

# NBSG86A

## 2.5V/3.3V SiGe Differential Smart Gate with Output Level Select

The NBSG86A is a multi-function differential Logic Gate which can be configured as an AND/NAND, OR/NOR, XOR/XNOR, or 2:1 MUX. This device is part of the GigaComm™ family of high performance Silicon Germanium products. The device is housed in a low profile 4x4 mm, 16-pin, flip-chip BGA or a 3x3 mm 16 pin QFN package.

Differential inputs incorporate internal 50 Ω termination resistors and accept NECL (Negative ECL), PECL (Positive ECL), LVCMOS/LVTTL, CML, or LVDS. The Output Level Select (OLS) input is used to program the peak-to-peak output amplitude between 0 and 800 mV in five discrete steps.

The NBSG86A employs input default circuitry so that under open input conditions ( $D_x$ ,  $\overline{D}_x$ ,  $\overline{VTD}_x$ ,  $VTD_x$ , VTSEL) the outputs of the device will remain stable.

### Features

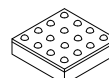
- Maximum Input Clock Frequency > 8 GHz Typical
- Maximum Input Data Rate > 8 Gb/s Typical
- 165 ps Typical Propagation Delay
- 40 ps Typical Rise and Fall Times
- Selectable Swing PECL Output with Operating Range:  $V_{CC} = 2.375 \text{ V to } 3.465 \text{ V}$  with  $V_{EE} = 0 \text{ V}$
- Selectable Swing NECL Output with NECL Inputs with Operating Range:  $V_{CC} = 0 \text{ V}$  with  $V_{EE} = -2.375 \text{ V to } -3.465 \text{ V}$
- Selectable Output Level (0 V, 200 mV, 400 mV, 600 mV, or 800 mV Peak-to-Peak Output)
- 50 Ω Internal Input Termination Resistors
- Pb-Free Packages are Available



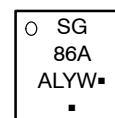
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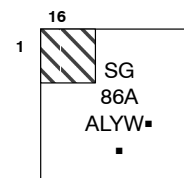
### MARKING DIAGRAMS\*



FCBGA-16  
BA SUFFIX  
CASE 489



QFN-16  
MN SUFFIX  
CASE 485G



A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

\*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 12 of this data sheet.

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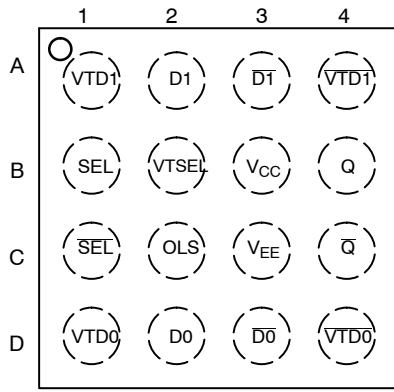


Figure 1. BGA-16 Pinout (Top View)

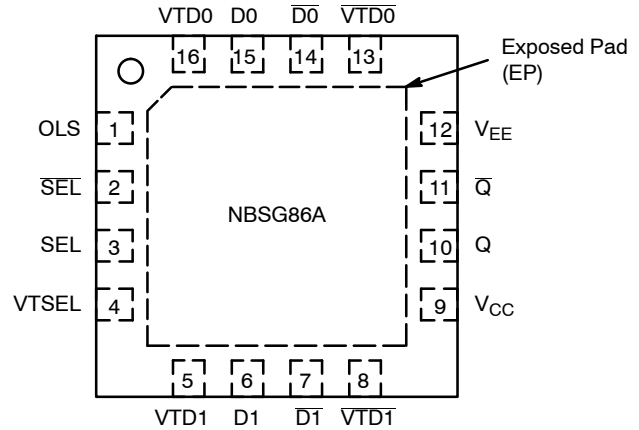


Figure 2. QFN-16 Pinout (Top View)

Table 1. Pin Description

Pin		Name	I/O	Description
BGA	QFN			
C2	1	OLS (Note 3)	Input	Input Pin for the Output Level Select (OLS). See Table 2.
C1	2	SEL	ECL, CML, LVCMOS, LVDS, LVTTTL Input	Inverted Differential Select Logic Input.
B1	3	SEL	ECL, CML, LVCMOS, LVDS, LVTTTL Input	Noninverted Differential Select Logic Input.
B2	4	VTSEL	-	Common Internal 50 $\Omega$ Termination Pin for SEL/SEL. See Table 7. (Note 1)
A1	5	VTD1	-	Internal 50 $\Omega$ termination pin. See Table 7. (Note 1)
A2	6	D1	ECL, CML, LVCMOS, LVDS, LVTTTL Input	Noninverted Differential Input 1. Internal 75 k $\Omega$ to $V_{EE}$ .
A3	7	$\bar{D}1$	ECL, CML, LVCMOS, LVDS, LVTTTL Input	Inverted Differential Input 1. Internal 75 k $\Omega$ to $V_{EE}$ and 36.5 k $\Omega$ to $V_{CC}$ .
A4	8	$\bar{V}TD1$	-	Internal 50 $\Omega$ Termination Pin. See Table 7. (Note 1)
B3	9	$V_{CC}$	-	Positive Supply Voltage (Note 2)
B4	10	Q	RSECL Output	Noninverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{TT} = V_{CC} - 2 V$ .
C4	11	$\bar{Q}$	RSECL Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{TT} = V_{CC} - 2 V$
C3	12	$V_{EE}$	-	Negative Supply Voltage (Note 2)
D4	13	$\bar{V}TD0$	-	Internal 50 $\Omega$ Termination Pin. See Table 7. (Note 1)
D3	14	$\bar{D}0$	ECL, CML, LVCMOS, LVDS, LVTTTL Input	Inverted Differential Input 0. Internal 75 k $\Omega$ to $V_{EE}$ and 36.5 k $\Omega$ to $V_{CC}$ .
D2	15	D0	ECL, CML, LVCMOS, LVDS, LVTTTL Input	Noninverted Differential Input 0. Internal 75 k $\Omega$ to $V_{EE}$ .
D1	16	VTD0	-	Internal 50 $\Omega$ Termination Pin. See Table 7. (Note 1)
N/A	-	EP	-	The Exposed Pad (EP) and the QFN-16 package bottom is thermally connected to the die for improved heat transfer out of package. The exposed pad must be attached to a heat-sinking conduit. The pad is not electrically connected to the die but may be electrically and thermally connected to $V_{EE}$ on the PC board.

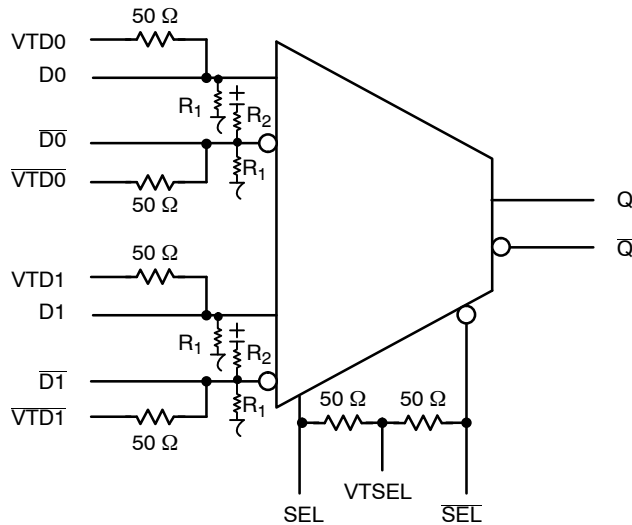
1. In the differential configuration when the input termination pins (VTDx,  $\bar{V}TDx$ , VTSEL) are connected to a common termination voltage, and if no signal is applied then the device will be susceptible to self-oscillation.
2. All  $V_{CC}$  and  $V_{EE}$  pins must be externally connected to Power Supply to guarantee proper operation.
3. When an output level of 400 mV is desired and  $V_{CC} - V_{EE} > 3.0 V$ , 2 k $\Omega$  resistor should be connected from OLS pin to  $V_{EE}$ .

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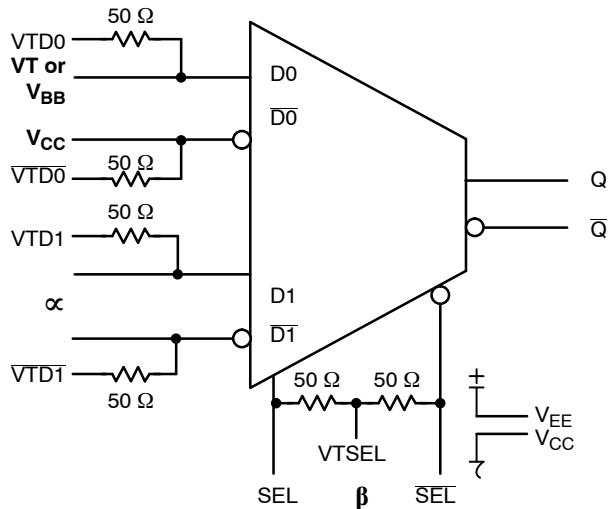
**Table 2. OUTPUT LEVEL SELECT OLS**

OLS	Q/Q VPP	OLS Sensitivity
V <sub>CC</sub>	800 mV	OLS - 75 mV
V <sub>CC</sub> - 0.4 V	200 mV	OLS ± 150 mV
V <sub>CC</sub> - 0.8 V	600 mV	OLS ± 100 mV
V <sub>CC</sub> - 1.2 V	0	OLS ± 75 mV
V <sub>EE</sub> (Note 4)	400 mV	OLS ± 100 mV
Float	600 mV	N/A

4. When an output level of 400 mV is desired and V<sub>CC</sub> - V<sub>EE</sub> > 3.0 V, 2.0 kΩ resistor should be connected from OLS to V<sub>EE</sub>.



**Figure 3. Logic Diagram**



**Figure 4. Configuration for AND/NAND Function**

**Table 3. AND/NAND TRUTH TABLE (Note 5)**

	$\alpha$	$\beta$	$\alpha * \beta$
D0	D1	SEL	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1

5. D0-bar, D1-bar, SEL are inverse of D0, D1, SEL unless specified otherwise.

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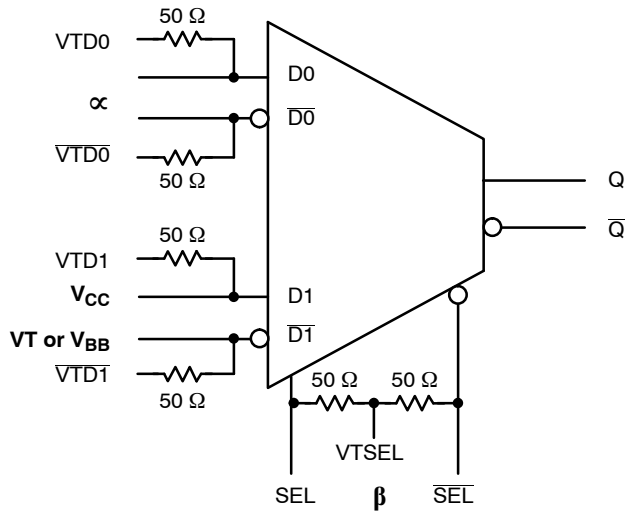


Figure 5. Configuration for OR/NOR Function

Table 4. OR/NOR TRUTH TABLE\*\*

$\alpha$		$\beta$	$\alpha$ or $\beta$
D0	D1	SEL	Q
0	1	0	0
0	1	1	1
1	1	0	1
1	1	1	1

\*\* D0, D1, SEL are inverse of D0, D1, SEL unless specified otherwise.

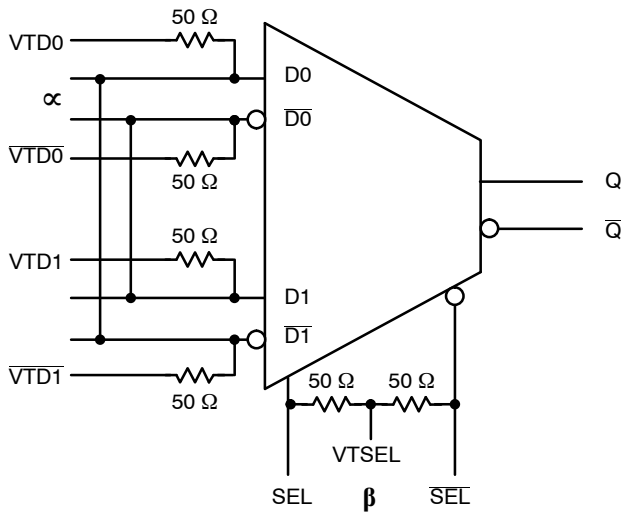


Figure 6. Configuration for XOR/XNOR Function

Table 5. XOR/XNOR TRUTH TABLE\*\*

$\alpha$		$\beta$	$\alpha$ XOR $\beta$
D0	D1	SEL	Q
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0

\*\* D0, D1, SEL are inverse of D0, D1, SEL unless specified otherwise.

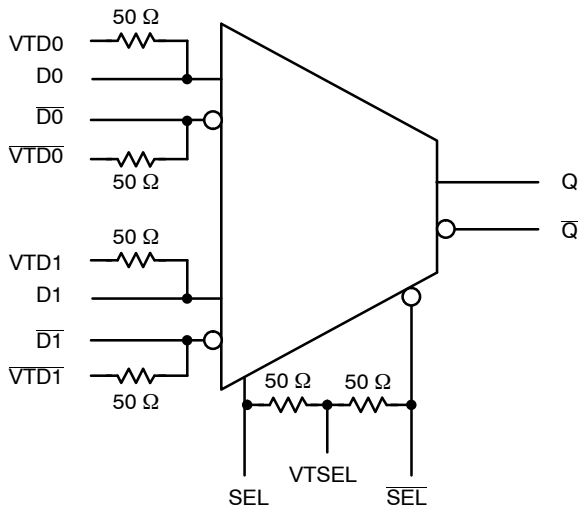


Figure 7. Configuration for 2:1 MUX Function

Table 6. 2:1 MUX TRUTH TABLE\*\*

SEL	Q
1	D1
0	D0

\*\* D0, D1, SEL are inverse of D0, D1, SEL unless specified otherwise.

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**Table 7. Interfacing Options**

INTERFACING OPTIONS	CONNECTIONS
CML	Connect VTD0, VTD1, VTSEL and $\overline{\text{VTD0}}$ , $\overline{\text{VTD1}}$ to $V_{CC}$
LVDS	Connect VTD0, VTD1, $\overline{\text{VTD0}}$ and $\overline{\text{VTD1}}$ together. Leave VTSEL open.
AC-COUPLED	Bias VTD0, VTD1, VTSEL and $\overline{\text{VTD0}}$ , $\overline{\text{VTD1}}$ Inputs within (VIHCMR) Common Mode Range
RSECL, PECL, NECL	Standard ECL Termination Techniques
LVTTTL, LVCMOS	An external voltage should be applied to the unused complementary differential input. Nominal voltage 1.5 V for LVTTTL and $V_{CC}/2$ for LVCMOS inputs.

**Table 8. ATTRIBUTES**

Characteristics	Value	
Internal Input Pulldown Resistors ( $R_1$ )	75 k $\Omega$	
Internal Input Pullup Resistor ( $R_2$ )	37.5 k $\Omega$	
ESD Protection	Human Body Model Machine Model Charged Device Model	> 1 KV > 50 V > 4 KV
Moisture Sensitivity (Note 6)	Pb Pkg	Pb-Free Pkg
	FCBGA-16 QFN-16	Level 3 Level 1
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in
Transistor Count	364	
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test		

6. For additional information, see Application Note AND8003/D.

**Table 9. MAXIMUM RATINGS** (Note 7)

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
$V_{CC}$	Positive Power Supply	$V_{EE} = 0 \text{ V}$		3.6	V
$V_{EE}$	Negative Power Supply	$V_{CC} = 0 \text{ V}$		-3.6	V
$V_I$	Positive Input Negative Input	$V_{EE} = 0 \text{ V}$ $V_{CC} = 0 \text{ V}$	$V_I \leq V_{CC}$ $V_I \geq V_{EE}$	3.6 -3.6	V V
$V_{INPP}$	Differential Input Voltage $ D_n - \overline{D_n} $	$V_{CC} - V_{EE} \geq 2.8 \text{ V}$ $V_{CC} - V_{EE} < 2.8 \text{ V}$		2.8 $ V_{CC} - V_{EE} $	V V
$I_{IN}$	Input Current Through $R_T$ (50 $\Omega$ Resistor)	Static Surge		45 80	mA mA
$I_{out}$	Output Current	Continuous Surge		25 50	mA mA
$T_A$	Operating Temperature Range	FCBGA-16 QFN-16		-40 to +70 -40 to +85	$^{\circ}\text{C}$ $^{\circ}\text{C}$
$T_{stg}$	Storage Temperature Range			-65 to +150	$^{\circ}\text{C}$
$\theta_{JA}$	Thermal Resistance (Junction-to-Ambient) (Note 8)	0 lfpm 500 lfpm 0 lfpm 500 lfpm	FCBGA-16 FCBGA-16 QFN-16 QFN-16	108 86 41.6 35.2	$^{\circ}\text{C}/\text{W}$ $^{\circ}\text{C}/\text{W}$ $^{\circ}\text{C}/\text{W}$ $^{\circ}\text{C}/\text{W}$
$\theta_{JC}$	Thermal Resistance (Junction-to-Case)	2S2P (Note 8) 2S2P (Note 9)	FCBGA-16 QFN-16	5.0 4.0	$^{\circ}\text{C}/\text{W}$ $^{\circ}\text{C}/\text{W}$
$T_{sol}$	Wave Solder	Pb (BGA) Pb-Free	< 15 sec < 3 sec @ 260 $^{\circ}\text{C}$	225 265	$^{\circ}\text{C}$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

7. Maximum Ratings are those values beyond which device damage may occur.

8. JEDEC standard multilayer board - 2S2P (2 signal, 2 power).

9. JEDEC standard multilayer board - 2S2P (2 signal, 2 power) with 8 filled thermal vias under exposed pad.

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**Table 10. DC CHARACTERISTICS, INPUT WITH PECL OUTPUT**  $V_{CC} = 2.5\text{ V}$ ;  $V_{EE} = 0\text{ V}$  (Note 10)

Symbol	Characteristic	-40°C			25°C			70°C(BGA)/85°C(QFN)**			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Negative Power Supply Current	23	30	39	23	30	39	23	30	39	mA
$V_{OH}$	Output HIGH Voltage (Note 11)	1460	1510	1560	1490	1540	1590	1515	1565	1615	mV
$V_{OL}$	Output LOW Voltage (Note 11)										mV
	(OLS = $V_{CC}$ )	555	705	855	595	745	895	625	775	925	
	(OLS = $V_{CC} - 0.4\text{ V}$ )	1235	1295	1385	1270	1330	1420	1295	1355	1445	
	(OLS = $V_{CC} - 0.8\text{ V}$ , OLS = FLOAT)	775	895	1015	810	930	1050	840	960	1080	
	(OLS = $V_{CC} - 1.2\text{ V}$ )	1455	1505	1585	1490	1540	1620	1510	1560	1640	
	(OLS = $V_{EE}$ )	1005	1095	1215	1040	1130	1250	1065	1155	1275	
$V_{OUTPP}$	Output Voltage Amplitude										mV
	(OLS = $V_{CC}$ )	670	800		660	795		655	790		
	(OLS = $V_{CC} - 0.4\text{ V}$ )	125	215		120	210		120	210		
	(OLS = $V_{CC} - 0.8\text{ V}$ , OLS = FLOAT)	510	615		505	610		500	605		
	(OLS = $V_{CC} - 1.2\text{ V}$ )	0	5		0	0		0	5		
	(OLS = $V_{EE}$ )	325	415		320	410		320	410		
$V_{IH}$	Input HIGH Voltage (Single-Ended) (Note 13) $D, \bar{D}$	$V_{EE} + 1275$	$V_{CC} - 1000^*$	$V_{CC}$	$V_{EE} + 1275$	$V_{CC} - 1000^*$	$V_{CC}$	$V_{EE} + 1275$	$V_{CC} - 1000^*$	$V_{CC}$	mV
$V_{IL}$	Input LOW Voltage (Single-Ended) (Note 14) $D, \bar{D}$	$V_{EE}$	$V_{CC} - 1400^*$	$V_{IH} - 150$	$V_{EE}$	$V_{CC} - 1400^*$	$V_{IH} - 150$	$V_{EE}$	$V_{CC} - 1400^*$	$V_{IH} - 150$	mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 12)	1.2		2.5	1.2		2.5	1.2		2.5	V
$R_{TIN}$	Internal Input Termination Resistor	45	50	55	45	50	55	45	50	55	$\Omega$
$I_{IH}$	Input HIGH Current (@ $V_{IH}$ ) $D, \bar{D}$ SEL		30 5	100 50		30 5	100 50		30 5	100 50	$\mu\text{A}$
$I_{IL}$	Input LOW Current (@ $V_{IL}$ ) $D, \bar{D}$ SEL		20 5	100 50		20 5	100 50		20 5	100 50	$\mu\text{A}$

NOTE: GigaComm circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500 lfm is maintained.

10. Input and output parameters vary 1:1 with  $V_{CC}$ .  $V_{EE}$  can vary +0.125 V to -0.965 V.

11. All loading with 50  $\Omega$  to  $V_{CC} - 2.0\text{ V}$ .

12.  $V_{IHCMR}$  min varies 1:1 with  $V_{EE}$ .  $V_{IHCMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

13.  $V_{IH}$  cannot exceed  $V_{CC}$ .

14.  $V_{IL}$  always  $\geq V_{EE}$ .

\*Typicals used for testing purposes.

\*\*The device packaged in FCBGA-16 have maximum ambient temperature specification of 70°C and devices packaged in QFN-16 have maximum ambient temperature specification of 85°C.

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**Table 11. DC CHARACTERISTICS, INPUT WITH PECL OUTPUT**  $V_{CC} = 3.3\text{ V}$ ;  $V_{EE} = 0\text{ V}$  (Note 15)

Symbol	Characteristic	-40°C			25°C			70°C(BGA)/85°C(QFN)***			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Negative Power Supply Current	23	30	39	23	30	39	23	30	39	mA
$V_{OH}$	Output HIGH Voltage (Note 16)	2260	2310	2360	2290	2340	2390	2315	2365	2415	mV
$V_{OL}$	Output LOW Voltage (Note 16) (OLS = $V_{CC}$ ) (OLS = $V_{CC} - 0.4\text{ V}$ ) (OLS = $V_{CC} - 0.8\text{ V}$ , OLS = FLOAT) (OLS = $V_{CC} - 1.2\text{ V}$ ) **(OLS = $V_{EE}$ )	1320 2030 1550 2260 1785	1470 2090 1670 2310 1875	1620 2180 1790 2390 1995	1360 2065 1585 2290 1820	1510 2125 1705 2340 1910	1660 2215 1825 2420 2030	1390 2090 1615 2315 1850	1540 2150 1735 2365 1940	1690 2240 1855 2445 2060	mV
$V_{OUTPP}$	Output Amplitude Voltage (OLS = $V_{CC}$ ) (OLS = $V_{CC} - 0.4\text{ V}$ ) (OLS = $V_{CC} - 0.8\text{ V}$ , OLS = FLOAT) (OLS = $V_{CC} - 1.2\text{ V}$ ) **(OLS = $V_{EE}$ )	705 130 535 0 345	815 220 640 0 435		695 125 530 0 340	805 215 635 0 430		690 125 525 0 335	800 215 630 0 425		mV
$V_{IH}$	Input HIGH Voltage (Single-Ended) (Note 18) D, $\bar{D}$	$V_{EE} + 1275$	$V_{CC} - 1000^*$	$V_{CC}$	$V_{EE} + 1275$	$V_{CC} - 1000^*$	$V_{CC}$	$V_{EE} + 1275$	$V_{CC} - 1000^*$	$V_{CC}$	mV
$V_{IL}$	Input LOW Voltage (Single-Ended) (Note 19) D, $\bar{D}$	$V_{IH} - 2600$	$V_{CC} - 1400^*$	$V_{IH} - 150$	$V_{IH} - 2600$	$V_{CC} - 1400^*$	$V_{IH} - 150$	$V_{IH} - 2600$	$V_{CC} - 1400^*$	$V_{IH} - 150$	mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 17)	1.2		3.3	1.2		3.3	1.2		3.3	V
$R_{TIN}$	Internal Input Termination Resistor	45	50	55	45	50	55	45	50	55	$\Omega$
$I_{IH}$	Input HIGH Current (@ $V_{IH}$ ) D, $\bar{D}$ SEL		30 5	100 50		30 5	100 50		30 5	100 50	$\mu\text{A}$
$I_{IL}$	Input LOW Current (@ $V_{IL}$ ) D, $\bar{D}$ SEL		20 5	100 50		20 5	100 50		20 5	100 50	$\mu\text{A}$

NOTE: GigaComm circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500 lfm is maintained.

15. Input and output parameters vary 1:1 with  $V_{CC}$ .  $V_{EE}$  can vary +0.925 V to -0.165 V.

16. All loading with 50  $\Omega$  to  $V_{CC} - 2.0\text{ V}$ .

17.  $V_{IHCMR}$  min varies 1:1 with  $V_{EE}$ .  $V_{IHCMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

18.  $V_{IH}$  cannot exceed  $V_{CC}$ .

19.  $V_{IL}$  always  $\geq V_{EE}$ .

\*Typicals used for testing purposes.

\*\*When an output level of 400 mV is desired and  $V_{CC} - V_{EE} > 3.0\text{ V}$ , a 2 k $\Omega$  resistor should be connected from OLS to  $V_{EE}$ .

\*\*\*The device packaged in FCBGA-16 have maximum ambient temperature specification of 70°C and devices packaged in QFN-16 have maximum ambient temperature specification of 85°C.

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**Table 12. DC CHARACTERISTICS, NECL INPUT WITH NECL OUTPUT**  $V_{CC} = 0\text{ V}$ ;  $V_{EE} = -3.465\text{ V}$  to  $-2.375\text{ V}$  (Note 20)

Symbol	Characteristic	-40°C			25°C			70°C(BGA)/85°C(QFN)***			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Negative Power Supply Current	23	30	39	23	30	39	23	30	39	mA
$V_{OH}$	Output HIGH Voltage (Note 21)	-1040	-990	-940	-1010	-960	-910	-985	-935	-885	mV
$V_{OL}$	Output LOW Voltage (Note 21) $-3.465\text{ V} \leq V_{EE} \leq -3.0\text{ V}$ (OLS = $V_{CC}$ ) (OLS = $V_{CC} - 0.4\text{ V}$ ) (OLS = $V_{CC} - 0.8\text{ V}$ , OLS = FLOAT) (OLS = $V_{CC} - 1.2\text{ V}$ ) **(OLS = $V_{EE}$ ) $-3.0\text{ V} < V_{EE} \leq -2.375\text{ V}$ (OLS = $V_{CC}$ ) (OLS = $V_{CC} - 0.4\text{ V}$ ) (OLS = $V_{CC} - 0.8\text{ V}$ , OLS = FLOAT) (OLS = $V_{CC} - 1.2\text{ V}$ ) (OLS = $V_{EE}$ )	-1980 -1270 -1750 -1040 -1515 -1945 -1265 -1725 -1045 -1495	-1830 -1210 -1630 -990 -1425 -1795 -1205 -1605 -995 -1405	-1680 -1120 -1510 -910 -1305 -1645 -1115 -1485 -915 -1285	-1940 -1235 -1715 -1010 -1480 -1905 -1230 -1690 -1010 -1460	-1790 -1175 -1595 -960 -1390 -1755 -1170 -1570 -960 -1370	-1640 -1085 -1475 -880 -1270 -1605 -1080 -1450 -880 -1250	-1910 -1210 -1685 -985 -1450 -1875 -1205 -1660 -990 -1435	-1760 -1150 -1565 -935 -1360 -1725 -1145 -1540 -940 -1345	-1610 -1060 -1445 -855 -1240 -1575 -1055 -1420 -860 -1225	mV
$V_{OUTPP}$	Output Voltage Amplitude $-3.465\text{ V} \leq V_{EE} \leq -3.0\text{ V}$ (OLS = $V_{CC}$ ) (OLS = $V_{CC} - 0.4\text{ V}$ ) (OLS = $V_{CC} - 0.8\text{ V}$ , OLS = FLOAT) (OLS = $V_{CC} - 1.2\text{ V}$ ) **(OLS = $V_{EE}$ ) $-3.0\text{ V} < V_{EE} \leq -2.375\text{ V}$ (OLS = $V_{CC}$ ) (OLS = $V_{CC} - 0.4\text{ V}$ ) (OLS = $V_{CC} - 0.8\text{ V}$ , OLS = FLOAT) (OLS = $V_{CC} - 1.2\text{ V}$ ) (OLS = $V_{EE}$ )	705 130 535 0 345 670 125 510 0 325	815 220 640 0 435 800 215 615 5 415		695 125 530 0 340 660 120 505 0 320	805 215 635 0 430 795 210 610 0 410		690 125 525 0 335 655 120 500 0 320	800 215 630 0 425 790 210 605 5 410		mV
$V_{IH}$	Input HIGH Voltage (Single-Ended) (Note 23) D, $\bar{D}$	$V_{EE} + 1275$	$V_{CC} - 1000^*$	$V_{CC}$	$V_{EE} + 1275$	$V_{CC} - 1000^*$	$V_{CC}$	$V_{EE} + 1275$	$V_{CC} - 1000^*$	$V_{CC}$	mV
$V_{IL}$	Input LOW Voltage (Single-Ended) (Note 24) D, $\bar{D}$	$V_{IH} - 2600$	$V_{CC} - 1400^*$	$V_{IH} - 150$	$V_{IH} - 2600$	$V_{CC} - 1400^*$	$V_{IH} - 150$	$V_{IH} - 2600$	$V_{CC} - 1400^*$	$V_{IH} - 150$	mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 22)	$V_{EE} + 1.2$		0.0	$V_{EE} + 1.2$		0.0	$V_{EE} + 1.2$		0.0	V
$R_{TIN}$	Internal Input Termination Resistor	45	50	55	45	50	55	45	50	55	$\Omega$
$I_{IH}$	Input HIGH Current (@ $V_{IH}$ ) D, $\bar{D}$ SEL		30 5	100 50		30 5	100 50		30 5	100 50	$\mu\text{A}$
$I_{IL}$	Input LOW Current (@ $V_{IL}$ ) D, $\bar{D}$ SEL		20 5	100 50		20 5	100 50		20 5	100 50	$\mu\text{A}$

NOTE: GigaComm circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500lfpm is maintained.

20. Input and output parameters vary 1:1 with  $V_{CC}$ .

21. All loading with  $50\ \Omega$  to  $V_{CC} - 2.0\text{ V}$ .

22.  $V_{IHCMR}$  min varies 1:1 with  $V_{EE}$ ,  $V_{IHCMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

23.  $V_{IH}$  cannot exceed  $V_{CC}$ .

24.  $V_{IL}$  always  $\geq V_{EE}$ .

\*Typicals used for testing purposes.

\*\*When an output level of 400 mV is desired and  $V_{CC} - V_{EE} > 3.0\text{ V}$ , a 2 k $\Omega$  resistor should be connected from OLS to  $V_{EE}$ .

\*\*\*The device packaged in FCBGA-16 have maximum ambient temperature specification of 70°C and devices packaged in QFN-16 have maximum ambient temperature specification of 85°C.



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**Table 13. AC CHARACTERISTICS for FCBGA-16**

$V_{CC} = 0\text{ V}$ ;  $V_{EE} = -3.465\text{ V}$  to  $-2.375\text{ V}$  or  $V_{CC} = 2.375\text{ V}$  to  $3.465\text{ V}$ ;  $V_{EE} = 0\text{ V}$

Symbol	Characteristic	-40°C			25°C			70°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$f_{max}$	Maximum Frequency (See Figure 8) (Note 25)	7	8		7	8		7	8		GHz
$V_{OUTPP}$	Output Voltage Amplitude (OLS = $V_{CC}$ ) $f_{in} \leq 7\text{ GHz}$	550	740		500	720		450	700		mV
$t_{PLH}$ , $t_{PHL}$	Propagation Delay to Output Differential D/SEL → Q	110	160	210	115	165	215	120	170	220	ps
$t_{SKEW}$	Duty Cycle Skew (Note 26)		5	15		5	15		5	15	ps
$t_{SKEW}$	Channel Skew Q → D/SEL		5	20		5	20		5	20	ps
$t_{JITTER}$	RMS Random Clock Jitter (See Figure 8) (Note 25) $f_{in} \leq 7\text{ GHz}$ Peak-to-Peak Data Dependent Jitter $f_{in} \leq 7\text{ Gb/s}$		0.5	1.5		0.5	1.5		0.5	1.5	ps
$V_{INPP}$	Input Voltage Swing/Sensitivity (Differential Configuration) (Note 27)	75		2600	75		2600	75		2600	mV
$t_r$ $t_f$	Output Rise/Fall Times (20% – 80%) (Q, $\bar{Q}$ ) @ 1 GHz	20	40	65	20	40	65	20	40	65	ps

25. Measured using a 500 mV source, 50% duty cycle clock source. All loading with  $50\ \Omega$  to  $V_{CC} - 2.0\text{ V}$ . Input edge rates 40 ps (20% – 80%).

26.  $t_{SKEW} = |t_{PLH} - t_{PHL}|$  for a nominal 50% differential clock input waveform. See Figure 12.

27.  $V_{INPP}$  (max) cannot exceed  $V_{CC} - V_{EE}$ .

**Table 14. AC CHARACTERISTICS for QFN-16**

$V_{CC} = 0\text{ V}$ ;  $V_{EE} = -3.465\text{ V}$  to  $-2.375\text{ V}$  or  $V_{CC} = 2.375\text{ V}$  to  $3.465\text{ V}$ ;  $V_{EE} = 0\text{ V}$

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$f_{max}$	Maximum Frequency (See Figure 8) (Note 28)	7	8		7	8		7	8		GHz
$V_{OUTPP}$	Output Voltage Amplitude (OLS = $V_{CC}$ ) $f_{in} \leq 7\text{ GHz}$ $f_{in} = 8\text{ GHz}$	590	730		470	720		540	700		mV mV
$t_{PLH}$ , $t_{PHL}$	Propagation Delay to Output Differential D/SEL → Q	110	160	210	115	165	215	120	170	220	ps
$t_{SKEW}$	Duty Cycle Skew (Note 29)		5	15		5	15		5	15	ps
$t_{SKEW}$	Channel Skew Q → D/SEL		5	20		5	20		5	20	ps
$t_{JITTER}$	RMS Random Clock Jitter (See Figure 8) (Note 31) $f_{in} \leq 7\text{ GHz}$ Peak-to-Peak Data Dependent Jitter (Note 32) $f_{in} \leq 7\text{ Gb/s}$		0.5	1.5		0.5	1.5		0.5	1.5	ps
$V_{INPP}$	Input Voltage Swing/Sensitivity (Differential Configuration) (Note 30)	75		2600	75		2600	75		2600	mV
$t_r$ $t_f$	Output Rise/Fall Times (20% – 80%) (Q, $\bar{Q}$ ) @ 1 GHz	30	45	60	30	45	60	30	45	60	ps
		17	35	65	17	35	65	17	35	65	

28. Measured using a 500 mV source, 50% duty cycle clock source. All loading with  $50\ \Omega$  to  $V_{CC} - 2.0\text{ V}$ . Input edge rates 40 ps (20% – 80%).

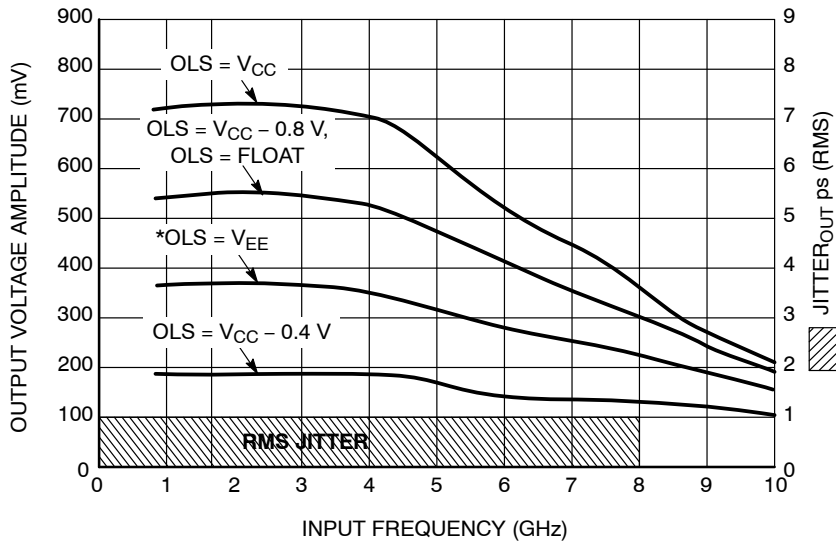
29.  $t_{SKEW} = |t_{PLH} - t_{PHL}|$  for a nominal 50% differential clock input waveform. See Figure 12.

30.  $V_{INPP}$  (max) cannot exceed  $V_{CC} - V_{EE}$ .

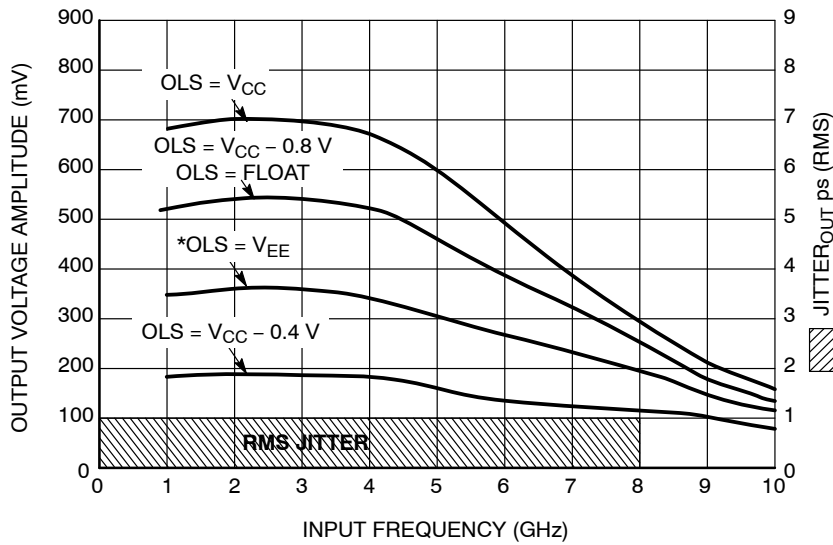
31. Additive RMS jitter with 50% duty cycle clock signal at 7 GHz.

32. Additive Peak-to-Peak data dependent jitter with NRZ PRBS  $2^{31}-1$  data rate at 7 Gb/s.

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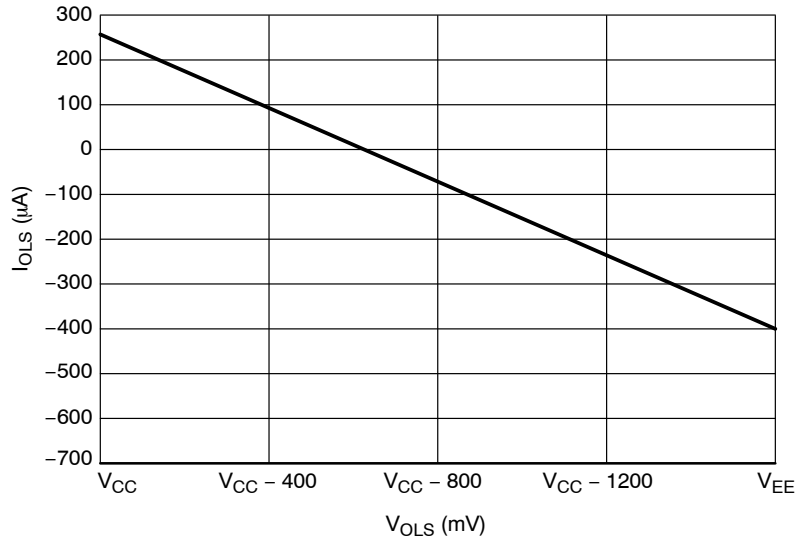
**Figure 8. Output Voltage Amplitude ( $V_{OUTPP}$ ) / RMS Jitter vs. Input Frequency ( $f_{in}$ ) for 2:1 MUX Mode ( $V_{CC} - V_{EE} = 2.5\text{ V}$  @  $25^\circ\text{C}$ ; Repetitive 1010 Input Data Pattern)**



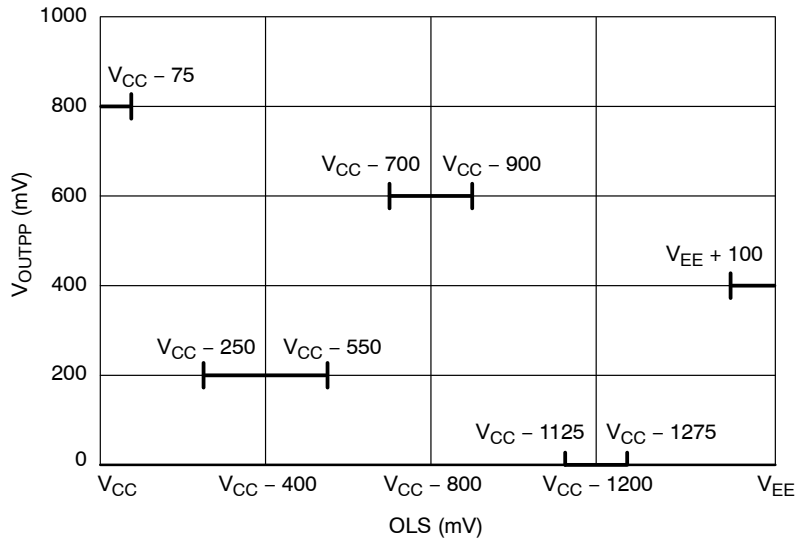
**Figure 9. Output Voltage Amplitude ( $V_{OUTPP}$ ) / RMS Jitter vs. Input Frequency ( $f_{in}$ ) for 2:1 MUX Mode ( $V_{CC} - V_{EE} = 3.3\text{ V}$  @  $25^\circ\text{C}$ ; Repetitive 1010 Input Data Pattern)**

\*When an output level of 400 mV is desired and  $V_{CC} - V_{EE} > 3.0\text{ V}$ , a 2 k $\Omega$  resistor should be connected from OLS to  $V_{EE}$ .

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**Figure 10. Typical OLS Input Current vs. OLS Input Voltage**  
 $(V_{CC} - V_{EE} = 3.3 \text{ V @ } 25^\circ\text{C})$



**Figure 11. OLS Operating Area**

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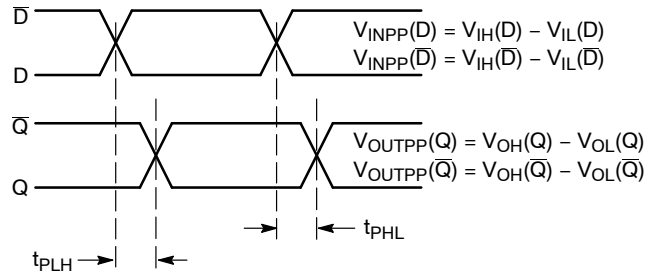


Figure 12. AC Reference Measurement

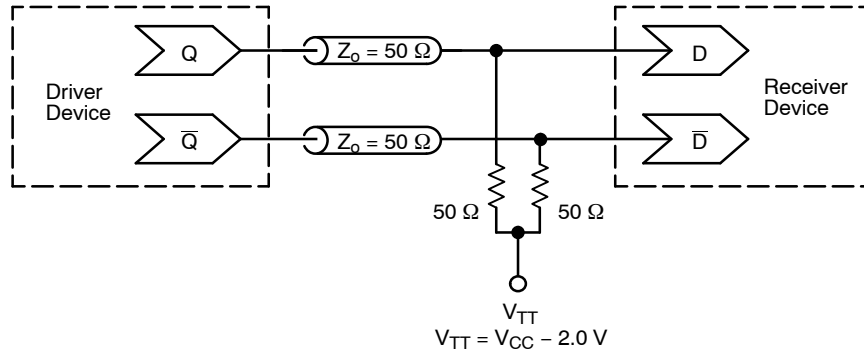


Figure 13. Typical Termination for Output Driver and Device Evaluation  
(See Application Note AND8020/D – Termination of ECL Logic Devices.)

### ORDERING INFORMATION

Device	Package Type	Shipping <sup>†</sup>
NBSG86ABAHTBG	FCBGA-16 (Pb-Free)	100 / Tape & Reel
NBSG86ABA	4x4 mm FCBGA-16	100 Units / Tray (Contact Sales Representative)
NBSG86ABAR2	4x4 mm FCBGA-16	100 / Tape & Reel (Contact Sales Representative)
NBSG86AMN	3x3 mm QFN-16	123 Units / Rail
NBSG86AMNG	3x3 mm QFN-16 (Pb-Free)	123 Units / Rail
NBSG86AMNR2G	3x3 mm QFN-16 (Pb-Free)	3000 / Tape & Reel
NBSG86AMNHTBG	QFN-16 (Pb-Free)	100 / Tape & Reel

Board	Description
NBSG86ABAEVB	NBSG86ABA Evaluation Board

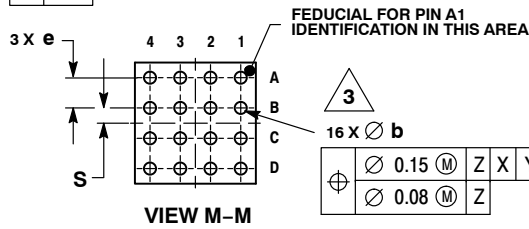
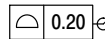
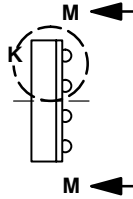
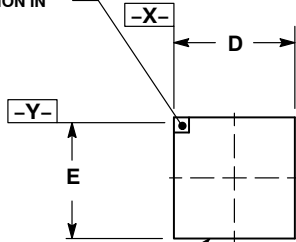
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# NBSG86A

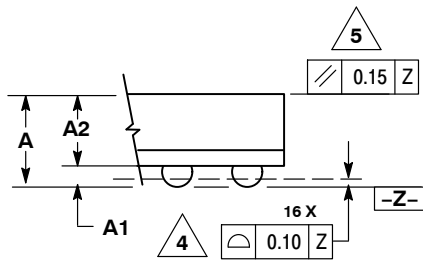
## PACKAGE DIMENSIONS

FCBGA-16  
 BA SUFFIX  
 PLASTIC 4 X 4 (mm) BGA FLIP CHIP PACKAGE  
 CASE 489-01  
 ISSUE O

LASER MARK FOR PIN 1  
 IDENTIFICATION IN  
 THIS AREA



VIEW M-M



DETAIL K  
 ROTATED 90° CLOCKWISE

### NOTES:

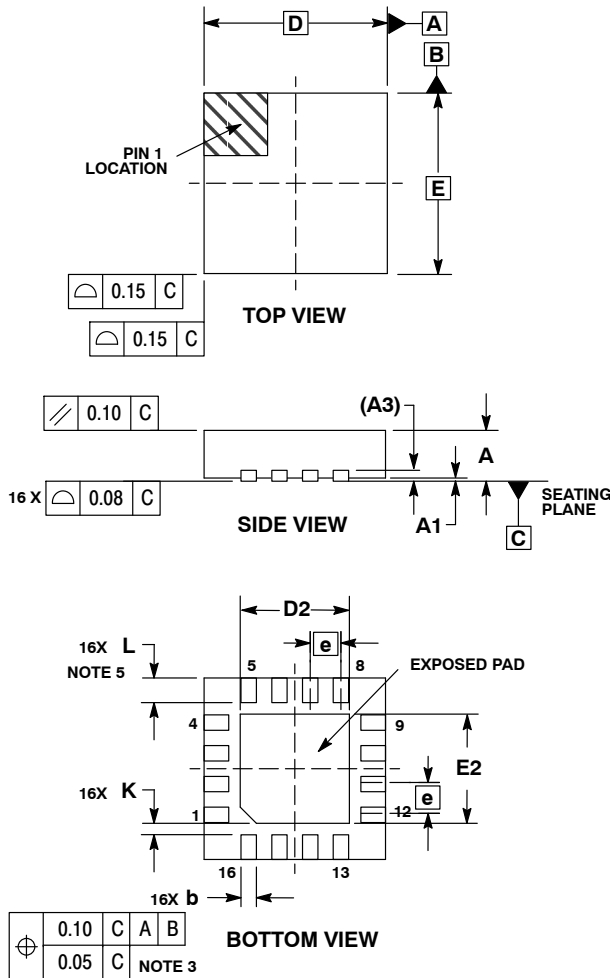
1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSION  $b$  IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER, PARALLEL TO DATUM PLANE Z.
4. DATUM Z (SEATING PLANE) IS DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
5. PARALLELISM MEASUREMENT SHALL EXCLUDE ANY EFFECT OF MARK ON TOP SURFACE OF PACKAGE.

MILLIMETERS		
DIM	MIN	MAX
A	1.40	MAX
A1	0.25	0.35
A2	1.20	REF
b	0.30	0.50
D	4.00	BSC
E	4.00	BSC
e	1.00	BSC
S	0.50	BSC

# NBSG86A

## PACKAGE DIMENSIONS

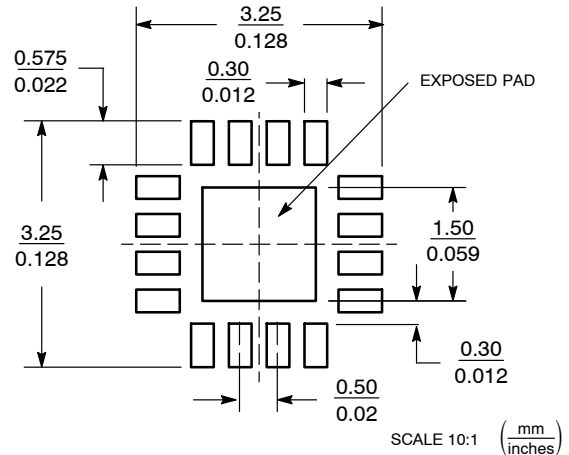
16 PIN QFN  
CASE 485G-01  
ISSUE C



- 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 0.25 AND 0.30 MM FROM TERMINAL.
  4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
  5.  $L_{\text{max}}$  CONDITION CAN NOT VIOLATE 0.2 MM MINIMUM SPACING BETWEEN LEAD TIP AND FLAG

MILLIMETERS		
DIM	MIN	MAX
A	0.80	1.00
A1	0.00	0.05
A3	0.20 REF	
b	0.18	0.30
D	3.00 BSC	
D2	1.65	1.85
E	3.00 BSC	
E2	1.65	1.85
e	0.50 BSC	
K	0.18 TYP	
L	0.30	0.50

### SOLDERING FOOTPRINT\*



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

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