# NCA1042

# High-speed CAN Transceiver with standby mode

Datasheet (EN) 1.2

## Product Overview

The NCA1042 is a high-speed CAN transceiver that provides an interface between a Controller Area Network (CAN) protocol controller and the physical two-wire CAN bus. The NCA1042 implements the CAN physical layer as defined in ISO 11898-2:2016 and SAE J2284-1 to SAE J2284-5. This implementation enables reliable communication in the CAN FD fast phase at data rates up to 5 Mbit/s. The NCA1042 provides thermal protection and transmit data dominant time out function.

## Key Features

- Fully compatible with the ISO11898-2 standard
- I/O voltage range supports 3.3V and 5V MCU
- Power supply voltage

  VIO: 3V to 5.5V

  VCC: 4.5V to 5.5V
- Bus fault protection of -70V to +70V
- Transmit data (TXD) dominant time out function
- Bus dominant time out function in standby mode
- Very low-current Standby mode with wake-up capability
- Over current and over temperature protection
- Date rate: up to 5Mbps
- Low loop delay: <250ns
- Operation temperature: -40℃~125℃
- RoHS-compliant packages:

  SOP8

## Applications

- 5Mbps operation in highly loaded CAN networks down to 10 kbps networks using TXD DTO
- Industrial automation, control, sensors, and drive systems
- Building, security, and climate control automation
- CAN bus standards such as CANopen、DeviceNet、NMEA2000、ARNIC825、ISO11783 and CANaerospace

## Device Information

| *Part Number* | *Package* | *Body Size* |
|---|---|---|
| NCA1042-DSPR | SOP8 | 4.90mm × 3.90mm |

## Functional Block Diagrams

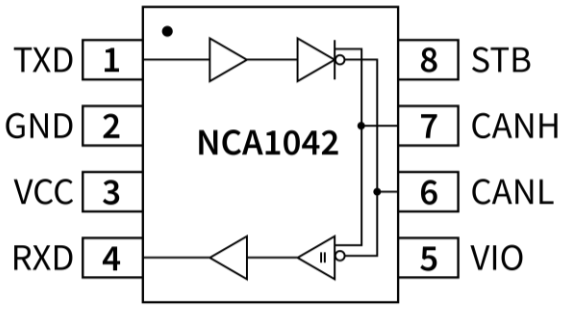



Figure 1. NCA1042 Block Diagram

# INDEX

# 1. Pin Configuration and Functions

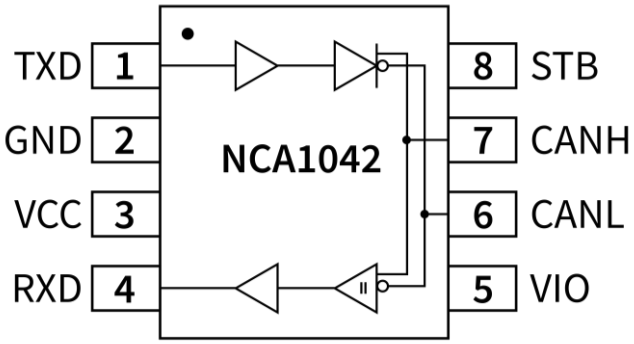



Figure 1.1 NCA1042 Package

Table1.1 NCA1042 Pin Configuration and Description

| *NCA1042 PIN NO.* | *SYMBOL* | *FUNCTION* |
|---|---|---|
| 1 | TXD | CAN transmit data input (LOW for dominant and HIGH for recessive bus states) |
| 2 | GND | Ground |
| 3 | VCC | Power Supply |
| 4 | RXD | CAN receive data output (LOW for dominant and HIGH for recessive bus states) |
| 5 | VIO | Logic I/O supply voltage |
| 6 | CANL | Low-level CAN bus line |
| 7 | CANH | High-level CAN bus line |
| 8 | STB | STB (standby mode) select pin (active high) |

# 2. Absolute Maximum Ratings

| *Parameters* | *Symbol* | *Min* | *Typ* | *Max* | *Unit* | *Comments* |
|---|---|---|---|---|---|---|
| Power Supply Voltage | VCC, VIO | -0.3 | | 7 | V | |
| Logic I/O Voltage | TXD, RXD, STB | -0.3 | | 7 | V | |
| Differential input voltage | $V_{ID}$ | -27 | | 27 | V | |
| Maximum BUS Pin Voltage | $V_{CANH}$, $V_{CANL}$ | -70 | | +70 | V | |
| Operating Temperature | Topr | -40 | | 125 | ℃ | |
| Junction Temperature | Tj | -40 | | 150 | ℃ | |
| Storage Temperature | Tstg | -40 | | 150 | ℃ | |

| | | | | | | |
|---|---|---|---|---|---|---|
| System level Electro-Static Discharge | ESD | | | ±5 | kV | IEC61000-4-2: Powered contact discharge:CAN bus terminals to GND |
| Human Body Model (HBM) ESD stress voltage | | | | ±8 | kV | All terminals |
| Charged Device Model (CDM)ESD stress voltage | | | | ±2 | kV | All terminals |

## 3. Recommended Operating Conditions

| *Parameters* | *Symbol* | *min* | *typ* | *max* | *unit* |
|---|---|---|---|---|---|
| Power Supply Voltage | VCC | 4.5 | | 5.5 | V |
| | VIO | 3 | | 5.5 | V |
| Differential input voltage | $V_{ID}$ | -3 | | 8 | V |
| CAN bus terminal HIGH level output current | $I_{OH(CAN)}$ | -50 | | | mA |
| CAN bus terminal LOW level output current | $I_{OL(CAN)}$ | | | 50 | mA |
| RXD terminal HIGH level output current | $I_{OH(RXD)}$ | -2 | | | mA |
| RXD terminal LOW level output current | $I_{OL(RXD)}$ | | | 2 | mA |

## 4. Thermal Characteristics

| *Parameters* | *Symbol* | *SOW16* | *Unit* |
|---|---|---|---|
| IC Junction-to-Air Thermal Resistance | $\theta_{JA}$ | 105.8 | ℃/W |
| Junction-to-case (top) thermal resistance | $\theta_{JC（top）}$ | 46.8 | ℃/W |
| Junction-to-board thermal resistance | $\theta_{JB}$ | 48.3 | ℃/W |

# 5. Specifications

## 5.1.Electrical Characteristics

($V_{CC}$=4.5V~5.5V,$V_{IO}$=3V~5.5V, Ta=-40℃ to 125℃. Unless otherwise noted, Typical values are at VCC=5V,VIO=3.3V,Ta = 25℃)

| *Parameters* | *Symbol* | *Min* | *Typ* | *Max* | *Unit* | *Comments* |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.5 | | 5.5 | V | |
| undervoltage detection voltage on pin VCC | $V_{uvd\ (VCC)}$ | 3.5 | | 4.5 | V | |
| supply voltage on pin VIO | $V_{IO}$ | 3 | | 5.5 | V | |
| undervoltage detection voltage on pin VIO | $V_{uvd\ (VIO)}$ | 1.5 | | 2.7 | | |
| supply current | $I_{CC}$ | | 45 | 70 | mA | Normal mode, dominant, TXD=0,STB=0,$R_L$=60Ω |
| | | | 1.7 | 5 | mA | Normal mode, recessive, TXD=$V_{IO}$, STB=0 |
| | | | 0.51 | 5 | uA | Standby mode, STB=$V_{IO}$, TXD=$V_{IO}$ |
| supply current on pin VIO | $I_{IO}$ | | 525 | 900 | uA | Normal mode, dominant, $V_{TXD}$=0V |
| | | | 30 | 100 | uA | Normal mode, recessive, $V_{TXD}$=$V_{IO}$ |
| | | | 6.5 | 15 | uA | Standby mode; VTXD=$V_{IO}$ |
| Thermal-Shutdown Threshold | $T_{TS}$ | 155 | 165 | 180 | ℃ | |
| **Logic Side** | | | | | | |
| High level input voltage | $V_{IH}$ | 0.7*$V_{IO}$ | | | V | TXD &STB pin |
| Low level input voltage | $V_{IL}$ | | | 0.3*$V_{IO}$ | V | TXD &STB pin |
| High level input current | $I_{IH}$ | -5 | | 5 | uA | TXD &STB pin |
| Low level input current | $I_{IL}$ | -200 | | -30 | uA | TXD pin |
| | | -15 | | -1 | uA | STB pin |
| Output High Voltage | $V_{OH}$ | 0.8*$V_{IO}$ | | | V | RXD, IO=-2mA |
| Output Low Voltage | $V_{OL}$ | | | 0.2*$V_{IO}$ | V | RXD, IO=2mA |
| Input Capacitance | $C_{IN}$ | | 5 | | pF | TXD pin |
| **Driver** | | | | | | |
| CANH output voltage (Dominant) | $V_{OH(D)}$ | 2.8 | 3.44 | 4.5 | V | STB=0,TXD=0V, $R_{Load}$ =60Ω |

| *Parameters* | *Symbol* | *Min* | *Typ* | *Max* | *Unit* | *Comments* |
|---|---|---|---|---|---|---|
| CANL output voltage (Dominant) | $V_{OL(D)}$ | 0.5 | 1.33 | 2.25 | V | STB=0,TXD=0V, $R_{Load}$ =60Ω |
| CAN bus output voltage (Recessive) | $V_{O(R)}$ | 2 | 0.5*VCC | 3 | V | TXD=$V_{IO}$; recessive;no load |
| | | -0.1 | | 0.1 | V | Standby mode, no load |
| Differential output voltage (Dominant) | $V_{OD(D)}$ | 1.5 | | 3 | V | VCC=5V,TXD=0, $R_{Load}$ =60Ω, see Figure 5.1 |
| Differential output voltage (Recessive) | $V_{OD(R)}$ | -0.05 | | 0.05 | V | VCC=5V,TXD=VIO, $R_{Load}$ =60Ω, see Figure 5.1 |
| | | -0.1 | | 0.1 | V | VCC=5V, TXD=$V_{IO}$,NO Load, see Figure 5.1 |
| Short- circuit output current | $I_{OS}$ | -105 | -44.1 | | mA | Dominant, CANH=-30V, CANL open, see Figure 5.9 |
| | | | 1.77 | 5 | mA | Recessive, CANH=30V, CANL open, see Figure 5.9 |
| | | -5 | -2.11 | | mA | Recessive, CANL=-30V, CANH open, see Figure 5.9 |
| | | | 42.5 | 105 | mA | Dominant, CANL=30V, CANH open, see Figure 5.9 |
| **Receiver** | | | | | | |
| Positive-going bus input threshold voltage | $V_{IT+}$ | | 750 | 900 | mV | $V_{COM(CAN)}$=0V |
| Negative-going bus input threshold voltage | $V_{IT-}$ | 500 | 650 | | mV | $V_{COM(CAN)}$=0V |
| Hysteresis voltage | $V_{HYS}$ | | 100 | | mV | |
| Power-off (unpowered) bus input leakage current | $I_{IOFF(LKG)}$ | -1.5 | | 1.5 | uA | $V_{CANH}$ / $V_{CANL}$ = 5 V, VCC = 0V, VIO= 0 V |
| Input capacitance to ground | $C_I$ | | 13 | | pF | CANH or CANL |
| Differential input | $C_{ID}$ | | 5 | | pF | |
| Differential input resistance | $R_{ID}$ | 30 | | 80 | kΩ | |
| Input resistance | $R_{IN}$ | 15 | 30 | 40 | kΩ | |
| Input resistance matching | $R_{Imatch}$ | -3 | | +3 | % | CANH=CANL |
| Common-mode voltage range | $V_{COM}$ | -30 | | +30 | V | |

## 5.2. Switching Electrical Characteristics

($V_{CC}$=4.5V~5.5V,$V_{IO}$=3V~5.5V, Ta=-40℃ to 125℃. Unless otherwise noted, Typical values are at VCC=5V,VIO=3.3V,Ta = 25℃)

| *Parameters* | *Symbol* | *Min* | *Typ* | *Max* | *Unit* | *Comments* |
|---|---|---|---|---|---|---|
| Loop delay1 | $T_{loop1}$ | | 90 | 220 | ns | Driver input to receiver output, Recessive to Dominant, see Figure 5.7 |
| Loop delay2 | $T_{loop2}$ | | 100 | 220 | ns | Driver input to receiver output, Dominant to Recessive, see Figure 5.7 |
| transmitted recessive bit width | $t_{bit(bus)}$ | 435 | | 530 | ns | $t_{bit(TXD)}$ = 500 ns |
| | | 155 | | 210 | ns | $t_{bit(TXD)}$ = 200 ns |
| bit time on pin RXD | $t_{bit(RXD)}$ | 400 | | 550 | ns | $t_{bit(TXD)}$ = 500 ns |
| | | 120 | | 220 | ns | $t_{bit(TXD)}$ = 200 ns |
| **Driver** | | | | | | |
| Propagation delay time from TXD to bus dominant | $t_{PLH}$ | | 90 | | ns | Normal mode, see Figure 5.4 |
| Propagation delay time from TXD to bus recessive | $t_{PHL}$ | | 65 | | ns | Normal mode, see Figure 5.4 |
| Differential output signal rise time | $t_r$ | | 20 | | ns | see Figure 5.4 |
| Differential output signal fall time | $t_f$ | | 42 | | ns | see Figure 5.4 |
| Bus dominant time-out time | $t_{TXD\_DTO}$ | 800 | 2000 | 4000 | us | see Figure 5.8 |
| **Receiver** | | | | | | |
| Propagation delay time from bus dominant to RXD | $t_{PLH}$ | | 21 | | ns | see Figure 5.6 |
| Propagation delay time from bus recessive to RXD | $t_{PHL}$ | | 27 | | ns | see Figure 5.6 |
| RXD signal rise time | $t_r$ | | 10 | | ns | see Figure 5.6 |
| RXD signal fall time | $t_f$ | | 10 | | ns | see Figure 5.6 |
| Receiver dominant time out | $t_{RXD\_DTO}$ | 800 | 2600 | 4000 | us | Standby mode |
| bus wake-up filter time | $t_{fltr(wake)bus}$ | 0.5 | | 5 | us | Standby mode |

| | | | | | | |
|---|---|---|---|---|---|---|
| standby to normal mode delay time | $t_{d(stb-norm)}$ | 7 | | 47 | us | standby to normal mode delay time |

## 5.3. Parameter Measurement Information

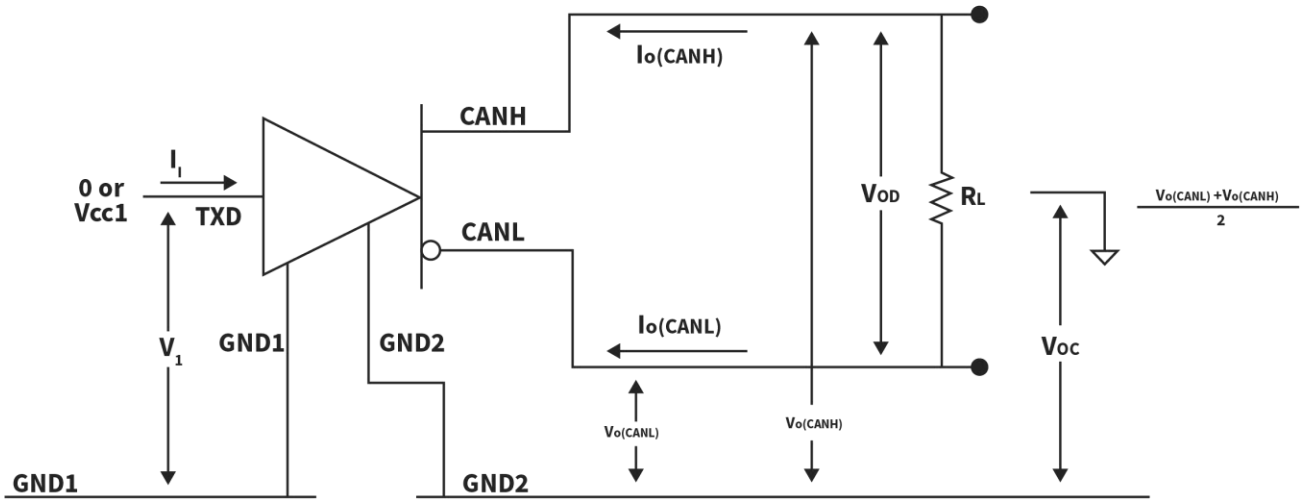



Figure 5.1. Driver Voltage, Current and Test Definitions

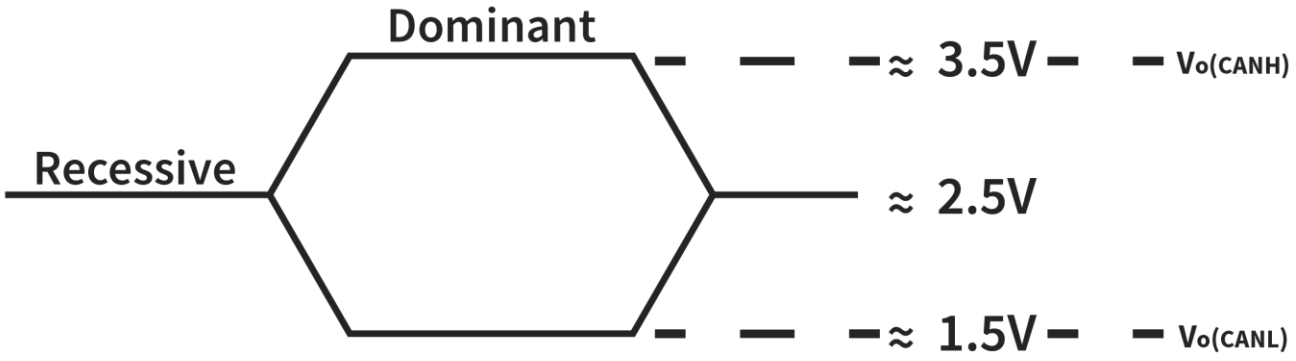



Figure 5.2. Bus Logic State Voltage Definitions

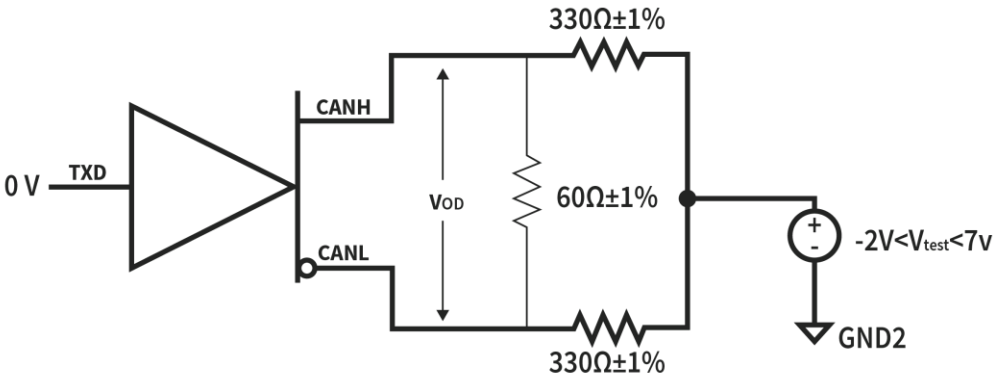
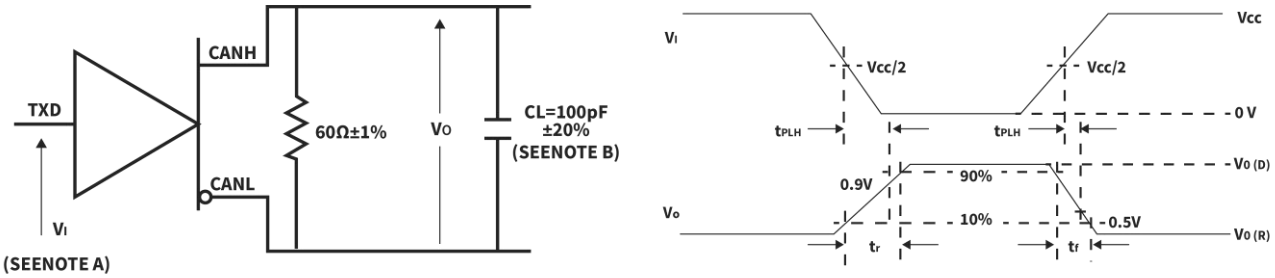



Figure 5.3. Driver $V_{OD}$ With Common-Mode Loading Test Circuit




A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 125 kHz, 50% duty cycle, tr ≤ 6 ns, tf ≤ 6 ns, ZO = 50 Ω.

B. CL includes instrumentation and fixture capacitance within ±20%.

Figure 5.4. Driver Test Circuit and Voltage Waveforms

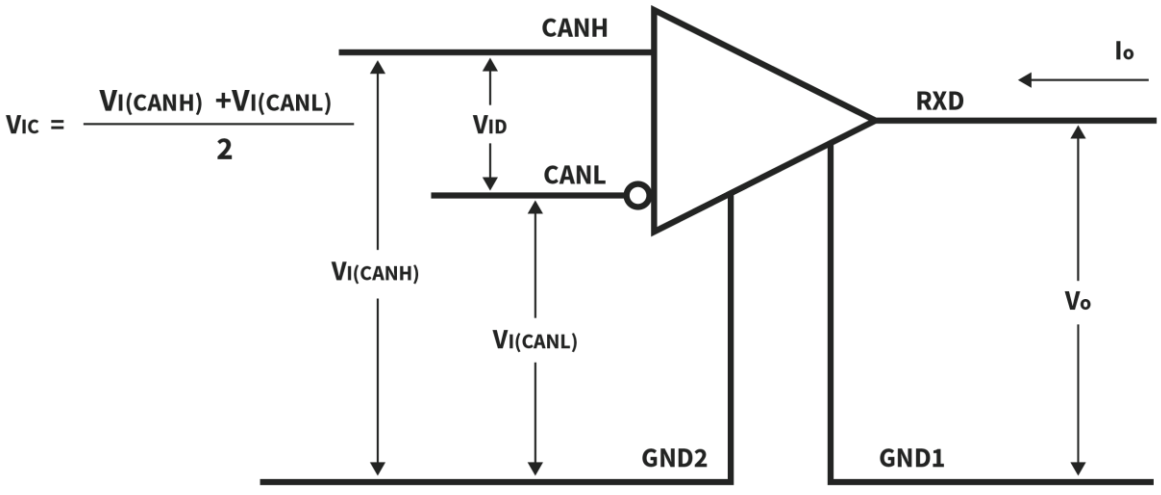
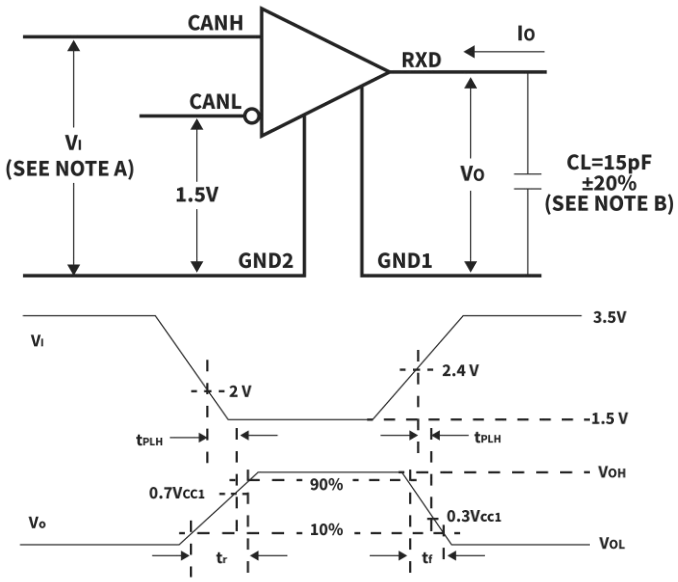



Figure 5.5. Receiver Voltage and Current Definitions




A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 125 kHz, 50% duty cycle, $t_r$ ≤ 6 ns, $t_f$ ≤ 6 ns, $Z_O$ = 50 Ω.

B. $C_L$ includes instrumentation and fixture capacitance within ±20%.

Figure 5.6. Receiver Test Circuit and Voltage Waveforms

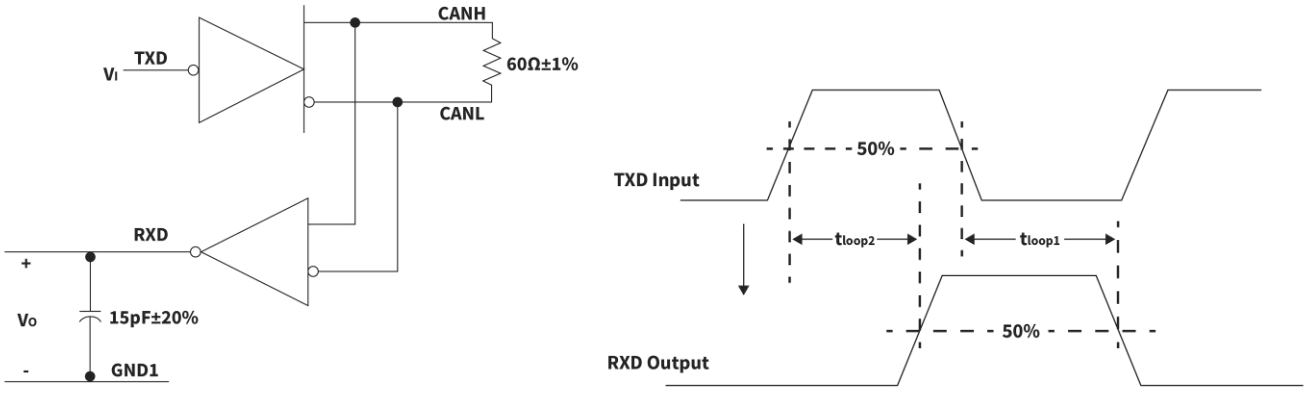
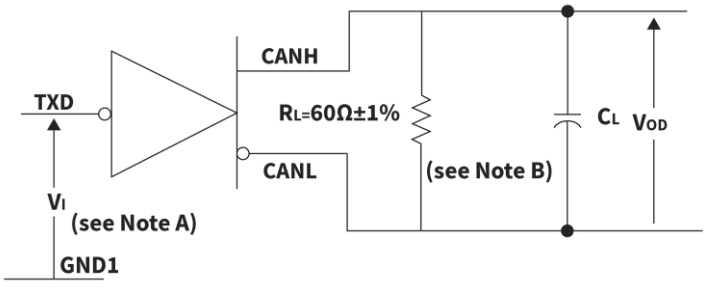
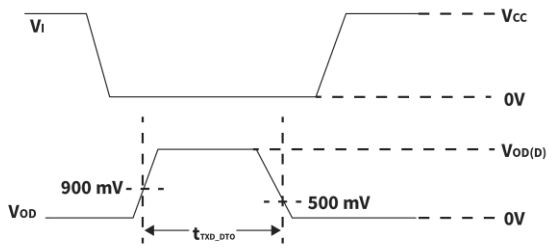



Figure 5.7. $t_{LOOP}$ Test Circuit and Voltage Waveforms






A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 125 kHz, 50% duty cycle, $t_r$ ≤ 6 ns, $t_f$ ≤ 6 ns, $Z_O$ = 50 Ω.

B. $C_L$ includes instrumentation and fixture capacitance within ±20%.

Figure 5.8. Dominant Time-out Test Circuit and Voltage Waveforms

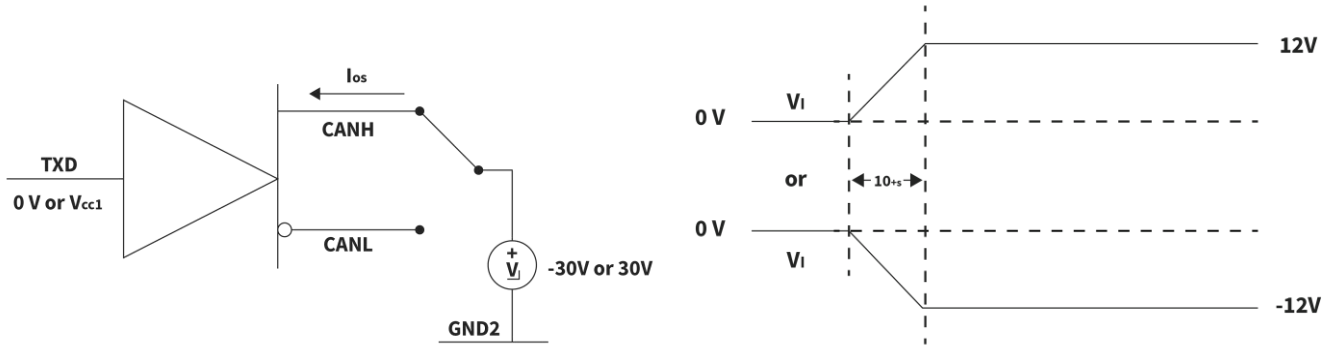



Figure 5.9. Driver Short-Circuit Current Test Circuit and Waveforms

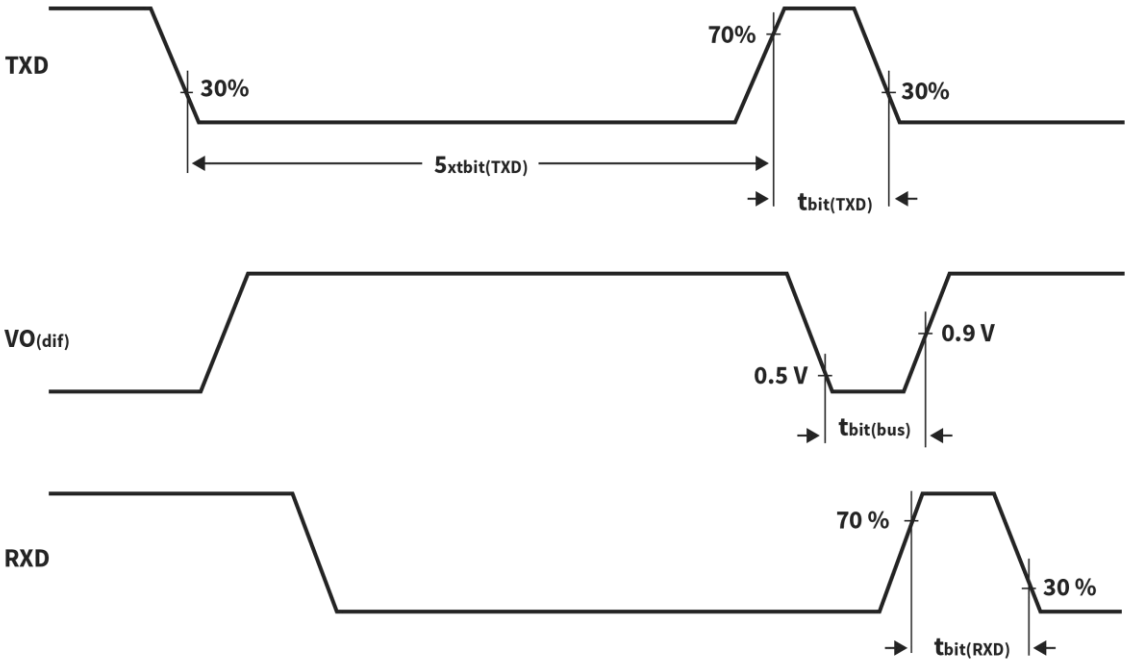



Figure 5.10. $t_{bit(RXD)}$ Test Circuit and Waveforms

# 6. Function Description

## 6.1. Overview

The NCA1042 is a CAN transceiver which fully compatible with the ISO11898-2 standard. The NCA1042 is providing high electromagnetic immunity and low emissions. The data rate of the NCA1042 is up to 5Mbps. The NCA1042 provides thermal protection and transmit data dominant time out function.

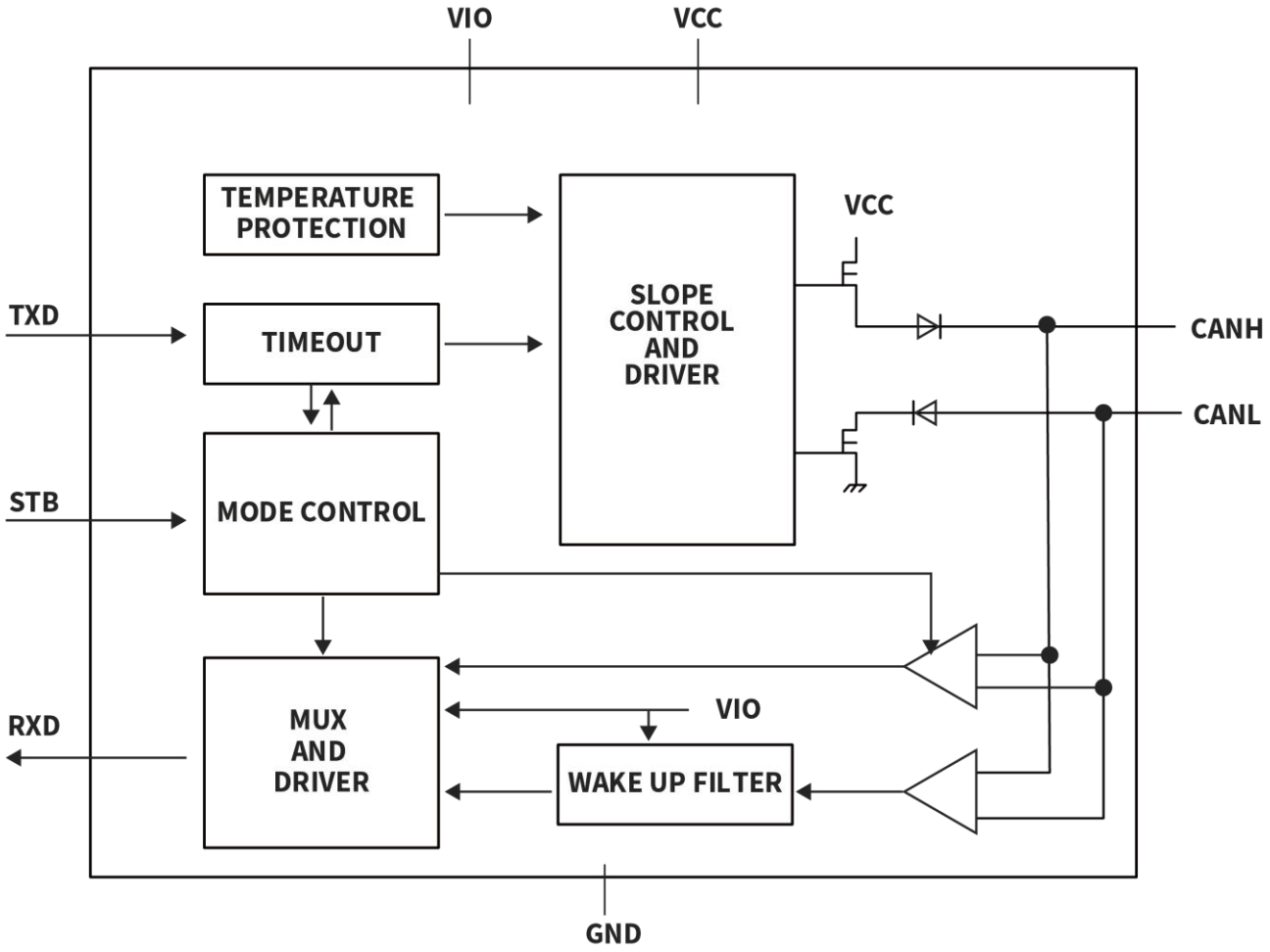



Figure 6.1 Block diagram of NCA1042

## 6.2. Device Functional Modes

Table 6.1. Driver Function Table

| *TXD* | *CANH* | *CANL* | *BUS STATE* |
|---|---|---|---|
| L[1] | H[1] | L[1] | Dominant |
| H[1] | Z[1] | Z[1] | Recessive |
| Open | Z[1] | Z[1] | Recessive |

[1] H= high level; L=low level; Z= common mode(recessive) bias to $V_{CC}/2$

Table 6.2. Receiver Function Table

| *$V_{ID}$=CANH-CANL* | *RXD* | *BUS STATE* |
|---|---|---|
| $V_{ID} \geq 0.9V$ | L[2] | Dominant |
| $0.5< V_{ID} <0.9V$ | X[2] | Uncertain |
| $V_{ID} \leq 0.5V$ | H[2] | Recessive |
| Open | H[2] | Recessive |

[2] H= high level; L=low level; X= uncertain

## 6.3. Normal mode

A LOW level on pin STB selects Normal mode. In this mode, the transceiver can transmit and receive data via the bus lines CANH and CANL (see Figure 6.1 for the block diagram). The differential receiver converts the analog data on the bus lines into digital data which is output to pin RXD. The slopes of the output signals on the bus lines are controlled internally and are optimized in a way that guarantees the lowest possible EME.

## 6.4. Standby mode

A HIGH level on pin STB selects Standby mode. In Standby mode, the transceiver is not able to transmit or correctly receive data via the bus lines. The transmitter and Normal-mode receiver blocks are switched off to reduce supply current, and only a low-power differential receiver monitors the bus lines for activity. The wake-up filter on the output of the low-power receiver does not latch bus dominant states, but ensures that only bus dominant and bus recessive states that persist longer than $t_{filtr(wake)}$ bus are reflected on pin RXD. In Standby mode, the bus lines are biased to ground to minimize the system supply current. The low-power receiver is supplied by VIO, and is capable of detecting CAN bus activity even if VIO is the only supply voltage available. When pin RXD goes LOW to signal a wake-up request, a transition to Normal mode will not be triggered until STB is forced LOW.

## 6.5. TXD dominant time-out function

A ‘TXD dominant time-out’ timer circuit prevents the bus lines from being driven to a permanent dominant state(blocking all network communication) if pin TXD is forced permanently LOW by a hardware and/or software application failure. The timer is triggered by a negative edge on pin TXD.

If the duration of the LOW level on pin TXD exceeds the internal timer value ($t_{TXD\_DTO}$), the transmitter is disabled, driving the bus lines into a recessive state. The timer is reset by a positive edge on pin TXD.The TXD dominant time-out time also defines the minimum possible bit rate of 10 kbit/s.

## 6.6. RXD dominant time-out function

In Standby mode a 'bus dominant time-out' timer is started when the CAN bus changes from recessive to dominant state. If the dominant state on the bus persists for longer than $t_{RXD\_RTO}$, the RXD pin is reset to HIGH. This function prevents a clamped dominant

bus (due to a bus short-circuit or a failure in one of the other nodes on the network) from generating a permanent wake-up request. The bus dominant time-out timer is reset when the CAN bus changes from dominant to recessive state.

### 6.7. Current Protection

A current-limiting circuit protects the transmitter output stage from damage caused by accidental short-circuit to either positive or negative supply voltage, although power dissipation increases during this fault condition.

### 6.8. Over Temperature Protection

The output drivers are protected against over-temperature conditions. If the virtual junction temperature exceeds the shutdown junction temperature $T_{TS}$, the output drivers will be disabled until the virtual junction temperature becomes lower than $T_{TS}$ and TXD becomes recessive again.

By including the TXD condition, the occurrence of output driver oscillation due to temperature drifts is avoided.

### 6.9. VIO Output Supply

Pin VIO should be connected to the microcontroller supply voltage (see Figure 7.1). This will adjust the signal levels of pins TXD, RXD and STB to the I/O levels of the microcontroller. This sets the signal levels of pins TXD, RXD and STB to levels compatible with 3.3 V microcontrollers.

## 7. Application Note

### 7.1. Typical Application

The NCA1042 requires a 0.1 µF bypass capacitors between VCC and GND. The capacitor should be placed as close as possible to the package. The figure7.1 is the basic schematic of NCA1042.

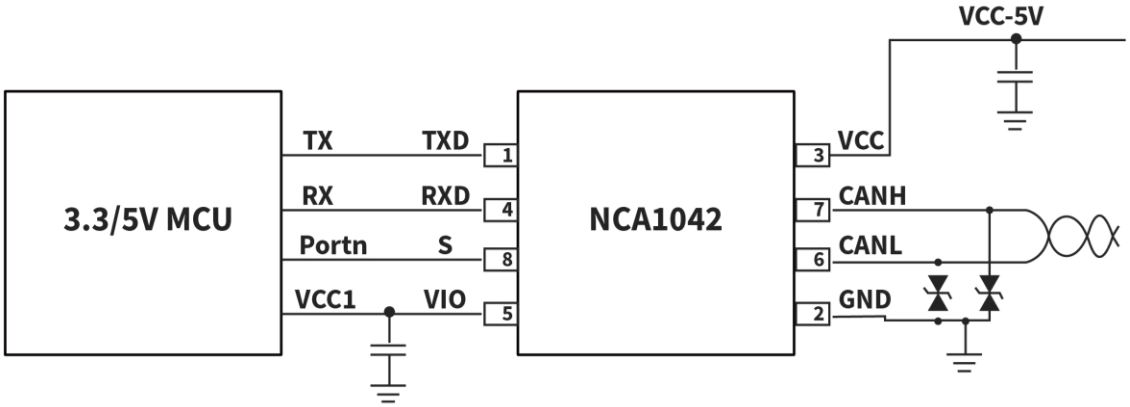
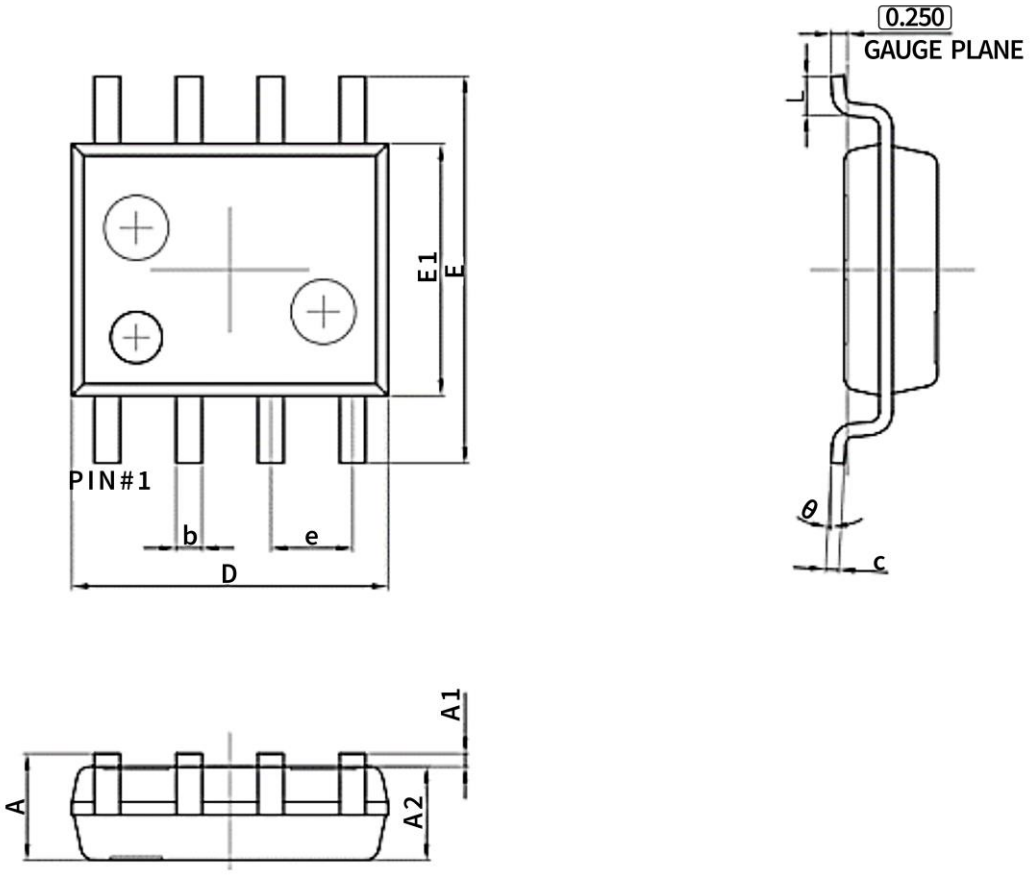



Figure 7.1 Basic schematic of NCA1042

# 8. Package Information




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 1.450 | 1.750 | 0.057 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.007 | 0.010 |
| D | 4.700 | 5.100 | 0.185 | 0.201 |
| E | 5.800 | 6.200 | 0.228 | 0.244 |
| E1 | 3.800 | 4.000 | 0.150 | 0.157 |
| e | 1.270(BSC) | | 0.500(BSC) | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

Figure 8.1 SOP8 Package Shape and Dimension in millimeters

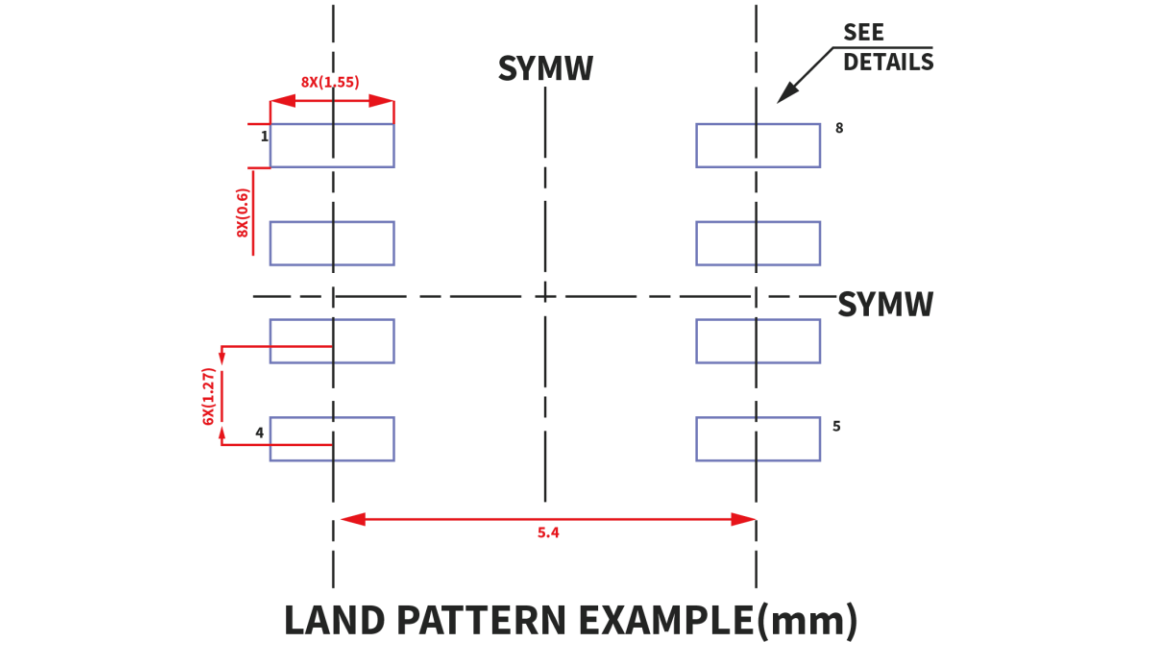



Figure 9.2 SOP8 Package Board Layout Example

# 9. Order Information

| *Part Number* | *Max Data Rate (Mbps)* | *Temperature* | *MSL* | *Package Type* | *Package Drawing* | *SPQ* |
|---|---|---|---|---|---|---|
| NCA1042-DSPR | 5 | -40 to 125℃ | 3 | SOP8(150mil) | SOP8 | 4000 |
| NOTE: All packages are RoHS-compliant with peak reflow temperatures of 260 °C according to the JEDEC industry standard classifications and peak solder temperatures. | | | | | | |

# 10. Documentation Support

| *Part Number* | *Product Folder* | *Datasheet* | *Technical Documents* | *Isolator selection guide* |
|---|---|---|---|---|
| NCA1042 | Click here | Click here | Click here | Click here |

## 11. Tape and Reel Information

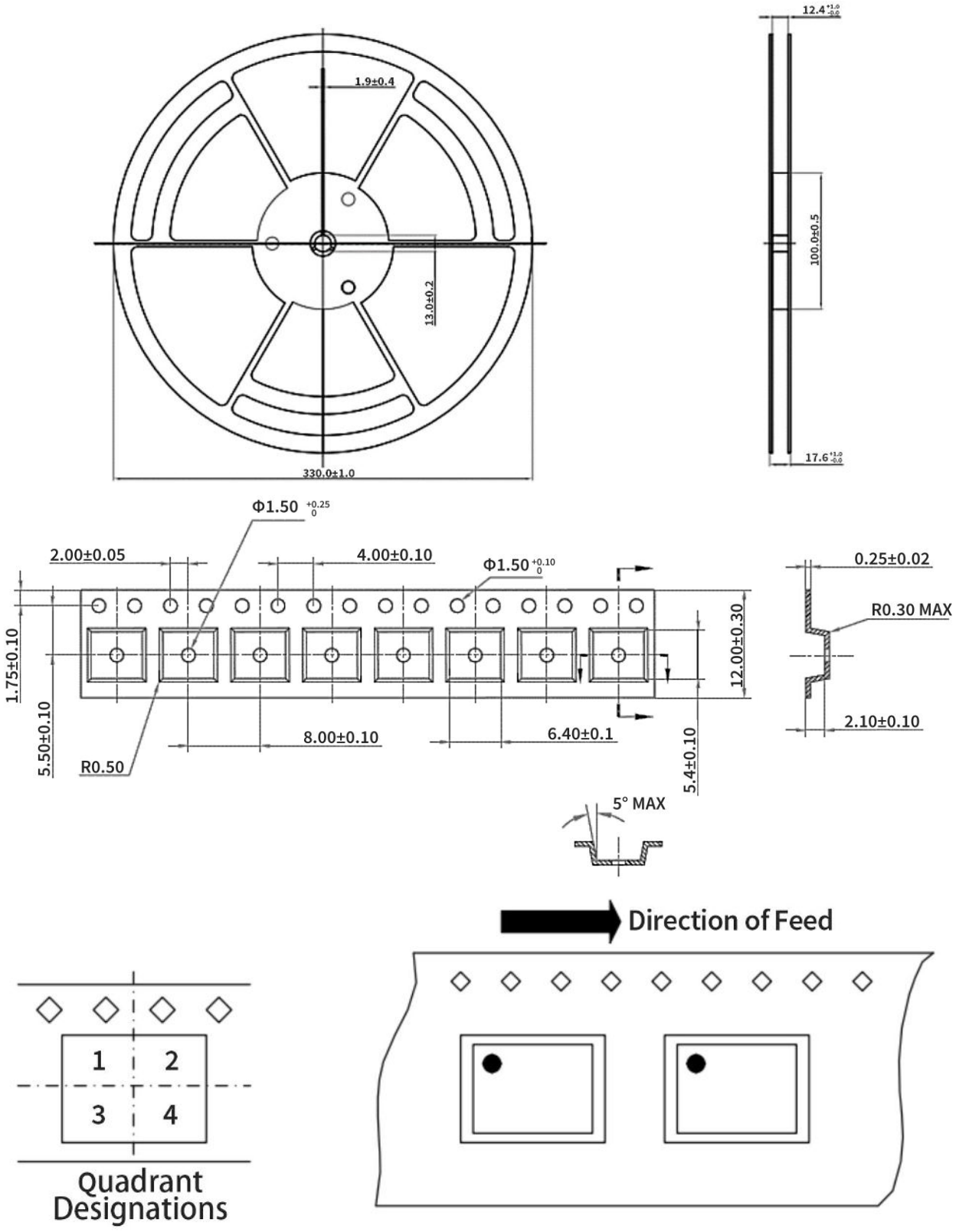


Figure 11.1 Tape and Reel Information of SOP8

# 12. Revision History

| *Revision* | *Description* | *Date* |
|---|---|---|
| 1.0 | Initial version | 2021/7/4 |
| 1.1 | Changed Bus fault protection | 2021/7/19 |
| 1.2 | Correct the font. Add Board Layout Example. Update Low level input current in STB, VID and IOH/IOL in Absolute Maximum Ratings and Recommended Operating Conditions. | 2022/10/12 |

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