

3.3 V Differential 1:21 Differential Fanout Clock Driver with HCSL level Output

NB4N121K

Description

The NB4N121K is a Clock differential input fanout distribution 1 to 21 HCSL level differential outputs, optimized for ultra low propagation delay variation. The NB4N121K is designed with HCSL clock distribution for FBDIMM applications in mind.

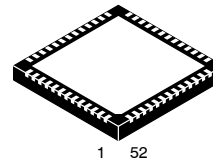
Inputs can accept differential LVPECL, CML, or LVDS levels. Single-ended LVPECL, CML, LVCMOS or LVTTL levels are accepted with the proper V_{REFAC} supply (see Figures 5, 10, 11, 12, and 13). Clock input pins incorporate an internal $50\ \Omega$ on die termination resistors.

Output drive current at I_{REF} (Pin 1) for 1X load is selected by connecting to GND. To drive a 2X load, connect I_{REF} to V_{CC} . See Figure 9.

The NB4N121K specifically guarantees low output-to-output skews. Optimal design, layout, and processing minimize skew within a device and from device to device. System designers can take advantage of the NB4N121K's performance to distribute low skew clocks across the backplane or the motherboard.

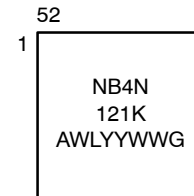
Features

- Typical Input Clock Frequency 100, 133, 166, 200, 266, 333 and 400 MHz
- 340 ps Typical Rise and Fall Times
- 800 ps Typical Propagation Delay
- Δt_{pd} 100 ps Maximum Propagation Delay Variation Per Each Differential Pair
- Additive Phase RMS Jitter: 1 ps Max
- Operating Range: $V_{CC} = 3.0\text{ V to }3.6\text{ V}$ with $V_{EE} = 0\text{ V}$
- Differential HCSL Output Level (700 mV Peak-to-Peak)
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



QFN-52
MN SUFFIX
CASE 485M

MARKING DIAGRAM*



A	= Assembly Site
WL	= Wafer Lot
YY	= Year
WW	= Work Week
G	= Pb-Free Package

*For additional marking information, refer to Application Note [AND8002/D](#).

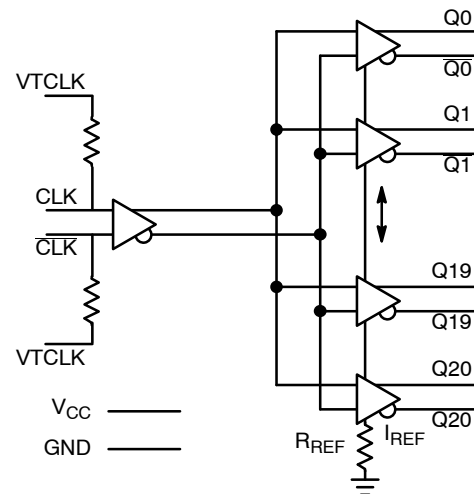


Figure 1. Pin Configuration (Top View)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

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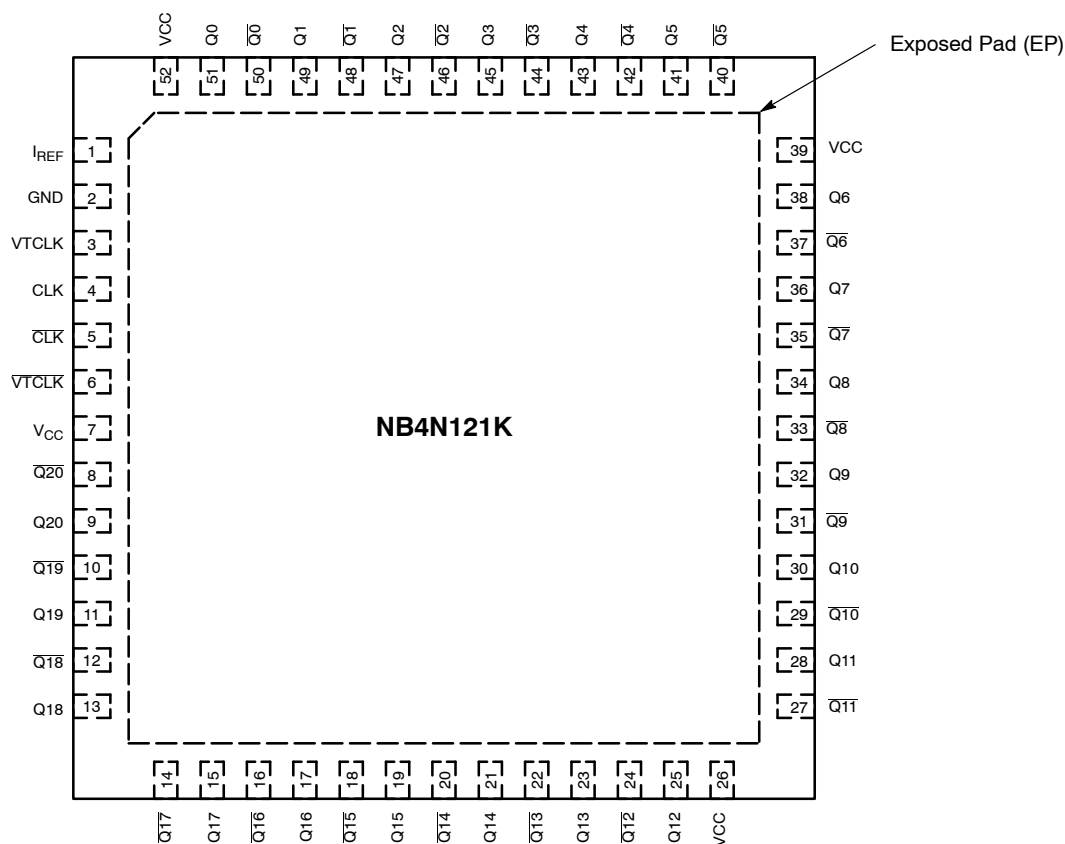


Figure 2. Pinout Configuration (Top View)

Table 1. PIN DESCRIPTION

Pin	Name	I/O	Description
1	I_{REF}	Output	Output current programming pin to select load drive. For 1X configuration, connect I_{REF} to GND, or for 2X configuration, connect I_{REF} to V_{CC} (See Figure 9).
2	GND	–	Supply Ground. GND pin must be externally connected to power supply to guarantee proper operation.
3, 6	VTCLK, VTCLK	–	Internal 50 Ω Termination Resistor connection Pins. In the differential configuration when the input termination pins are connected to the common termination voltage, and if no signal is applied then the device may be susceptible to self-oscillation.
4	CLK	LVPECL Input	CLOCK Input (TRUE)
5	\overline{CLK}	LVPECL Input	CLOCK Input (INVERT)
7, 26, 39, 52	V_{CC}	–	Positive Supply pins. V_{CC} pins must be externally connected to a power supply to guarantee proper operation.
8, 10, 12, 14, 16, 18, 20, 22, 24, 27, 29, 31, 33, 35, 37, 40, 42, 44, 46, 48, 50	$\overline{Q[20-0]}$	HCSL Output	Output (INVERT)
9, 11, 13, 15, 17, 19, 21, 23, 25, 28, 30, 32, 34, 36, 38, 41, 43, 45, 47, 49, 51	$Q[20-0]$	HCSL Output	Output (TRUE)
Exposed Pad	EP	GND	Exposed Pad. The thermally exposed pad (EP) on package bottom (see case drawing) must be attached to a sufficient heat-sinking conduit for proper thermal operation. (Note 1)

1. The exposed pad must be connected to the circuit board ground.

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Table 2. ATTRIBUTES

Characteristic	Value
Input Default State Resistors	None
ESD Protection Human Body Model Machine Model	>2 kV 400 V
Moisture Sensitivity (Note 2) QFN-52	Level 1
Flammability Rating Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in
Transistor Count	622
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test	

2. For additional information, see Application Note [AND8003/D](#).

Table 3. MAXIMUM RATINGS (Note 3)

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
V_{CC}	Positive Power Supply	GND = 0 V		4.6	V
V_I	Positive Input	GND = 0 V		$GND - 0.3 \leq V_I \leq V_{CC}$	V
V_{INPP}	Differential Input Voltage CLK – CLKb			V_{CC}	V
I_{OUT}	Output Current	Continuous Surge		50 100	mA mA
T_A	Operating Temperature Range	QFN-52		–40 to +70	°C
T_{stg}	Storage Temperature Range			–65 to +150	°C
θ_{JA}	Thermal Resistance (Junction-to-Ambient) (Note 3)	0 lfpm 500 lfpm	QFN-52 QFN-52	25 19.6	°C/W °C/W
θ_{JC}	Thermal Resistance (Junction-to-Case)	2S2P (Note 4)	QFN-52	21	°C/W
T_{sol}	Wave Solder Pb-Free			265	°C

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

3. JEDEC standard 51–6, multilayer board – 2S2P (2 signal, 2 power).

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

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Table 4. DC CHARACTERISTICS ($V_{CC} = 3.0\text{ V to }3.6\text{ V}$, $T_A = -40^\circ\text{C to }+70^\circ\text{C}$ Note 5)

Symbol	Characteristic	Min	Typ	Max	Unit
I_{GND}	GND Supply Current (All Outputs Loaded)	70	98	120	mA
I_{CC}	Power Supply Current (All Outputs Loaded) 1X 2X		420 780		mA
I_{IH}	Input HIGH Current $CLKx$, \overline{CLKx}		2.0	150	μA
I_{IL}	Input LOW Current $CLKx$, \overline{CLKx}	-150	-2.0		μA

DIFFERENTIAL INPUT DRIVEN SINGLE-ENDED (Figures 5 and 7)

V_{th}	Input Threshold Reference Voltage Range (Note 6)	1050		$V_{CC} - 150$	mV
V_{IH}	Single-Ended Input HIGH Voltage	$V_{th} + 150$		V_{CC}	mV
V_{IL}	Single-Ended Input LOW Voltage	GND		$V_{th} - 150$	mV

DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY (Figures 6 and 8)

V_{IHD}	Differential Input HIGH Voltage	1200		V_{CC}	mV
V_{ILD}	Differential Input LOW Voltage	GND		$V_{CC} - 75$	mV
V_{ID}	Differential Input Voltage ($V_{IHD} - V_{ILD}$)	75		2400	mV
V_{CMR}	Input Common Mode Range	1163		$V_{CC} - 75$	

HCSL OUTPUTS (Figure 4)

V_{OH}	Output HIGH Voltage	600	740	900	mV
V_{OL}	Output LOW Voltage	-150	0	150	mV

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm.

- Input parameters vary 1:1 with V_{CC} . Measurements taken with outputs in either 1X (all outputs loaded $50\ \Omega$ to GND) or 2X (all outputs loaded $25\ \Omega$ to GND) configuration, see Figure 9. For 1X configuration, connect I_{REF} to GND, or for 2X configuration, connect I_{REF} to V_{CC} .
- V_{th} is applied to the complementary input when operating in single ended mode.

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Table 5. AC CHARACTERISTICS $V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$, $GND = 0 \text{ V}$; $-40^{\circ}\text{C to } +70^{\circ}\text{C}$ (Note 7)

Symbol	Characteristic	Min	Typ	Max	Unit
V_{OUTPP}	Output Voltage Amplitude (@ $V_{INPPmin}$) $f_{in} = 133 \text{ MHz}$ $f_{in} = 166 \text{ MHz}$ $f_{in} = 200 \text{ MHz}$		725 725 725	900 900 900	mV
t_{PLH} , t_{PHL}	Propagation Delay to (See Figure 3) CLK/\overline{CLK} to Qx/\overline{Qx}	550	800	950	ps
Δt_{PLH} , Δt_{PHL}	Propagation Delay Variations Variation Per Each Diff Pair CLK/\overline{CLK} to Qx/\overline{Qx} (Note 8) (See Figure 3)			100	ps
t_{SKEW}	Duty Cycle Skew (Note 9) Within-Device Skew, 1X Mode Only (Note 10) Within-Device Skew, 2X Mode (Note 10) Device-to-Device Skew (Note 10)			20 50 80 150	ps ps ps ps
$t_{jit(\phi)}$	Additive RMS Phase RMS (Note 11) $f_{in} = 133 \text{ MHz to } 200 \text{ MHz}$			1	ps
V_{cross}	Absolute Crossing Magnitude Voltage	250		550	mV
ΔV_{cross}	Variation in Magnitude of V_{cross}			150	mV
t_r , t_f	Absolute Magnitude in Output Risetime and Falltime (From 175 mV to 525 mV) Qx , \overline{Qx}	175	340	700	ps
Δt_r , Δt_f	Variation in Magnitude of Risetime and Falltime (Single-Ended) (See Figure 4) Qx , \overline{Qx} 1X 2X			125 150	ps

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfm.

7. Measured by forcing V_{INPP} (MIN) from a 50% duty cycle clock source. Measurements taken with outputs in either 1X (all outputs loaded 50Ω to GND) or 2X (all outputs loaded 25Ω to GND) configuration, see Figure 9. For 1X configuration, connect I_{REF} to GND, or for 2X configuration, connect I_{REF} to V_{CC} . Typical gain is 20 dB.
8. Measured from the input pair crosspoint to each single output pair crosspoint across temp and voltage ranges.
9. Duty cycle skew is measured between differential outputs using the deviations of the sum of T_{pw-} and T_{pw+} .
10. Skew is measured between outputs under identical transition @ 133 MHz.
11. Additive RMS jitter with 50% duty cycle clock signal using phase noise integrated from 12 KHz to 33 MHz

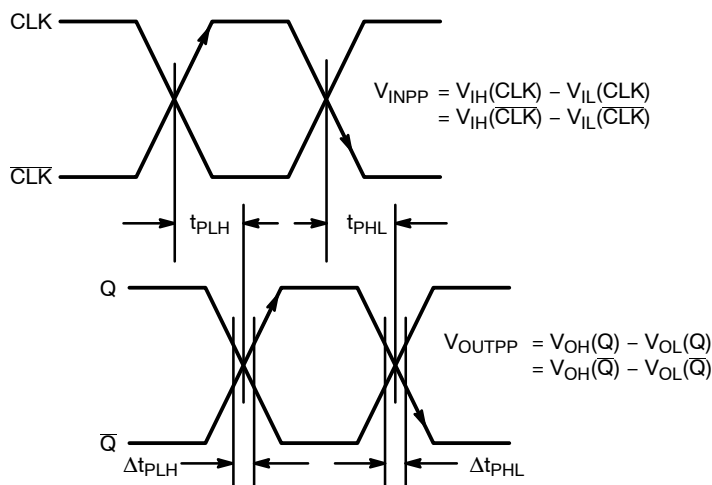


Figure 3. AC Reference Measurement

NB4N121K

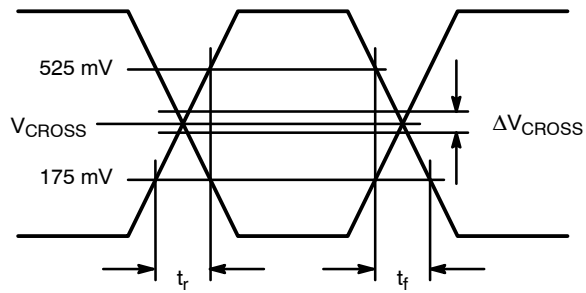


Figure 4. HCSL Output Parameter Characteristics

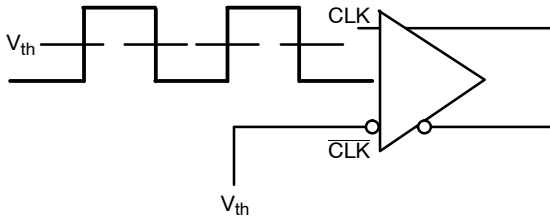


Figure 5. Differential Input Driven Single-Ended ($V_{th} = V_{REFAC}$)

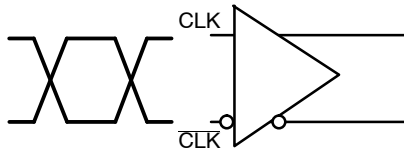


Figure 6. Differential Inputs Driven Differentially

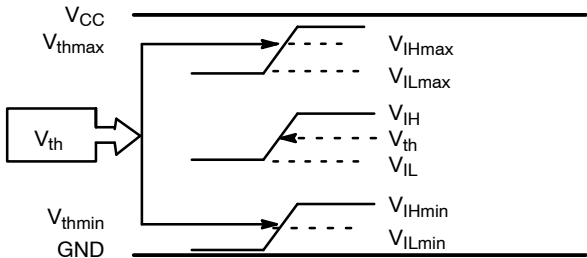


Figure 7. V_{th} Diagram

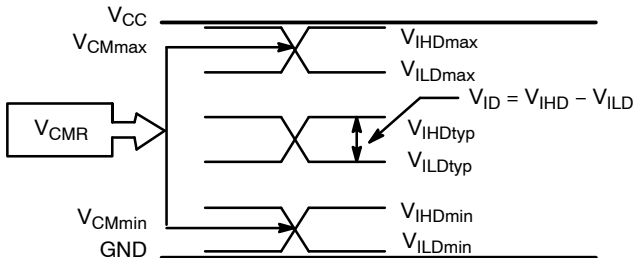


Figure 8. V_{CMR} Diagram

The diagram shows an HCSSL Driver with two outputs, Q_X and $\overline{Q_X}$. The Q_X output is connected to a resistor R_{S1}^C and a capacitor $Z_0 = 50\ \Omega$. The $\overline{Q_X}$ output is connected to a resistor R_{S2}^C and a capacitor $Z_0 = 50\ \Omega$. A reference resistor R_{REF}^A is connected to the $\overline{Q_X}$ output and ground. The driver is connected to two receiver inputs. The first receiver, labeled "Receiver", has a 1X Load configuration with a 50 Ω resistor R_{L1}^B and a 50 Ω resistor R_{L2}^B in parallel, followed by a 2 pF capacitor $CL1^D$ and a 2 pF capacitor $CL2^D$ in series. The second receiver, labeled "Receiver 2", has a 2X Load Option configuration with a 2 pF capacitor $CL3^D$ and a 2 pF capacitor $CL4^D$ in series. The diagram also includes a ground symbol and a VCC pin.

For 1X configuration, connect I_{REF} pin to V_{CC} . To adjust load drive for 1X configuration, use R_{REF} from 0 Ω to 20 k Ω . To adjust 2X load, use 20 k Ω to 200 k Ω .

For 1X Load, R_{L1} , R_{L2} : 50 Ω for 1X Load

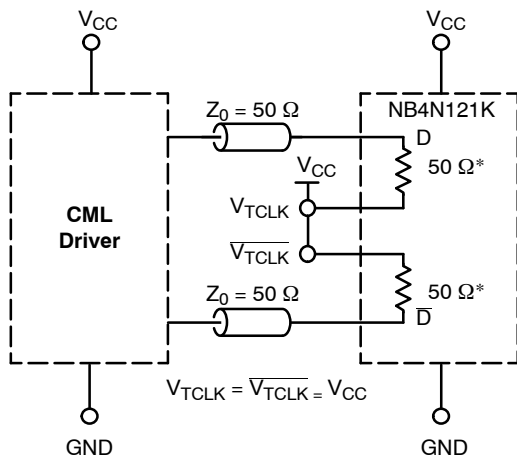
For 2X Load, R_{L1} , R_{L2} : 0 Ω for Test and 200 k Ω for Minimizing Ringing.

For 2X Load, $CL1$, $CL2$, $CL3$, $CL4$: Receiver Input Load Capacitance Only

The schematic diagram illustrates the LVPECL driver circuit for the NB4N121K device. It consists of two main functional blocks: an LVPECL Driver and the NB4N121K device itself.

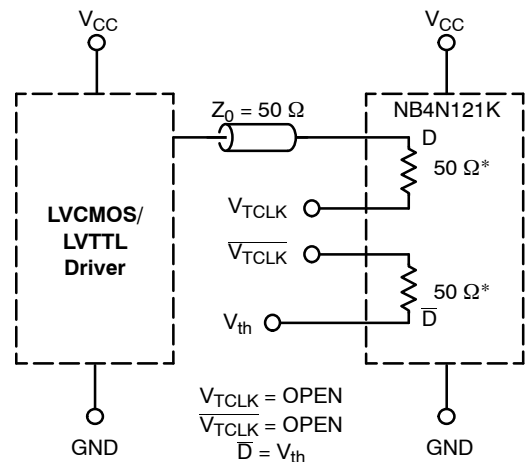
- LVPECL Driver:** Represented by a dashed box on the left. It has a $V_{CC} = 3.3\text{ V}$ supply at the top and a GND connection at the bottom. It provides two differential outputs, labeled V_{TCLK} and $\overline{V_{TCLK}}$.
- Termination:** Each output from the driver is connected to a $50\ \Omega$ resistor, labeled $Z_0 = 50\ \Omega$.
- NB4N121K Device:** Represented by a dashed box on the right. It also has a $V_{CC} = 3.3\text{ V}$ supply at the top and a GND connection at the bottom. It features two differential inputs, labeled D and \overline{D} , each with a $50\ \Omega^*$ termination resistor connected to GND.
- Connections:** The $50\ \Omega$ resistor on the V_{TCLK} line connects to the D input of the NB4N121K. Similarly, the $50\ \Omega$ resistor on the $\overline{V_{TCLK}}$ line connects to the \overline{D} input of the NB4N121K.
- Equation:** Below the driver block, the relationship $V_{TCLK} = \overline{V_{TCLK}} = V_{CC} - 2.0\text{ V}$ is specified.

Figure 11. LVDS Interface

NB4N121K

*RTIN, Internal Input Termination Resistor

Figure 12. Standard 50 Ω Load CML Interface



*RTIN, Internal Input Termination Resistor

Figure 13. LVCMOS/LVTTL Interface

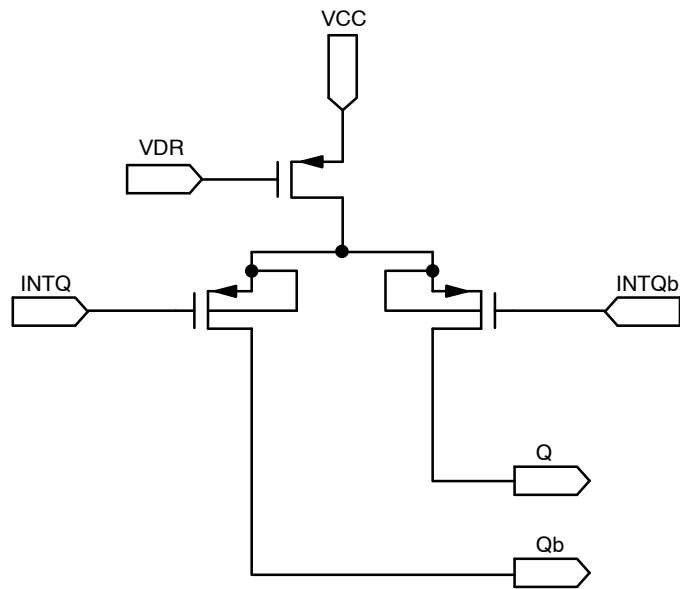
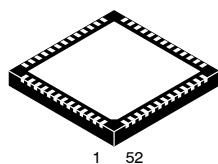


Figure 14. HCSL Output Structure

ORDERING INFORMATION

Device	Package	Shipping [†]
NB4N121KMNR2G	QFN-52 (Pb-Free)	2000 / Tape & Reel

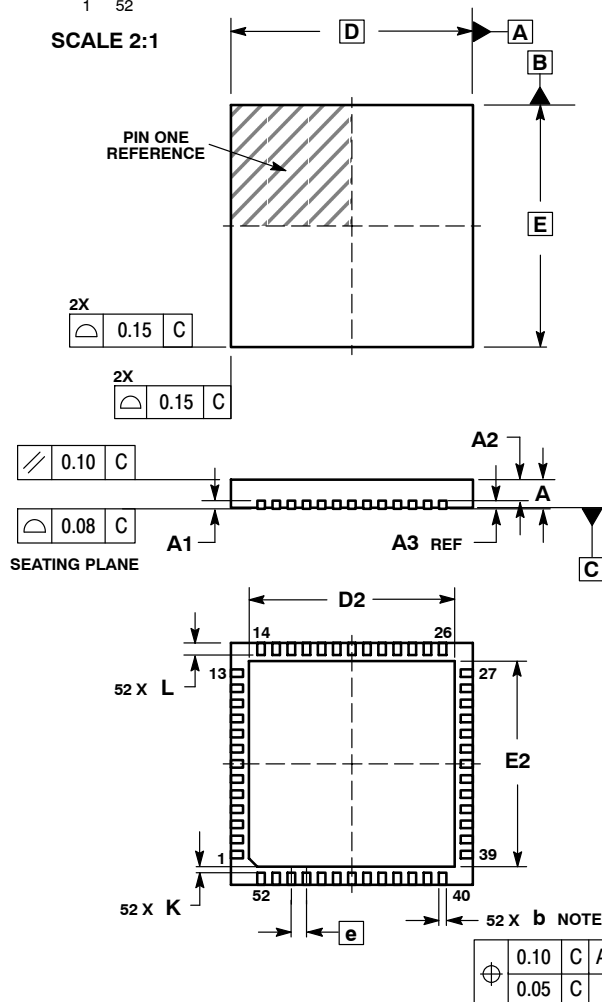
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, [BRD8011/D](#).



QFN52 8x8, 0.5P
CASE 485M
ISSUE C

DATE 16 FEB 2010

SCALE 2:1

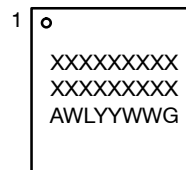


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CIRCULATING 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.

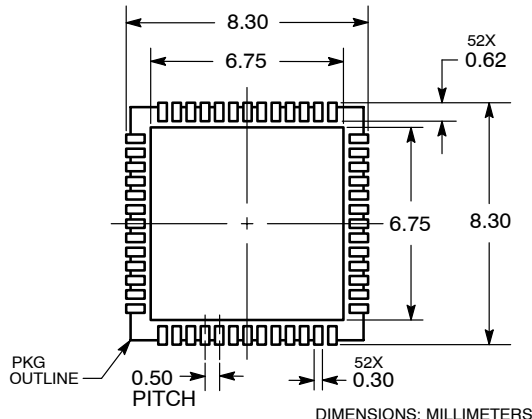
DIM	MILLIMETERS	
	MIN	MAX
A	0.80	1.00
A1	0.00	0.05
A2	0.60	0.80
A3	0.20 REF	
b	0.18	0.30
D	8.00 BSC	
D2	6.50	6.80
E	8.00 BSC	
E2	6.50	6.80
e	0.50 BSC	
K	0.20	---
I	0.30	0.50

GENERIC MARKING DIAGRAM



XXXXXXXXXX = Device Code
A = Assembly Site
WL = Wafer Lot
YY = Year
WW = Work Week
G = Pb-Free Package

RECOMMENDED SOLDERING FOOTPRINT



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DESCRIPTION:	52 PIN QFN, 8X8, 0.5P	PAGE 1 OF 1

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