NB2304A

3.3 V Zero Delay Clock Buffer

The NB2304A is a versatile, 3.3 V zero delay buffer designed to distribute high−speed clocks in PC, workstation, datacom, telecom and other high−performance applications. It is available in an 8 pin package. The part has an on−chip PLL which locks to an input clock presented on the REF pin. The PLL feedback is required to be driven to FBK pin, and can be obtained from one of the outputs. The input−to−output propagation delay is guaranteed to be less than 250 ps, and the output−to−output skew is guaranteed to be less than 200 ps.

The NB2304A has two Banks of two outputs each. Multiple NB2304A devices can accept the same input clock and distribute it. In this case, the skew between the outputs of the two devices is guaranteed to be less than 500 ps.

The NB2304A is available in two different configurations (Refer to NB2304A Configurations Table). The NB2304Ax1* is the base part, where the output frequencies equal the reference if there is no counter in the feedback path. The NB2304Ax1H is the high−drive version of the −1 and the rise and fall times on this device are much faster.

The NB2304Ax2 allows the user to obtain REF, 1/2 X and 2X frequencies on each output Bank. The exact configuration and output frequencies depend on which output drives the feedback pin.

Features

- Zero Input − Output Propagation Delay, Adjustable by Capacitive Load on FBK Input
- Multiple Configurations − Refer to NB2304A Configurations Table
- Input Frequency Range: 15 MHz to 133 MHz
- Multiple Low−Skew Outputs
- Output−Output Skew < 200 ps
- Device−Device Skew < 500 ps
- Two Banks of Four Outputs
- Less than 200 ps Cycle−to−Cycle Jitter (−1, −1H, −5H)
- Available in Space Saving, 8 pin 150 mil SOIC Package
- 3.3 V Operation
- Advanced 0.35 μ CMOS Technology
- Industrial Temperature Available
- These are Pb−Free Devices

*x = C for Commercial; I for Industrial.

ON Semiconductor®

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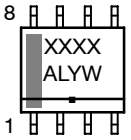
MARKING DIAGRAM*

SOIC−8
D SUFFIX
CASE 751



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

*For additional marking information, refer to Application Note AND8002/D.

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

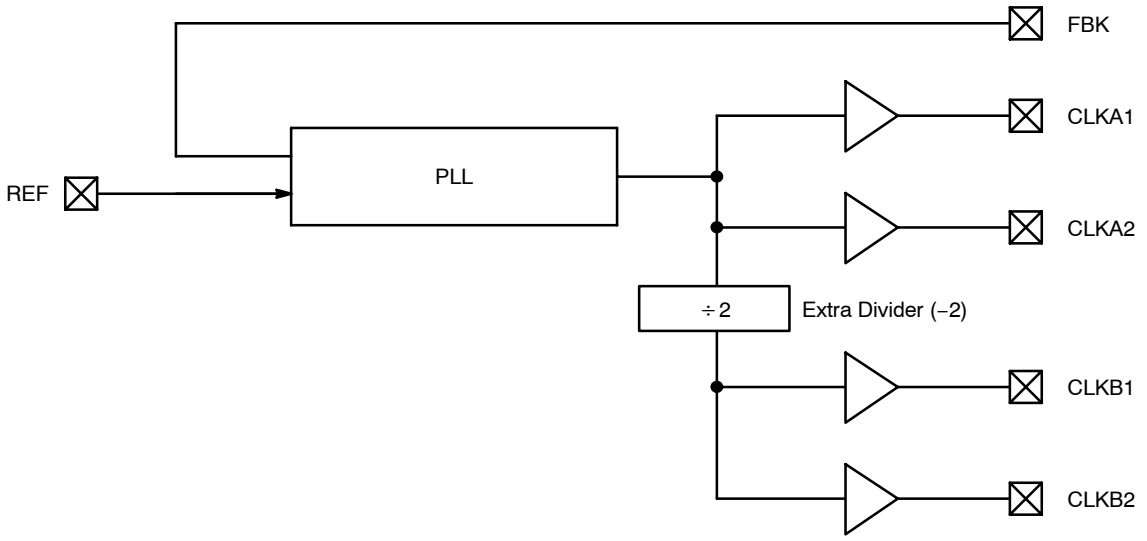


Figure 1. Basic Block Diagram
(see Figures 11 and 12 for device specific Block Diagrams)

Table 1. CONFIGURATIONS (x = C for Commercial; I for Industrial)

Device	Feedback From	Bank A Frequency	Bank B Frequency
NB2304Ax1	Bank A or Bank B	Reference	Reference
NB2304Ax1H	Bank A or Bank B	Reference	Reference
NB2304Ax2	Bank A	Reference	Reference ÷2
NB2304Ax2	Bank B	2 X Reference	Reference

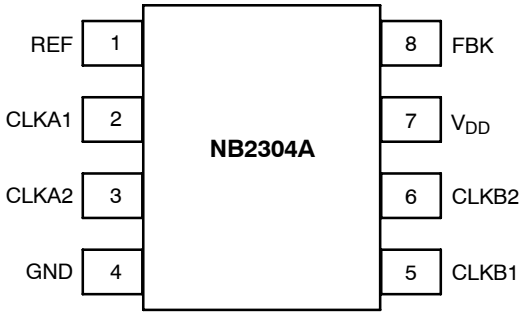


Figure 2. Pin Configuration

Table 2. PIN DESCRIPTION

Pin #	Pin Name	Description
1	REF (Note 1)	Input reference frequency, 5 V tolerant input.
2	CLKA1 (Note 2)	Buffered clock output, Bank A.
3	CLKA2 (Note 2)	Buffered clock output, Bank A.
4	GND	Ground.
5	CLKB1 (Note 2)	Buffered clock output, Bank B.
6	CLKB2 (Note 2)	Buffered clock output, Bank B.
7	V_{DD}	3.3 V supply.
8	FBK	PLL feedback input.

1. Weak pulldown.
2. Weak pulldown on all outputs.

Table 3. MAXIMUM RATINGS

Parameter	Min	Max	Unit
Supply Voltage to Ground Potential	−0.5	+7.0	V
DC Input Voltage (Except REF)	−0.5	V_{DD} + 0.5	V
DC Input Voltage (REF)	−0.5	7	V
Storage Temperature	−65	+150	°C
Maximum Soldering Temperature (10 sec)		260	°C
Junction Temperature		150	°C
Static Discharge Voltage (per MIL−STD−883, Method 3015)		> 2000	V

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

Table 4. OPERATING CONDITIONS FOR COMMERCIAL AND INDUSTRIAL TEMPERATURE DEVICES

Parameter	Description		Min	Max	Unit
V_{DD}	Supply Voltage		3.0	3.6	V
T_A	Operating Temperature (Ambient Temperature)	Commercial Industrial	0 −40	70 85	°C
C_L	Load Capacitance, 15 MHz to 100 MHz			30	pF
C_L	Load Capacitance, from 100 MHz to 133 MHz			15	pF
C_{IN}	Input Capacitance (Note 3)			7	pF

3. Applies to both REF Clock and FBK.

Table 5. ELECTRICAL CHARACTERISTICS FOR COMMERCIAL TEMPERATURE DEVICES

Parameter	Description	Test Conditions	Min	Max	Unit
V_{IL}	Input LOW Voltage			0.8	V
V_{IH}	Input HIGH Voltage		2.0		V
I_{IL}	Input LOW Current	V_{IN} = 0 V		50.0	μA
I_{IH}	Input HIGH Current	V_{IN} = V_{DD}		100.0	μA
V_{OL}	Output LOW Voltage	I_{OL} = 8 mA (−1, −2) I_{OL} = 12 mA (−1H)		0.4	V
V_{OH}	Output HIGH Voltage	I_{OH} = −8 mA (−1, −2) I_{OH} = −12 mA (−1H)	2.4		V
I_{DD}	Supply Current	Unloaded outputs 100 MHz REF Select inputs at V_{DD} or GND		45	mA
		Unloaded outputs, 66 MHz REF (−1, −2)		32	
		Unloaded outputs, 33 MHz REF (−1, −2)		18	

Table 6. SWITCHING CHARACTERISTICS FOR COMMERCIAL TEMPERATURE DEVICES

Parameter	Description	Test Conditions	Min	Typ	Max	Unit
t_1	Output Frequency	30 pF load (all devices) 15 pF load (−1, −2)	15 15		133 133.3	MHz
	Duty Cycle = (t_2 / t_1) * 100 (all devices)	Measured at 1.4 V, F_{OUT} = 66.66 MHz 30 pF load	40.0	50.0	60.0	%
		Measured at 1.4 V, $F_{OUT} \leq$ 50 MHz 15 pF load	45.0	50.0	55.0	
t_3	Output Rise Time (−1, −2)	Measured between 0.8 V and 2.0 V 30 pF load			2.20	ns
		Measured between 0.8 V and 2.0 V 15 pF load			1.50	
	Output Rise Time (−1H)	Measured between 0.8 V and 2.0 V 30 pF load			1.50	
t_4	Output Fall Time (−1, −2)	Measured between 2.0 V and 0.8 V 30 pF load			2.20	ns
		Measured between 2.0 V and 0.8 V 15 pF load			1.50	
	Output Fall Time (−1H)	Measured between 2.0 V and 0.8 V 30 pF load			1.25	
t_5	Output−to−Output Skew on same Bank (−1, −2)	All outputs equally loaded			200	ps
	Output−to−Output Skew (−1H)	All outputs equally loaded			200	
	Output Bank A−to−Output Bank B Skew (−1)	All outputs equally loaded			200	
	Output Bank A−to−Output Bank B Skew (−2)	All outputs equally loaded			400	
t_6	Delay, REF Rising Edge to FBK Rising Edge	Measured at V_{DD}/2		0	±250	ps
t_7	Device−to−Device Skew	Measured at V_{DD}/2 on the FBK pins of the device		0	500	ps
t_8	Output Slew Rate	Measured between 0.8 V and 2.0 V using Test Circuit #2	1			V/ns
t_J	Cycle−to−Cycle Jitter (−1, −1H)	Measured at 66.67 MHz, loaded outputs, 15 pF load			175	ps
		Measured at 66.67 MHz, loaded outputs, 30 pF load			200	
		Measured at 133.3 MHz, loaded outputs, 15 pF load			100	
	Cycle−to−Cycle Jitter (−2)	Measured at 66.67 MHz, loaded outputs, 30 pF load			400	ps
		Measured at 66.67 MHz, loaded outputs, 15 pF load			375	
t_{LOCK}	PLL Lock Time	Stable power supply, valid clock presented on REF and FBK pins			1.0	ms

Table 7. ELECTRICAL CHARACTERISTICS FOR INDUSTRIAL TEMPERATURE DEVICES

Parameter	Description	Test Conditions	Min	Max	Unit
V_{IL}	Input LOW Voltage			0.8	V
V_{IH}	Input HIGH Voltage		2.0		V
I_{IL}	Input LOW Current	V_{IN} = 0 V		50.0	μA
I_{IH}	Input HIGH Current	V_{IN} = V_{DD}		100.0	μA
V_{OL}	Output LOW Voltage	I_{OL} = 8 mA (–1, –2) I_{OL} = 12 mA (–1H)		0.4	V
V_{OH}	Output HIGH Voltage	I_{OH} = –8 mA (–1, –2) I_{OH} = –12 mA (–1H)	2.4		V
I_{DD}	Supply Current	Unloaded outputs 100 MHz REF Select inputs at V_{DD} or GND		45	mA
		Unloaded outputs, 66 MHz REF (–1, –2)		35	
		Unloaded outputs, 33 MHz REF (–1, –2)		20	

Table 8. SWITCHING CHARACTERISTICS FOR INDUSTRIAL TEMPERATURE DEVICES
(All parameters are specified with loaded outputs)

Parameter	Description	Test Conditions	Min	Typ	Max	Unit
t_1	Output Frequency	30 pF load (all devices) 15 pF load (−1, −2)	15 15		100 133.3	MHz
t_1	Duty Cycle = (t_2 / t_1) * 100 (all devices)	Measured at 1.4 V, $F_{OUT} \leq$ 66.66 MHz 30 pF load	40.0	50.0	60.0	%
		Measured at 1.4 V, $F_{OUT} \leq$ 50 MHz 15 pF load	45.0	50.0	55.0	
t_3	Output Rise Time (−1, −2)	Measured between 0.8 V and 2.0 V 30 pF load			2.50	ns
		Measured between 0.8 V and 2.0 V 15 pF load			1.50	
	Output Rise Time (−1H)	Measured between 0.8 V and 2.0 V 30 pF load			1.50	
t_4	Output Fall Time (−1, −2)	Measured between 2.0 V and 0.8 V 30 pF load			2.50	ns
		Measured between 2.0 V and 0.8 V 15 pF load			1.50	
	Output Fall Time (−1H)	Measured between 2.0 V and 0.8 V 30 pF load			1.25	
t_5	Output−to−Output Skew on same Bank (−1, −2)	All outputs equally loaded			200	ps
	Output−to−Output Skew (−1H)	All outputs equally loaded			200	
	Output Bank A−to−Output Bank B skew (−1)	All outputs equally loaded			200	
	Output Bank A−to−Output Bank B skew (−2)	All outputs equally loaded			400	
t_6	Delay, REF Rising Edge to FBK Rising Edge	Measured at $V_{DD}/2$		0	±250	ps
t_7	Device−to−Device Skew	Measured at $V_{DD}/2$ on the FBK pins of the device		0	500	ps
t_8	Output Slew Rate	Measured between 0.8 V and 2.0 V using Test Circuit #2	1			V/ns
t_J	Cycle−to−Cycle Jitter (−1, −1H)	Measured at 66.67 MHz, loaded outputs, 15 pF load			180	ps
		Measured at 66.67 MHz, loaded outputs, 30 pF load			200	
		Measured at 133.3 MHz, loaded outputs, 15 pF load			100	
	Cycle−to−Cycle Jitter (−2)	Measured at 66.67 MHz, loaded outputs, 30 pF load			400	ps
		Measured at 66.67 MHz, loaded outputs, 15 pF load			380	
t_{LOCK}	PLL Lock Time	Stable power supply, valid clock presented on REF and FBK pins			1.0	ms

Zero Delay and Skew Control

For applications requiring zero input−output delay, all outputs must be equally loaded.

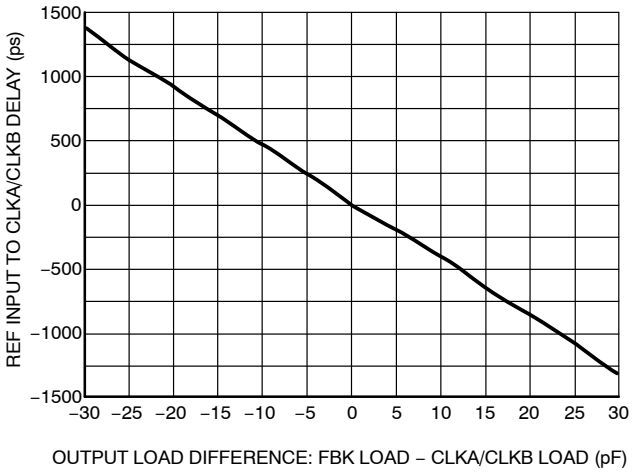


Figure 3. REF Input to CLKA/CLKB Delay vs. Difference in Loading between FBK Pin and CLKA/CLKB Pins

To close the feedback loop of the NB2304A, the FBK pin can be driven from any of the four available output pins. The output driving the FBK pin will be driving a total load of 7 pF plus any additional load that it drives. The relative loading of this output (with respect to the remaining outputs) can adjust the input output delay. This is shown in Figure 3.

For applications requiring zero input−output delay, all outputs including the one providing feedback should be equally loaded. If input−output delay adjustments are required, use Figure 3 to calculate loading differences between the feedback output and remaining outputs. For zero output−output skew, be sure to load outputs equally.

SWITCHING WAVEFORMS

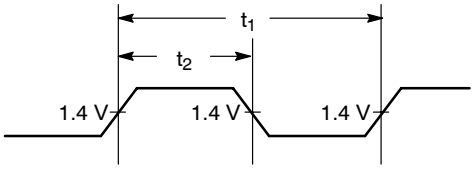


Figure 4. Duty Cycle Timing

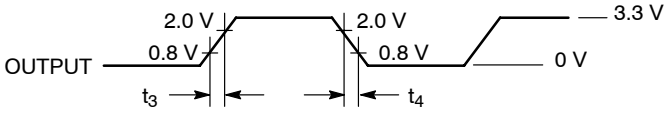


Figure 5. All Outputs Rise/Fall Time

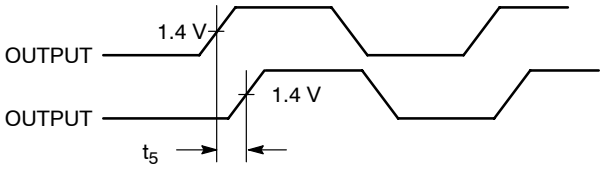


Figure 6. Output − Output Skew

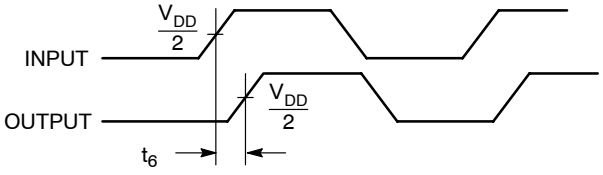


Figure 7. Input − Output Propagation Delay

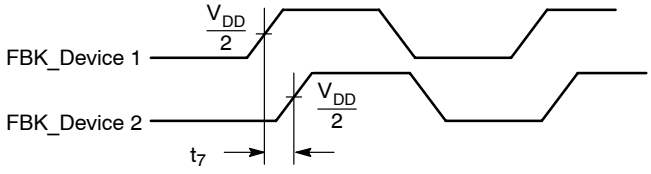


Figure 8. Device − Device Skew

TEST CIRCUITS

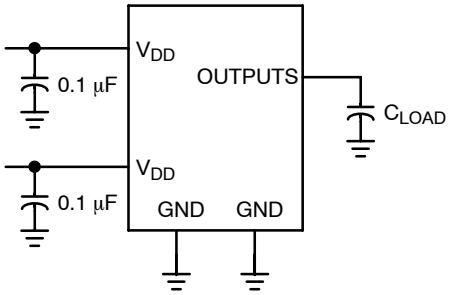


Figure 9. Test Circuit #1

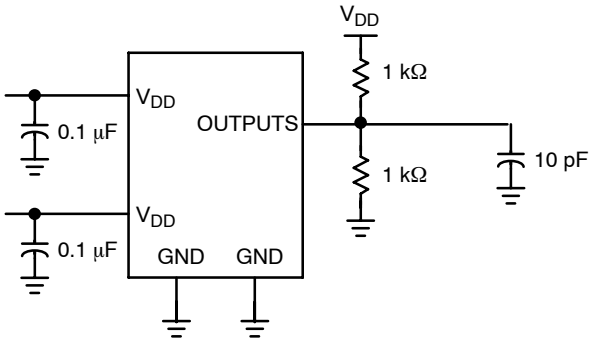


Figure 10. Test Circuit #2
For parameter t_8 (output slew rate) on –1H devices

BLOCK DIAGRAMS

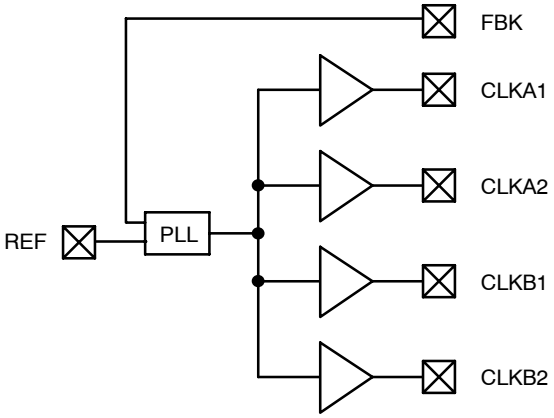


Figure 11. NB2304Ax1 and NB2304Ax1H

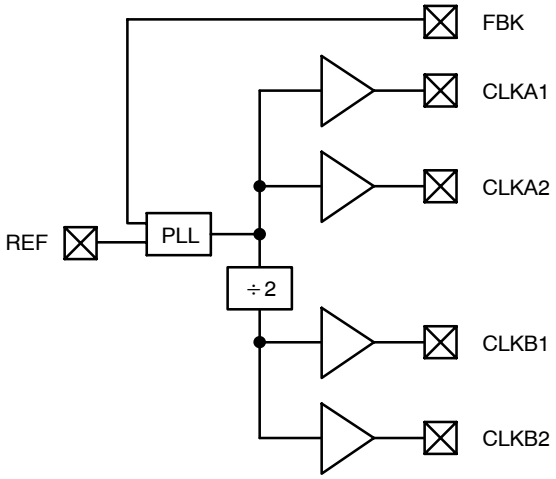


Figure 12. NB2304Ax2

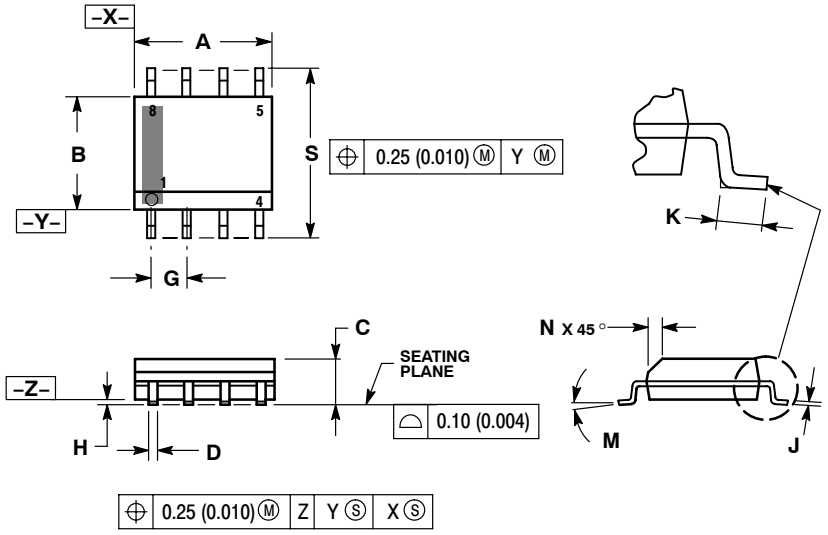
ORDERING INFORMATION

Device	Marking	Operating Range	Package	Shipping†	Availability
NB2304AC1DG	4C1	Commercial	SOIC−8 (Pb−Free)	98 Units / Rail	*Now*
NB2304AC1DR2G	4C1	Commercial	SOIC−8 (Pb−Free)	2500 Tape & Reel	*Now*
NB2304AI1DG	4I1	Industrial	SOIC−8 (Pb−Free)	98 Units / Rail	*Now*
NB2304AI1DR2G	4I1	Industrial	SOIC−8 (Pb−Free)	2500 Tape & Reel	*Now*
NB2304AC1HDG	4C1H	Commercial	SOIC−8 (Pb−Free)	98 Units / Rail	*Now*
NB2304AC1HDR2G	4C1H	Commercial	SOIC−8 (Pb−Free)	2500 Tape & Reel	*Now*
NB2304AI1HDG	4I1H	Industrial	SOIC−8 (Pb−Free)	98 Units / Rail	*Now*
NB2304AI1HDR2G	4I1H	Industrial	SOIC−8 (Pb−Free)	2500 Tape & Reel	*Now*
NB2304AC2DG	4C2	Commercial	SOIC−8 (Pb−Free)	98 Units / Rail	*Now*
NB2304AC2DR2G	4C2	Commercial	SOIC−8 (Pb−Free)	2500 Tape & Reel	*Now*
NB2304AI2DG	4I2	Industrial	SOIC−8 (Pb−Free)	98 Units / Rail	*Now*
NB2304AI2DR2G	4I2	Industrial	SOIC−8 (Pb−Free)	2500 Tape & Reel	*Now*

†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

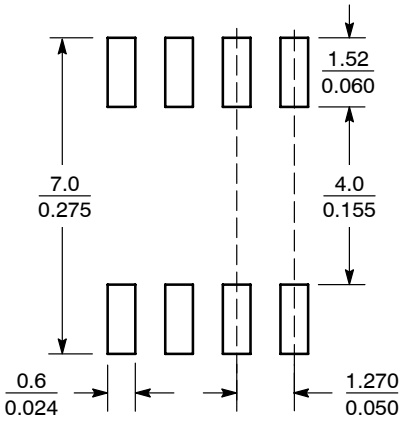
SOIC−8 NB
CASE 751−07
ISSUE AG



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751−01 THRU 751−06 ARE OBSOLETE. NEW STANDARD IS 751−07.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0 °	8 °	0 °	8 °
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT*



SCALE 6:1 (mm / inches)

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

PUBLICATION ORDERING INFORMATION

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