SN65LBC174, SN75LBC174 Quadruple Low-power Differential Line Drivers

1 Features

- Meets or exceeds the standard EIA-485
- Designed for high-speed multipoint transmission on long bus lines in noisy environments
- Supports data rates up to and exceeding ten million transfers per second
- Common-mode output voltage range of –7V to 12V
- Positive- and negative-current limiting
- Low Power Consumption: 1.5mA Max (output disabled)
- Functionally interchangeable with SN75174

2 Applications

- Chemical and gas sensors
- Field transmitters: temperature sensors and pressure sensors
- Motor drives: brushless DC and brushed DC
- Temperature sensors and controllers using modbus

3 Description

The SN65LBC174 and SN75LBC174 are monolithic, quadruple, differential line drivers with 3-state outputs. Both devices are designed to meet the requirements of the Electronics Industry Association Standard EIA-485. These devices are optimized for balanced multipoint bus transmission at data rates up to and exceeding 10 million bits per second. Each driver features wide positive and negative common-mode output voltage ranges, current limiting, and thermal-shutdown protection, making it suitable for party-line applications in noisy environments. Both devices are designed using LinBiCMOS™, facilitating ultralow power consumption and inherent robustness.

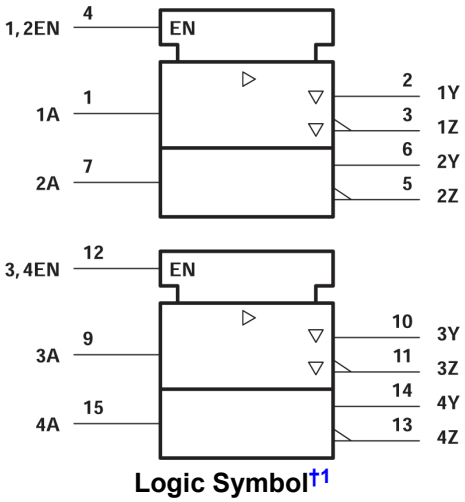
Both the SN65LBC174 and SN75LBC174 provide positive- and negative-current limiting and thermal shutdown for protection from line fault conditions on the transmission bus line. These devices offer optimum performance when used with the SN75LBC173 or SN75LBC175 quadruple line receivers. The SN65LBC174 and SN75LBC174 are available in the 16-terminal DIP package (N) and the 20-terminal wide-body small outline integrated circuit (SOIC) package (DW).

The SN75LBC174 is characterized for operation over the commercial temperature range of 0°C to 70°C. The SN65LBC174 is characterized over the industrial temperature range of –40°C to 85°C.

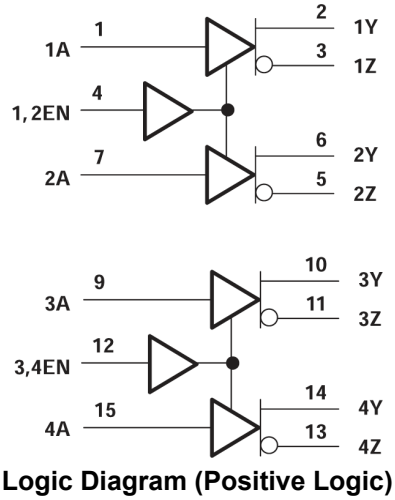
Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
SN65LBC174	DW	12.8mm × 10.3mm
	N	19.3mm × 9.4mm
SN75LBC174	DW	12.8mm × 10.3mm
	N	19.3mm × 9.4mm

(1) For more information, see Section 10.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.



Logic Symbol†1



Logic Diagram (Positive Logic)

† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
1 Pin numbers shown are for the N package.

Table of Contents

4 Pin Configuration and Functions

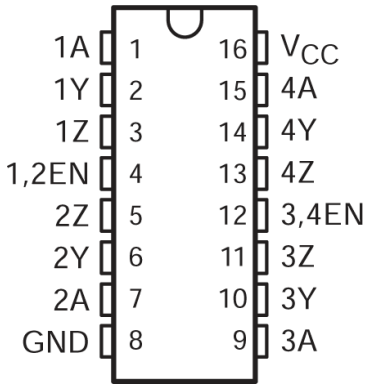
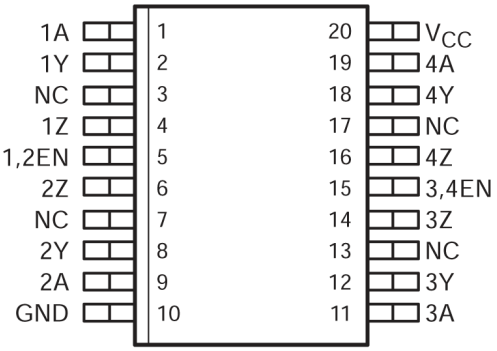


Figure 4-1. N Package (Top View)

Table 4-1. Pin Functions

PIN		TYPE[1]	DESCRIPTION
NAME	NO.		
1A	1	I	Driver 1 input
1Y	2	O	Driver 1 output
1Z	3	O	Driver 1 inverted output
1,2EN	4	I	Active high driver enable channel 1 and 2
2Z	5	O	Driver 2 inverted output
2Y	6	O	Driver 2 output
2A	7	I	Driver 2 input
GND	8	-	Ground pin
3A	9	I	Driver 3 input
3Y	10	O	Driver 3 output
3Z	11	O	Driver 3 inverted output
3,4EN	12	I	Active high driver enable channel 3 and 4
4Z	13	O	Driver 4 inverted output
4Y	14	O	Driver 4 output
4A	15	I	Driver 4 input
V_{CC}	16	–	Power pin

(1) Signal Types: I = Input, O = Output, I/O = Input or Output.



NC – No internal connection

Figure 4-2. DW Package (Top View)

Table 4-2. Pin Functions

PIN		TYPE(1)	DESCRIPTION
NAME	NO.		
1A	1	I	Driver 1 input
1Y	2	O	Driver 1 output
NC	3	-	No Internal Connection
1Z	4	O	Driver 1 inverted output
1,2EN	5	I	Active high driver enable channel 1 and 2
2Z	6	O	Driver2 inverted output
NC	7	-	No Internal Connection
2Y	8	O	Driver 2 output
2A	9	I	Driver 2 input
GND	10	–	Ground pin
3A	11	I	Driver 3 input
3Y	12	O	Driver 3 output
NC	13	–	No Internal Connection
3Z	14	O	Driver 3 inverted output
3,4EN	15	I	Active high driver enable channel 3 and 4
4Z	16	O	Driver 4 inverted output
NC	17	–	No Internal Connection
4Y	18	O	Driver 4 output
4A	19	I	Driver 4 input
V_{CC}	20	–	Power pin

(1) Signal Types: I = Input, O = Output, I/O = Input or Output.

5 Specifications

5.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V_{CC} (see Note 1)	Supply voltage range, see Note (2)		–0.3	7	V
V_O	Output voltage range		–10	15	V
V	Voltage range at A, 1/2EN, 3/4EN		–0.3	V_{CC} +0.5	V
P_D	Continuous total power dissipation		Internally limited(2)		
T_A	Operating free-air temperature range:	SN65LBC174	–40	85	°C
		SN75LBC174	0	70	°C
T_{stg}	Storage temperature range		–65	150	°C
T_{lead}	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds			260	°C

(1) Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The maximum operating junction temperature is internally limited. Use the Dissipation Rating Table to operate below this temperature.
NOTE 1: All voltage values are with respect to GND.

5.2 Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		4.75	5	5.25	V
High-level input voltage, V_{IH}		2			V
Low-level input voltage, V_{IL}				0.8	V
Voltage at any bus terminal (separately or common-mode), V_O	Y or Z			12	V
				–7	
High-level output current, I_{OH}	Y or Z			–60	mA
Low-level output current, I_{OL}	Y or Z			60	mA
Continuous total power dissipation		See Dissipation Rating Table			
Operating free-air temperature, T_A	SN65LBC174	–40		85	°C
	SN75LBC174	0		70	

5.3 Dissipation Rating Table

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING
DW	1125mW	9.0mW/°C	720mW	585mW
N	1150mW	9.2mW/°C	736mW	598mW

5.4 Thermal Information

THERMAL METRIC[1]		DW 20 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	66.8	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	34.4	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	39.7	°C/W
ψ_{JT}	Junction-to-top characterization parameter	8.9	°C/W
ψ_{JB}	Junction-to-board characterization parameter	39	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	n/a	°C/W

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

5.5 Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP[1]	MAX	UNIT
V_{IK}	Input clamp voltage	I_I = -18mA				-1.5	V
$\|V_{OD}\|$	Differential output voltage[2]	R_L = 54Ω, See Figure 6-1	SN65LBC174	1.1	1.8	5	
			SN75LBC174	1.5	1.8	5	V
		R_L = 60Ω, See Figure 6-2	SN65LBC174	1.1	1.7	5	
			SN75LBC174	1.5	1.7	5	
$\Delta\|V_{OD}\|$	Change in magnitude of common-mode output voltage[3]	R_L = 54Ω,	See Figure 6-1			±0.2	V
V_{OC}	Common-mode output voltage			-1		3	V
$\Delta\|V_{OC}\|$	Change in magnitude of common-mode output voltage[3]					±0.2	V
I_O	Output current with power off	V_{CC} = 0,	V_O = - 7V to 12V			± 100	µA
I_{OZ}	High-impedance-state output current	V_O = - 7V to 12V				± 100	µA
I_{IH}	High-level input current	V_I = 2.4V				-100	µA
I_{IL}	Low-level input current	V_I = 0.4V				-100	µA
I_{OS}	Short-circuit output current	V_O = -7V to 12V				±250	mA
I_{CC}	Supply current (all drivers)	No load	Outputs enabled			7	mA
			Outputs disabled			1.5	

(1) All typical values are at V_{CC} = 5V and T_A = 25°C.
(2) The minimum V_{OD} specification does not fully comply with EIA-485 at operating temperatures below 0°C. The lower output signal should be used to determine the maximum signal transmission distance.
(3) $\Delta|V_{OD}|$ and $\Delta|V_{OC}|$ are the changes in magnitude of V_{OD} and V_{OC}, respectively, that occur when the input is changed from a high level to a low level.

5.6 Switching Characteristics

V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$t_{d(OD)}$	Differential output delay time	R_L = 54Ω,	See Figure 6-3	2	11	20	ns
$t_{t(OD)}$	Differential output transition time			9	15	25	ns
t_{PZH}	Output enable time to high level	R_L = 110Ω,	See Figure 6-3		20	30	ns
t_{PZL}	Output enable time to low level	R_L = 110Ω,	See Figure 6-5		21	30	ns
t_{PHZ}	Output disable time from high level	R_L = 110Ω,	See Figure 6-4		48	70	ns
t_{PLZ}	Output disable time from low level	R_L = 110Ω,	See Figure 6-5		21	30	ns

5.7 Typical Characteristics

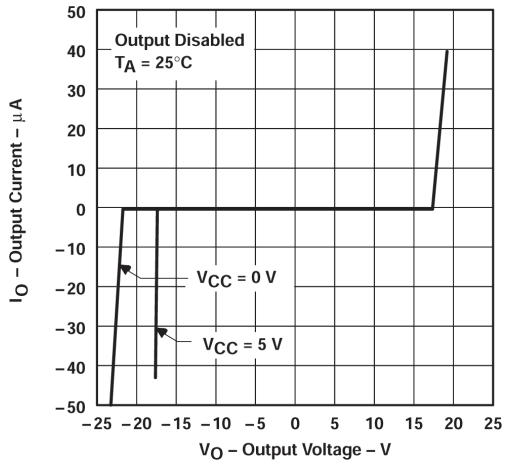


Figure 5-1. Output Current vs Output Voltage

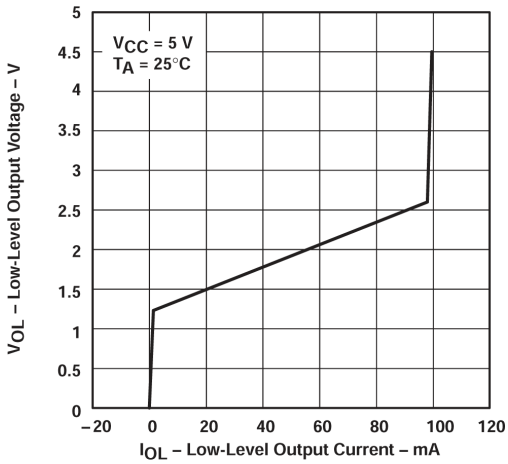


Figure 5-2. Low-level Output Voltage vs Low-level Output Current

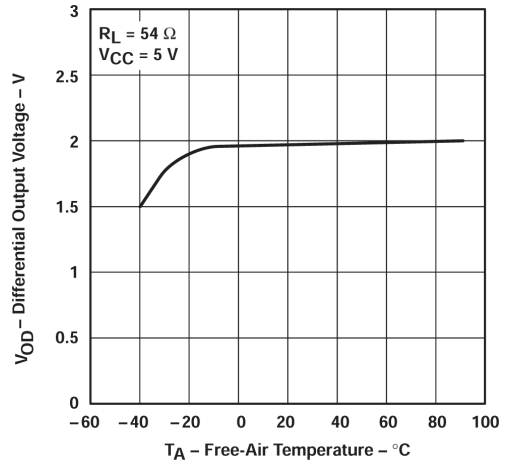


Figure 5-3. Differential Output Voltage vs Free-air Temperature

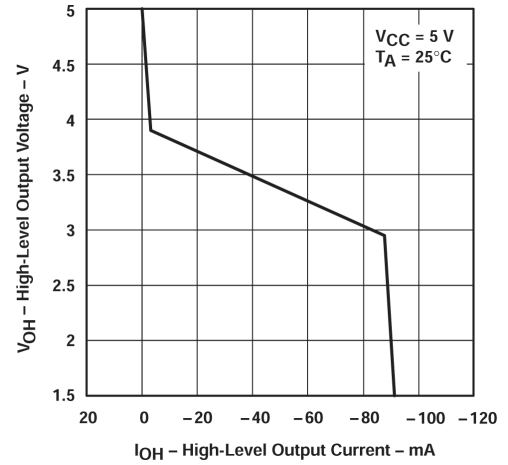


Figure 5-4. High-level Output Voltage vs High-level Output Current

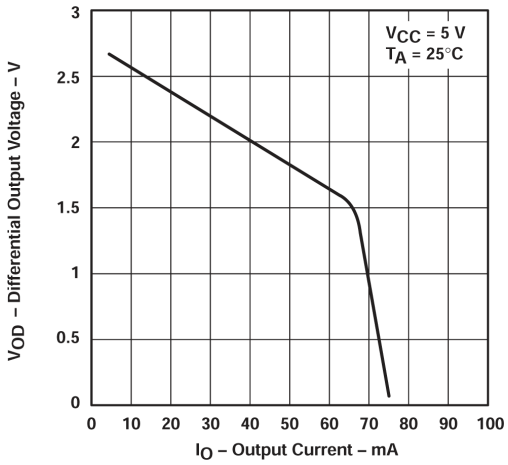


Figure 5-5. Differential Output Voltage vs Output Current

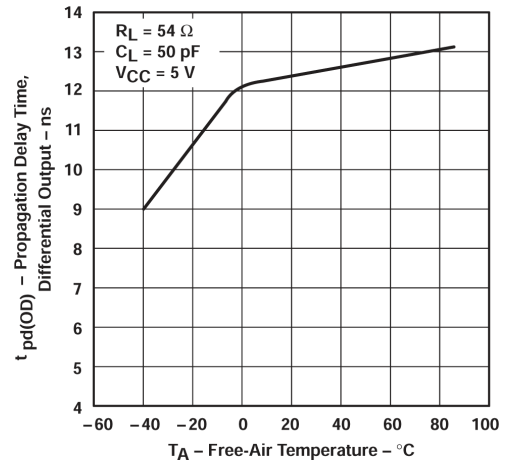


Figure 5-6. Propagation Delay Time, Differential Output vs Free-air Temperature

6 Parameter Measurement Information

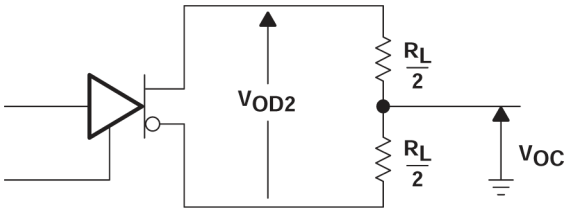


Figure 6-1. Differential and Common-Mode Output Voltages

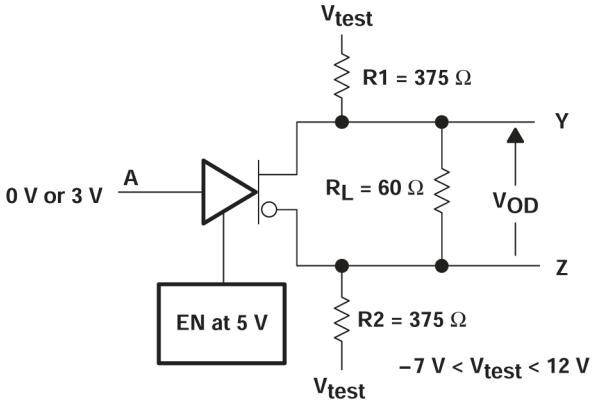
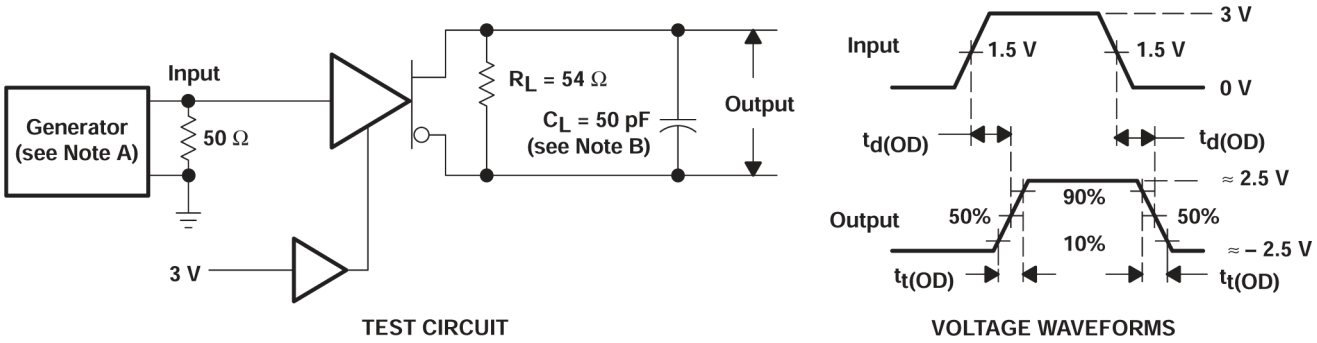


Figure 6-2. Driver V_{OD} Test Circuit



A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1MHz, duty cycle = 50%, t_r ≤ 5ns, t_f ≤ 5ns, Z_O = 50Ω.

B. C_L includes probe and stray capacitance.

Figure 6-3. Time Waveforms for Driver Differential Output Test Circuit Delay and Transition

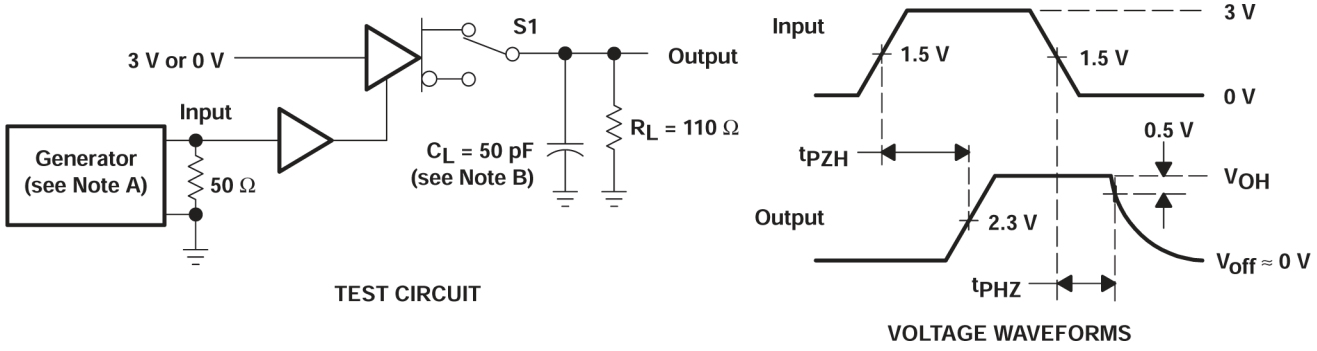
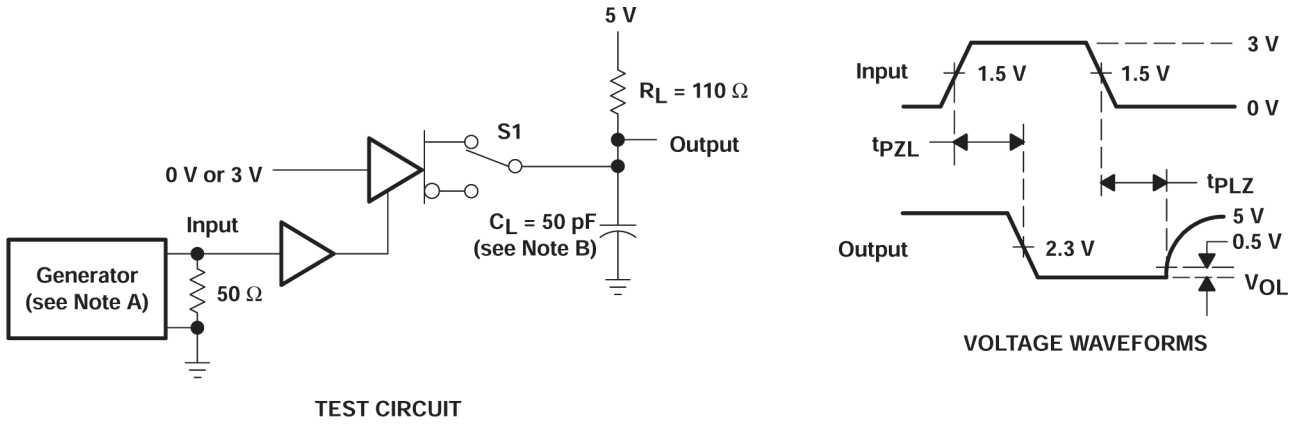


Figure 6-4. t_{PZH} and t_{PHZ} Test Circuit and Waveforms



A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1MHz, duty cycle = 50%, t_r ≤ 5ns, t_f ≤ 5ns, Z_O = 50Ω.

B. C_L includes probe and stray capacitance.

Figure 6-5. t_{PZL} and t_{PLZ} Test Circuit and Waveforms

7 Detailed Description

7.1 Thermal Characteristics of Ic Packages

Θ_{JA} (Junction-to-Ambient Thermal Resistance) is defined as the difference in junction temperature to ambient temperature divided by the operating power

Θ_{JA} is NOT a constant and is a strong function of

- the PCB design (50% variation)
- altitude (20% variation)
- device power (5% variation)

Θ_{JA} can be used to compare the thermal performance of packages if the specific test conditions are defined and used. Standardized testing includes specification of PCB construction, test chamber volume, sensor locations, and the thermal characteristics of holding fixtures. Θ_{JA} is often misused when it is used to calculate junction temperatures for other installations.

TI uses two test PCBs as defined by JEDEC specifications. The low-k board gives *average* in-use condition thermal performance and consists of a single trace layer 25mm long and 2-oz thick copper. The high-k board gives *best case* in−use condition and consists of two 1-oz buried power planes with a single trace layer 25 mm long with 2-oz thick copper. A 4% to 50% difference in Θ_{JA} can be measured between these two test cards

Θ_{JC} (Junction-to-Case Thermal Resistance) is defined as difference in junction temperature to case divided by the operating power. It is measured by putting the mounted package up against a copper block cold plate to force heat to flow from die, through the mold compound into the copper block.

Θ_{JC} is a useful thermal characteristic when a heatsink is applied to package. It is NOT a useful characteristic to predict junction temperature as it provides pessimistic numbers if the case temperature is measured in a non-standard system and junction temperatures are backed out. It can be used with Θ_{JB} in 1-dimensional thermal simulation of a package system.

Θ_{JB} (Junction-to-Board Thermal Resistance) is defined to be the difference in the junction temperature and the PCB temperature at the center of the package (closest to the die) when the PCB is clamped in a cold−plate structure. Θ_{JB} is only defined for the high-k test card.

Θ_{JB} provides an overall thermal resistance between the die and the PCB. Including a bit for the PCB thermal resistance (especially for BGAs with thermal balls), and can be used for simple 1-dimensional network analysis of package system (see Figure 7-1).

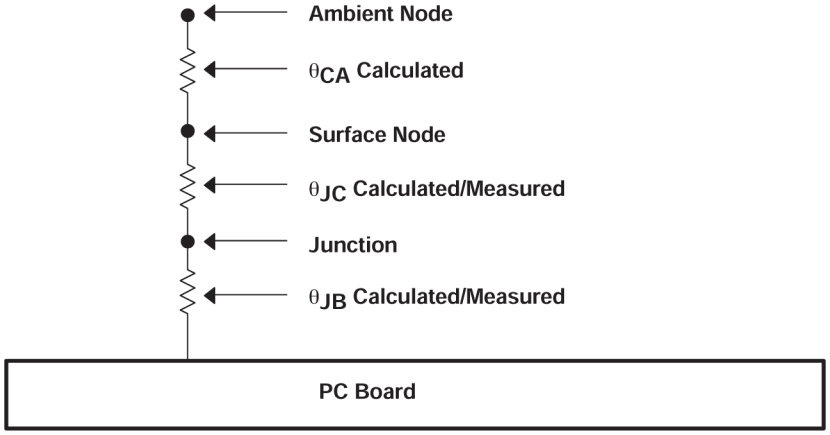


Figure 7-1. Thermal Resistance

7.2 Device Functional Modes

Table 7-1. Functional Tables (Each Driver)

INPUT(1)	ENABLE	OUTPUTS	
		Y	Z
H	H	H	L
L	H	L	H
X	L	Z	Z

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off)

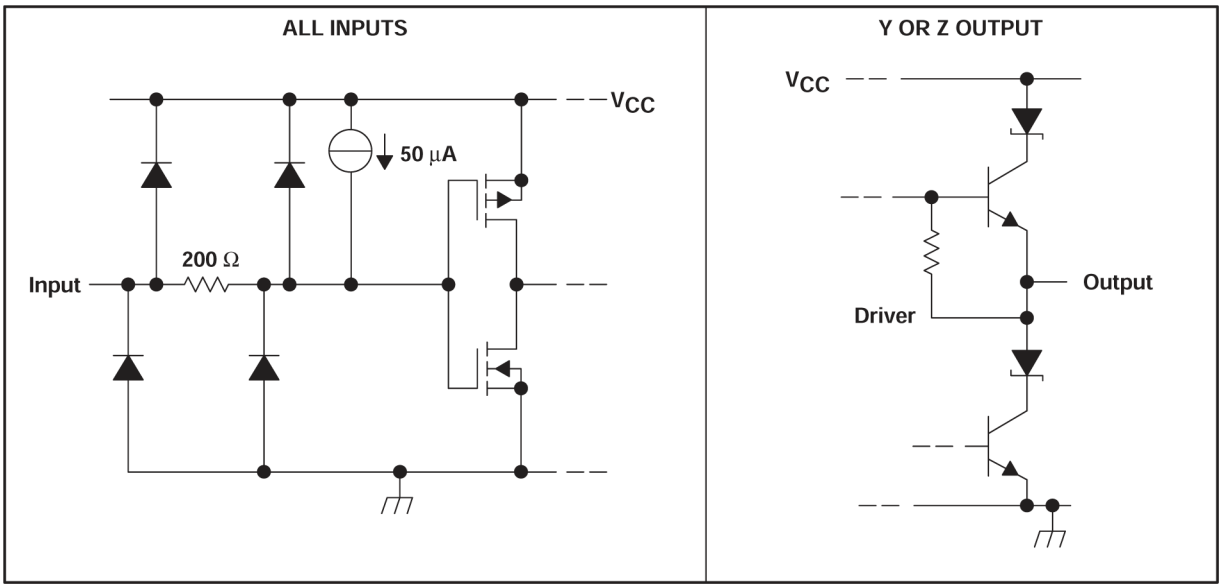


Figure 7-2. Schematic of Inputs and Outputs

8 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

8.1 Receiving Notification of Documentation Updates

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

8.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

8.3 Trademarks

LinBiCMOS™ and TI E2E™ are trademarks of Texas Instruments.
All trademarks are the property of their respective owners.

8.4 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

8.5 Glossary

TI Glossary	This glossary lists and explains terms, acronyms, and definitions.

9 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision E (April 2006) to Revision F (April 2024)	Page
• Changed the numbering format for tables, figures, and cross-references throughout the document	1
• Added the *Thermal Information* table	6
• Changed the $t_{t(OD)}$ MIN value from 10ns to 9ns in the *Switching Characteristics*	7

10 Mechanical, Packaging, and Orderable Information

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

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
SN65LBC174DW	Obsolete	Production	SOIC (DW) | 20	-	-	Call TI	Call TI	-40 to 85	SN65LBC174
SN65LBC174DWR	Active	Production	SOIC (DW) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	SN65LBC174
SN65LBC174DWR.A	Active	Production	SOIC (DW) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	SN65LBC174
SN65LBC174N	Active	Production	PDIP (N) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 85	SN65LBC174N
SN65LBC174N.A	Active	Production	PDIP (N) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 85	SN65LBC174N
SN75LBC174DW	Obsolete	Production	SOIC (DW) | 20	-	-	Call TI	Call TI	0 to 70	SN75LBC174
SN75LBC174DW.B	Obsolete	Production	SOIC (DW) | 20	-	-	Call TI	Call TI	0 to 70	SN75LBC174
SN75LBC174N	Active	Production	PDIP (N) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	SN75LBC174N
SN75LBC174N.A	Active	Production	PDIP (N) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	SN75LBC174N

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

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

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative

and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF SN75LBC174 :

- Military : SN55LBC174

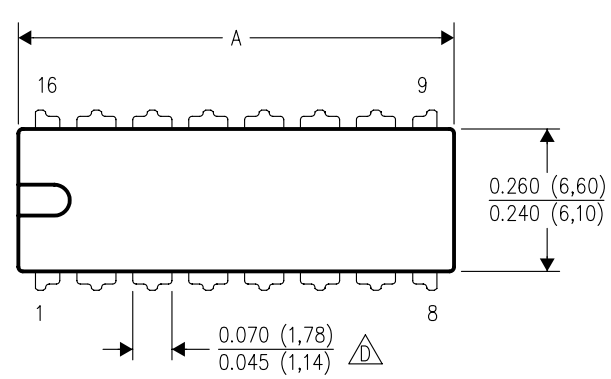
NOTE: Qualified Version Definitions:

- Military - QML certified for Military and Defense Applications

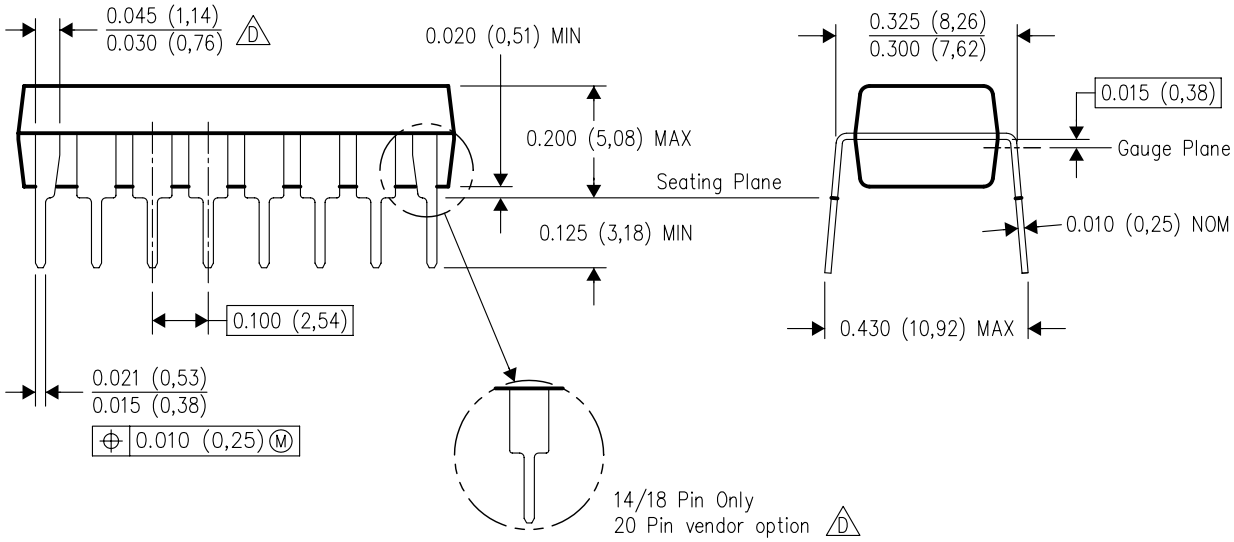
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN

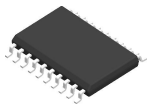


DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

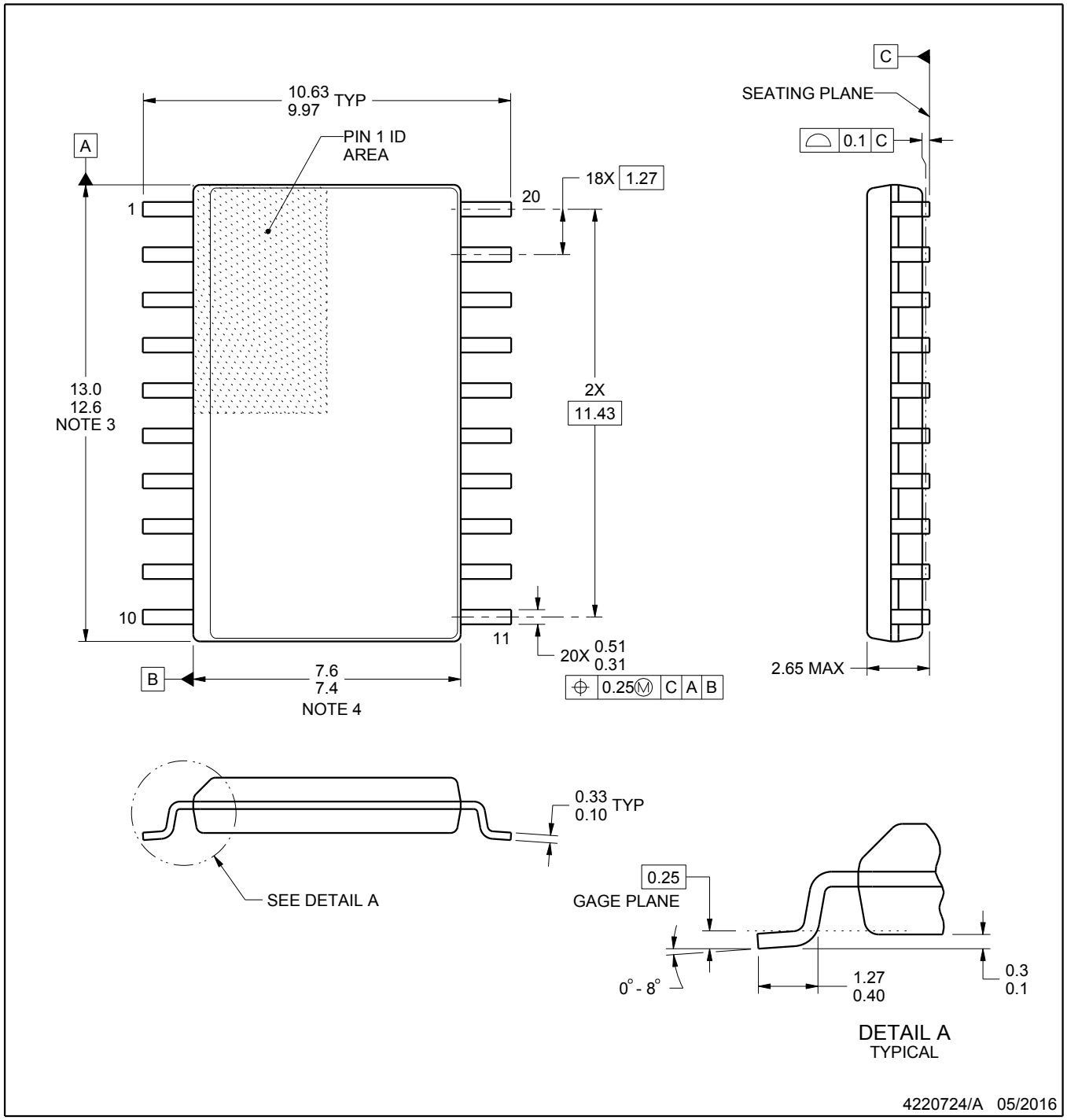


PACKAGE OUTLINE

DW0020A

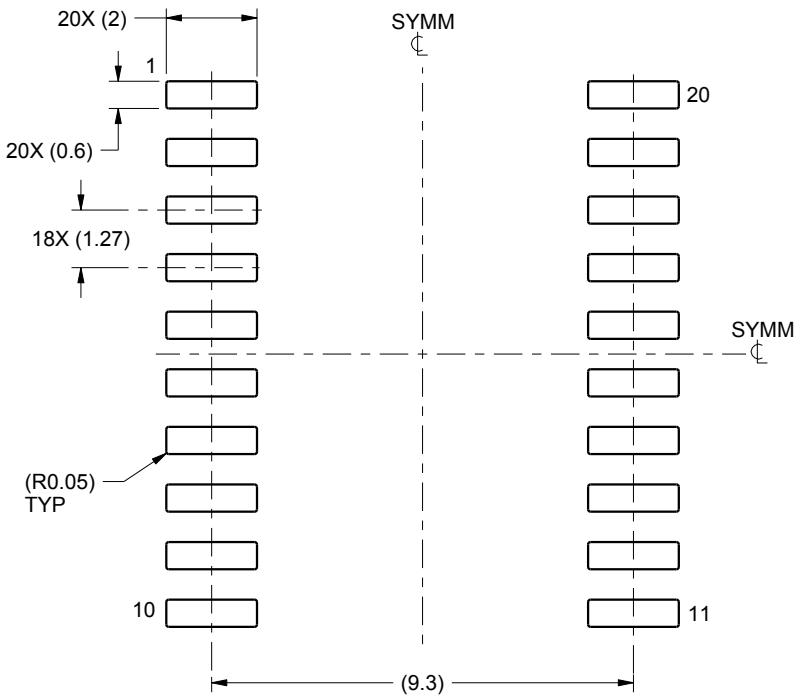
SOIC - 2.65 mm max height

SOIC

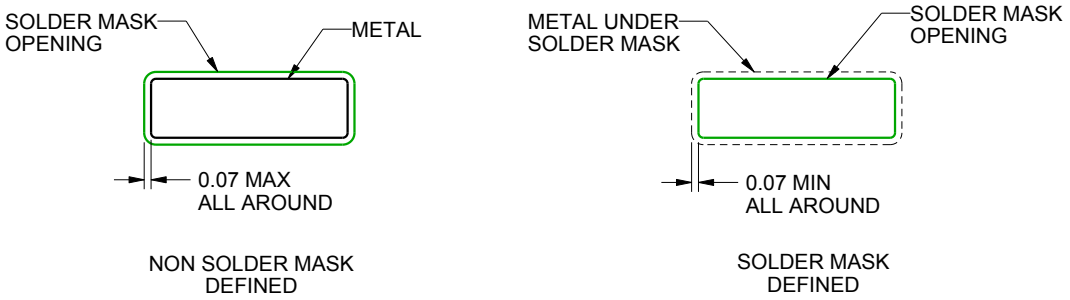


NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm per side.
5. Reference JEDEC registration MS-013.



LAND PATTERN EXAMPLE
SCALE:6X

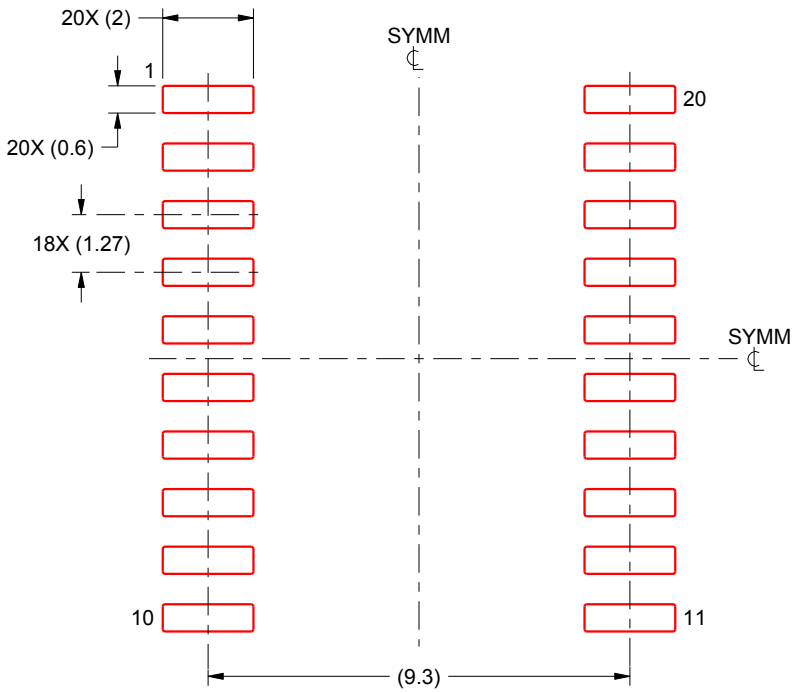


SOLDER MASK DETAILS

4220724/A 05/2016

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

4220724/A 05/2016

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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