

Product Overview

The NCA1021 is a LIN (Local Interconnect Network) transceiver with a low-power mode and multiple wake-up methods. Support up to 20kbps for sending and receiving communication.

The NCA1021 has a sleep mode with extremely low power consumption. Support remote wake-up and local wake-up via LIN bus or other pins. The device can also use the INH output pin as a flag to control the working status of other devices in the local system to achieve low-power operation of the system.

The NCA1021 converts the signal received by TXD into a LIN bus signal through waveform shaping and slew rate adjustment to reduce Electro Magnetic Emission (EME). TXD has a fault timeout protection function to prevent the LIN bus from being occupied.

Key Features

- Fully compatible with the ISO 17987-4 standard
- Very low Electro Magnetic Emission (EME)
- High Electro Magnetic Immunity (EMI)
- Support for 12-V applications
- Input levels compatible with 3.3 V and 5 V devices
- Bus fault protection of -40V to +40V
- Wake-up source recognition (local or remote)
- Integrated LIN pull-up resistor
- Transmit data (TXD) dominant time out function

- Over temperature protection
- Data rate: up to 20Kbps
- Operation temperature: -40°C~150°C
- RoHS-compliant packages:
SOP8

Applications

- Body sensor and module control
- Car steering wheel and instrument cluster
- Powertrain system and electric engine

Device Information

Part Number	Package	Body Size
NCA1021-Q1SPR	SOP8	4.90mm × 3.90mm

Pins Diagram

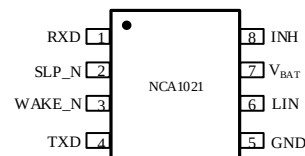


Figure 1. NCA1021 Block Diagram

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1. Pin Configuration and Functions

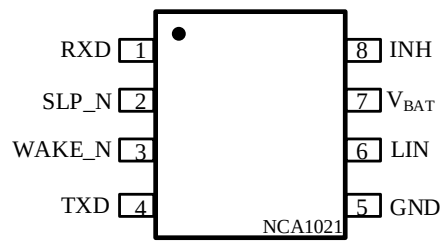


Figure 1.1 NCA1021 Package

Table1.1 NCA1021 Pin Configuration and Description

NCA1021-DSPR PIN NO.	SYMBOL	FUNCTION
1	RXD	receive data output (open-drain); active LOW after a wake-up event
2	SLP_N	sleep control input (active LOW); controls inhibit output; resets wake-up source flag on TXD and wake-up request on RXD
3	WAKE_N	local wake-up input (active LOW); negative edge triggered
4	TXD	transmit data input; active LOW output after a local wake-up event
5	GND	ground
6	LIN	LIN bus line input/output
7	V _{BAT}	battery supply voltage
8	INH	battery related inhibit output for controlling an external voltage regulator; active HIGH after a wake-up event

2. Absolute Maximum Ratings

Parameters	Symbol	Min	Typ	Max	Unit	Comments
battery supply voltage	V _{BAT}	-0.3		40	V	
voltage on pin LIN	V _{LIN}	-40		40	V	Limiting value with respect to GND, VBAT and VWAKE_N
voltage on pin WAKE_N	V _{WAKE_N}	-0.3		40	V	
current on pin WAKE_N	I _{WAKE_N}	-15			mA	only relevant if V _{WAKE_N} < V _{GND} -0.3 current will flow into pin GND
voltage on pin INH	V _{INH}	-0.3		V _{BAT} +0.3	V	
electrostatic discharge voltage	V _{ESD}	-6		6	kV	on pins WAKE_N, LIN and VBAT, according to IEC 61000-4-2
		-8		8	kV	HBM, on pins WAKE_N, LIN, VBAT and INH
		-2		2	kV	HBM on pins RXD, SLP_N and TXD
virtual junction temperature	T _{vj}	-40		150	°C	
Storage Temperature	T _{stg}	-55		150	°C	

3. Recommended Operating Conditions

Parameters	Symbol	min	typ	max	unit
battery Supply Voltage	V _{BAT}	5.5		27	V
LIN Bus input voltage	V _{LIN}	0		27	V
High level input voltage	V _{IH}	2		7	V
Low level input voltage	V _{IL}	-0.3		0.8	V

4. Thermal Characteristics

Parameters	Symbol	SOW16	Unit
Junction-to-Air Thermal Resistance	θ _{JA}	125.3	°C/W
Junction-to-case (top) thermal resistance	θ _{JC (top)}	65.4	°C/W
Junction-to-board thermal resistance	θ _{JB}	68.7	°C/W

5. Specifications

5.1. Electrical Characteristics

($V_{BAT} = 5.5\text{ V}$ to 27 V , $T_j = -40^\circ\text{C}$ to 150°C . Unless otherwise noted, Typical values are at $V_{BAT} = 12\text{V}$, $T_a = 25^\circ\text{C}$)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
battery supply current	I_{BAT}			10	uA	Sleep mode, $V_{LIN}=V_{BAT}$, $V_{WAKE_N}=V_{BAT}$, $V_{TXD}=0$, $V_{SLP_N}=0$
				1000	uA	Standby mode; bus recessive $V_{INH}=V_{BAT}$; $V_{LIN}=V_{BAT}$; $V_{WAKE_N}=V_{BAT}$; $V_{TXD}=0\text{ V}$; $V_{SLP_N}=0\text{ V}$
				1200	uA	Standby mode; bus dominant $V_{BAT}=12\text{V}$; $V_{INH}=12\text{V}$; $V_{LIN}=0\text{V}$ $V_{WAKE_N}=12\text{V}$; $V_{TXD}=0\text{V}$; $V_{SLP_N}=0\text{V}$
				1600	uA	Normal mode; bus recessive $V_{INH}=V_{BAT}$; $V_{LIN}=V_{BAT}$; $V_{WAKE_N}=V_{BAT}$ $V_{TXD}=5\text{ V}$; $V_{SLP_N}=5\text{ V}$
				4	mA	Normal mode; bus dominant $V_{BAT}=12\text{V}$; $V_{INH}=12\text{V}$; $V_{WAKE_N}=12\text{ V}$ $V_{TXD}=0\text{V}$; $V_{SLP_N}=5\text{ V}$
Power on reset	$V_{th(POR)L}$	1.6	3.1	3.9	V	Low-level power-on reset threshold voltage
	$V_{th(POR)H}$	2.3	3.4	4.3	V	High-level power-on reset threshold voltage
	$V_{hys(POR)}$	0.01	0.3	1	V	power-on reset hysteresis voltage
	$V_{th(VBATL)L}$	3.9	4.4	4.7	V	Low-level V_{BAT} LOW threshold voltage
	$V_{th(VBATL)H}$	4.2	4.7	4.9	V	High-level V_{BAT} LOW threshold voltage
	$V_{hys(VBATL)}$	0.01	0.3	1	V	V_{BAT} LOW hysteresis voltage
TXD						
High level input voltage	V_{IH}	2		7	V	
Low level input voltage	V_{IL}	-0.3		0.8	V	
hysteresis voltage	V_{hys}	50		400	mV	
Low level input current	I_{IL}	-5		5	uA	
Output Low current	I_{OL}	1.5			mA	local wake-up request; Standby mode; $V_{WAKE_N}=0\text{ V}$; $V_{LIN}=V_{BAT}$; $V_{TXD}=0.4\text{ V}$
pull-down resistance on pin	$R_{PD(TXD)}$	140		1200	k Ω	
SLP_N						

Parameters	Symbol	Min	Typ	Max	Unit	Comments
High level input voltage	V_{IH}	2		7	V	
Low level input voltage	V_{IL}	-0.3		0.8	V	
hysteresis voltage	V_{hys}	50		400	mV	
Low level input current	I_{IL}	-5		5	μA	
pull-down resistance on pin	$R_{PD(TXD)}$	140		1200	$k\Omega$	
RXD (Open drain)						
High level input current	I_{LH}	-5		5	μA	
Output Low current	I_{OL}	1.5			mA	Normal mode; $V_{LIN} = 0 V$; $V_{RXD} = 0.4 V$
WAKE_N						
High level input voltage	V_{IH}	$V_{BAT}-1$		$V_{BAT}+0.3$	V	
Low level input voltage	V_{IL}	-0.3		$V_{BAT}-3.3$	V	
High level input current	I_{IH}	-5		5	μA	$V_{WAKE_N} = 27 V$; $V_{BAT} = 27 V$
Low level input current	I_{IL}	-30		-1	μA	
INH						
switch-on resistance between pins VBAT and INH	$R_{sw(VBAT-INH)}$		20	50	Ω	switch-on resistance between pins V_{BAT} and INH
HIGH-level leakage current	I_{IH}	-5		5	μA	Sleep mode; $V_{INH} = 27 V$; $V_{BAT} = 27 V$
LIN						
current limitation for driver dominant state	I_{BUS_LIM}	40		100	mA	$V_{BAT} = 18 V$; $V_{LIN} = 18 V$ $V_{TXD} = 0V$
pull-up resistance	R_{pu}	50		250	$k\Omega$	Sleep mode; $V_{SLP_N} = 0 V$
receiver recessive input leakage current	$I_{BUS_PAS_rec}$			1	μA	$V_{LIN} = 27 V$; $V_{BAT} = 5.5 V$ $V_{TXD} = 5V$
receiver dominant input leakage current including pull-up resistor	$I_{BUS_PAS_dom}$	-600			μA	Normal mode; $V_{TXD} = 5V$ $V_{LIN} = 0 V$; $V_{BAT} = 12 V$
voltage drop at the serial diode	$V_{SerDiode}$	0.4		1	V	in pull-up path with R_{slave} $I_{SerDiode} = 10 \mu A$
loss-of-ground bus current	$I_{BUS_NO_GND}$	-750		10	μA	$V_{BAT} = 27 V$; $V_{LIN} = 0V$
loss-of-battery bus current	$I_{BUS_NO_BAT}$			1	μA	$V_{BAT} = 0 V$; $V_{LIN} = 27 V$
receiver dominant state	V_{BUSdom}			$0.4V_{BAT}$		

Parameters	Symbol	Min	Typ	Max	Unit	Comments
receiver recessive state	V _{BUSrec}	0.6V _{BAT}				
receiver center voltage	V _{BUS_CNT}	0.475V _B AT		0.525V _B AT	V	V _{BUS_CNT} = (V _{BUSrec} + V _{BUSdom})/2
slave resistance	R _{slave}	20		47	kΩ	connected between pins LIN and V _{BAT} ; V _{LIN} = 0 V; V _{BAT} = 12 V
dominant output voltage	V _{o(dom)}			1.4	V	Normal mode; V _{TXD} = 0 V, V _{BAT} = 7 V
				2.0	V	Normal mode; V _{TXD} = 0 V, V _{BAT} = 18 V

5.2. SWITCHING Electrical Characteristics

(V_{BAT} = 5.5 V to 18 V, T_j = -40°C to 150°C. Unless otherwise noted, Typical values are at V_{BAT} = 12V, T_a = 25°C)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
fall time	t _f			22.5	us	fall time
rise time	t _r			22.5	us	rise time
difference between rise and fall time transmitter propagation delay	t _(r-f)	-5		5	us	difference between rise and fall time
	t _{tx_pd}			6	us	transmitter propagation delay
transmitter propagation delay symmetry receiver propagation delay	t _{tx_sym}	-2.5		2.5	us	transmitter propagation delay symmetry
	t _{rx_pd}			6	us	rising and falling
receiver propagation delay symmetry	t _{rx_sym}	-2		2	us	
LIN dominant wake-up time	t _{wake(dom)LIN}	30		150	us	Sleep mode
dominant wake-up time on pin WAKE_N	t _{wake(dom)WAKE_N}	7		50	us	Sleep mode
go to normal time	t _{gotonorm}	2		10	us	time period for mode change from Sleep, Power-on or Standby mode into Normal mode
normal mode initialization time		5		20	us	normal mode, initialization time
go to sleep time	t _{gotosleep}	2		10	ms	time period for mode change from Normal slope mode into Sleep mode
TXD dominant time-out time	t _{to(dom)TXD}	27		90	ms	V _{TXD} = 0 V

5.3. Parameter Measurement Information

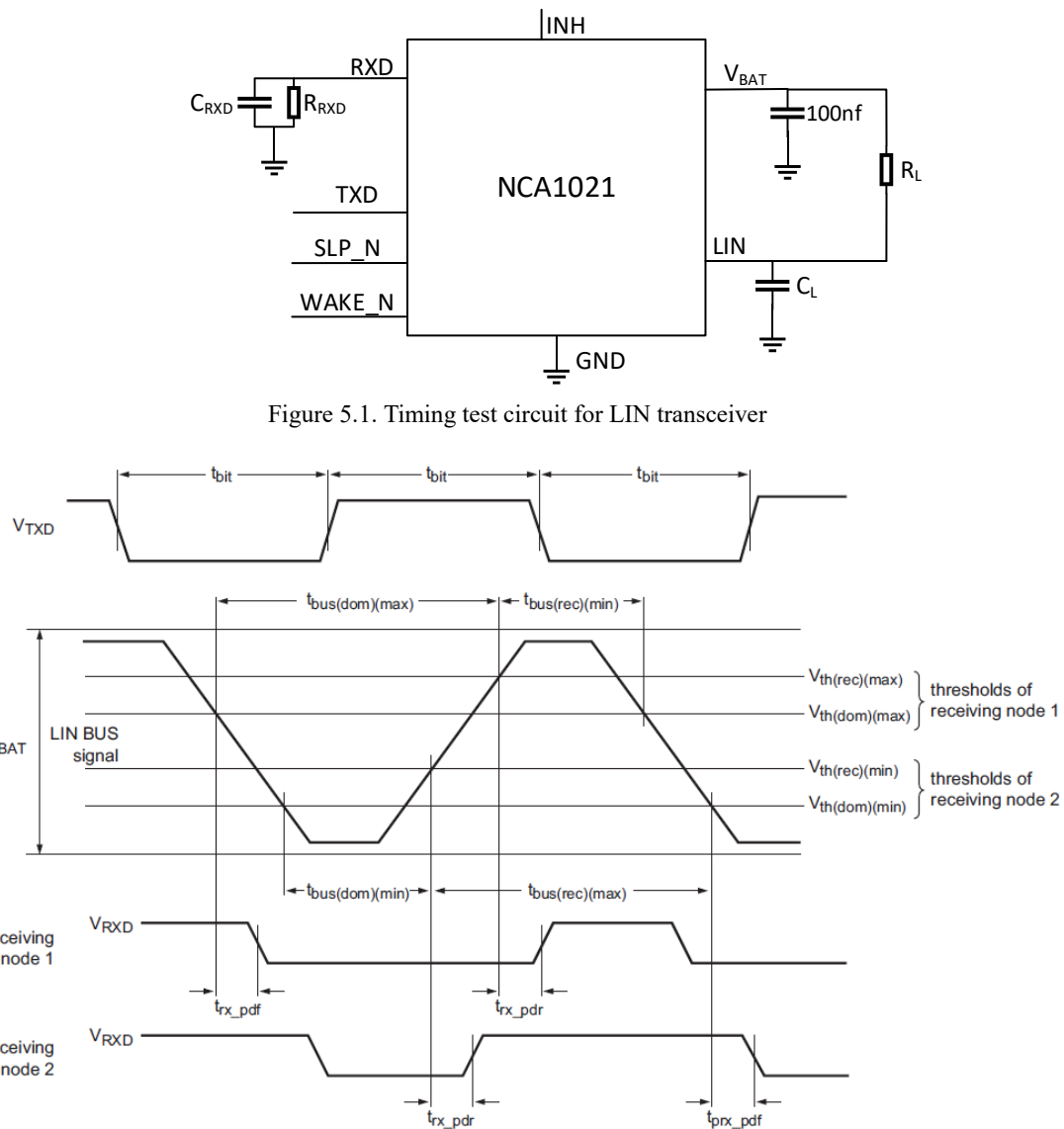


Figure 5.2. Timing diagram LIN transceiver

6. Function Description

6.1. Overview

The NCA1021 is a LIN transceiver with a low-power mode and multiple wake-up methods. The NCA1021 is fully compatible with the ISO 17987-4 standard. The NCA1021 is providing high electromagnetic immunity and low emissions. The data rate of the NCA1021 is up to 20Kbps. The NCA1021 provides thermal protection and transmit data dominant time out function.

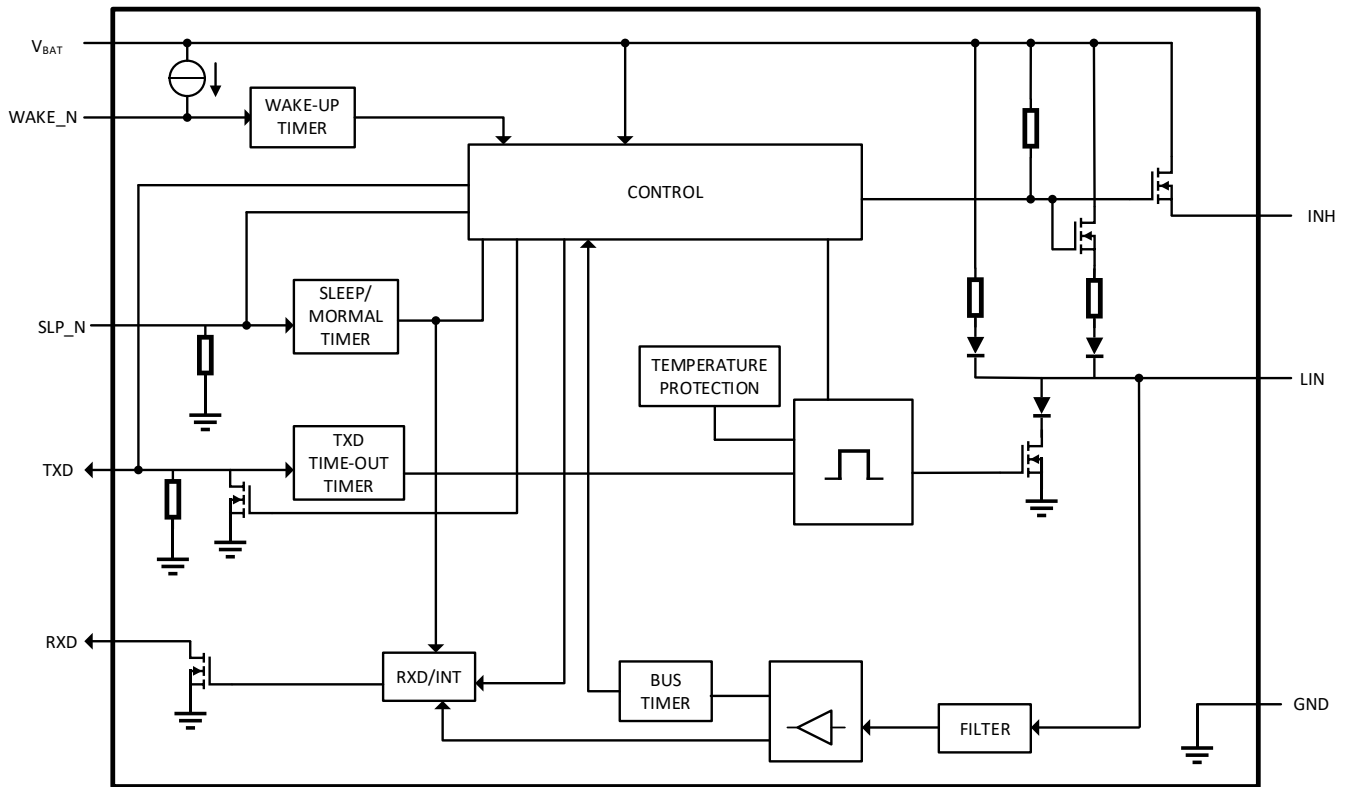


Figure6.1 Block diagram of NCA1021

6.2. Device Functional Modes

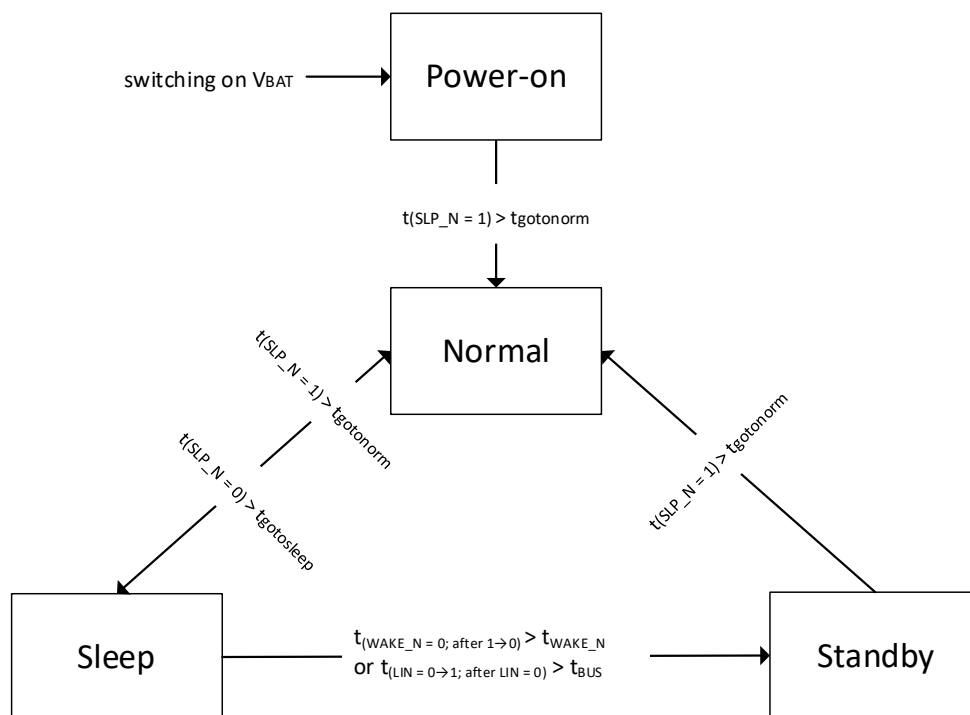


Figure 6.2 State diagram of NCA1021

Table 6.1. Function Table

Mode	SLP_N	LIN	TXD (output)	RXD	INH	Transmitter
Power-on	0	pull up by 30kohm	weak pull-down	floating	HIGH	Off
Normal ³	1	pull up by 30kohm	HIGH: recessive state LOW: dominant state	HIGH: recessive state LOW: dominant state	HIGH	ON
Sleep	0	pull up high ohmic	weak pull-down	floating	floating	Off
Standby	0	pull up by 30kohm	weak pull-down if remote wake-up strong pull-down if local wake-up ¹	LOW ²	HIGH	Off

¹ The internal wake-up source flag (set if a local wake-up did occur and fed to pin TXD) will be reset after a positive edge on pin SLP_N.

² The wake-up interrupt (on pin RXD) is released after a positive edge on pin SLP_N.

³ Normal mode is entered after a positive edge on SLP_N. If TXD is LOW, the transmitter is off. In the event of a short-circuit to ground on pin TXD, the transmitter will be disabled.

6.3. Normal mode

Under the normal mode of NCA1021, it can receive and send Normally on the LIN bus. In the Normal mode, the transmitter receives the signal from the MCU via the TXD, and first determines the dominant timeout, and then converts it into an optimized bus signal slew rate and waveform shaping to minimize EME. The LIN bus output is pulled HIGH via an internal slave termination resistor. The receiver detects the signal on the LIN bus input and transmits it to the microcontroller through the RXD. The recessive level on the bus is high and the dominant level is low.

After NCA1021 is powered on and $t_{(SLP_N=1)} > t_{gotonorm}$, it will enter the Normal mode. If $SLP_N=0$, it will remain in Power-on mode. In Sleep mode or Standby mode, when $t_{(SLP_N=1)} > t_{gotonorm}$, the Normal mode can be entered.

6.4. Sleep mode

Sleep mode is the lowest power consumption mode of NCA1021. In Sleep mode the transmitter is disabled, releasing the INH to floating state. LIN is in a weak current pull-up state, which can prevent false remote wake-up events. The only way to enter sleep mode is to make $t_{(SLP_N=0)} > t_{gotosleep}$ in normal mode. The NCA1021 in sleep mode supports 3 different methods to wake up. They are wake-up remotely via LIN bus, and wake-up locally via SLP_N or WAKE_N.

6.5. Standby mode

When NCA1021 is in sleep mode, it will enter standby mode by local or remote wake-up by LIN bus or WAKE_N. In standby mode, the INH changes from floating to high, which can be used as a control flag for other devices. At the same time, the 30kΩ pull-up resistor between LIN and VBAT is reconnected. Standby mode is signaled by a Low-level on RXD which can be used as an interrupt for the microcontroller.

It should be noted that two different wake-up methods will cause different states of the TXD. After being remotely awakened by the LIN bus, TXD will be in a weak pull-down state. After being woken up locally by the WAKE_N, TXD will be in a strong pull-down state. Therefore, the status of TXD can be used as a basis for judging the wake-up mode.

In standby mode, set the SLP_N high ($t_{(SLP_N=1)} > t_{gotonorm}$) to enter the normal mode. Release the state of TXD and RXD at this time.

6.6. TXD dominant time-out function

A TXD dominant time-out timer circuit prevents the bus line 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 ($t_{to(dom)TXD}$), the transmitter is disabled, driving the bus line into a recessive state. The timer is reset by a positive edge on pin TXD.

6.7. Fail-safe features

Pin TXD provides a pull-down to GND to force a predefined level on input pin TXD in case the pin TXD is unsupplied.

Pin SLP_N provides a pull-down to GND to force the transceiver into Sleep mode in case the pin SLP_N is unsupplied.

Pin RXD is set floating in case of lost power supply on pin V_{BAT}.

The current of the transmitter output stage is limited to protect the transmitter against short circuit to pins VBAT or GND.

A loss of power (pins V_{BAT} and GND) has no impact on the bus line and the microcontroller. There are no reverse currents from the bus. The LIN transceiver can be disconnected from the power supply without influencing the LIN bus.

The output driver at pin LIN is protected against overtemperature conditions. If the junction temperature exceeds the shutdown junction temperature $T_{j(sd)}$, the thermal protection circuit disables the output driver. The driver is enabled again when the junction temperature has dropped below $T_{j(sd)}$ and a recessive level is present at pin TXD.

If V_{BAT} drops below $V_{th(VBATL)_L}$, a protection circuit disables the output driver. The driver is enabled again when $V_{BAT} > V_{th(VBATL)_H}$ and a recessive level is present at pin TXD.

7. Application Note

7.1. Typical Application

The NCA1021 requires a 0.1 μF bypass capacitors between VCC and GND. The bypass capacitance value can also be determined according to the actual situation of the system. The capacitor should be placed as close as possible to the package. Master node applications require an external 1k Ω pullup resistor and serial diode. The LIN external capacitance value is selected according to the actual situation (refer to ISO 17987-4:2016 5.3.6 Line characteristics), generally 220pF for the slave or 1nF for the master. If RXD on the MCU does not have an internal pull-up, an external pull-up resistor is required. The figure 7.1 is the basic schematic of NCA1021.

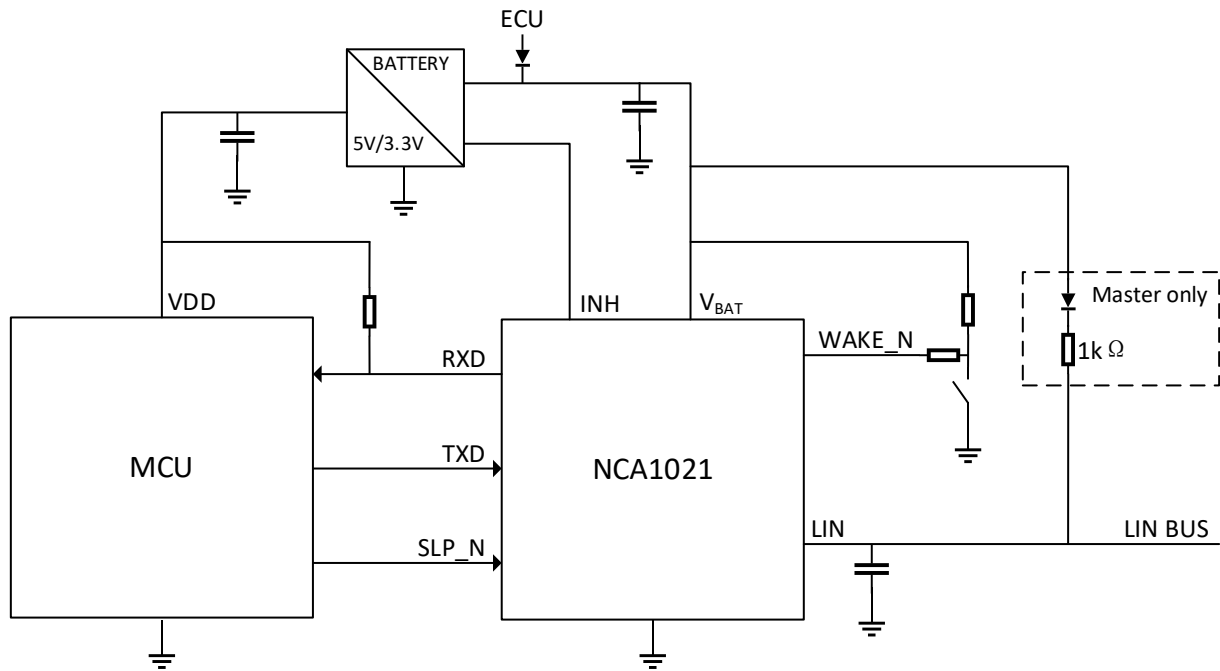
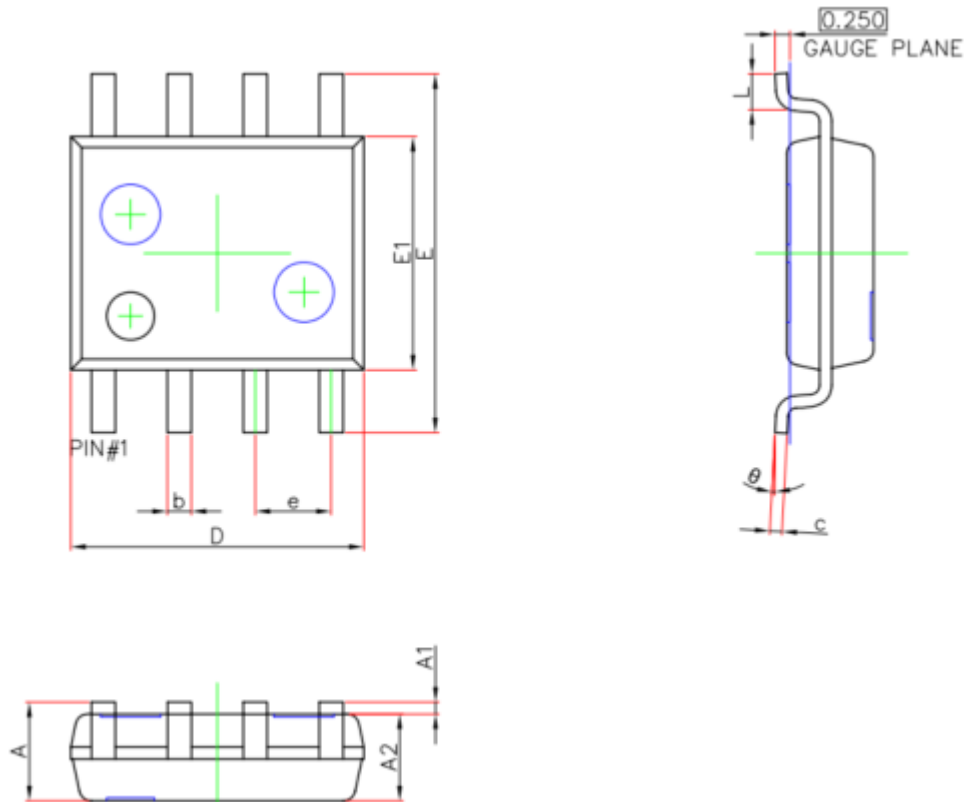


Figure 7.1 Basic schematic of NCA1021

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)		0.050(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

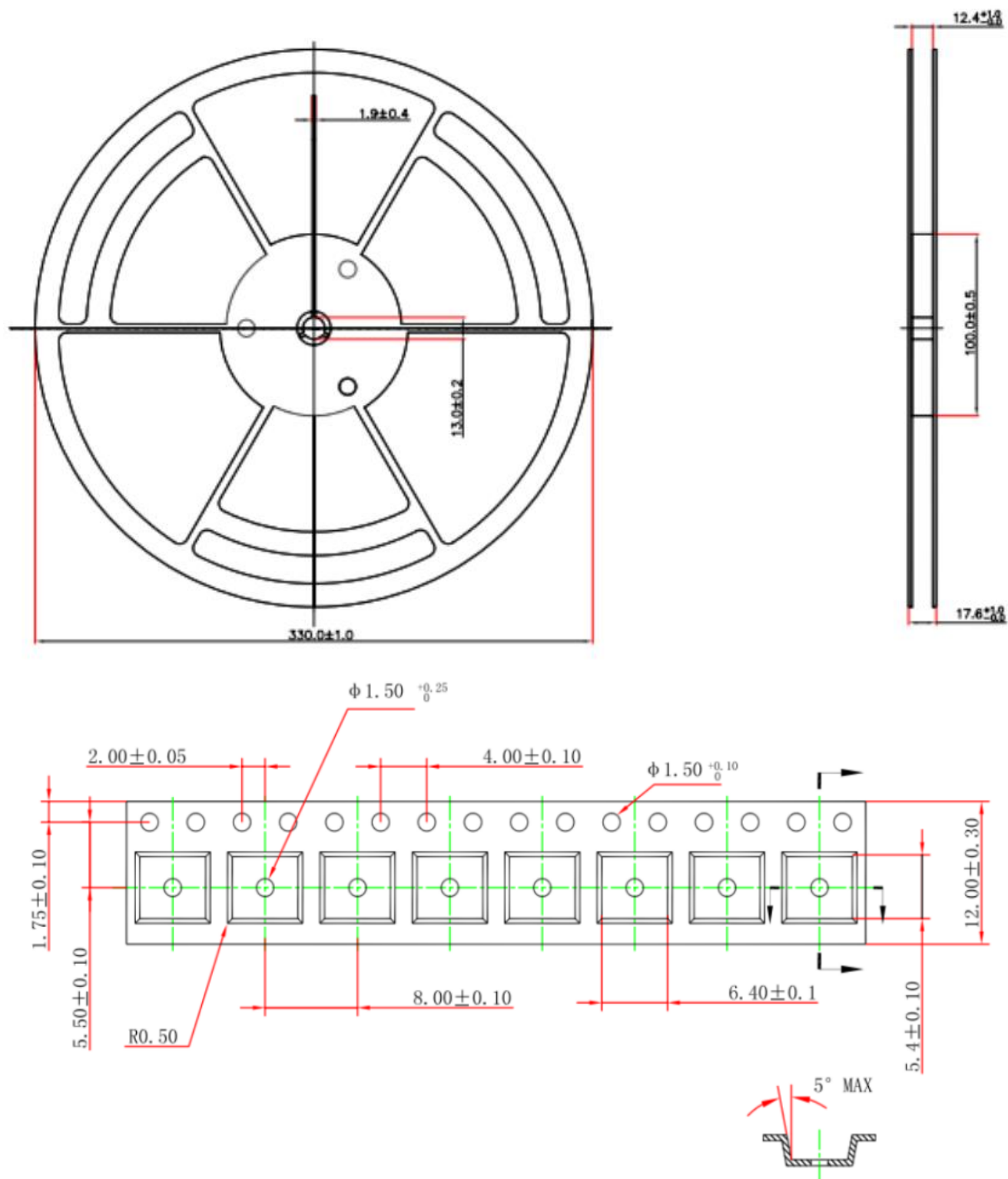
9. Order Information

<i>Part Number</i>	<i>Max Data Rate (Kbps)</i>	<i>Temperature</i>	<i>MSL</i>	<i>Package Type</i>	<i>Package Drawing</i>	<i>SPQ</i>
NCA1021-Q1SPR	20	-40 to 150°C	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

<i>Part Number</i>	<i>Product Folder</i>	<i>Datasheet</i>	<i>Technical Documents</i>	<i>Isolator selection guide</i>
NCA1021	Click here	Click here	Click here	Click here

11. Tape and Reel Information



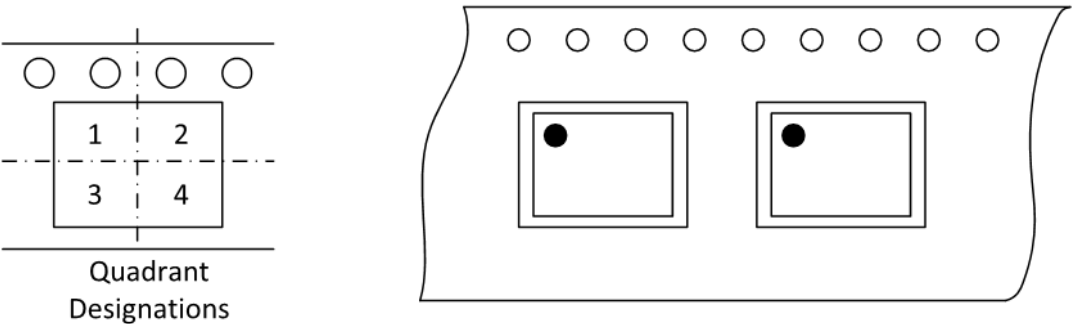


Figure 11.1 Tape and Reel Information of SOP8

12. Revision History

Revision	Description	Date
0.0	Initial version	2021/10/18