+ voltages in the range of 7 V to 36 V with respect to L-. The LDO is capable of delivering up to 20 mA.

In the DSBGA (YAH) package, TIOL1123L offers pin-configurable LDO output via VSEL pin. When VSEL is connected to GND, VCC_OUT is configured to provide a 5-V output. When VSEL is left floating, VCC_OUT provides a 3.3-V output.

表 8-6. LDO Output Configuration via VSEL pin (YAH Package)

| VSEL pin connection | VCC_OUT |
|---------------------|---------|
| Connected to L- | 5 V |
| Floating | 3.3 V |

The LDO is designed to be stable with standard ceramic capacitors with values of 1 μ F or larger at the output. X5R- and X7R-type capacitors are best because they have minimal variation in value and ESR over temperature. Maximum ESR should be less than 1 Ω . With tolerance and dc bias effects, the minimum capacitance for stability is 1 μ F.

The voltage regulator has an internal 35-mA current limit to protect against initial start-up inrush current due to large decoupling capacitors and accidental short circuit conditions.

8.3.8 Reverse Polarity Protection

Reverse polarity protection circuitry protects the devices against accidental reverse polarity connections to the L+, CQ and L- pins. The maximum voltage between any of the pins may not exceed 65 V DC at any time.

Figure 8-4 and Figure 8-5 shows all the possible connection combinations.

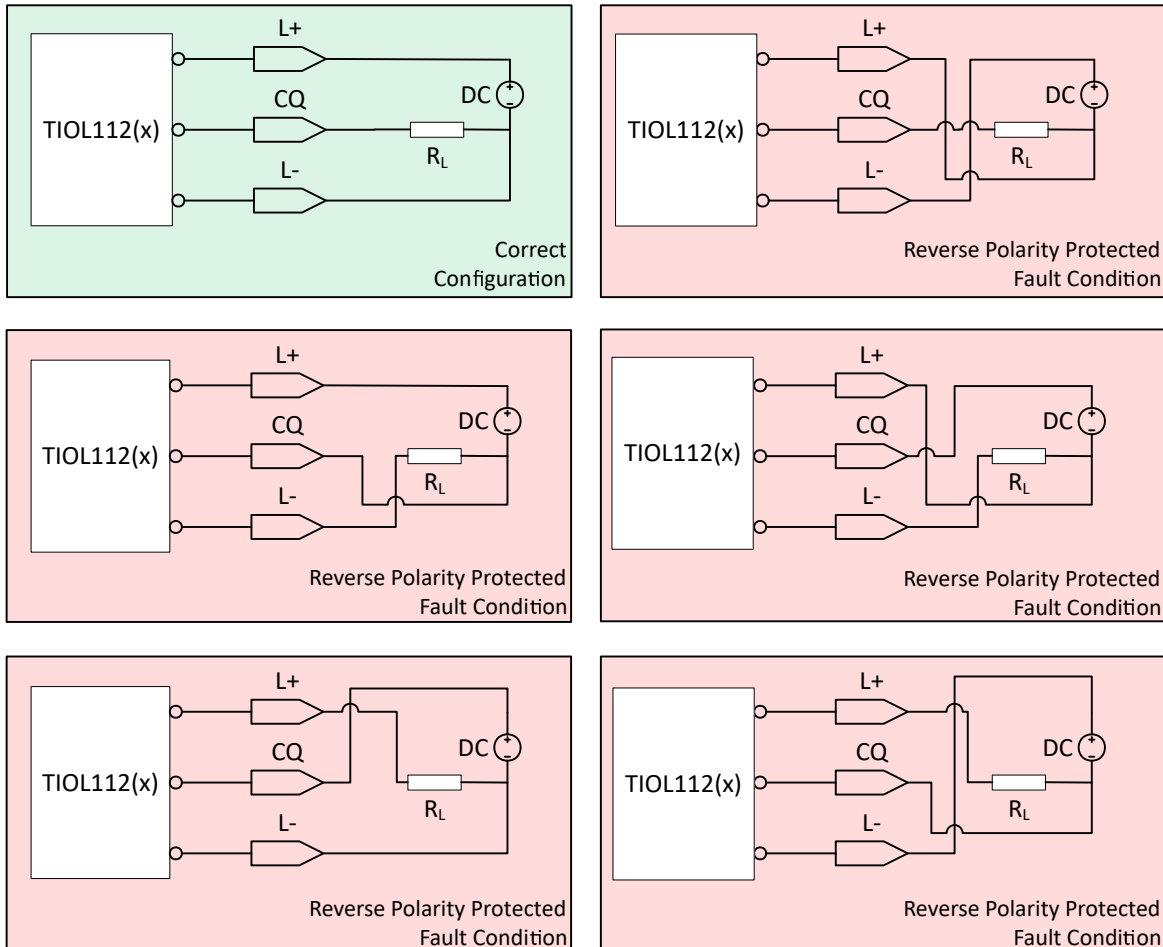
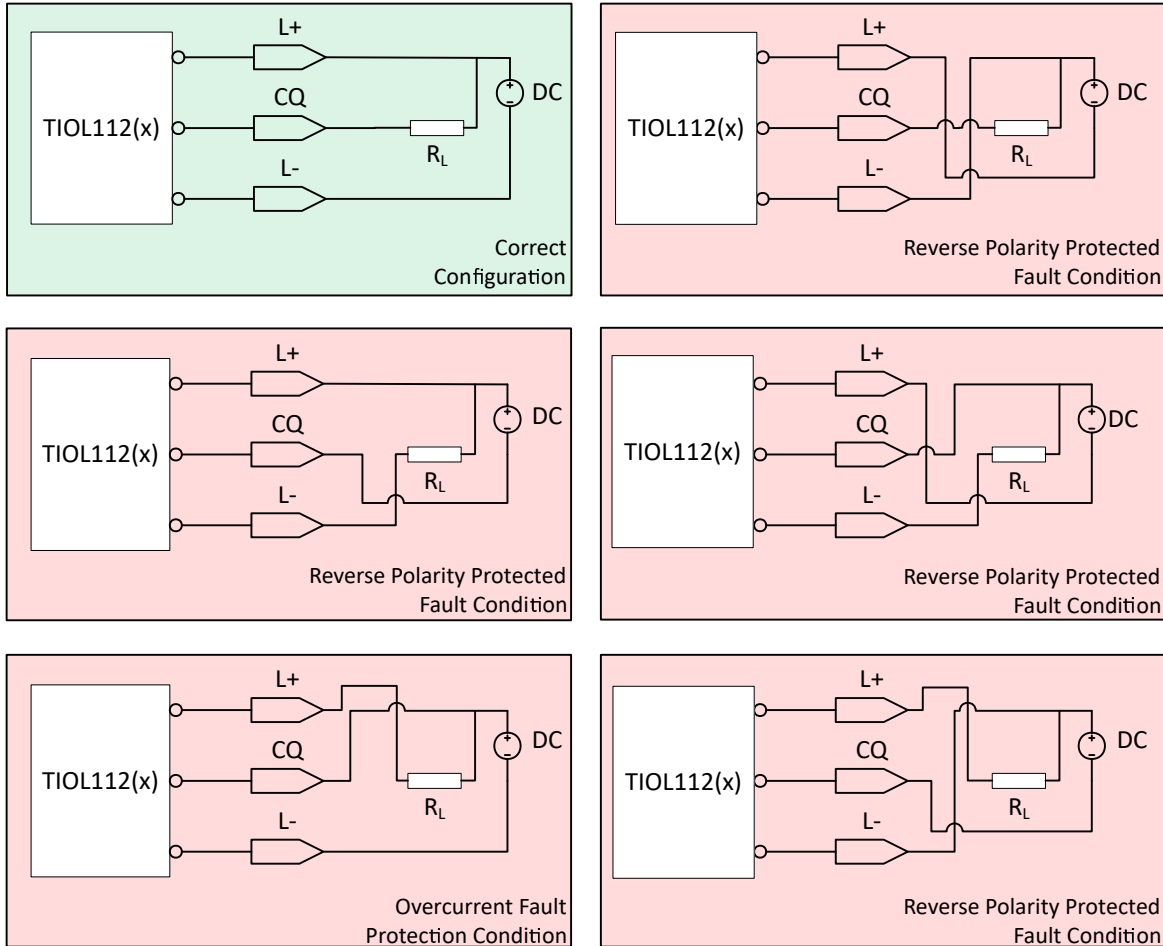


Figure 8-4. High-Side Driver Configuration

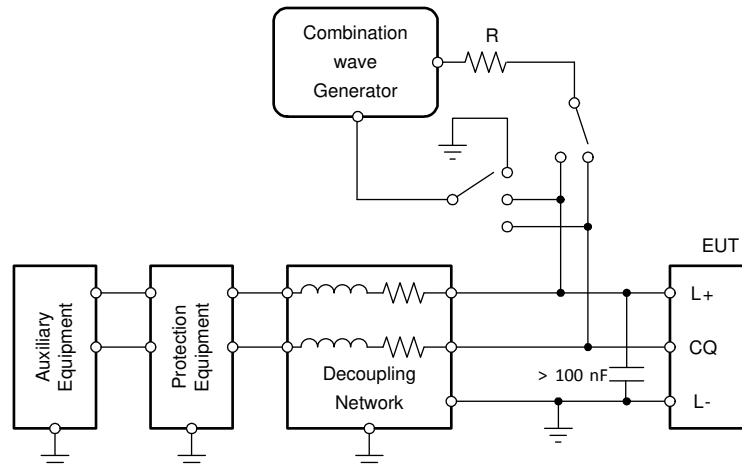


8-5. Low-Side Driver Configuration

8.3.9 Integrated Surge Protection and Transient Waveform Tolerance

The L+ and CQ pins of the device are capable of withstanding up to 1.2 kV of 1.2/50 – 8/20 μ s IEC 61000-4-5 surge with a source impedance of 500 Ω . The surge testing should be performed with a minimum 100 nF supply decoupling capacitor between L+ and L-, and 1 μ F between VCC_IN/OUT and L-.

External TVS diodes may be required for higher transient protection levels. The system designer should make sure the maximum clamping voltage of the external diodes is < 65 V at the desired current level. The device is capable of withstanding up to \pm 70-V transient pulses < 100 μ s.



1.2/50 – 8/20 μ s CWG

R = 500 Ω

✎ 8-6. Surge Test Setup

8.3.10 Power Up Sequence (TIOL112)

VCC_IN and L+ domains can be powered up in any sequence. In the event of L+ is powered and VCC_IN is not, the CQ pin will remain in high impedance.

8.3.11 Undervoltage Lock-Out (UVLO)

The device enters UVLO if the L+ voltage falls below $V_{(UVLO)}$. (For the device without the integrated LDO, the device monitors VCC_IN in addition to L+. UVLO happens if either supply falls below the threshold.)

As soon as the supply falls below $V_{(UVLO)}$, NFAULT is pulled low, and the driver (CQ) is disabled (Hi-Z). Receiver performance is not specified in this mode.

When the supply rises above $V_{(UVLO)}$, NFAULT returns to Hi-Z (given no other fault conditions present). The CQ output is turned on after $t_{(UVLO)}$ delay.

8.4 Device Functional Modes

These devices can operate in three different modes.

8.4.1 NPN Configuration (N-Switch SIO Mode)

Set TX pin high (or open) and use EN pin as control for realizing the function of an N-switch (low-side configuration) on CQ.

8.4.2 PNP Configuration (P-Switch SIO Mode)

Set TX pin low and use EN pin as control for realizing the function of a P-switch (high-side configuration) on CQ.

8.4.3 Push-Pull, Communication Mode

Set EN pin high and toggle TX as control for realizing the function of a push-pull output on CQ. 表 8-7, 表 8-8 and 表 8-9 summarize the pin configurations to accomplish the functional modes.

表 8-7. NPN Mode

| EN | TX | CQ |
|----------|----------|----------|
| L / Open | H / Open | Hi-Z |
| H | H / Open | N-Switch |

表 8-8. PNP Mode

| EN | TX | CQ |
|----------|----|----------|
| L / Open | L | Hi-Z |
| H | L | P-Switch |

表 8-9. Push-Pull, Communication Mode

| EN | TX | CQ |
|----------|----|----------|
| L / Open | X | Hi-Z |
| H | H | N-Switch |
| H | L | P-Switch |

9 Application and Implementation

注

以下のアプリケーション情報は、TI の製品仕様に含まれるものではなく、TI ではその正確性または完全性を保証いたしません。個々の目的に対する製品の適合性については、お客様の責任で判断していただくこととなります。お客様は自身の設計実装を検証しテストすることで、システムの機能を確認する必要があります。

9.1 Application Information

When TIOL112(x) is connected to an IO-Link master through a three-wire interface (図 9-1), the master can initiate communication and exchange data with a remote node with the TIOL112(x) IO-Link transceiver acting as a complete physical layer for the communication.

9.2 Typical Application

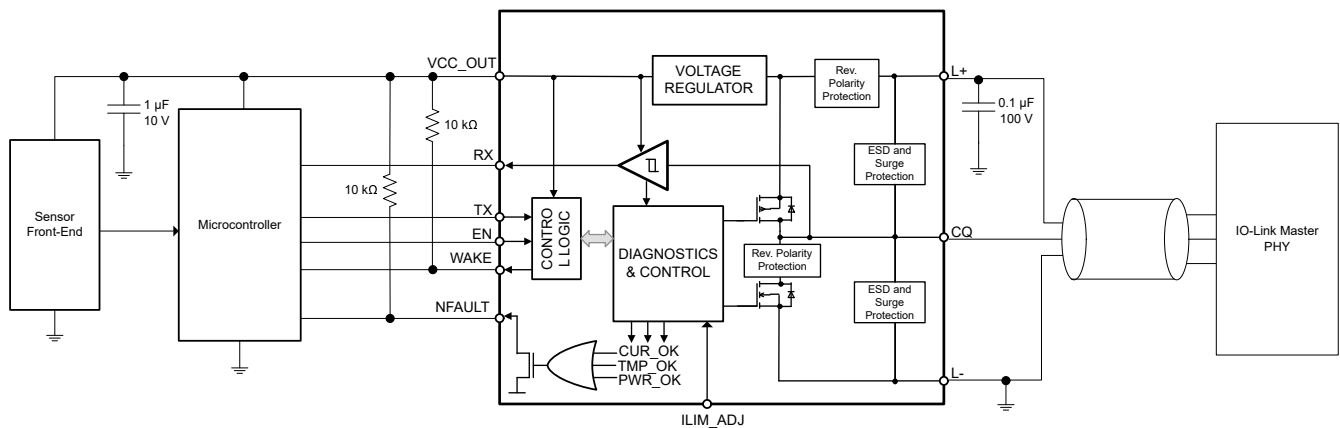


図 9-1. Typical Application Schematic

9.2.1 Design Requirements

TIOL112 and TIOL112x IO-Link transceivers can be used to communicate using the IO-Link protocol, or as standard digital outputs to either sense or drive a wide range of sensors and loads. 表 9-1 shows recommended components for a typical system design.

表 9-1. Design Parameters

| PARAMETERS | Design Requirement | TIOL112(x) Specification |
|---------------------------------------|------------------------|--|
| Input voltage range (L+) | 24 V (typ), 30 V (max) | 7 V to 36 V |
| Output current (CQ) | 200 mA | Choose 250 mA limit with $R_{SET} = 27 \text{ k}\Omega$ |
| LDO Output voltage | 5 V | Choose TIOL1125; $VCC_OUT = 5 \text{ V}$ |
| LDO output current | 5 mA | $I_{(VCC_OUT)}$: Up to 20 mA |
| Pull-up resistors for NFAULT and WAKE | 10 kΩ | 10 kΩ |
| L+ decoupling capacitor | 0.1 μF / 100 V | 0.1 μF / 100 V |
| LDO output capacitor | 1 μF / 10 V | 1 μF / 10 V |
| Maximum Ambient Temperature, T_A | 105 °C | TIOL112 can support up to T_A of 125 °C if $T_J < T_{(SDN)}$ |

9.2.2 Detailed Design Procedure

9.2.2.1 Maximum Junction Temperature Check

For a 200 mA current limit:

- Choose driver output current limit, $I_{O(LIM)} = 250 \text{ mA}$ (allowing for current limit tolerance); $R_{SET} = 27 \text{ k}\Omega$
- The maximum voltage drop across the high-side switch at 250 mA current is $V_{DS(ON)} = 1.1 \text{ V}$.

This causes a power consumption of:

$$PD_{OP} = V_{DS(ON)} \times I_{O(LIM)} = 1.1 \text{ V} \times 250 \text{ mA} = 275 \text{ mW} \quad (1)$$

For a 5 mA LDO current output,

$$PD_{LDO} = (V_{L+} - V_{VCC_{OUT}}) \times I_{VCC_{OUT}} = (30 - 5) \text{ V} \times 5 \text{ mA} = 125 \text{ mW} \quad (2)$$

Total power dissipation,

$$PD = PD_{LDO} + PD_{OP} = 275 \text{ mW} + 125 \text{ mW} = 400 \text{ mW} \quad (3)$$

Multiply this value with the Junction-to-ambient thermal resistance of $\theta_{JA} = 45.9 \text{ }^\circ\text{C/W}$ (taken from the *Thermal Information table* table) to receive the difference between junction temperature, T_J , and ambient temperature, T_A :

$$\Delta T = T_J - T_A = PD \times \theta_{JA} = 400 \text{ mW} \times 45.9 \text{ }^\circ\text{C/W} = 18.36 \text{ }^\circ\text{C} \quad (4)$$

Add this value to the maximum ambient temperature of $T_A = 105^\circ\text{C}$ to receive the final junction temperature:

$$T_J = T_A + \Delta T = T_A + PD \times \theta_{JA} = 105 \text{ }^\circ\text{C} + 400 \text{ mW} \times 45.9 \text{ }^\circ\text{C/W} = 105 \text{ }^\circ\text{C} + 18.36 \text{ }^\circ\text{C} = 123.36 \text{ }^\circ\text{C} \quad (5)$$

As long as T_J is below the recommended maximum value of 150°C , no thermal shutdown will occur. However, the junction temperature is closer to T_{WRN} and thermal warning may be generated if the junction temperature rises above T_{WRN} .

Note that the modeling of the complete system may be necessary to predict junction temperature in smaller PCBs and/or enclosures without air flow.

9.2.2.2 Driving Capacitive Loads

These devices are capable of driving capacitive loads on the CQ output. Assuming a pure capacitive load without series/parallel resistance, the maximum capacitance that can be charged without triggering current fault can be calculated as:

$$C_{LOAD} = \frac{[I_{O(LIM)} \times t_{SC}]}{V_{(L+)}} \quad (6)$$

To drive higher capacitive loads and avoid overcurrent condition disabling the driver, it is recommended leave ILIM_ADJ pin floating. With ILIM_ADJ floating, TIOL112(x) indicates overcurrent fault without blanking time delay (t_{SC}) but does not disable the driver. Another approach is to drive high capacitive loads with a series resistor between the CQ output and the load to avoid overcurrent condition. Capacitive loads can be connected to L- or L+.

9.2.2.3 Driving Inductive Loads

The TIOL112(x) family is capable of magnetizing and demagnetizing large inductive loads. These devices contain internal circuitry that enables fast and safe demagnetization when configured as either P-switch or N-switch mode.

In P-switch configuration, the load inductor L is magnetized when the CQ output is driven high. When the PNP is turned off, there is a significant amount of negative inductive kick back at the CQ pin. This voltage is safely clamped internally at about -15 V.

Similarly, in N-switch configuration, the load inductor L is magnetized when the CQ output is driven low. When the NPN is turned off, there is a significant amount of positive inductive kick back at the CQ pin. This voltage is safely clamped internally at about 15 V.

The equivalent protection circuits are shown in [Figure 9-2](#) and [Figure 9-3](#). The minimum value of the resistive load R can be calculated as:

$$R = \frac{V_{(L+)}}{I_{O(LIM)}} \quad (7)$$

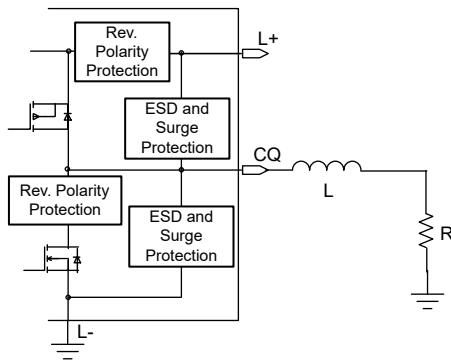


Figure 9-2. P-Switch Mode

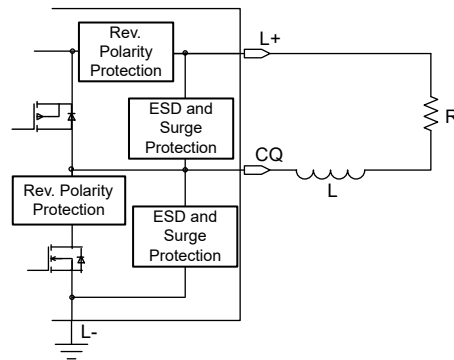
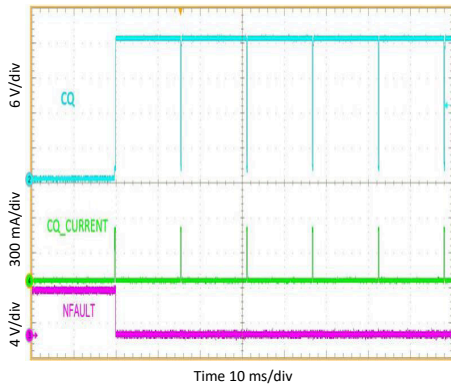
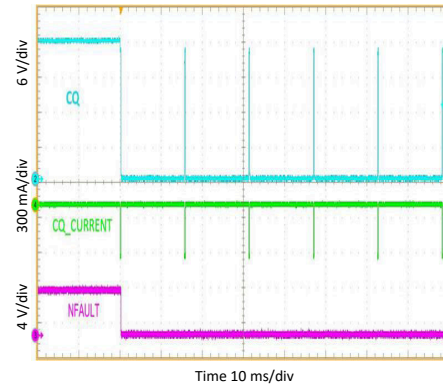


Figure 9-3. N-Switch Mode

9.2.3 Application Curves



9-4. CQ in Current Fault Auto Recovery, Low Side Mode



9-5. CQ in Current Fault Auto Recovery, High Side Mode



$L+ = 36\text{ V}$ $L = 1.5\text{ H}$ $R_L = 360\ \Omega$ $R_{SET} = 10\text{ k}\Omega$ $T_A = 25\text{ }^\circ\text{C}$

9-6. CQ Driving Inductive Load, Low Side Mode (NPN mode)



$L+ = 36\text{ V}$ $L = 1.5\text{ H}$ $R_L = 360\ \Omega$ $R_{SET} = 10\text{ k}\Omega$ $T_A = 25\text{ }^\circ\text{C}$

9-7. CQ Driving Inductive Load, High Side Mode (PNP mode)



NFAULT is indicated for the duration of charging and discharging of the capacitor but driver is not disabled when ILIM_ADJ is floating
 $L+ = 24\text{ V}$ $C_L = 20\ \mu\text{F}$ $R_L = 100\ \Omega$ $R_{SET} = 1\text{ M}\Omega$ (ILIM_ADJ Floating) $T_A = 25\text{ }^\circ\text{C}$

9-8. CQ Driving Capacitive Load, Push-Pull Mode

9.3 Power Supply Recommendations

The TIOL112 and TIOL112x transceivers are designed to operate from a 24-V nominal supply at L+, which can vary by +12 V and -17 V from the nominal value to remain within the device recommended supply voltage range of 7 V to 36 V. This supply should be buffered with at least a 100-nF/100-V capacitor.

9.4 Layout

9.4.1 Layout Guidelines

- Use of a 4-layer board is recommended for good heat conduction. Use layer 1 (top layer) for control signals, layer 2 as power ground layer for L-, layer 3 for the 24-V supply plane (L+), and layer 4 for the regulated output supply (VCC_IN/OUT).
- Connect the thermal pad to L- with maximum amount of thermal vias for best thermal performance.
- Use entire planes for L+, VCC_IN/OUT and L- to assure minimum inductance.
- The L+ terminal must be decoupled to ground with a low-ESR ceramic decoupling capacitor. The recommended minimum capacitor value is 100 nF. The capacitor must have a voltage rating of 50 V minimum (100 V depending on max sensor supply fault rating) and an X5R or X7R dielectric.
- The optimum placement of the capacitor is closest to the transceiver's L+ and L- terminals to reduce supply drops during large supply current loads. See [Figure 9-9](#) for a PCB layout example.
- Connect all open-drain control outputs via 10 k Ω pull-up resistors to the VCC_IN/OUT plane to provide a defined voltage potential to the system controller inputs when the outputs are high-impedance.
- Connect the R_{SET} resistor between ILIM_ADJ and L-.
- Decouple the regulated output voltage at VCC_IN/OUT to ground with a low-ESR, $\geq 1\text{-}\mu\text{F}$, ceramic decoupling capacitor. The capacitor should have a voltage rating of 10 V minimum and an X5R or X7R dielectric.

9.4.2 Layout Example

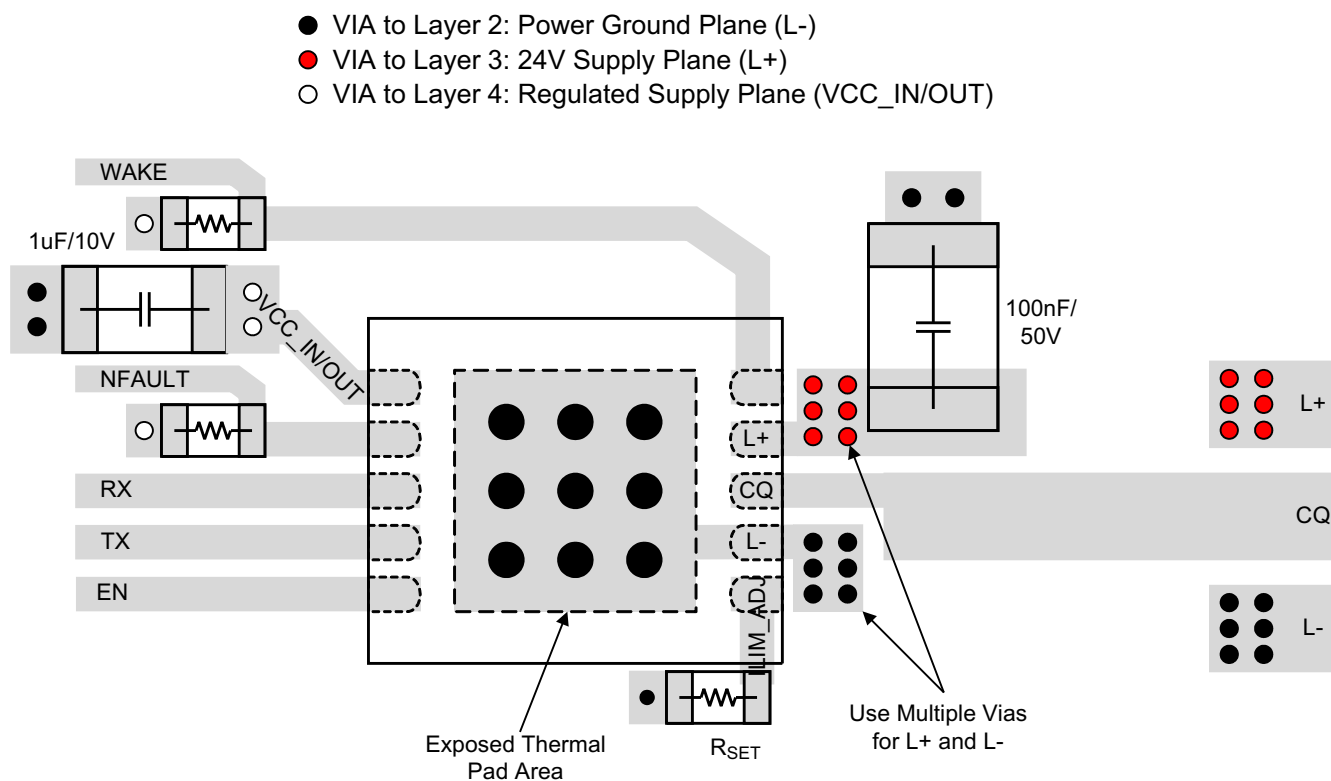


Figure 9-9. Layout Example

10 Device and Documentation Support

10.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

10.2 サポート・リソース

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10.4 静電気放電に関する注意事項



この IC は、ESD によって破損する可能性があります。テキサス・インスツルメンツは、IC を取り扱う際には常に適切な注意を払うことを推奨します。正しい取り扱いおよび設置手順に従わない場合、デバイスを破損するおそれがあります。

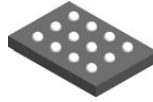
ESD による破損は、わずかな性能低下からデバイスの完全な故障まで多岐にわたります。精密な IC の場合、パラメータがわずかに変化するだけで公表されている仕様から外れる可能性があるため、破損が発生しやすくなっています。

10.5 用語集

[テキサス・インスツルメンツ用語集](#) この用語集には、用語や略語の一覧および定義が記載されています。

11 Mechanical, Packaging, and Orderable Information

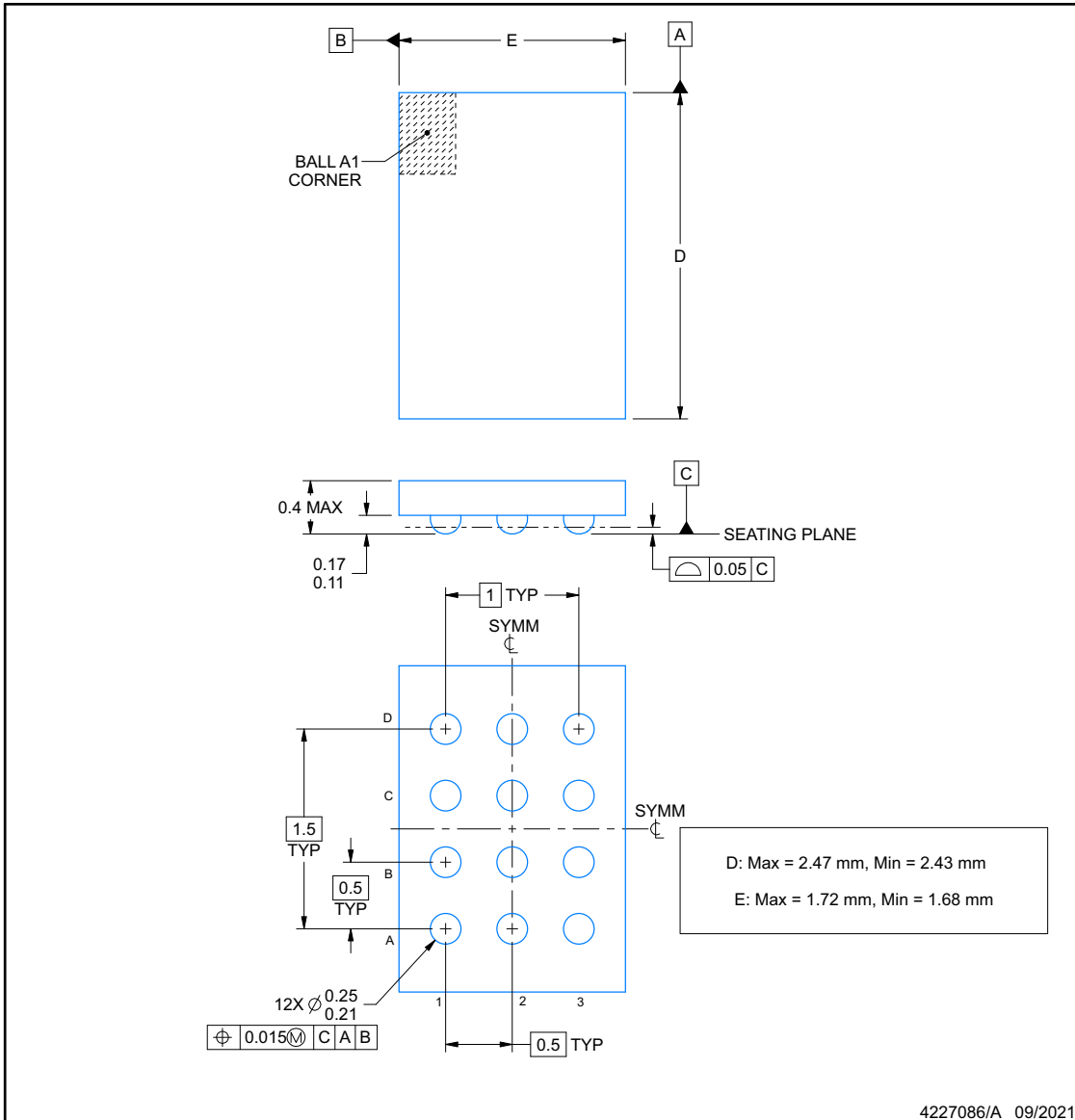
The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.



YAH0012-C01

PACKAGE OUTLINE
DSBGA - 0.4 mm max height

DIE SIZE BALL GRID ARRAY



NOTES:

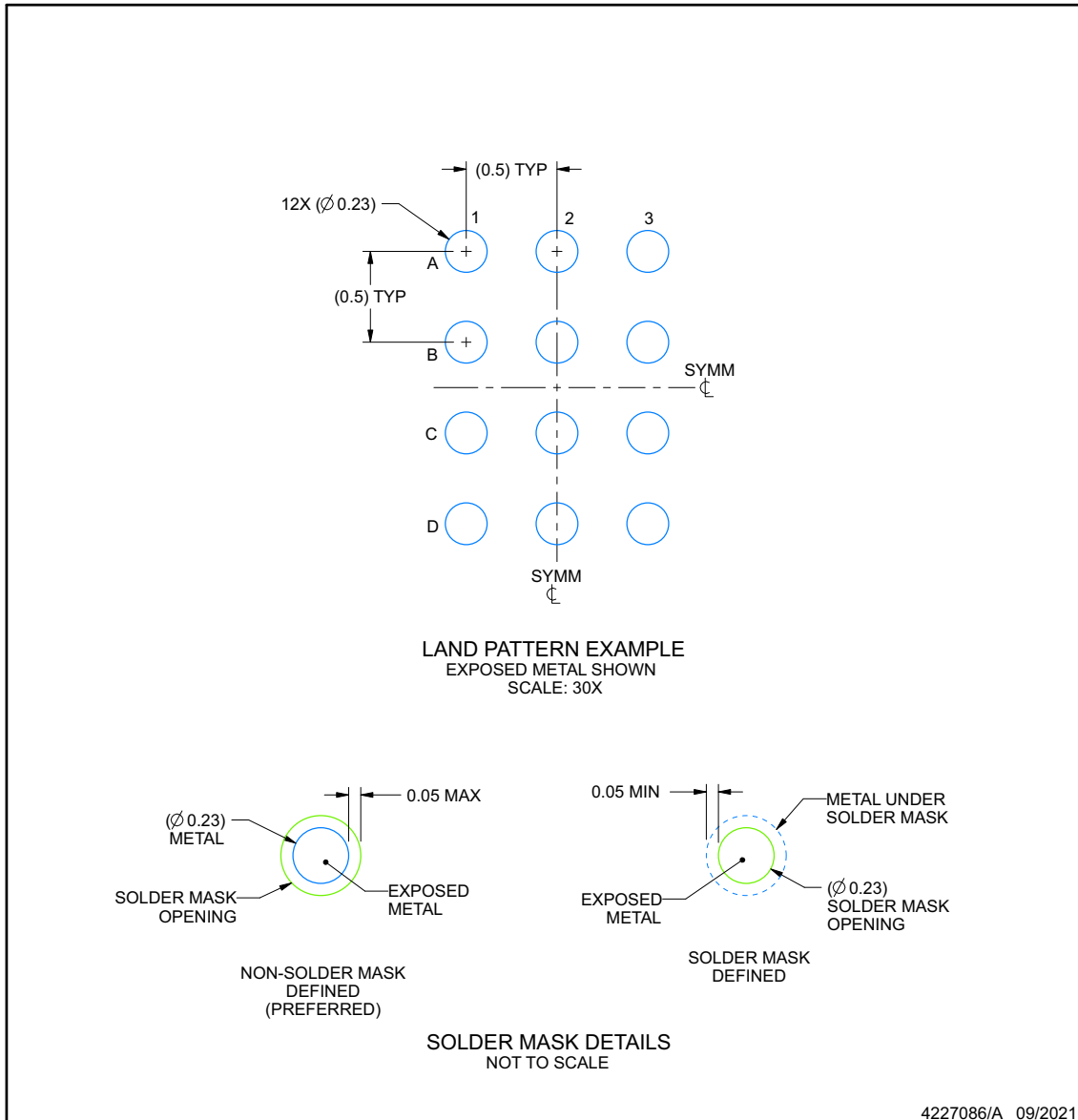
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

YAH0012-C01

DSBGA - 0.4 mm max height

DIE SIZE BALL GRID ARRAY



NOTES: (continued)

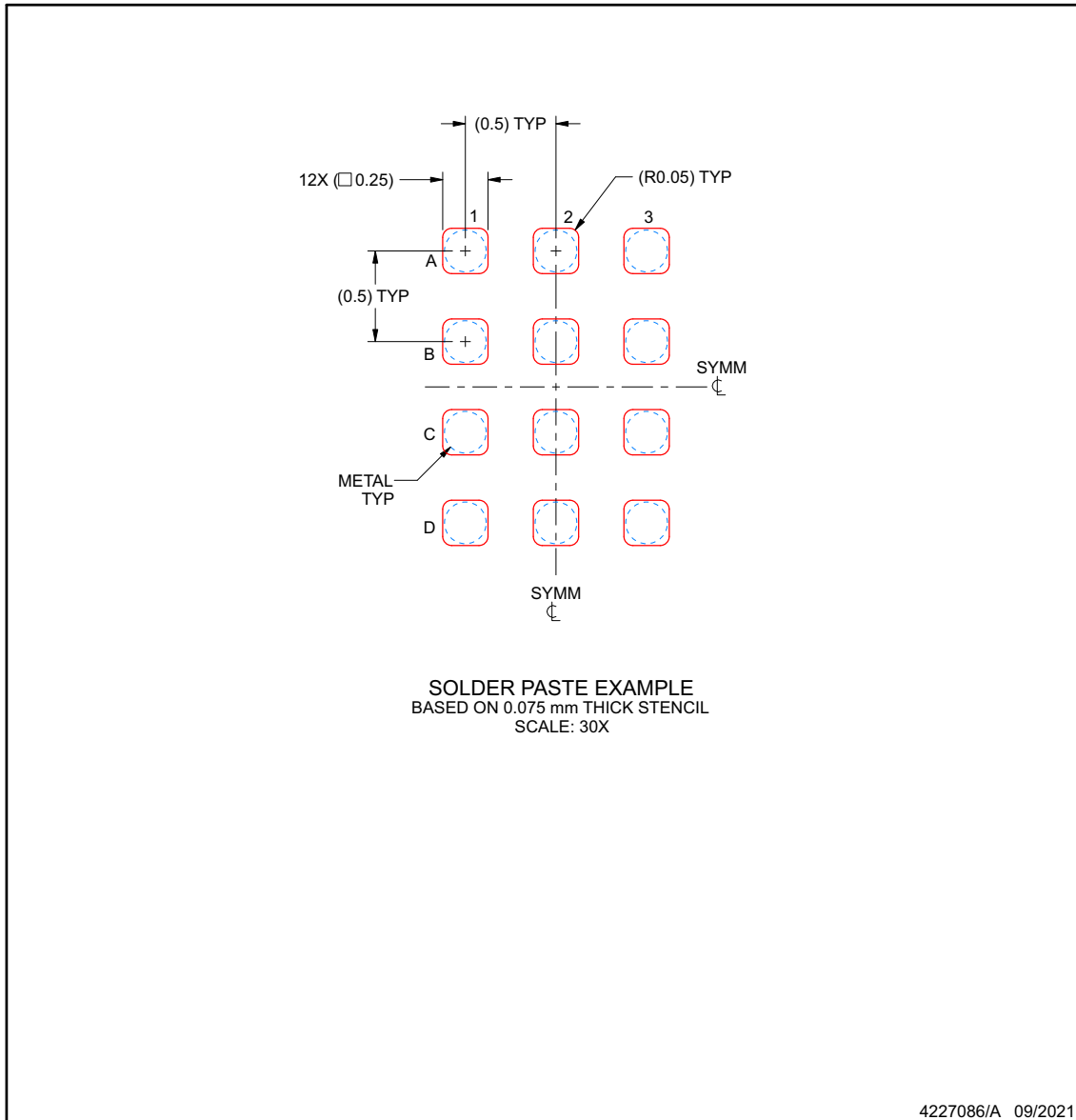
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. See Texas Instruments Literature No. SNVA009 (www.ti.com/lit/snva009).

EXAMPLE STENCIL DESIGN

YAH0012-C01

DSBGA - 0.4 mm max height

DIE SIZE BALL GRID ARRAY



NOTES: (continued)

- 4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TIOL1123DRCR | ACTIVE | VSON | DRC | 10 | 5000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 1123 | Samples |
| TIOL1123LYAHR | ACTIVE | DSBGA | YAH | 12 | 1500 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 125 | T1123L | Samples |
| TIOL1125DRCR | ACTIVE | VSON | DRC | 10 | 5000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 1125 | Samples |
| TIOL112DRCR | ACTIVE | VSON | DRC | 10 | 5000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 112 | Samples |
| TIOL112YAHR | ACTIVE | DSBGA | YAH | 12 | 1500 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 125 | TL112 | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TIOL1123DRRCR | VSON | DRC | 10 | 5000 | 330.0 | 12.4 | 3.3 | 3.3 | 1.1 | 8.0 | 12.0 | Q2 |
| TIOL1123LYAHR | DSBGA | YAH | 12 | 1500 | 180.0 | 8.4 | 1.88 | 2.63 | 0.53 | 4.0 | 8.0 | Q1 |
| TIOL1125DRRCR | VSON | DRC | 10 | 5000 | 330.0 | 12.4 | 3.3 | 3.3 | 1.1 | 8.0 | 12.0 | Q2 |
| TIOL112DRRCR | VSON | DRC | 10 | 5000 | 330.0 | 12.4 | 3.3 | 3.3 | 1.1 | 8.0 | 12.0 | Q2 |
| TIOL112YAHR | DSBGA | YAH | 12 | 1500 | 180.0 | 8.4 | 1.88 | 2.63 | 0.53 | 4.0 | 8.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TIOL1123DRCR | VSON | DRC | 10 | 5000 | 367.0 | 367.0 | 35.0 |
| TIOL1123LYAHR | DSBGA | YAH | 12 | 1500 | 182.0 | 182.0 | 20.0 |
| TIOL1125DRCR | VSON | DRC | 10 | 5000 | 367.0 | 367.0 | 35.0 |
| TIOL112DRCR | VSON | DRC | 10 | 5000 | 367.0 | 367.0 | 35.0 |
| TIOL112YAHR | DSBGA | YAH | 12 | 1500 | 182.0 | 182.0 | 20.0 |

GENERIC PACKAGE VIEW

DRC 10

VSON - 1 mm max height

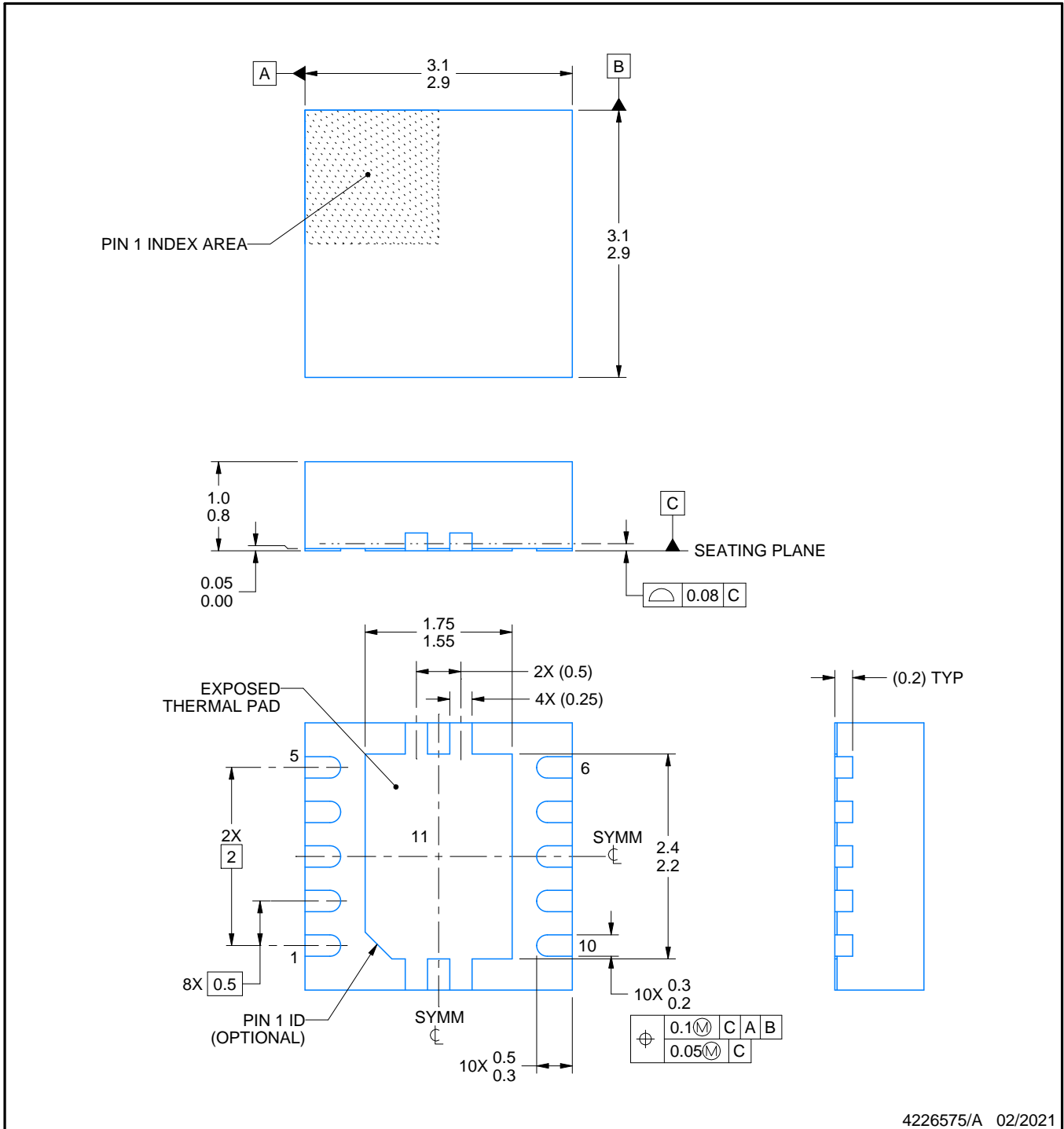
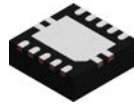
3 x 3, 0.5 mm pitch

PLASTIC SMALL OUTLINE - NO LEAD

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4226193/A



4226575/A 02/2021

NOTES:

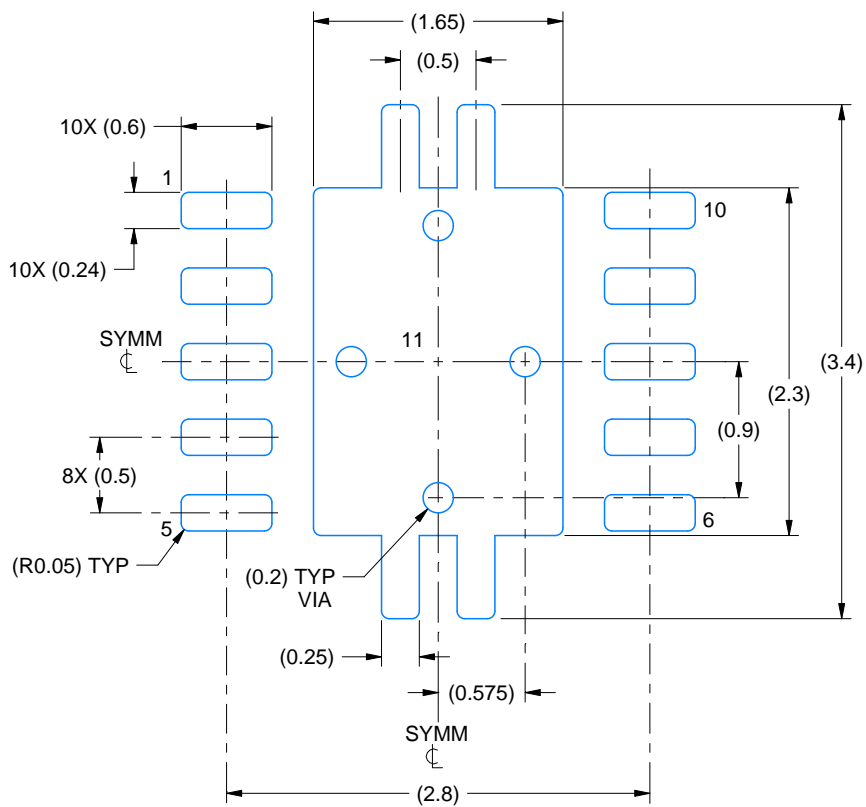
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

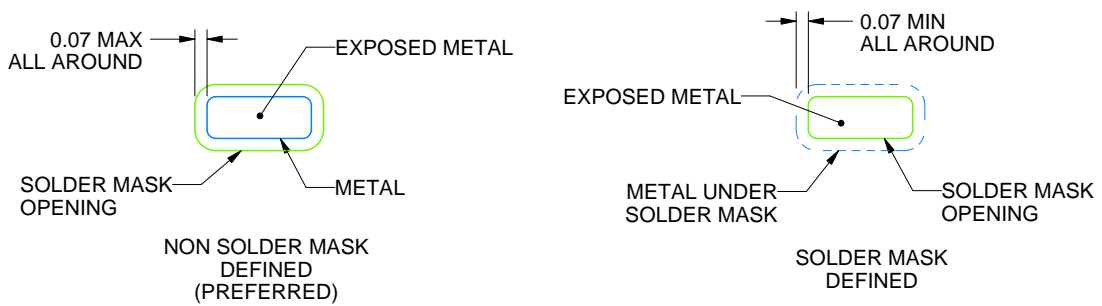
DRC0010V

VSON - 1 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:20X



SOLDER MASK DETAILS

4226575/A 02/2021

NOTES: (continued)

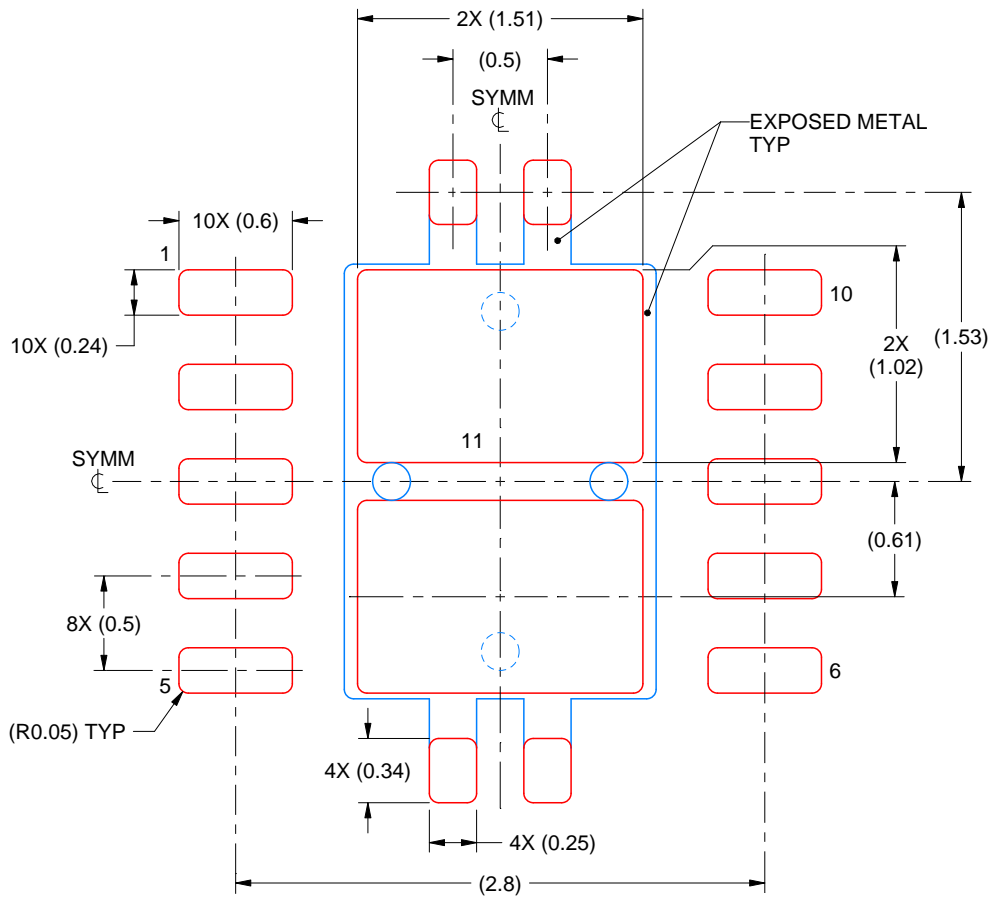
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

DRC0010V

VSON - 1 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE
 BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 11:
 80% PRINTED SOLDER COVERAGE BY AREA
 SCALE:25X

4226575/A 02/2021

NOTES: (continued)

- 6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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