

# ON Semiconductor

## Is Now



To learn more about onsemi™, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)

onsemi and onsemi. and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries. onsemi owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of onsemi product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). onsemi reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and onsemi makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using onsemi products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by onsemi. "Typical" parameters which may be provided in onsemi data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. onsemi does not convey any license under any of its intellectual property rights nor the rights of others. onsemi products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use onsemi products for any such unintended or unauthorized application, Buyer shall indemnify and hold onsemi and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that onsemi was negligent regarding the design or manufacture of the part. onsemi is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner. Other names and brands may be claimed as the property of others.

# NCV7424

## Four Channel LIN Transceiver

NCV7424 is a four channel physical layer device using the Local Interconnect Network (LIN) protocol. It allows interfacing of four independent LIN physical buses and the LIN protocol controllers. The device is compliant to LIN 2.x Protocol Specification package and the SAE J2602 standard.

The NCV7424 LIN device is a member of the in-vehicle networking (IVN) transceiver family. The device is a monolithic solution incorporating 4 times the NCV7321-1 transceiver.

### Features

- TSSOP-16 Package. Pin-out Compatible with One Single LIN NCV7321 Transceiver (Pin Numbers 4 to 7, and 10 to 13)
- Compliant with LIN2.x, Backwards Compatible to Version 1.3 and J2602
- Transmission Rate 1 kbps to 20 kbps
- Indefinite Short-Circuit Protection on LIN towards Supply and Ground
- Bus Pins Protected Against Transients in an Automotive Environment
- Thermal Shutdown
- System ESD on LIN Pin Exceeding 10 kV, No Need for External ESD Protections
- Load Dump Protection (45 V)
- Integrated Slope Control Resulting into Excellent EME Performance also without any Capacitor on LIN Pin
- Excellent EMI Performance
- Remote Wake-up via LIN Bus on all Four Channels
- 3.3 V and 5 V Compatible Digital Inputs

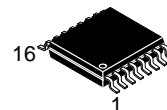
### Quality

- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



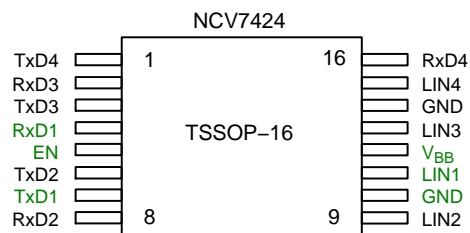
**ON Semiconductor®**

[www.onsemi.com](http://www.onsemi.com)

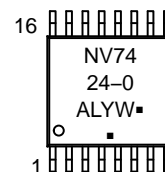


**TSSOP-16  
CASE 948F**

### PACKAGE PICTURE



### MARKING DIAGRAM



NV7424-0 = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering, marking and shipping information in the package dimensions section on page 11 of this data sheet.

# NCV7424

## BLOCK DIAGRAM

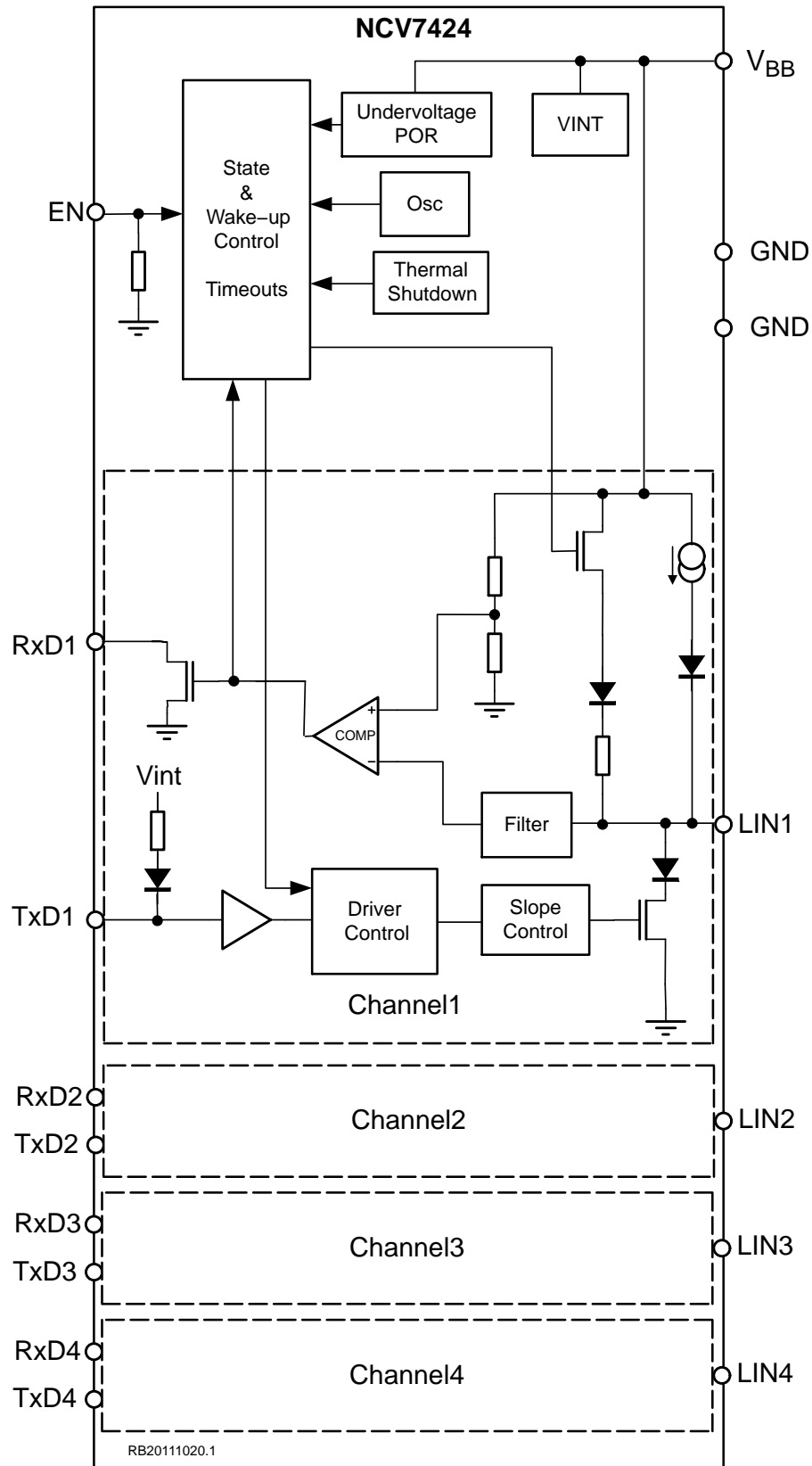


Figure 1. Block Diagram

**Table 1. KEY TECHNICAL CHARACTERISTICS AND OPERATING RANGES**

Symbol	Parameter	Min	Typ	Max	Unit
V <sub>BB</sub>	Nominal Battery Operating Voltage (Note 1)	5	12	27	V
	Load Dump Protection			45	
I <sub>BB_SLP</sub>	Supply Current in Sleep Mode, V <sub>BB</sub> = 12 V, T <sub>J</sub> < 85°C V <sub>LINx</sub> = V <sub>BB</sub>		10	30	μA
V <sub>LIN</sub>	LIN Bus Voltage	-45		45	V
V <sub>Dig_IO</sub>	Operating DC Voltage on Digital IO Pins (EN, RxD1-4, TxD1-4)	0		5.5	V
T <sub>J</sub>	Junction Thermal Shutdown Temperature	150	165	185	°C
T <sub>amb</sub>	Operating Ambient Temperature	-40		125	°C
V <sub>ESD</sub>	Electrostatic Discharge Voltage (all pins) Human Body Model (Note 2) Conform to EIA-JESD22-A114-B	-4		4	kV
	Electrostatic Discharge Voltage (LIN) System Human Body Model (Note 3) Conform to EIC 61000-4-2	-10		10	kV

- Below 5 V on V<sub>BB</sub> in normal mode, the bus will either stay recessive or comply with the voltage level specifications and transition time specifications as required by SAE J2602. It is ensured by the battery monitoring circuit. Above 27 V on V<sub>BB</sub>, LIN communication is operational (LIN pin toggling) but parameters cannot be guaranteed. For higher battery voltage operation above 27 V, LIN pull-up resistor must be selected large enough to avoid clamping of LIN pin by voltage drop over external pull-up resistor and LIN pin min current limitation.
- Equivalent to discharging a 100 pF capacitor through a 1.5 kΩ resistor.
- Equivalent to discharging a 150 pF capacitor through a 330 Ω resistor. System HBM levels are verified by an external test-house.

**Table 2. PIN FUNCTION DESCRIPTION**

Pin	Name	Description
1	TxD4	Transmit Data Input, Low for Dominant State; Pull-up to internal supply guaranteed above pin input threshold
2	RxD3	Receive Data Output; Low in Dominant State
3	TxD3	Transmit Data Input, Low for Dominant State; Pull-up to internal supply guaranteed above pin input threshold
4	RxD1	Receive Data Output; Low in Dominant State
5	EN	Enable Input, Transceiver in Normal Operation Mode when High, Pull-down Resistor to GND
6	TxD2	Transmit Data Input, Low for Dominant State; Pull-up to internal supply guaranteed above pin input threshold
7	TxD1	Transmit Data Input, Low for Dominant State; Pull-up to internal supply guaranteed above pin input threshold
8	RxD2	Receive Data Output; Low in Dominant State
9	LIN2	LIN Bus Output/Input
10	GND	Ground
11	LIN1	LIN Bus Output/Input
12	V <sub>BB</sub>	Battery Supply Input
13	LIN3	LIN Bus Output/Input
14	GND	Ground
15	LIN4	LIN Bus Output/Input
16	RxD4	Receive Data Output; Low in Dominant State

# NCV7424

## TYPICAL APPLICATION

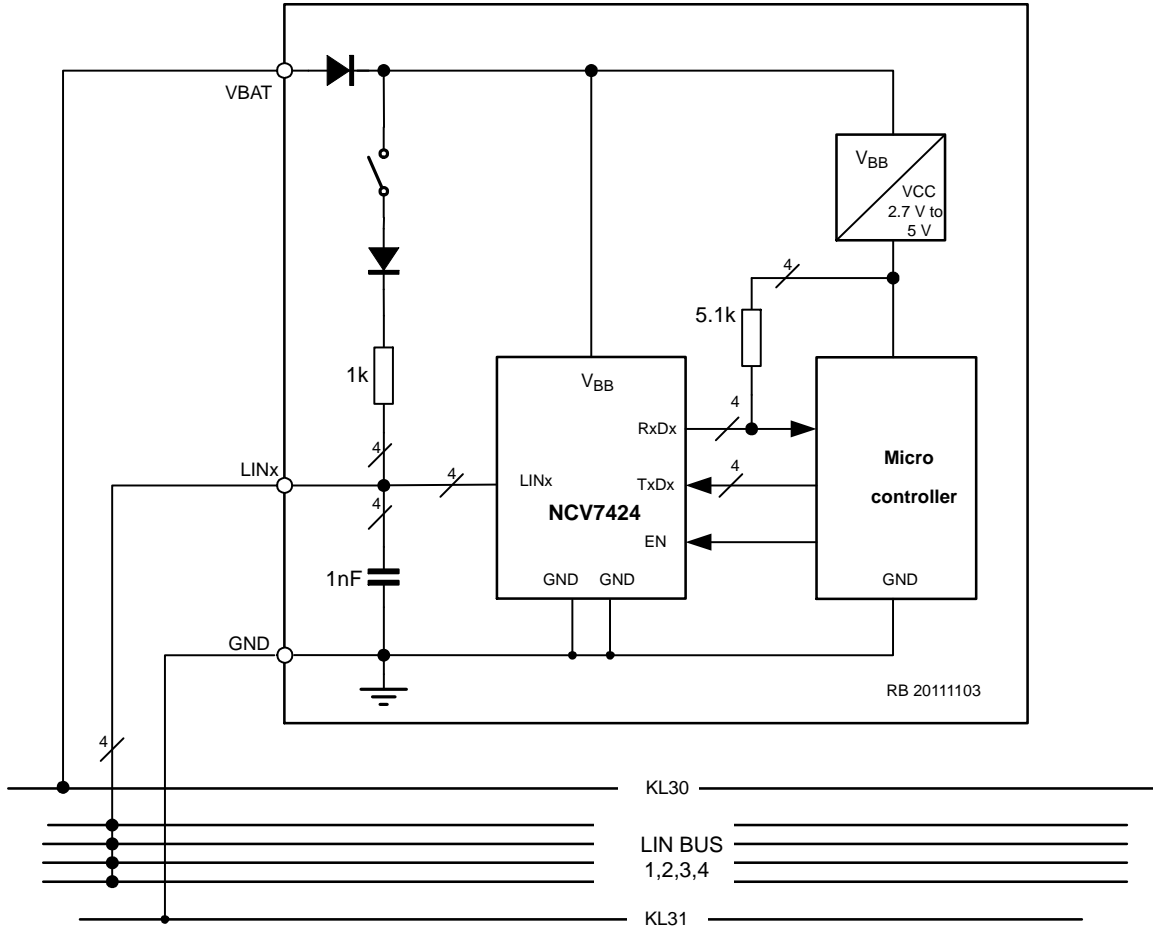


Figure 2. Application Diagram, Four LIN Master Nodes

Table 3. ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Min	Typ	Max	Unit
V <sub>BB</sub>	Voltage on Pin V <sub>BB</sub>	-0.3		45	V
V <sub>LINx</sub>	LINx Bus Voltage (LIN1-4)	-45		45	V
V <sub>Dig_IO</sub>	DC Input Voltage on Pins (EN, RxD1-4, TxD1-4)	-0.3		7	V
T <sub>J</sub>	Maximum Junction Temperature	-40		150	°C
V <sub>ESD</sub>	HBM (All Pins) (Note 4) Conform to EIA-JESD22-A114-B	-4		4	kV
	CDM (All Pins) According to ESD STM 5.3.1-1999	-750		750	V
	HBM (LINx and V <sub>BB</sub> ) (Note 4)	-8		8	kV
	System HBM (LINx and V <sub>BB</sub> ) (Note 5) Conform to EIC 61000-4-2	-10		10	kV

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.

4. Equivalent to discharging a 100 pF capacitor through a 1.5 kΩ resistor.

5. Equivalent to discharging a 150 pF capacitor through a 330 Ω resistor. System HBM levels are verified by an external test-house.

Table 4. THERMAL CHARACTERISTICS

Symbol	Parameter	Conditions	Value	Unit
R <sub>θJA_1</sub>	Thermal Resistance Junction-to-Air, JESD51-3 1S0P PCB	Free air	128	K/W
R <sub>θJA_2</sub>	Thermal Resistance Junction-to-Air, JESD51-7 2S2P PCB	Free air	72	K/W

## FUNCTIONAL DESCRIPTION

### Overall Functional Description

LIN is a serial communication protocol that efficiently supports the control of mechatronic nodes in distributed automotive applications. The domain is class-A multiplex buses with a single master node and a set of slave nodes.

The NCV7424 contains four independent LIN transmitters, LIN receivers plus common battery monitoring, power-on-reset (POR) circuits and thermal shutdown (TSD). The used LIN transmitter is optimized for the maximum specified transmission speed of 20 kbps with

excellent EMC performance due to reduced slew rate of the LIN outputs.

The junction temperature is monitored via a thermal shutdown circuit that switches the LIN transmitters off when temperature exceeds the TSD trigger level.

The NCV7424 has four operating states (unpowered mode, standby mode, normal mode and sleep mode) that are determined by the supply voltage  $V_{BB}$ , input signals EN and activity on the LIN bus. The operating states and principal transitions between them are depicted in Figure 3.

## OPERATING STATES

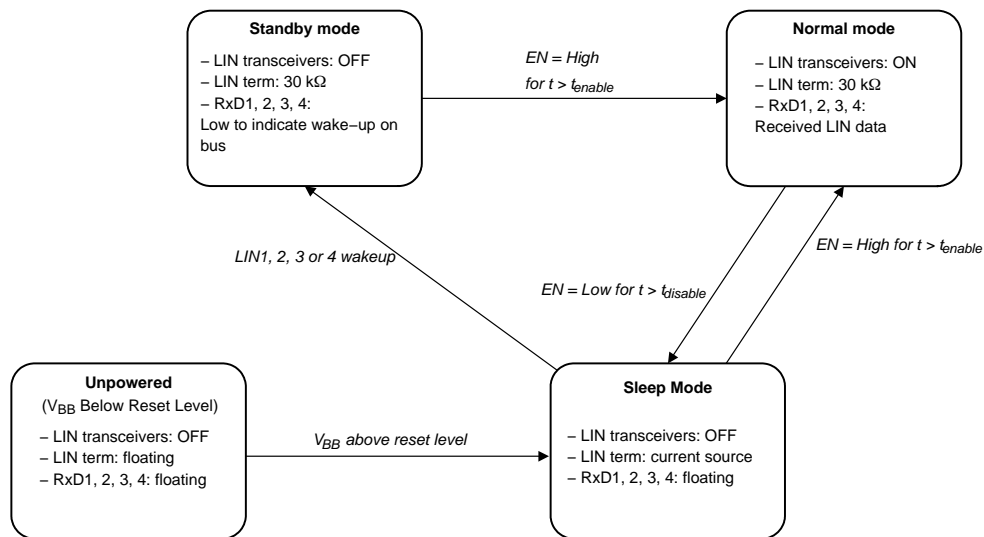


Figure 3. State Diagram

### Unpowered Mode

As long as  $V_{BB}$  remains below its power-on-reset level, the chip is kept in a safe unpowered state. LIN transmitters are inactive, LINx pins are left floating. Pins RxDx remain floating.

The unpowered state will be entered from any other state when  $V_{BB}$  falls below its power-on-reset level.

### Standby Mode

Standby mode is a low-power mode, where the LIN transceivers remain inactive. A 30 kΩ resistor in series with a reverse-protection diode is internally connected between individual LIN pins and pin  $V_{BB}$ . Standby mode is entered after a wake-up event is recognized while the chip was in the

sleep mode, the RxD1,2,3 or 4 pin is pulled low depending on which of the respective pins LIN1,2,3 or 4 the valid LIN wake-up occurred. While staying in standby mode, wake-up signaling by RxDx pins on each LIN channel is fully functional. This is also in case if wake event(s) started in sleep mode but actual transition from sleep to standby was caused by preceding wake-up event on other LIN channel.

### Normal Mode

In normal mode, the full functionality of the LIN transceivers is available. Data are sent to the LINx bus according to the state of TxDx inputs and RxDx pins reflect the logical symbol received on the LINx bus – high-impedant for recessive and Low level for dominant.

A 30 k $\Omega$  resistor in series with a reverse-protection diode is internally connected between LIN and V<sub>BB</sub> pins.

To avoid that, due to a failure of the application (e.g. software error, a short to ground, etc.), the LIN bus is permanently driven dominant and thus blocking all subsequent communication, the signal on each TxDx pin passes through an independent timer per LIN channel, which releases the bus in case TxDx remains

Low for longer than t<sub>TxD\_timeout</sub>. The transmission can continue once the TxDx returns to High logical level. This is independent on each channel, means permanent dominant on one channel is not blocking the other channels from communication.

In case the junction temperature increases above the thermal shutdown threshold, e.g. due to a short of the LIN wiring to the battery and high ambient temperature, all four transmitters are disabled and LIN buses are kept in recessive state independently of TxDx inputs. RxDx pins are kept Low during thermal shutdown.

Once the junction temperature decreases below the thermal shutdown release level, the transmission is enabled again. RxD pins are released from asserted thermal shutdown low level immediately when chip is below thermal shutdown threshold.

As required by SAE J2602, the transceiver behaves safely below its operating range – it either continues to transmit correctly (according to its specification) or remains silent (transmits a recessive state regardless of the TxDx signal). A battery monitoring circuit in NCV7424 deactivates the transmitter in normal mode if the V<sub>BB</sub> level drops below MONL\_VBB. Transmission is enabled again when V<sub>BB</sub> reaches MONH\_VBB. The internal logic remains in 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 is ensured by the implementation that the monitoring level never falls below the power-on-reset level.

Normal mode can be entered from either standby or sleep mode when EN Pin is High for longer than t<sub>enable</sub>. When the transition is made from standby mode, RxDx is put high-impedant immediately after EN becomes High (before the expiration of t<sub>enable</sub> filtering time). Transmission on each LINx channel is only possible for particular TxDx pin starting from High to Low level (if TxDx pin is Low when entering Normal mode, transmission is not enabled).

### Sleep Mode

Sleep mode provides extremely low current consumption. The LIN transceiver is inactive and the battery consumption is minimized. Only a weak pull-up current source is internally connected between LIN and V<sub>BB</sub> pins, in order to minimize current consumption even in case of LIN short to GND.

Sleep mode can be entered:

- After the voltage level at V<sub>BB</sub> pin rises above its power-on-reset level. RxDx pins are set high-impedant after start-up
- From normal mode by assigning a Low logical level to pin EN for longer than t<sub>disable</sub>. The sleep mode can be entered even if a permanent short occurs on the LINx Pin.

If a wake-up event occurs during the transition between normal and sleep mode (during the t<sub>disable</sub> filtering time), it will be regarded as a valid wake-up and the chip will enter standby mode with the appropriate setting of pins RxDx.

### LIN Wake-up

Remote (or LIN) wake-up can be recognized on all LINx pins on NCV7424 when LINx bus is externally driven dominant for longer than t<sub>LIN\_wake</sub> and a rising edge on LIN occurs afterwards – see Figure 4. Wake-up events can be exclusively detected in sleep mode or during the transition from normal mode to sleep mode. Due to timing tolerances, valid wake-up events beginning shortly before normal-to-sleep mode transition can be also sometimes regarded as valid wake-ups.

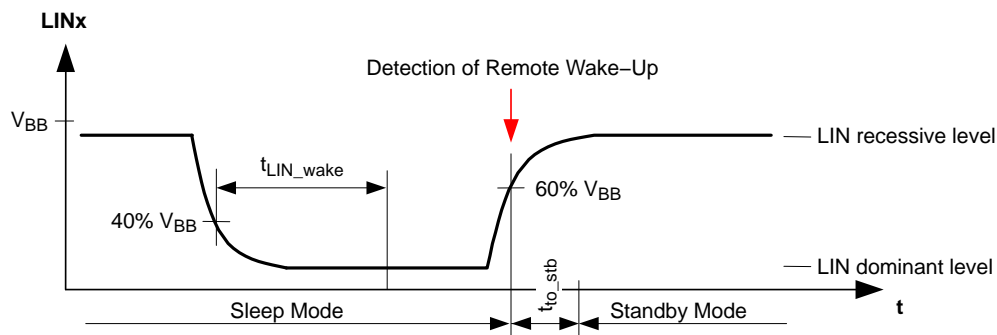


Figure 4. LIN Bus Wake-up Detection

## ELECTRICAL CHARACTERISTICS

## Definitions

All voltages are referenced to GND (Pins 10, 14. These pins are electrically connected inside of the package). Positive currents flow into the IC.

**Table 5. DC CHARACTERISTICS** ( $V_{BB} = 5\text{ V to }27\text{ V}$ ;  $T_J = -40^\circ\text{C to }+150^\circ\text{C}$ ;  $R_{L(LIN-V_{BB})} = 500\ \Omega$ , unless otherwise specified. Typical values are given at  $V(V_{BB}) = 12\text{ V}$  and  $T_J = 25^\circ\text{C}$ , unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
--------	-----------	------------	-----	-----	-----	------

## CURRENT CONSUMPTION

$I_{BB\_ON\_rec}$	$V_{BB}$ Consumption	Normal Mode; LIN Recessive $V_{LINx} = V_{BB}$		2.3	4.7	mA
$I_{BB\_ON\_dom}$	$V_{BB}$ Consumption	Normal Mode; LIN Dominant $TxDx = \text{Low}$		16.5	28	mA
$I_{BB\_STB}$	$V_{BB}$ Consumption	Standby Mode $V_{LINx} = V_{BB}$		0.22	0.45	mA
$I_{BB\_SLP}$	$V_{BB}$ Consumption	Sleep Mode $V_{LINx} = V_{BB}$		11	35	$\mu\text{A}$
$I_{BB\_SLP\_18V}$	$V_{BB}$ Consumption	Sleep Mode, $V_{BB} < 18\text{ V}$ $V_{LINx} = V_{BB}$		10	33	$\mu\text{A}$
$I_{BB\_SLP\_12V}$	$V_{BB}$ Consumption	Sleep Mode, $V_{BB} = 12\text{ V}$ , $T_J < 85^\circ\text{C}$ $V_{LINx} = V_{BB}$		9	30	$\mu\text{A}$

POR AND  $V_{BB}$  MONITOR

$PORH\_V_{BB}$	Power-on Reset High Level on $V_{BB}$	$V_{BB}$ Rising	2	3.3	4.5	V
$PORL\_V_{BB}$	Power-on Reset Low Level on $V_{BB}$	$V_{BB}$ Falling	1.7	2.9	4	V
$MONH\_V_{BB}$	Battery Monitoring High Level	$V_{BB}$ Rising		4.1	4.5	V
$MONL\_V_{BB}$	Battery Monitoring Low Level	$V_{BB}$ Falling	3	4		V

## LIN TRANSMITTERS

$V_{LINx\_dom\_LoSup}$	LINx Dominant Output Voltage	$TxDx = \text{Low}$ ; $V_{BB} = 7.3\text{ V}$		1	1.2	V
$V_{LINx\_dom\_HiSup}$	LINx Dominant Output Voltage	$TxDx = \text{Low}$ ; $V_{BB} = 18\text{ V}$		1.4	2.0	V
$V_{LINx\_REC}$	LIN Recessive Output Voltage	$TxDx = \text{High}$ ; $I_{LIN} = 10\ \mu\text{A}$ (Note 6)	$V_{BB} - 1.5$		$V_{BB}$	V
$I_{LINx\_lim}$	Short Circuit Current Limitation	$V_{LINx} = V_{BB} = 18\text{ V}$ ; $TxDx = \text{Low}$	70	140	200	mA
$RLINx_{slave}$	Internal Pull-up Resistance		20	33	47	$k\Omega$

## LIN RECEIVERS

$V_{LINx\_bus\_dom}$	Bus Voltage for Dominant State				0.4	$V_{BB}$
$V_{LINx\_bus\_rec}$	Bus Voltage for Recessive State		0.6			$V_{BB}$
$V_{LINx\_rec\_dom}$	Receiver Threshold	LIN Bus Recessive – Dominant	0.4	0.45	0.6	$V_{BB}$
$V_{LINx\_rec\_rec}$	Receiver Threshold	LIN Bus Dominant – Recessive	0.4	0.55	0.6	$V_{BB}$

6. The voltage drop in Normal mode between LIN and  $V_{BB}$  pin is the sum of the diode drop and the drop at serial pull-up resistor. The drop at the switch is negligible. See Figure 1.



**Table 5. DC CHARACTERISTICS** ( $V_{BB} = 5\text{ V to }27\text{ V}$ ;  $T_J = -40^\circ\text{C to }+150^\circ\text{C}$ ;  $R_{L(LIN-VBB)} = 500\ \Omega$ , unless otherwise specified. Typical values are given at  $V(V_{BB}) = 12\text{ V}$  and  $T_J = 25^\circ\text{C}$ , unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>LIN RECEIVERS</b>						
VLINx_rec_cnt	Receiver Centre Voltage	$(V_{LINx\_rec\_dom} + V_{LINx\_rec\_rec}) / 2$	0.475	0.5	0.525	$V_{BB}$
VLINx_rec_hys	Receiver Hysteresis	$(V_{LINx\_rec\_rec} - V_{LINx\_rec\_dom})$	0.05	0.1	0.175	$V_{BB}$
ILINx_off_dom	LIN Output Current, Bus externally driven to dominant state	Normal Mode, Driver Off; $V_{BB} = 12\text{ V}$ ; TxDx = High; $V_{LINx} = 0\text{ V}$	-1	-0.37	-0.2	mA
ILINx_off_dom_slp	LIN Output Current, Bus externally driven to dominant state	Sleep Mode, Driver Off; $V_{BB} = 12\text{ V}$ ; TxDx = High; $V_{LINx} = 0\text{ V}$	-20	-8	-2	$\mu\text{A}$
ILINx_off_rec	LIN Output Current, Bus in Recessive State	Driver Off; $V_{BB} < 18\text{ V}$ ; $V_{BB} < V_{LINx} < 18\text{ V}$			2	$\mu\text{A}$
ILINx_no_GND	Communication not Affected	$V_{BB} = \text{GND} = 12\text{ V}$ ; $0 < V_{LINx} < 18\text{ V}$	-1		1	mA
ILINx_no_VBB	LIN Bus Remains Operational	$V_{BB} = \text{GND} = 0\text{ V}$ ; $0 < V_{LINx} < 18\text{ V}$		0	5	$\mu\text{A}$
C <sub>LINx</sub>	Capacitance on LINx pin	Not tested in production, guaranteed by design		20	30	pF
<b>PIN EN</b>						
Vil_EN	Low Level Input Voltage		-0.3		0.8	V
Vih_EN	High Level Input Voltage		2.0		5.5	V
Rpd_EN	Pull-down Resistance to Ground		150	350	650	k $\Omega$
<b>PIN RxDx</b>						
Iol_RxDx	Low Level Output Current	$V_{RxD} = 0.4\text{ V}$ , Normal Mode, $V_{LINx} = 0\text{ V}$	1.5	4.3		mA
Ioh_RxDx	High Level Output Current	$V_{RxD} = 5\text{ V}$ , Normal Mode, $V_{LINx} = V_{BB}$	-5	0	5	$\mu\text{A}$
<b>PIN TxDx</b>						
Vil_TxDx	Low Level Input Voltage		-0.3		0.8	V
Vih_TxDx	High Level Input Voltage		2.0		5.5	V
Rpd_TxDx	Pull-up on TxDx Pins		60	100	150	k $\Omega$
<b>THERMAL SHUTDOWN</b>						
T <sub>JSD</sub>	Thermal Shutdown Junction Temperature	Temperature Rising	150	165	185	$^\circ\text{C}$
T <sub>JSD_HYST</sub>	Thermal Shutdown Hysteresis			5		$^\circ\text{C}$

6. The voltage drop in Normal mode between LIN and  $V_{BB}$  pin is the sum of the diode drop and the drop at serial pull-up resistor. The drop at the switch is negligible. See Figure 1.

**Table 6. AC CHARACTERISTICS** ( $V_{BB} = 5\text{ V to }27\text{ V}$ ;  $T_J = -40^\circ\text{C to }+150^\circ\text{C}$ ;  $R_{L(LIN-V_{BB})} = 500\ \Omega$ , unless otherwise specified.  
For the transmitter parameters, the following bus loads are considered:  $L1 = 1\text{ k}\Omega / 1\text{ nF}$ ;  $L2 = 660\ \Omega / 6.8\text{ nF}$ ;  $L3 = 500\ \Omega / 10\text{ nF}$

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>LIN TRANSMITTER</b>						
D1	Duty Cycle 1 = $t_{BUS\_REC(min)} / (2 \times t_{BIT})$	$TH_{REC(max)} = 0.744 \times V_{BB}$ $TH_{DOM(max)} = 0.581 \times V_{BB}$ $t_{BIT} = 50\ \mu\text{s}$ $V(V_{BB}) = 7\text{ V to }18\text{ V}$	0.396		0.5	
D2	Duty Cycle 2 = $t_{BUS\_REC(max)} / (2 \times t_{BIT})$	$TH_{REC(min)} = 0.422 \times V_{BB}$ $TH_{DOM(min)} = 0.284 \times V_{BB}$ $t_{BIT} = 50\ \mu\text{s}$ $V(V_{BB}) = 7.6\text{ V to }18\text{ V}$	0.5		0.581	
D3	Duty Cycle 3 = $t_{BUS\_REC(min)} / (2 \times t_{BIT})$	$TH_{REC(max)} = 0.778 \times V_{BB}$ $TH_{DOM(max)} = 0.616 \times V_{BB}$ $t_{BIT} = 96\ \mu\text{s}$ $V(V_{BB}) = 7\text{ V to }18\text{ V}$	0.417		0.5	
D4	Duty Cycle 4 = $t_{BUS\_REC(max)} / (2 \times t_{BIT})$	$TH_{REC(min)} = 0.389 \times V_{BB}$ $TH_{DOM(min)} = 0.251 \times V_{BB}$ $t_{BIT} = 96\ \mu\text{s}$ $V(V_{BB}) = 7.6\text{ V to }18\text{ V}$	0.5		0.590	
D1e	Duty Cycle 1 = $t_{BUS\_REC(min)} / (2 \times t_{BIT})$	$TH_{REC(max)} = 0.744 \times V_{BB}$ $TH_{DOM(max)} = 0.581 \times V_{BB}$ $t_{BIT} = 50\ \mu\text{s}$ $V(V_{BB}) = 5\text{ V to }40\text{ V}$ , (Notes 7 and 8)	0.39		0.5	
D2e	Duty Cycle 2 = $t_{BUS\_REC(max)} / (2 \times t_{BIT})$	$TH_{REC(min)} = 0.422 \times V_{BB}$ $TH_{DOM(min)} = 0.284 \times V_{BB}$ $t_{BIT} = 50\ \mu\text{s}$ $V(V_{BB}) = 5\text{ V to }40\text{ V}$ , (Notes 7 and 8)	0.5		0.59	
D3e	Duty Cycle 3 = $t_{BUS\_REC(min)} / (2 \times t_{BIT})$	$TH_{REC(max)} = 0.778 \times V_{BB}$ $TH_{DOM(max)} = 0.616 \times V_{BB}$ $t_{BIT} = 96\ \mu\text{s}$ $V(V_{BB}) = 5\text{ V to }40\text{ V}$ , (Notes 7 and 8)	0.41		0.5	
D4e	Duty Cycle 4 = $t_{BUS\_REC(max)} / (2 \times t_{BIT})$	$TH_{REC(min)} = 0.389 \times V_{BB}$ $TH_{DOM(min)} = 0.251 \times V_{BB}$ $t_{BIT} = 96\ \mu\text{s}$ $V(V_{BB}) = 5\text{ V to }40\text{ V}$ , (Notes 7 and 8)	0.5		0.6	
$t_{tx\_prop\_down\_x}$	Propagation Delay of Tx Dx to LINx. Tx D High to Low		1.3	4.2	10	$\mu\text{s}$
$t_{tx\_prop\_up\_x}$	Propagation Delay of Tx Dx to LINx. Tx D Low to High		1.3	4.6	10	$\mu\text{s}$
$t_{tx\_sym\_x}$	Propagation Delay Symmetry	$t_{tx\_prop\_down\_x} - t_{tx\_prop\_up\_x}$	-2.5	-0.4	2.5	$\mu\text{s}$
$t_{fall}$	LINx Falling Edge	Normal Mode; $V_{BB} = 12\text{ V}$		9	22.5	$\mu\text{s}$
$t_{rise}$	LINx Rising Edge	Normal Mode; $V_{BB} = 12\text{ V}$		10	22.5	$\mu\text{s}$
$t_{sym}$	LINx Slope Symmetry	Normal Mode; $V_{BB} = 12\text{ V}$	-4	0	4	$\mu\text{s}$

**LIN RECEIVERS**

$t_{rec\_prop\_down\_x}$	Propagation Delay of LINx to Rx Dx Receiver Falling Edge		0.1	1.6	6	$\mu\text{s}$
$t_{rec\_prop\_up\_x}$	Propagation Delay of LINx to Rx Dx Receiver Rising Edge		0.1	1.35	6	$\mu\text{s}$
$t_{rec\_sym\_x}$	Propagation Delay Symmetry	$t_{rec\_prop\_down\_x} - t_{rec\_prop\_up\_x}$	-2	0.25	2	$\mu\text{s}$

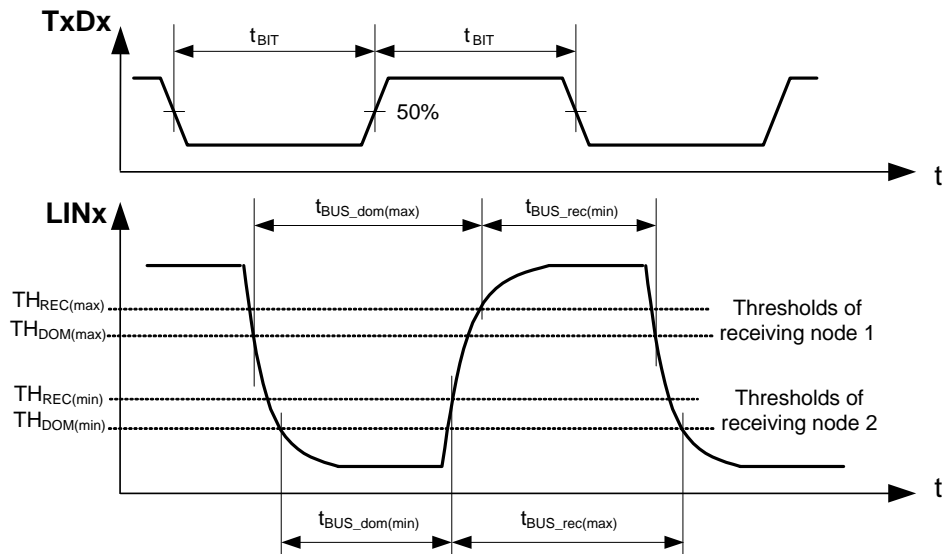
7. The external pull-up resistor for duty cycles on  $V(V_{BB}) = 40\text{ V}$  is  $1\text{ k}\Omega$

8. Not tested in production Extended battery range (5 V; 40 V) is tested on limited sample base only

**Table 6. AC CHARACTERISTICS** ( $V_{BB} = 5\text{ V}$  to  $27\text{ V}$ ;  $T_J = -40^\circ\text{C}$  to  $+150^\circ\text{C}$ ;  $R_{L(LIN-VBB)} = 500\ \Omega$ , unless otherwise specified.  
For the transmitter parameters, the following bus loads are considered: L1 =  $1\text{ k}\Omega / 1\text{ nF}$ ; L2 =  $660\ \Omega / 6.8\text{ nF}$ ; L3 =  $500\ \Omega / 10\text{ nF}$

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>MODE TRANSITIONS AND TIMEOUTS</b>						
$t_{LINx\_wake}$	Duration of LINx Dominant for Detection of Wake-up via LINx bus	Sleep Mode	30	90	150	$\mu\text{s}$
$t_{to\_stb}$	Delay from LIN Bus Dominant to Recessive Edge to Entering of Standby Mode after Valid LIN Wake-up	See Figure 4	2	2.8	18.5	$\mu\text{s}$
$t_{enable}$	Duration of High Level on EN Pin for Transition to Normal Mode		2	18	47	$\mu\text{s}$
$t_{disable}$	Duration of Low Level on EN Pin for Transition to Sleep Mode		2	7.5	18.5	$\mu\text{s}$
$t_{TxD\_timeout}$	TxD Dominant Timeout	Normal Mode, TxD = Low, Guarantees Baudrate as Low as 1 kbps	15	28	50	ms

7. The external pull-up resistor for duty cycles on  $V(V_{BB}) = 40\text{ V}$  is  $1\text{ k}\Omega$   
8. Not tested in production Extended battery range ( $5\text{ V}$ ;  $40\text{ V}$ ) is tested on limited sample base only



**Figure 5. LINx Bus Transmitter Duty Cycle**

# NCV7424

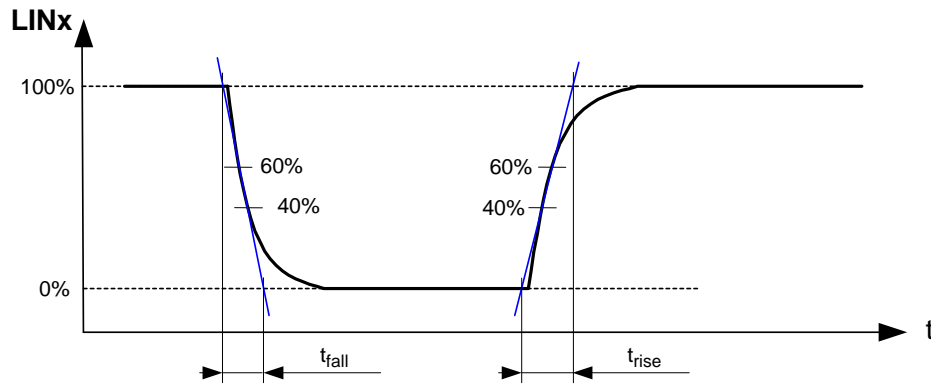


Figure 6. LINx Bus Transmitter Rising and Falling Times

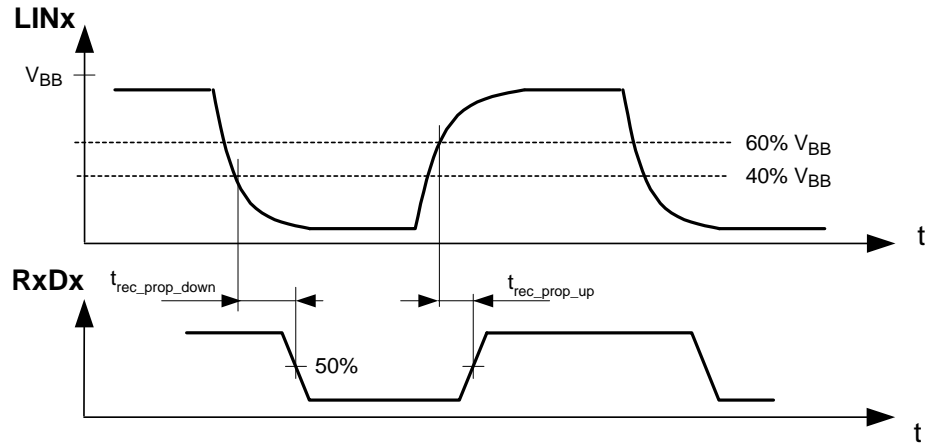


Figure 7. LINx Bus Receiver Timing

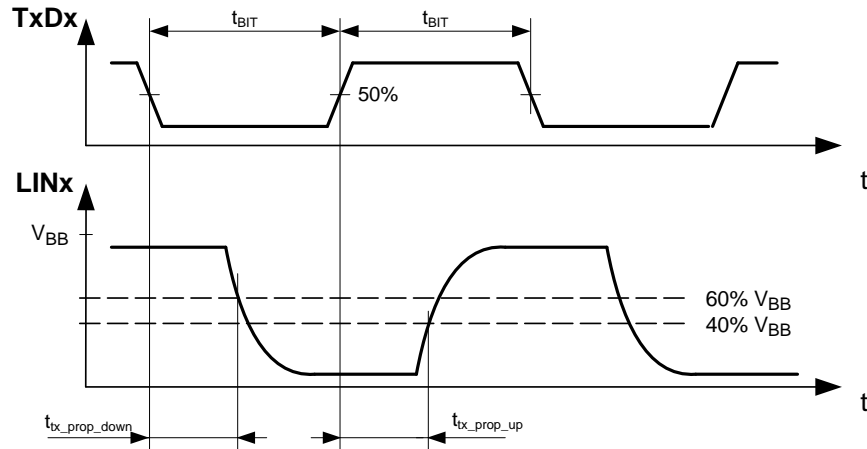


Figure 8. LINx Transmitter Timing

## ORDERING INFORMATION

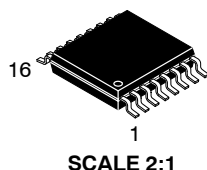
Part Number	Description	Temperature Range	Package	Shipping†
NCV7424DB0R2G	Quad LIN Transceiver	-40°C to +125°C	TSSOP-16 (Pb-Free)	2500 / Tape & Reel

†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.

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

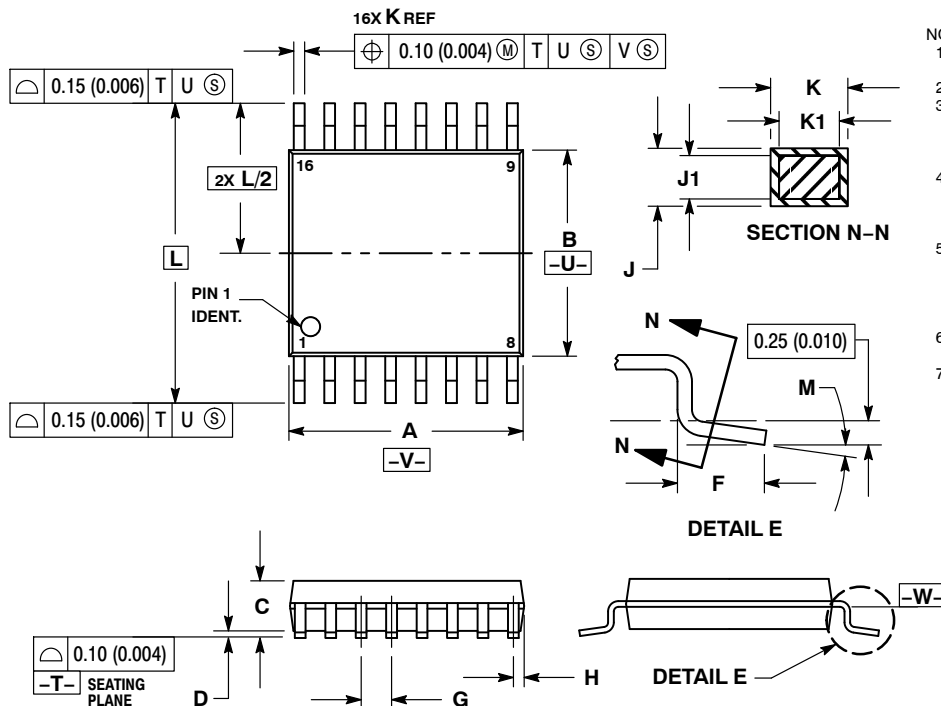
ON Semiconductor®

ON

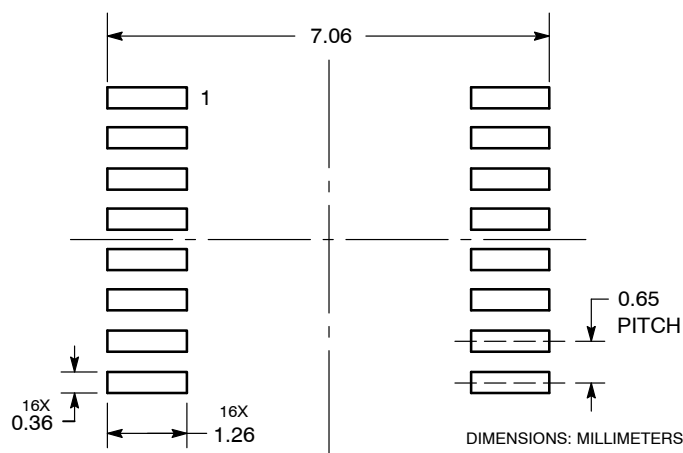


**TSSOP-16**  
CASE 948F-01  
ISSUE B

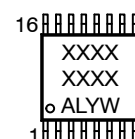
DATE 19 OCT 2006



## SOLDERING FOOTPRINT



## GENERIC MARKING DIAGRAM\*




XXXX = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
G or ■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present.

DOCUMENT NUMBER:	98ASH70247A	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	TSSOP-16	PAGE 1 OF 1

ON Semiconductor and are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. ON Semiconductor does not convey any license under its patent rights nor the rights of others.

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Email Requests to: [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

ON Semiconductor Website: [www.onsemi.com](http://www.onsemi.com)

### TECHNICAL SUPPORT

#### North American Technical Support:

Voice Mail: 1 800-282-9855 Toll Free USA/Canada

Phone: 011 421 33 790 2910

#### Europe, Middle East and Africa Technical Support:

Phone: 00421 33 790 2910

For additional information, please contact your local Sales Representative

