NCV7327

LIN Transceiver, Stand-alone

Description

The NCV7327 is a fully featured local interconnect network (LIN) transceiver designed to interface between a LIN protocol controller and the physical bus.

The LIN bus is designed to communicate low rate data from control devices such as door locks, mirrors, car seats, and sunroofs at the lowest possible cost. The bus is designed to eliminate as much wiring as possible and is implemented using a single wire in each node. Each node has a slave MCU−state machine that recognizes and translates the instructions specific to that function.

The main attraction of the LIN bus is that all the functions are not time critical and usually relate to passenger comfort.

Features

- LIN−Bus Transceiver
  - Compliant to ISO 17987−4 (Backwards Compatible to LIN Specification rev. 2.x, 1.3) and SAE J2602
  - Bus Voltage ±42 V
  - Transmission Rate up to 20 kbps (No low limit due to absence of TxD Timeout function)
  - Integrated Slope Control
- Protection
  - Thermal Shutdown
  - Undervoltage Protection
  - Bus Pins Protected Against Transients in an Automotive Environment
- Modes
  - Normal Mode: LIN Transceiver Enabled, Communication via the Bus is Possible
  - Sleep Mode: LIN Transceiver Disabled, the Consumption from V_{BB} is Minimized
  - Standby Mode: Transition Mode Reached after Wake−up Event on the LIN Bus
- Compatibility
  - Pin−Compatible Subset with NCV7321
  - K−line Compatible
  - NCV7327 differs from NCV7329 only by absence of TxD Timeout function

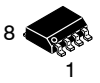
Quality

- Wettable Flank Package for Enhanced Optical Inspection
- AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

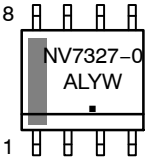
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MARKING DIAGRAMS

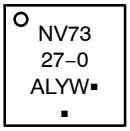


SOIC−8
CASE 751AZ





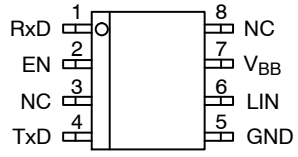
DFNW8
CASE 507AB



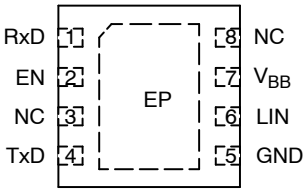
A	= Assembly Location
L	= Wafer Lot
Y	= Year
W	= Work Week
▪	= Pb−Free Package

(Note: Microdot may be in either location)

PIN CONNECTIONS



SOIC−8 (Top View)



DFNW8 (Top View)

ORDERING INFORMATION

See detailed ordering and shipping information on page 10 of this data sheet.

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BLOCK DIAGRAM

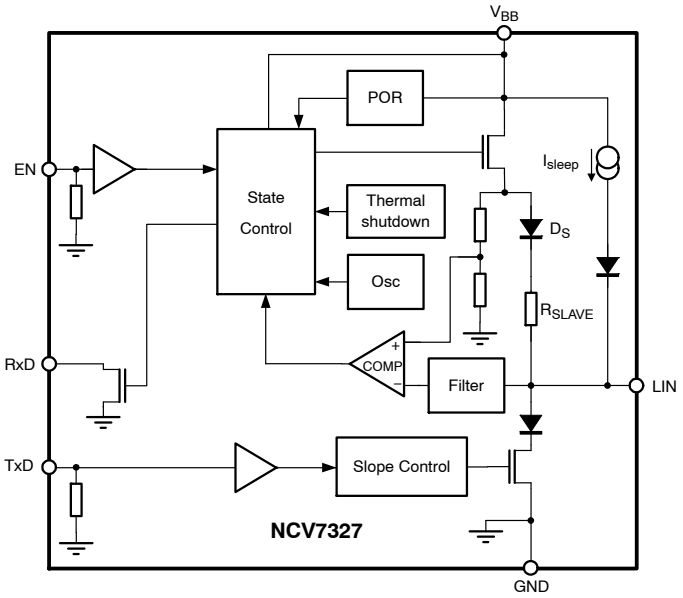


Figure 1. Block Diagram

TYPICAL APPLICATION

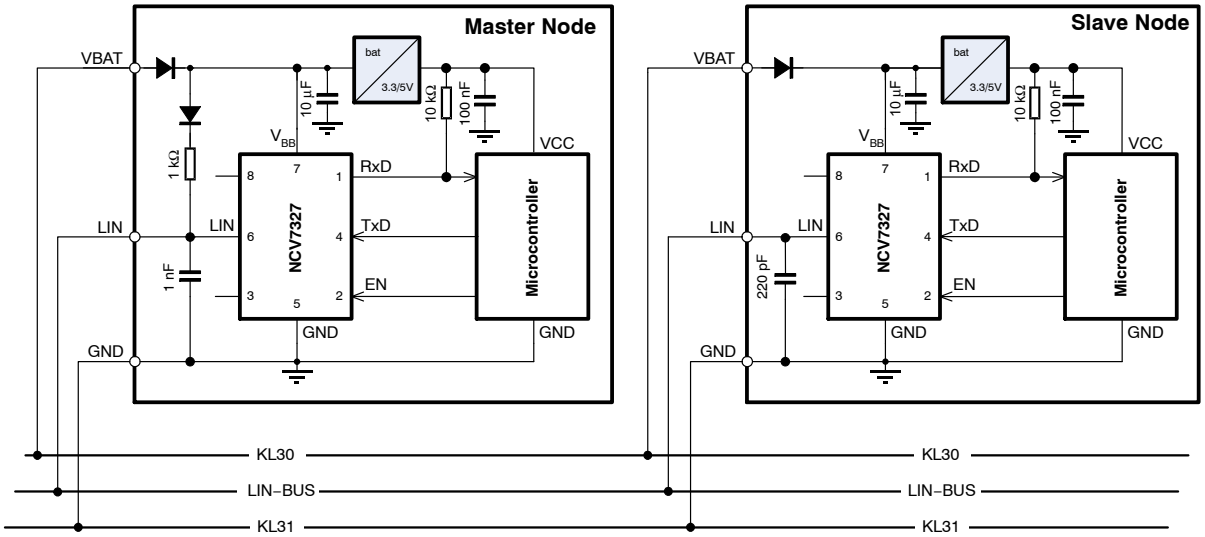


Figure 2. Typical Application Diagram for a Master Node

Table 1. PIN DESCRIPTION

Pin	Name	Description
1	RxD	Receive Data Output; Low in Dominant State; Open−Drain Output
2	EN	Enable Input, Transceiver in Normal Operation Mode when High, Pull−down Resistor to GND
3	NC	Not Connected
4	TxD	Transmit Data Input, Low for Dominant State, Pull−down to GND
5	GND	Ground
6	LIN	LIN Bus Output/Input
7	V_{BB}	Battery Supply Input
8	NC	Not Connected
−	EP	Exposed Pad. Recommended to connect to GND or left floating in application (DFNW8 package only).

Table 2. ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Min	Max	Unit
V_{BB}	Voltage on Pin V_{BB}	−0.3	+42	V
V_{LIN}	LIN Bus Voltage with respect to GND	−42	+42	V
	LIN Bus Voltage with respect to V_{BB}	−42	+42	V
V_Dig_IO	DC Input Voltage on Pins (EN, RxD, TxD)	−0.3	+7	V
V_{ESD}	Human Body Model (LIN Pin) (Note 1)	−8	+8	kV
	Human Body Model (All pins) (Note 1)	−4	+4	kV
	Charged Device Model (All Pins) (Note 2)	−750	+750	V
	Machine Model (All Pins) (Note 3)	−200	+200	V
V_{ESDIEC}	Electrostatic Discharge Voltage (LIN Pin) System Human Body Model (Note 4) Conform to IEC 61000−4−2	−8	+8	kV
T_J	Junction Temperature Range	−40	+150	°C
T_{STG}	Storage Temperature Range	−55	+150	°C
MSL_{SOIC}	Moisture sensitivity level for SOIC−8	2		−
MSL_{DFN}	Moisture sensitivity level for DFNW8	1		−
T_{SLD}	Lead Temperature Soldering Reflow (SMD Styles Only), Pb−Free Versions (Note 5)	260		°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Standardized human body model electrostatic discharge (ESD) pulses in accordance to EIA−JESD22. Equivalent to discharging a 100 pF capacitor through a 1.5 kΩ resistor.
2. Standardized charged device model ESD pulses when tested according to AEC−Q100−011.
3. In accordance to JEDEC JESD22−A115. Equivalent to discharging a 200 pF capacitor through a 10 Ω resistor and 0.75 μH coil.
4. Equivalent to discharging a 150 pF capacitor through a 330 Ω resistor. System HBM levels are verified by an external test−house.
5. For information, please refer to our Soldering and Mounting Techniques Reference Manual, SOLDERRM/D

Table 3. THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Unit
Thermal characteristics, SOIC−8 (Note 6)			
Thermal Resistance Junction−to−Air, Free air, 1S0P PCB (Note 7)	$R_{\theta JA}$	131	°C/W
Thermal Resistance Junction−to−Air, Free air, 2S2P PCB (Note 8)	$R_{\theta JA}$	81	°C/W
Thermal characteristics, DFNW8 (Note 6)			
Thermal Resistance Junction−to−Air, Free air, 1S0P PCB (Note 7)	$R_{\theta JA}$	125	°C/W
Thermal Resistance Junction−to−Air, Free air, 2S2P PCB (Note 8)	$R_{\theta JA}$	58	°C/W

6. Refer to ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for Safe Operating parameters.
7. Values based on test board according to EIA/JEDEC Standard JESD51−3, signal layer with 10% trace coverage.
8. Values based on test board according to EIA/JEDEC Standard JESD51−7, signal layers with 10% trace coverage.

ELECTRICAL CHARACTERISTICS

Definitions

All voltages are referenced to GND (pin 5) unless otherwise specified. Positive currents flow into the IC. Sinking current means the current is flowing into the pin; sourcing current means the current is flowing out of the pin.

Table 4. DC CHARACTERISTICS (V_{BB} = 5 V to 18 V; T_J = −40°C to +150°C; Bus Load = 500 Ω (V_{BB} to LIN); unless otherwise specified. Typical values are given at V_{BB} = 12 V and T_J = 25°C, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
SUPPY PIN (V_{BB})						
V_{BB}	Battery Supply Voltage		5.0	–	18	V
I_{BB}	Battery Supply Current	Normal Mode; LIN Recessive	0.2	0.55	1.2	mA
I_{BB}	Battery Supply Current	Normal Mode; LIN Dominant	2.0	3.9	6.5	mA
I_{BB}	Battery Supply Current	Sleep and Standby Mode; LIN Recessive; $V_{LIN} = V_{BB}$; T_J<85°C	–	6.0	10	μA
I_{BB}	Battery Supply Current	Sleep and Standby Mode; LIN Recessive; $V_{LIN} = V_{BB}$	–	6.0	15	μA
POR AND V_{BB} MONITOR						
PORH_V_{BB}	Power−on Reset; High Level on V_{BB}	V_{BB} Rising	2.7	3.5	4.4	V
PORL_V_{BB}	Power−on Reset; Low Level on V_{BB}	V_{BB} Falling	1.3	2.1	2.7	V
MONH_V_{BB}	Battery Monitoring High Level	V_{BB} Rising	3.2	4.2	5.0	V
MONL_V_{BB}	Battery Monitoring Low Level	V_{BB} Falling	3.0	4.0	4.8	V
TRANSMITTER DATA INPUT (PIN TxD)						
V_{IL_TxD}	Low Level Input Voltage		−0.3	–	+0.8	V
V_{IH_TxD}	High Level Input Voltage		2.0	–	7.0	V
R_{PD_TxD}	Pull−down Resistor on TxD Pin		50	125	325	kΩ
RECEIVER DATA OUTPUT (PIN RxD)						
I_{OL_RxD}	Low Level Output Current	V_{RxD} = 0.4 V	2.0	–	–	mA
I_{OH_RxD}	High Level Output Current		−5	–	+5	μA
ENABLE INPUT (PIN EN)						
V_{IL_EN}	Low Level Input Voltage		−0.3	–	+0.8	V
V_{IH_EN}	High Level Input Voltage		2.0	–	7.0	V
R_{PD_EN}	Pull−down Resistor to Ground		100	250	650	kΩ
LIN BUS LINE (PIN LIN)						
V_{BUS_DOM}	Bus Voltage for Dominant State		–	–	0.4	V_{BB}
V_{BUS_REC}	Bus Voltage for Recessive State		0.6	–	–	V_{BB}
V_{REC_DOM}	Receiver Threshold	LIN Bus Recessive − Dominant	0.4	–	0.6	V_{BB}
V_{REC_REC}	Receiver Threshold	LIN Bus Dominant − Recessive	0.4	–	0.6	V_{BB}
V_{REC_CNT}	Receiver Centre Voltage	(V_{REC_DOM} + V_{REC_REC}) / 2	0.475	0.500	0.525	V_{BB}
V_{REC_HYS}	Receiver Hysteresis	(V_{REC_REC} − V_{REC_DOM})	0.050	–	0.175	V_{BB}
V_{LIN_DOM}	Dominant Output Voltage	Normal mode; V_{BB} = 7 V	–	–	1.2	V
		Normal mode; V_{BB} = 18 V	–	–	2.0	V
$I_{BUS_no_GND}$	Communication not Affected	V_{BB} = GND = 12 V; 0 < V_{LIN} < 18 V	−1.0	–	+1.0	mA
$I_{BUS_no_VBB}$	LIN Bus Remains Operational	V_{BB} = GND = 0 V; 0 < V_{LIN} < 18 V	–	–	5.0	μA
I_{BUS_LIM}	Current Limitation for Driver	Dominant State; V_{LIN} = V_{BB_MAX}	40	–	200	mA
$I_{BUS_PAS_dom}$	Receiver Leakage Current; Driver OFF	TxD = High; V_{LIN} = 0 V; V_{BB} = 12 V	−1.0	–	–	mA

Table 4. DC CHARACTERISTICS (V_{BB} = 5 V to 18 V; T_J = −40°C to +150°C; Bus Load = 500 Ω (V_{BB} to LIN); unless otherwise specified. Typical values are given at V_{BB} = 12 V and T_J = 25°C, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
LIN BUS LINE (PIN LIN)						
I_{sleep}	Receiver Leakage Current; see Figure 1	Sleep Mode; V_{LIN} = 0 V; V_{BB} = 12 V	−16	−8.0	−3.0	μA
$I_{BUS_PAS_rec}$	Receiver Leakage Current; Driver OFF; (Note 9)	TxD = High; 8 V < V_{BB} < 18 V; 8 V < V_{LIN} < 18 V; $V_{LIN} \geq V_{BB}$	–	–	20	μA
$V_{SEDiode}$	Voltage Drop on Serial Diode	Voltage drop on D_S, see Figure 1	0.4	0.7	1.0	V
R_{SLAVE}	Internal Pull−up Resistance	See Figure 1	20	30	60	kΩ
C_{LIN}	Capacitance on Pin LIN, (Note 9)		–	20	30	pF
THERMAL SHUTDOWN						
$T_{J(sd)}$	Shutdown Junction Temperature	Temperature Rising	160	180	200	°C

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

9. Values based on design and characterization. Not tested in production.

Table 5. AC CHARACTERISTICS (V_{BB} = 5 V to 18 V; T_J = −40°C to +150°C; unless otherwise specified. For the transmitter parameters, the following bus loads are considered: L1 = 1 kΩ / 1 nF; L2 = 660 Ω / 6.8 nF; L3 = 500 Ω / 10 nF)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
LIN TRANSMITTER						
D1	Duty Cycle 1 = $t_{BUS_REC(min)}$ / (2xt_{BIT})	$TH_{REC(max)}$ = 0.744 x V_{BB} $TH_{DOM(max)}$ = 0.581 x V_{BB} t_{BIT} = 50 μs V_{BB} = 5 V to 18 V	0.396	–	0.500	–
D2	Duty Cycle 2 = $t_{BUS_REC(max)}$ / (2xt_{BIT})	$TH_{REC(min)}$ = 0.422 x V_{BB} $TH_{DOM(min)}$ = 0.284 x V_{BB} t_{BIT} = 50 μs V_{BB} = 5 V to 18 V	0.500	–	0.581	–
D3	Duty Cycle 3 = $t_{BUS_REC(min)}$ / (2xt_{BIT})	$TH_{REC(max)}$ = 0.778 x V_{BB} $TH_{DOM(max)}$ = 0.616 x V_{BB} t_{BIT} = 96 μs V_{BB} = 5 V to 18 V	0.417	–	0.500	–
D4	Duty Cycle 4 = $t_{BUS_REC(max)}$ / (2xt_{BIT})	$TH_{REC(min)}$ = 0.389 x V_{BB} $TH_{DOM(min)}$ = 0.251 x V_{BB} t_{BIT} = 96 μs V_{BB} = 5 V to 18 V	0.500	–	0.590	–
$t_{TX_PROP_DOWN}$	Propagation Delay of TxD to LIN. TxD High to Low		–	–	14	μs
$t_{TX_PROP_UP}$	Propagation Delay of TxD to LIN. TxD Low to High		–	–	14	μs
LIN RECEIVER						
t_{RX_PD}	Propagation Delay of Receiver, Rising and Falling Edge (See Figure 5)	R_{RxD} = 2.4 kΩ; C_{RxD} = 20 pF	0.1	–	6.0	μs
t_{RX_SYM}	Propagation Delay Symmetry	R_{RxD} = 2.4 kΩ; C_{RxD} = 20 pF; Rising Edge with Respect to Falling Edge	−2.0	–	+2.0	μs
MODE TRANSITIONS AND TIMEOUTS						
t_{LIN_WAKE}	Duration of LIN Dominant for Detection of Wake−up via LIN Bus (See Figure 6)	Sleep Mode	40	70	150	μs
t_{INIT_NORM}	Time from Rising Edge of EN pin to the moment when the Transmitter is able to correctly transmit		15	30	75	μs
t_{ENABLE}	Duration of EN pin in High Level State for transition to Normal Mode		11	20	55	μs
$t_{DISABLE}$	Duration of EN pin in Low Level State for transition to Sleep Mode		11	20	55	μs
t_{TO_STB}	Delay from LIN Bus Dominant to Recessive Edge to Entering of Standby Mode after Valid LIN Wake−up	Sleep Mode	–	10	–	μs

10. Values based on design and characterization. Not tested in production.

FUNCTIONAL DESCRIPTION

Overall Functional Description

LIN is a serial communication protocol that efficiently supports the control of mechatronic nodes in distributed automotive applications.

The NCV7327 contains the LIN transmitter, LIN receiver, power−on−reset (POR) circuits and thermal shutdown (TSD). The LIN transmitter is optimized for a maximum specified transmission speed of 20 kbps.

Table 6. OPERATING MODES

Pin EN	Mode	Pin RxD	LIN bus
x	Unpowered	Floating	OFF; Floating
Low	Sleep	Floating	OFF; Floating
Low	Standby	Low indicates wake−up	OFF; 30 kΩ
High	Normal	LOW: dominant HIGH: recessive	ON; 30 kΩ

Unpowered Mode

As long as V_{BB} remains below its power−on−reset level, the chip is kept in a safe unpowered state. The LIN transmitter is inactive, the LIN pin is left floating and only a weak pull−down is connected on pin TxD. Pin RxD remains floating.

The unpowered state will be entered from any other state when V_{BB} falls below its power−on−reset level (PORL_V_{BB}). When V_{BB} rises above the power−on−reset high threshold (PORH_V_{BB}), the NCV7327 switches to a Sleep mode.

Normal Mode

In the Normal mode, the full functionality of the LIN transceiver is available. The transceiver can transmit and receive data via the LIN bus with speed up to 20 kbps. Data according the state of TxD input are sent to the LIN bus while pin RxD reflects the logical symbol received on the LIN bus − high−impedant for recessive and Low for dominant. A 30 kΩ resistor in series with a reverse−protection diode is internally connected between LIN and V_{BB} pins.

In case the junction temperature increases above the thermal shutdown threshold ($T_{J(sd)}$), e.g. due to a short of the LIN wiring to the battery, the transmitter is disabled and releases the LIN bus to recessive. Once the junction temperature decreases back below the thermal shutdown level, the transmission can be enabled again. However, to avoid thermal oscillations, first a High logical level on TxD must be encountered before the transmitter is enabled.

As required by SAE J2602, the transceiver must behave safely below its operating range – it shall either continue to transmit correctly (according its specification) or remain silent (transmit a recessive state regardless of the TxD signal). A battery monitoring circuit in NCV7327 deactivates the transmitter in the Normal mode if the V_{BB} level drops below MONL_V_{BB}. Transmission is enabled again when V_{BB} reaches MONH_V_{BB}. The internal logic remains in the Normal mode and the reception from the LIN line is still possible even if the battery monitor disables the transmission. Although the specifications of the monitoring and power−on−reset levels are overlapping, it's ensured by the implementation that the monitoring level never falls below the power−on−reset level.

The Normal mode can be entered from either Standby or Sleep mode when EN Pin is High for longer than t_{ENABLE}. When the transition is made from Standby mode, TxD pull−down is set to weak and RxD is put into a high−impedance immediately after EN becomes High (before the expiration of t_{ENABLE} filtering time). This excludes signal conflicts between the Standby mode pin settings and the signals required to control the chip in the Normal mode after a local wake−up vs. High logical level on TxD required to send a recessive symbol to the LIN bus.

Sleep Mode

Sleep mode provides extremely low current consumption. The LIN transceiver is inactive and the battery consumption is minimized.

This mode is entered in one of the following ways:

- After the voltage level at V_{BB} pin rises above its power−on−reset level (PORH_V_{BB}). In this case, RxD Pin remains high−impedant and the pull−down applied on pin TxD remains weak.
- After assigning Low logical level to pin EN for longer than $t_{DISABLE}$ while NCV7327 is in the Normal mode.

Standby Mode

Standby mode is entered from the Sleep mode when a remote wake−up event occurred. The Low level on RxD pin indicates interrupt flag for the microcontroller.

OPERATING STATES

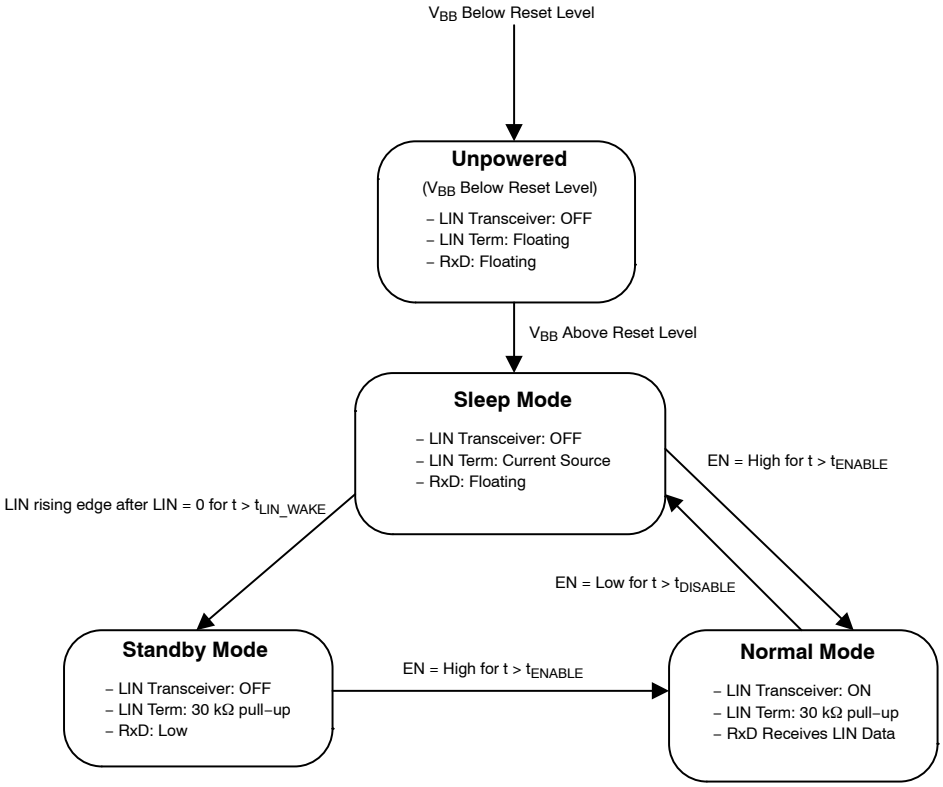


Figure 3. State Diagram

MEASUREMENT SETUPS AND DEFINITIONS

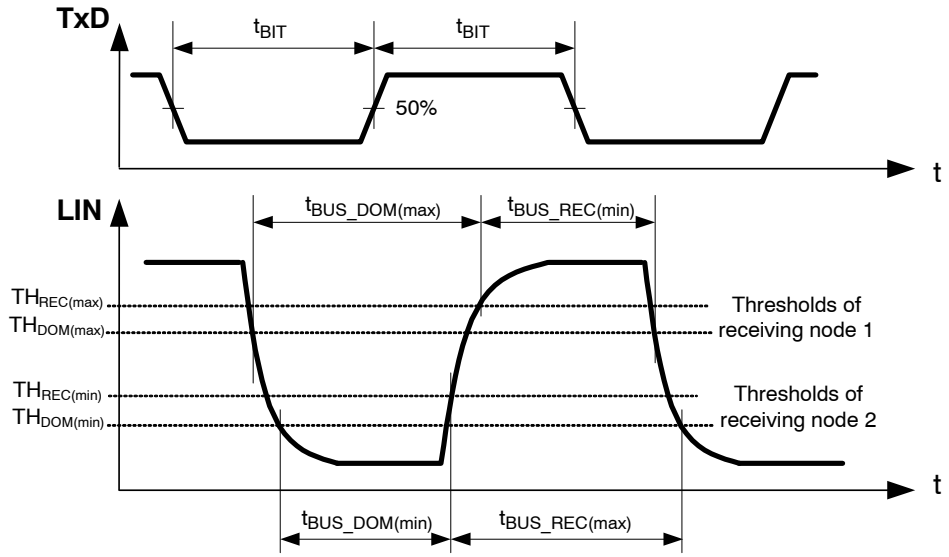


Figure 4. LIN Transmitter Duty Cycle

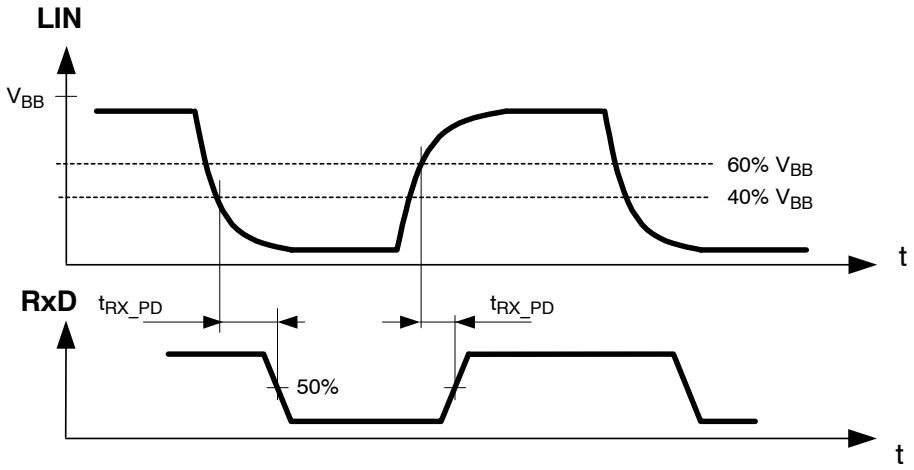


Figure 5. LIN Receiver Timing

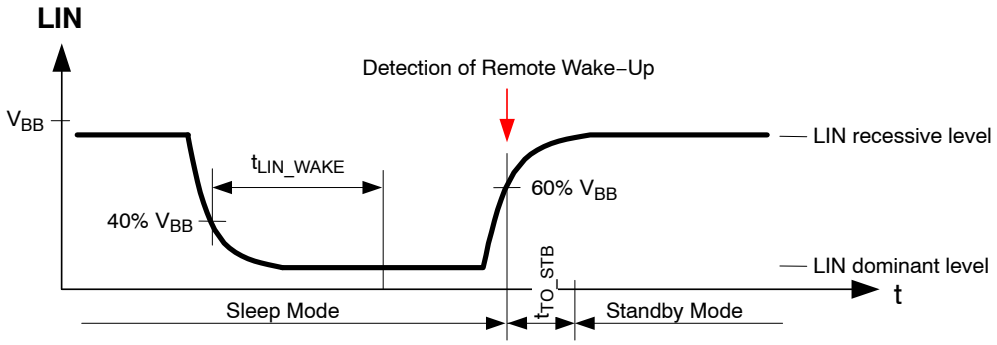


Figure 6. Remote (LIN) Wake−up Detection

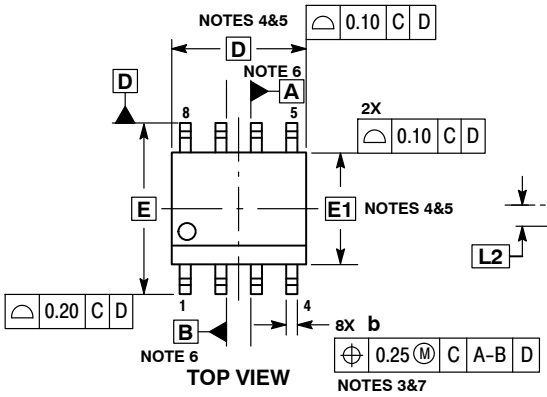
DEVICE ORDERING INFORMATION

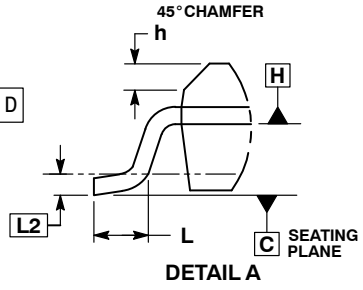
Part Number	Description	Temperature Range	Package	Shipping†
NCV7327D10R2G	LIN Transceiver, Stand−alone	−40°C to +150°C	SOIC−8 (Pb−Free)	3000 / Tape & Reel
NCV7327MW0R2G	LIN Transceiver, Stand−alone	−40°C to +150°C	DFNW8 (Pb−Free)	3000 / Tape & Reel

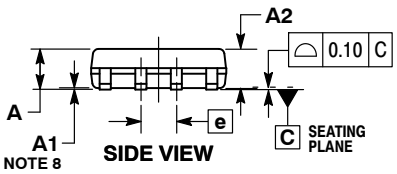
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

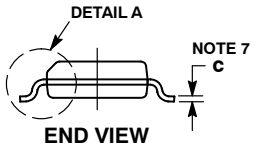
PACKAGE DIMENSIONS

SOIC−8
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ISSUE B





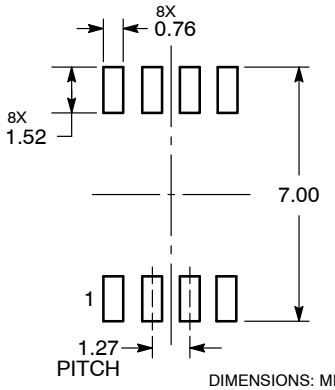




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.004 mm IN EXCESS OF MAXIMUM MATERIAL CONDITION.
4. DIMENSION D DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.006 mm PER SIDE. DIMENSION E1 DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.010 mm PER SIDE.
5. THE PACKAGE TOP MAY BE SMALLER THAN THE PACKAGE BOTTOM. DIMENSIONS D AND E1 ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
6. DIMENSIONS A AND B ARE TO BE DETERMINED AT DATUM H.
7. DIMENSIONS b AND c APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.10 TO 0.25 FROM THE LEAD TIP.
8. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.

	MILLIMETERS	
DIM	MIN	MAX
A	---	1.75
A1	0.10	0.25
A2	1.25	---
b	0.31	0.51
c	0.10	0.25
D	4.90 BSC	
E	6.00 BSC	
E1	3.90 BSC	
e	1.27 BSC	
h	0.25	0.41
L	0.40	1.27
L2	0.25 BSC	

RECOMMENDED SOLDERING FOOTPRINT*

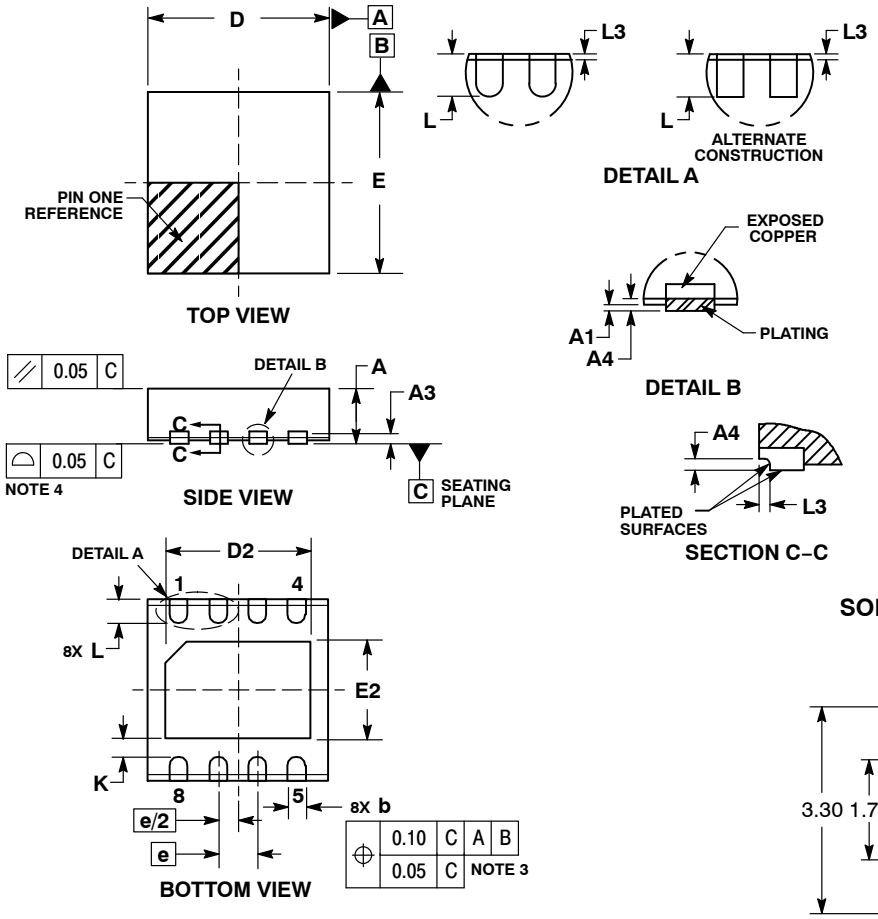


DIMENSIONS: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

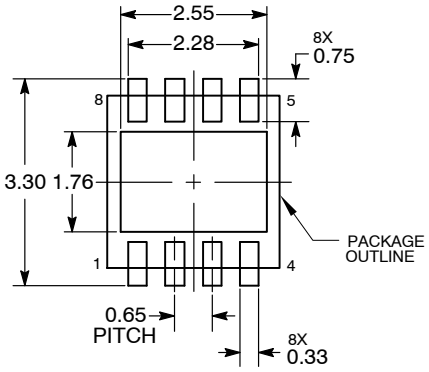
DFNW8 3x3, 0.65P
CASE 507AB
ISSUE D



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.10 AND 0.20mm FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. THIS DEVICE CONTAINS WETTABLE FLANK DESIGN FEATURES TO AID IN FILLET FORMATION ON THE LEADS DURING MOUNTING.

	MILLIMETERS		
DIM	MIN	NOM	MAX
A	0.80	0.85	0.90
A1	---	---	0.05
A3	0.20 REF		
A4	0.10	---	---
b	0.25	0.30	0.35
D	2.95	3.00	3.05
D2	2.30	2.40	2.50
E	2.95	3.00	3.05
E2	1.50	1.60	1.70
e	0.65 BSC		
K	0.30 REF		
L	0.35	0.40	0.45
L3	0.00	0.05	0.10

RECOMMENDED SOLDERING FOOTPRINT*



DIMENSIONS: MILLIMETERS

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