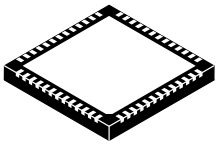
NB7L111M

2.5V/3.3V, 6.125Gb/s 2:1:10 Differential Clock/Data Driver with CML Output

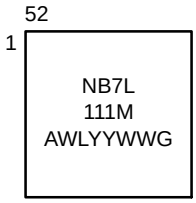
ON Semiconductor®

www.onsemi.com



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.

ORDERING INFORMATION

See detailed ordering and shipping information on page 12 of this data sheet.

Description

The NB7L111M is a low skew 2:1:10 differential clock/data driver, designed with clock/data distribution in mind. It accepts two clock/data sources into multiplexer input and reproduces ten identical CML differential outputs. This device is ideal for clock/data distribution across the backplane or a board, and redundant clock switchover applications.

The input signals can be either differential or single–ended (if the external reference voltage is provided). Differential inputs incorporate internal 50 Ω termination resistors and accept Negative ECL (NECL), Positive ECL (PECL), LVCMOS, LVTTL, CML, or LVDS (using appropriate power supplies). The differential 16 mA CML output provides matching internal 50 Ω termination, and 400 mV output swing when externally terminated 50 Ω to V_{CC}.

The NB7L111M operates from a 2.5 V ±5% supply or a 3.3 V ±5% supply and is guaranteed over the full industrial temperature range of −40°C to +85°C. This device is packaged in a low profile 8x8 mm, QFN−52 package with 0.5 mm pitch (see package dimension on the back of the datasheet).

Application notes, models, and support documentation are available at www.onsemi.com.

Features

- Maximum Input Clock Frequency > 5.5 GHz Typical
- Maximum Input Data Rate > 6.125 Gb/s Typical
- < 0.5 ps Maximum Clock RMS Jitter
- < 15 ps Maximum Data Dependent Jitter at 3.125 Gb/s
- 50 ps Typical Rise and Fall Times
- 240 ps Typical Propagation Delay
- 2 ps Typical Duty Cycle Skew
- 10 ps Typical Within Device Skew
- 15 ps Typical Device−to−Device Skew
- Operating Range: V_{CC} = 2.5 V ±5 and 3.3 V ±5
- 400 mV Differential CML Output Swing
- 50 Ω Internal Input and Output Termination Resistors
- These Devices are Pb−Free and are RoHS Compliant*

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

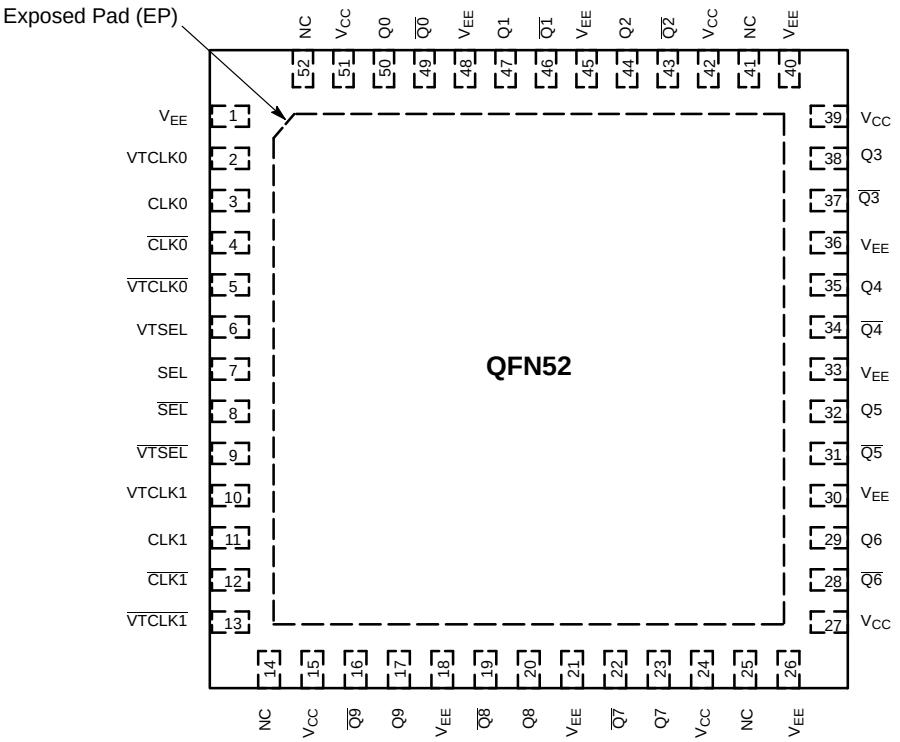


Figure 1. Pinout (Top View)

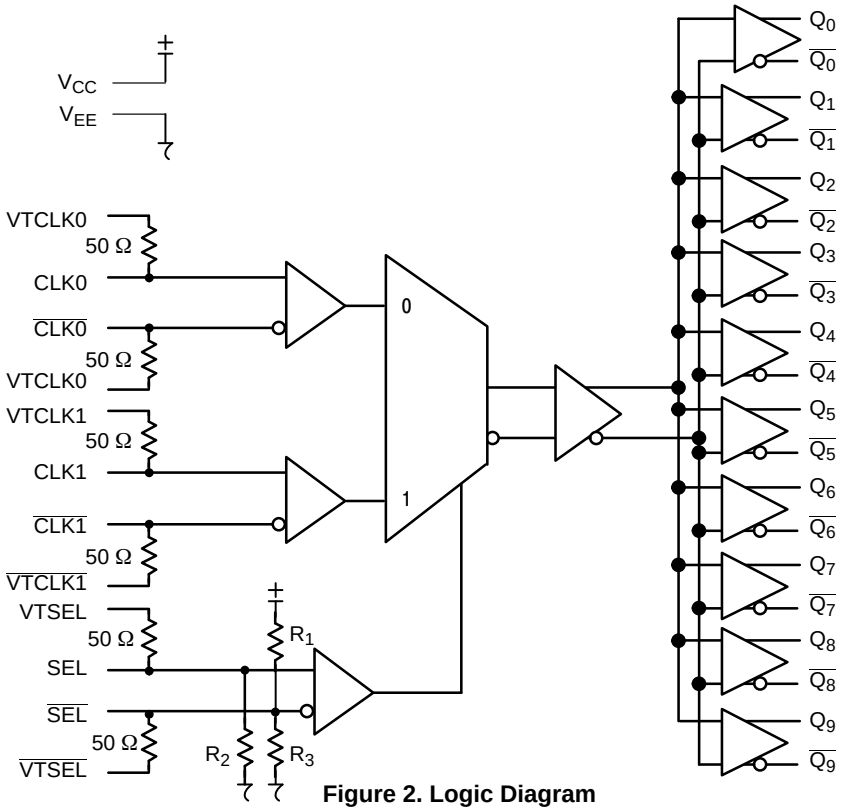


Figure 2. Logic Diagram

Table 1. FUNCTION TABLE

SEL	$\overline{SEL}$	CLK0/$\overline{CLK0}$	CLK1/$\overline{CLK1}$
LOW	HIGH	ON	OFF
HIGH	LOW	OFF	ON

Table 2. PIN DESCRIPTION

Pin	Name	I/O	Description
15, 24, 27, 39, 42, 51	V_{CC}	−	Positive supply voltage. All V_{CC} pins must be externally connected to power supply to guarantee proper operation.
1, 18, 21, 26, 30, 33, 36, 40, 45, 48	V_{EE}	−	Negative supply voltage. All V_{EE} pins must be externally connected to power supply to guarantee proper operation.
2	VTCLK0	−	Internal 50 Ω termination pin for CLK0. (Note 2)
3	CLK0	LVPECL, CML, LVCMOS, LVTTL, LVDS Input	Non−inverted differential clock/data input 0 (Note 2).
4	$\overline{\text{CLK0}}$	LVPECL, CML, LVCMOS, LVTTL, LVDS Input	Inverted differential clock/data input 0 (Note 2).
5	$\overline{\text{VTCLK0}}$	−	Internal 50 Ω termination pin for $\overline{\text{CLK0}}$. (Note 2)
6	VTSEL		Internal 50 Ω termination pin for SEL. (Note 2)
7	SEL	LVPECL, CML, LVCMOS, LVTTL, LVDS Input	Non−inverted differential clock/data select input. Internal 75 kΩ to V_{EE}.
8	$\overline{\text{SEL}}$	LVPECL, CML, LVCMOS, LVTTL, LVDS Input	Inverted differential clock/data select input. Internal 56 KΩ to V_{CC} and 56 kΩ to V_{EE} bias this pin to (V_{CC}−V_{EE})/2.
9	$\overline{\text{VTSEL}}$	LVPECL, CML, LVCMOS, LVTTL, LVDS Input	Internal 50 Ω termination pin for $\overline{\text{SEL}}$. (Note 2)
10	VTCLK1	−	Internal 50 Ω termination pin for CLK1. (Note 2)
11	CLK1	LVPECL, CML, LVCMOS, LVTTL, LVDS Input	Non−inverted differential clock/data input 1 (Note 2).
12	$\overline{\text{CLK1}}$	LVPECL, CML, LVCMOS, LVTTL, LVDS Input	Inverted differential clock/data input 1 (Note 2).
13	$\overline{\text{VTCLK1}}$	−	Internal 50 Ω termination pin for $\overline{\text{CLK1}}$. (Note 2)
14, 25, 41, 52	NC	−	
17, 20, 23, 29, 32, 35, 38, 44, 47, 50	Q[0−9]	CML Outputs	Non−inverted CML outputs [0−9] with internal 50 Ω source termination resistor (Note 1).
16, 19, 22, 28, 31, 34, 37, 43, 46, 49	$\overline{\text{Q[0−9]}}$	CML Outputs	Inverted CML outputs [0−9] with internal 50 Ω source termination resistor (Note 1).
EP	−	−	Exposed Pad (EP). The thermally exposed pad on package bottom (see case drawing) must be attached to a heat−sinking conduit on the printed circuit board.

1. CML output requires 50 Ω receiver termination resistor to V_{CC} for proper operation.
2. In the differential configuration when the input termination pin (VTCLK, $\overline{\text{VTCLK}}$) are connected to a common termination voltage or left open, and if no signal is applied on CLK and $\overline{\text{CLK}}$ then the device will be susceptible to self−oscillation.

Table 3. ATTRIBUTES

Characteristics		Value	
Input Default State Resistors	R1, R3 R2	56 kΩ 75 kΩ	
ESD Protection	Human Body Model Machine Model	> 1400 V > 80 V	
Moisture Sensitivity (Note 3)		Pb Pkg	Pb−Free Pkg
	QFN−52	Level 2	Level 1
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V−0 @ 0.125 in	
Transistor Count		339	
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test			

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

Table 4. MAXIMUM RATINGS (Note 4)

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
V_{CC}	Positive Power Supply	V_{EE} = 0 V		3.6	V
V_I	Input Voltage	V_{EE} = 0 V	$V_{EE} \le V_I \le V_{CC}$	3.6	V
V_{INPP}	Differential Input Voltage |CLK − $\overline{CLK}$|	$V_{CC} - V_{EE} \ge 2.8$ V $V_{CC} - V_{EE} < 2.8$ V		2.8 $\|V_{CC} - V_{EE}\|$	V V
I_{in}	Input Current Through R_T (50 Ω Resistor)	Continuous Surge		25 50	mA mA
I_{out}	Output Current	Continuous Surge		25 50	mA mA
T_A	Operating Temperature Range	QFN52		−40 to +85	°C
T_{stg}	Storage Temperature Range			−65 to +150	°C
θ_{JA}	Thermal Resistance (Junction−to−Ambient) (Note 5)	0 lfpm 500 lfpm	QFN52	25 19.6	°C/W °C/W
θ_{JC}	Thermal Resistance (Junction−to−Case)	1S2P (Note 8)	QFN52	21	°C/W
T_{sol}	Wave Solder Pb Pb−Free			265 265	°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.

4. Maximum Ratings are those values beyond which device damage may occur.
5. JEDEC standard multilayer board − 1S2P (1 signal, 2 power).

Table 5. DC CHARACTERISTICS V_{CC} = 2.375 V 2.625 V and 3.135 V to 3.465 V, V_{EE} = 0 V, T_A = −40°C to +85°C (Notes 6 and 7)

Symbol	Characteristic	Min	Typ	Max	Unit
I_{CC}	Power Supply Current (Inputs and Outputs Open) V_{CC} = 2.375 V to 2.625 V V_{CC} = 3.135 V to 3.465 V	 255 270	 290 305	 325 340	mA
V_{OH}	Output HIGH Voltage (Notes 6 and 7)	V_{CC} − 40	V_{CC} − 20	V_{CC}	mV
V_{OL}	Output LOW Voltage (Notes 6 and 7) V_{CC} = 2.375 V to 2.625 V V_{CC} = 3.135 V to 3.465 V	 V_{CC} − 440 V_{CC} − 490	 V_{CC} − 350 V_{CC} − 400	 V_{CC} – 290 V_{CC} − 340	mV
DIFFERENTIAL INPUT DRIVEN SINGLE−ENDED (See Figures 13 and 15)					
V_{th}	Input Threshold Reference Voltage Range (Note 8)	1125		V_{CC} – 75	mV
V_{IH}	Single−ended Input HIGH Voltage (Note 7)	V_{th} + 75		V_{CC}	mV
V_{IL}	Single−ended Input LOW Voltage (Note 7)	V_{EE}		V_{CC} – 150	mV
DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY (See Figures 14 and 16)					
V_{IHD}	Differential Input HIGH Voltage	1200		V_{CC}	mV
V_{ILD}	Differential Input LOW Voltage	V_{EE}		V_{CC} – 75	mV
V_{CMR}	Input Common Mode Range (Differential Configuration) (Note 9)	1163		V_{CC} – 37	mV
V_{ID}	Differential Input Voltage (V_{IHD} − V_{ILD})	75		2500	mV
I_{IH}	Input HIGH Current (Termination Pins Open) CLK[0−1]/$\overline{\text{CLK[0−1]}}$ SEL/$\overline{\text{SEL}}$	 −100 −150	 5	 100 150	μA
I_{IL}	Input LOW Current (Termination Pins Open) CLK[0−1]/$\overline{\text{CLK[0−1]}}$ SEL/$\overline{\text{SEL}}$	 −100 −150	 5	 100 150	μA
R_{TIN}	Internal Input Termination Resistor	45	50	55	Ω
R_{TOUT}	Internal Output Termination Resistor	45	50	55	Ω
$R_{Temp\ Coef}$	Internal I/O Termination Resistor Temperature Coefficient		−3.75		mΩ/C

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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.

6. CML outputs require 50 Ω receiver termination resistors to V_{CC} for proper operation.
7. Input and output parameters vary 1:1 with V_{CC}.
8. V_{th} is applied to the complementary input when operating in single−ended mode.
9. V_{CMR}(MIN) varies 1:1 with V_{EE}, V_{CMR}(MAX) varies 1:1 with V_{CC}.

Table 6. AC CHARACTERISTICS V_{CC} = 2.375 V to 2.625 V and 3.135 V to 3.465 V, V_{EE} = 0 V; (Note 10)

Symbol	Characteristic	−40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_{OUTPP}	Output Voltage Amplitude (@ $V_{inppmin}$) (See Figures 3, 4, 5, and 6)										mV
	V_{CC} = 2.375 V to 2.625 V										
	$f_{in} \le 3$ GHz	240	330		240	330		240	330		
	$f_{in} \le 5.5$ GHz	115	220		115	220		115	220		
	V_{CC} = 3.135 V to 3.465 V										
	$f_{in} \le 3$ GHz	250	350		250	350		250	350		
	$f_{in} \le 5.5$ GHz	130	250		130	250		130	250		
f_{DATA}	Maximum Operating Data Rate	5	6		5	6		5	6		Gb/s
t_{PLH}, t_{PHL}	Differential Input−to−Output Propagation Delay @ 1 GHz (See Figures 7 and 11) CLK−Q	200	240	280	200	240	280	200	240	280	ps
	SEL−Q	290	340	390	290	340	390	290	340	390	
t_{SKEW}	Duty Cycle Skew (Note 11)		2	15		2	15		2	15	ps
	Within Device Skew		10	20		10	20		10	20	
	Device−to−Device Skew (Note 15)		15	80		15	80		15	80	
t_{JITTER}	RMS Random Clock Jitter (Note 13)										ps
	f_{in} = 3 GHz		0.2	0.5		0.2	0.5		0.2	0.5	
	f_{in} = 5.5 GHz		0.2	0.5		0.2	0.5		0.2	0.5	
	Peak−to−Peak Data Dependent Jitter (Note 14)										
	f_{DATA} = 3.125 Gb/s		6	15		6	15		6	15	
	f_{DATA} = 5 Gb/s		15	25		15	25		15	25	
	f_{DATA} = 6.125 Gb/s		15	25		15	25		15	25	
V_{INPP}	Input Voltage Swing/Sensitivity (Differential Configuration) (Note 12 and Figures 3, 4, 5, and 6)	75	400	2500	75	400	2500	75	400	2500	mV
t_r t_f	Output Rise/Fall Times @ 1 GHz (20% − 80%)		50	75		50	75		50	75	ps

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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.

10. Measured by forcing V_{INPP}(MIN) from a 50% duty cycle clock source. All loading with an external R_L = 50 Ω to V_{CC}. Input edge rates 40 ps (20% − 80%).
11. Duty cycle skew is measured between differential outputs using the deviations of the sum of Tpw− and Tpw+ @ 1 GHz.
12. V_{INPP}(MAX) cannot exceed V_{CC} − V_{EE}. Input voltage swing is a single−ended measurement operating in differential mode.
13. Additive RMS jitter with 50% duty cycle clock signal.
14. Additive peak−to−peak data dependent jitter with input NRZ data at PRBS 2^{23}−1.
15. Device−to−device skew is measured between outputs under identical transition and conditions @ 1 GHz.

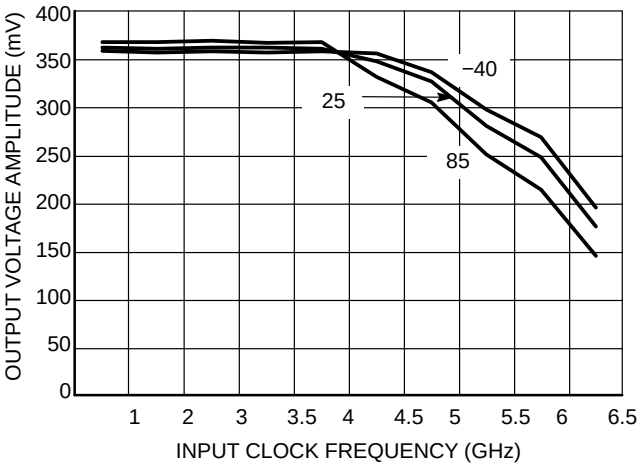


Figure 3. Output Voltage Amplitude vs. Input Clock Frequency and Temperature (V_{inpp} = 400 mV; V_{CC} = 3.3 V)

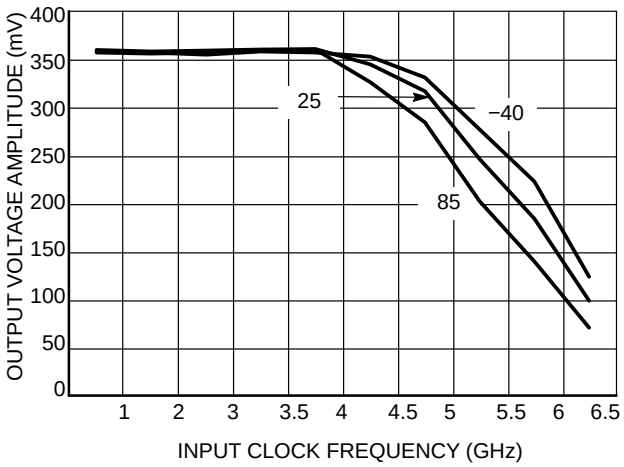


Figure 4. Output Voltage Amplitude vs. Input Clock Frequency and Temperature (V_{inpp} = 75 mV; V_{CC} = 3.3 V)

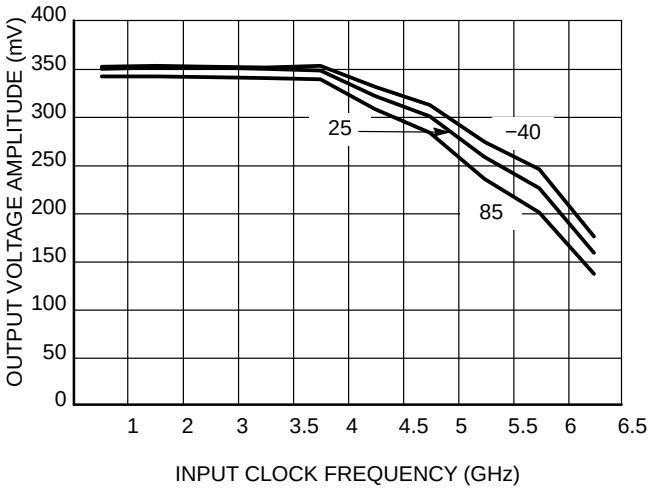


Figure 5. Output Voltage Amplitude vs. Input Clock Frequency and Temperature (V_{inpp} = 400 mV; V_{CC} = 2.5 V)

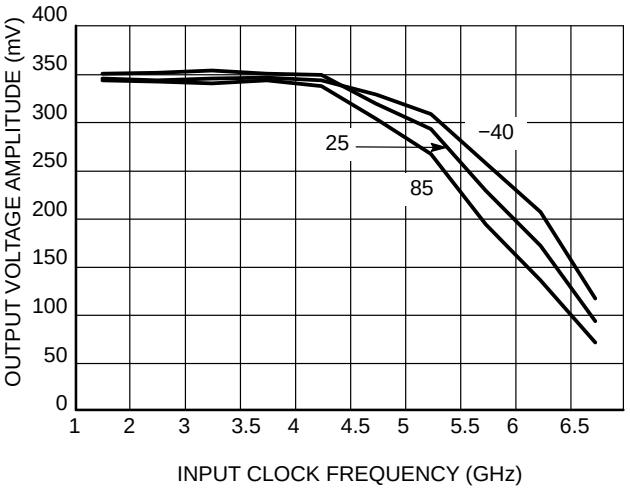


Figure 6. Output Voltage Amplitude vs. Input Clock Frequency and Temperature (V_{inpp} = 75 mV; V_{CC} = 2.5 V)

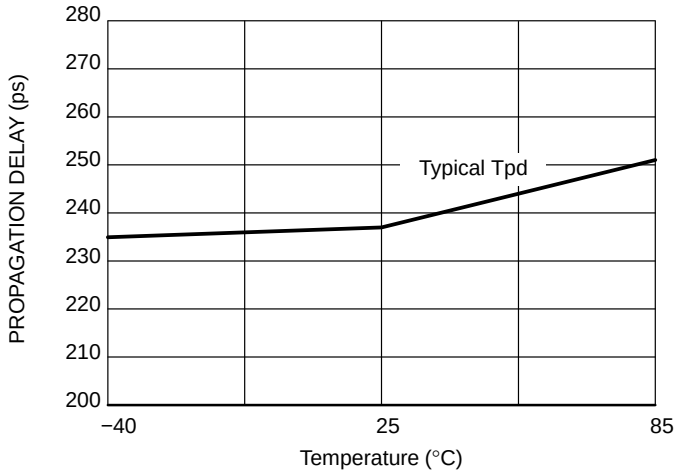


Figure 7. Propagation Delay versus Temperature

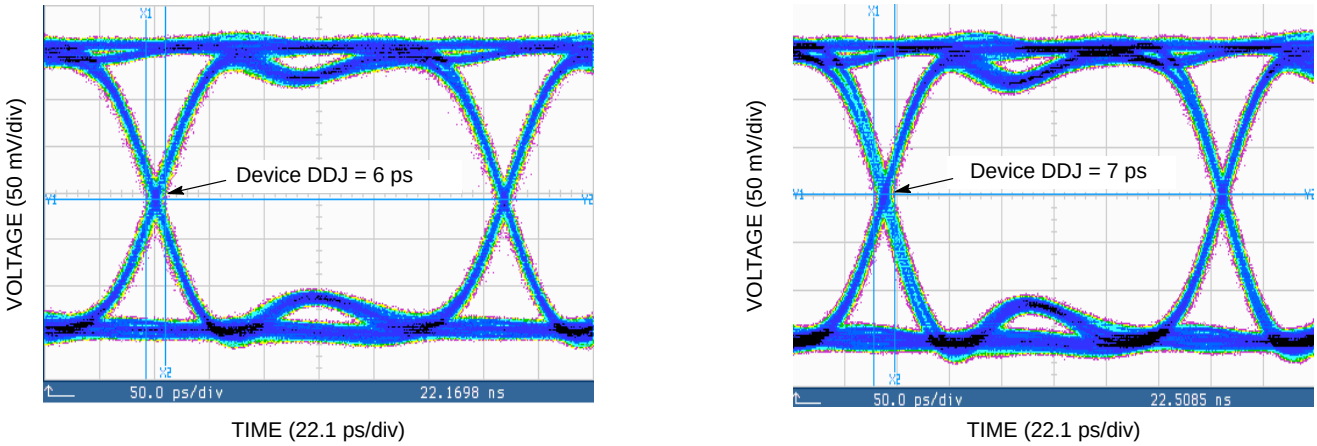


Figure 8. Typical Output Waveform at 3.125 Gb/s with PRBS $2^{23}-1$ (V_{inpp} = 75 mV−left and 400 mV−right)

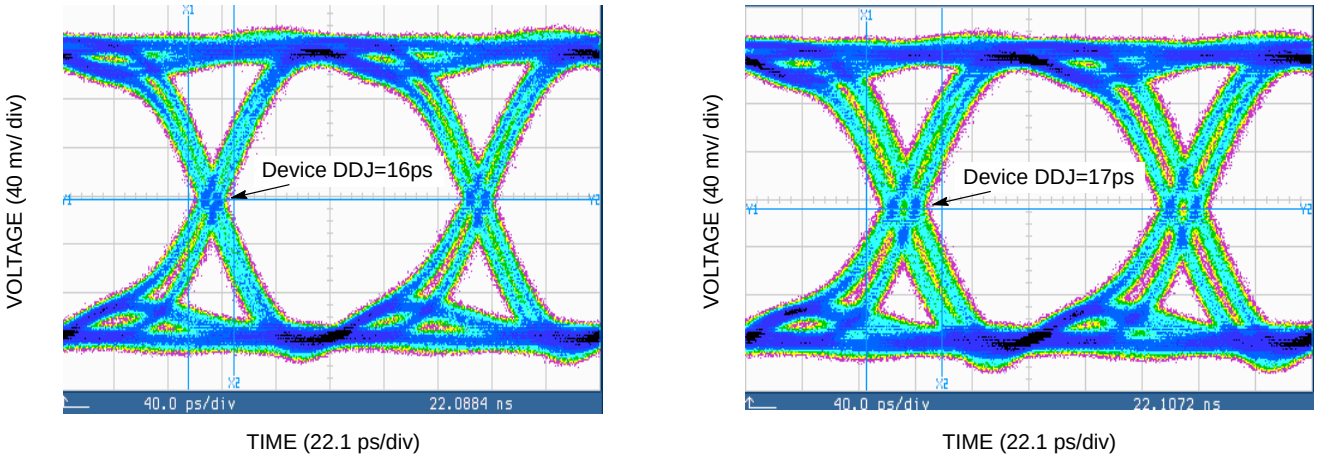


Figure 9. Typical Output Waveform at 5 Gb/s with PRBS $2^{23}-1$ (V_{inpp}=75 mV−left and 400 mV−right)

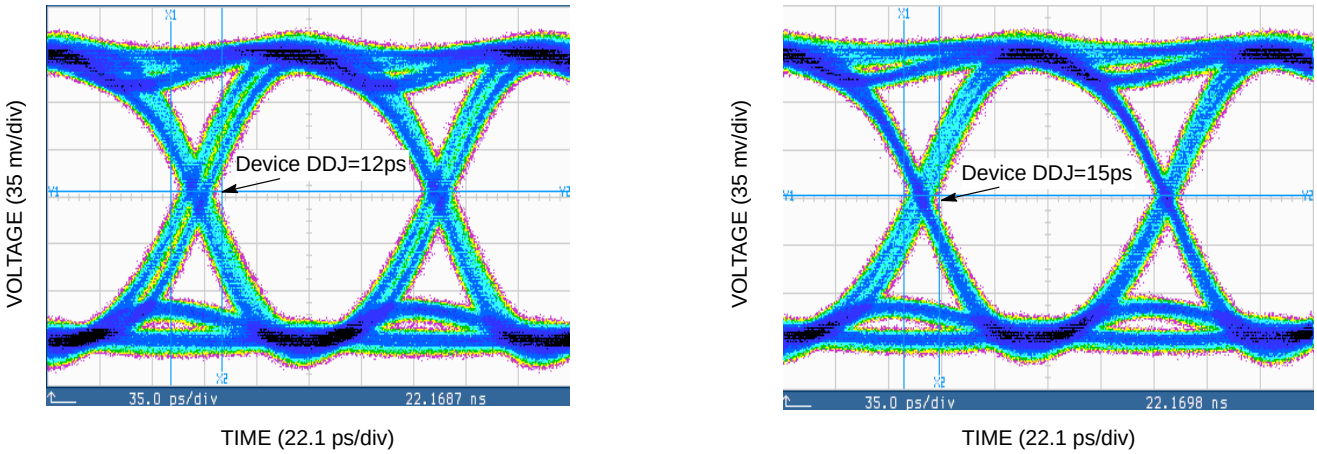


Figure 10. Typical Output Waveform at 6.125 Gb/s with PRBS $2^{23}-1$ (V_{inpp} = 75 mV−left and 400 mV−right)

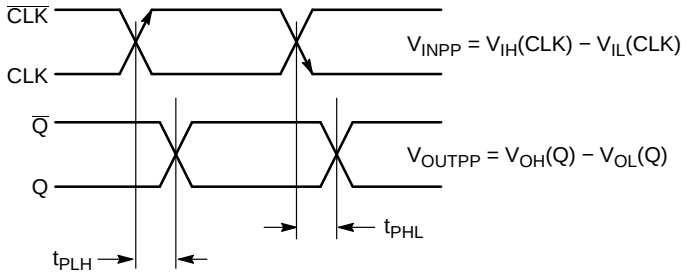


Figure 11. AC Reference Measurement

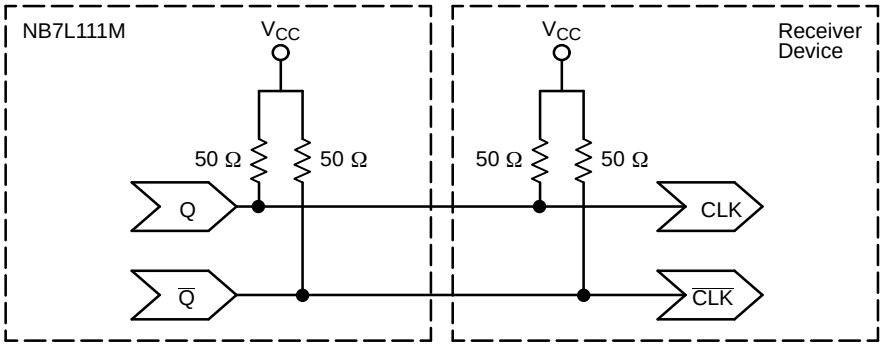


Figure 12. Typical Termination for 16 mA Output Drive and Device Evaluation

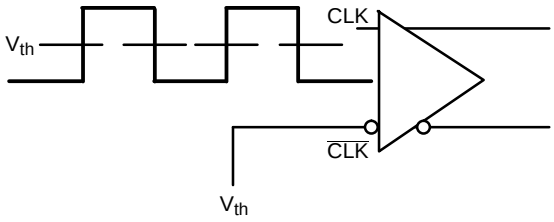


Figure 13. Differential Input Driven Single−Ended

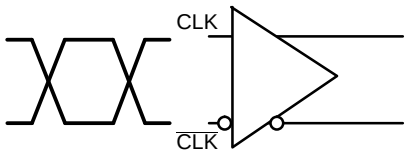


Figure 14. Differential Inputs Driven Differentially

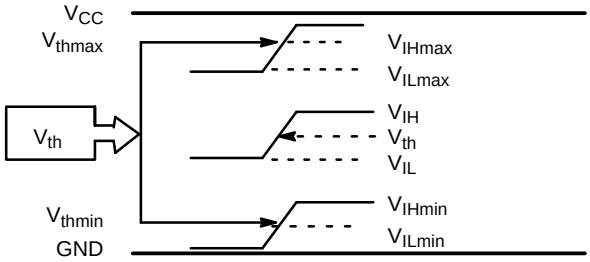


Figure 15. V_{th} Diagram

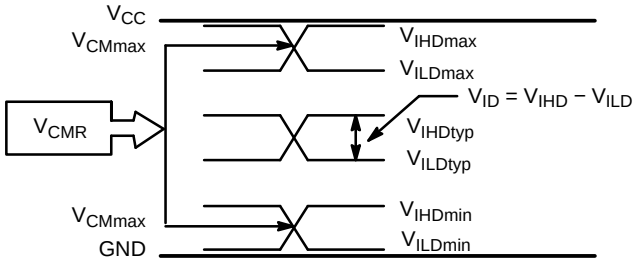


Figure 16. V_{CMR} Diagram

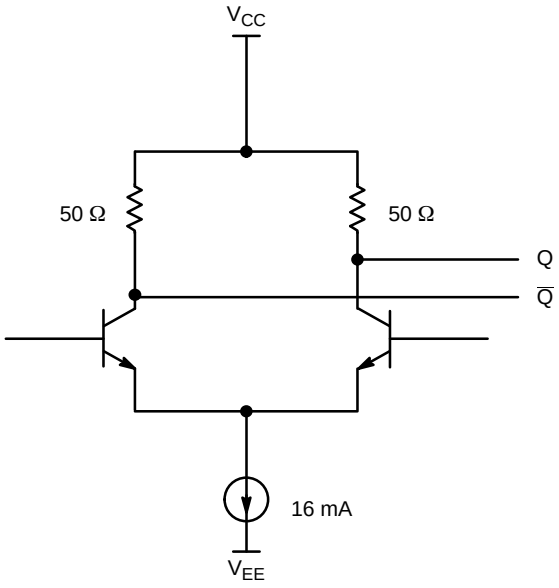


Figure 17. CML Output Structure

Table 7. Interfacing Options

INTERFACING OPTIONS	CONNECTIONS
CML	Connect VTCLK0, $\overline{\text{VTCLK0}}$, VTCLK1, $\overline{\text{VTCLK1}}$, VTSEL, $\overline{\text{VTSEL}}$ to V_{CC}
LVDS	Connect VTCLK0, $\overline{\text{VTCLK0}}$ together for CLK0 input; Connect VTCLK1, $\overline{\text{VTCLK1}}$ together for CLK1 input; Connect VTSEL, $\overline{\text{VTSEL}}$ together for SEL control input.
AC−COUPLED	Bias VTCLK0, $\overline{\text{VTCLK0}}$, VTSEL, $\overline{\text{VTSEL}}$ and VTCLK1, $\overline{\text{VTCLK1}}$ inputs within (VCMR) Common Mode Range.
RSECL, LVPECL	Standard ECL termination techniques. See AND8020.
LVTTL, LVCMOS	An external voltage should be applied to the unused complementary differential input. Nominal voltage 1.5 V for LVTTL and V_{CC}/2 for LVCMOS inputs.

Application Information

All NB7L111M inputs can accept LVPECL, CML, LVTTL, LVCMOS and LVDS signal levels. The limitations for differential input signal (LVDS, PECL, or CML) are minimum input swing of 75 mV_{PP} and the maximum input swing of 2500 mV_{PP}. Within these differential conditions, the input HIGH voltage can range from V_{CC} to 1.2 V. Examples of interfaces are illustrated below in a 50 Ω environment (Z = 50 Ω).

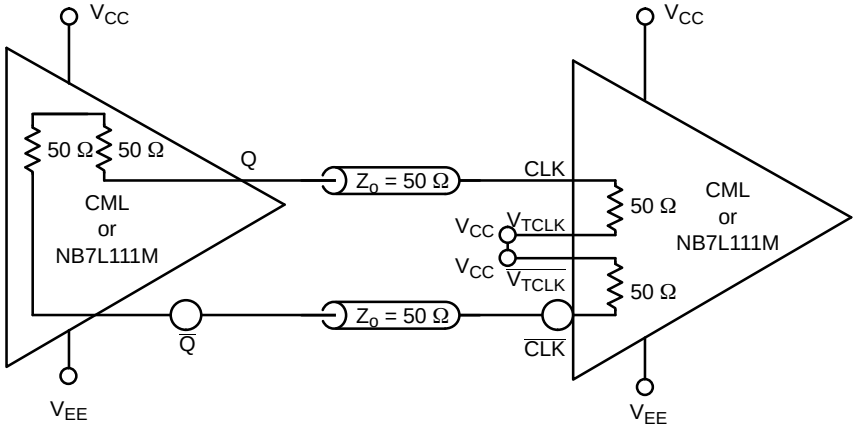
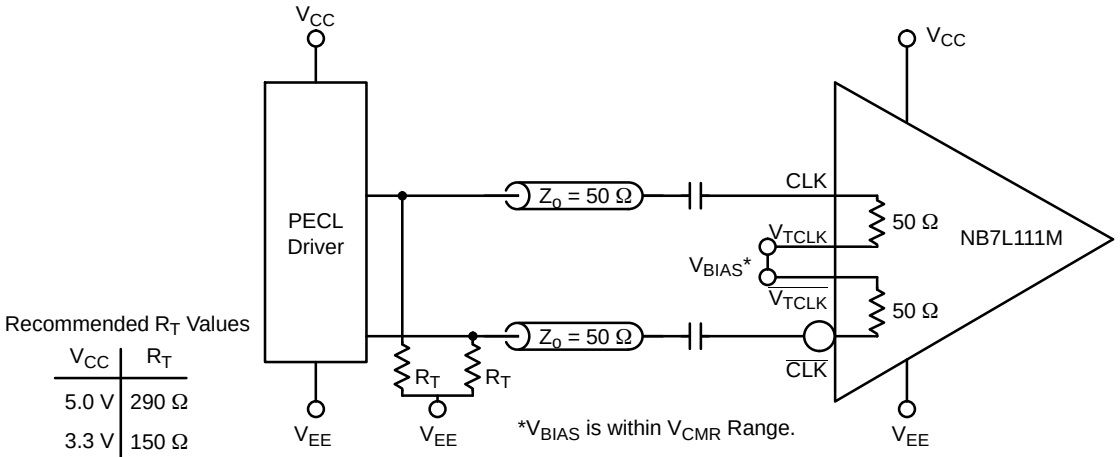


Figure 18. CML to CML Interface



Recommended R_T Values

V_{CC}	R_T
5.0 V	290 Ω
3.3 V	150 Ω
2.5 V	80 Ω

Figure 19. PECL to CML Receiver Interface

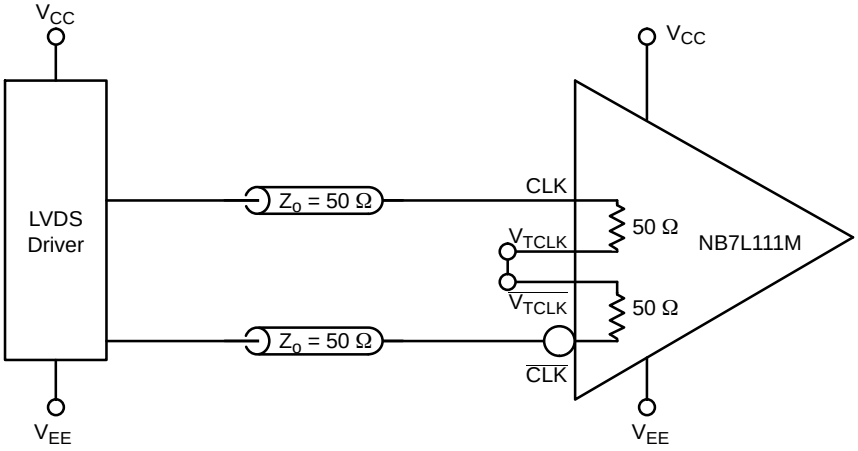


Figure 20. LVDS to CML Receiver Interface

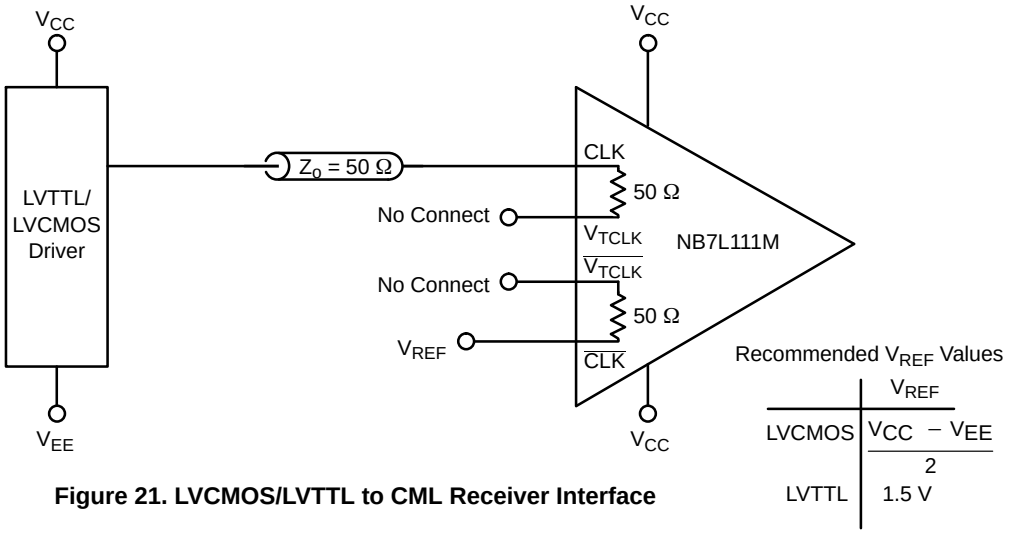


Figure 21. LVCMOS/LVTTL to CML Receiver Interface

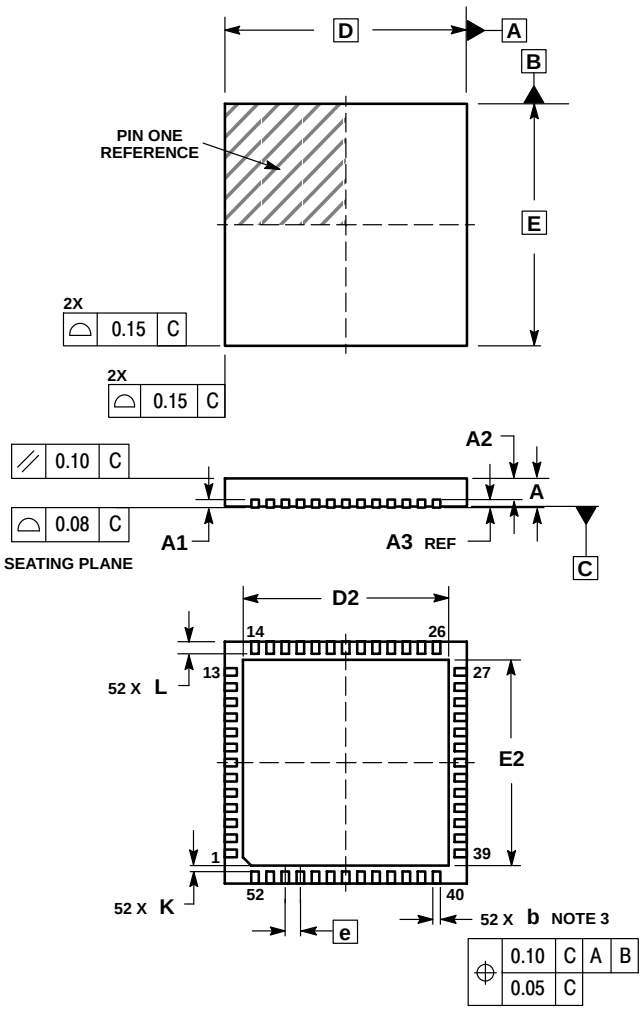
ORDERING INFORMATION

Device	Package	Shipping†
NB7L111MMNG	QFN−52 (Pb−Free)	260 Units / Tray
NB7L111MMNR2G	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.

PACKAGE DIMENSIONS

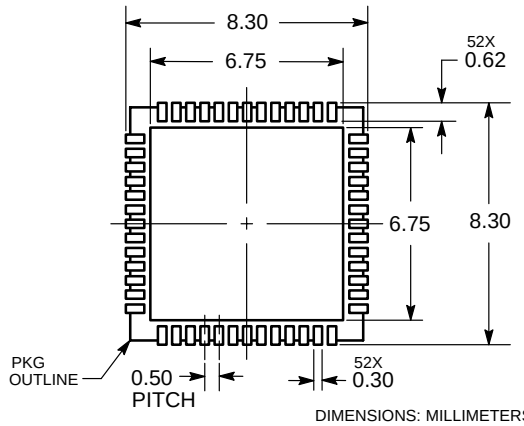
QFN52 8x8, 0.5P
CASE 485M
ISSUE C



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.

	MILLIMETERS	
DIM	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	---
L	0.30	0.50

RECOMMENDED SOLDERING FOOTPRINT*



DIMENSIONS: MILLIMETERS

*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

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5817−1050

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative

pubnumber/D