

# NB6L239

## 2.5V / 3.3V Any Differential Clock IN to Differential LVPECL OUT $\div 1/2/4/8$ , $\div 2/4/8/16$ Clock Divider

### Description

The NB6L239 is a high-speed, low skew clock divider with two divider circuits, each having selectable clock divide ratios;  $\div 1/2/4/8$  and  $\div 2/4/8/16$ . Both divider circuits drive a pair of differential LVPECL outputs. (More device information on page 8). The NB6L239 is a member of the ECLinPS MAX™ Family of the high performance clock products.

### Features

- Maximum Clock Input Frequency, 3.0 GHz
- CLOCK Inputs Compatible with LVDS/LVPECL/CML/HSTL
- $\overline{EN}$ ,  $\overline{MR}$ , and SEL Inputs Compatible with LVTTTL/LVCMOS
- Rise/Fall Time 65 ps Typical
- < 10 ps Typical Output-to-Output Skew
- Example: 622.08 MHz Input Generates 38.88 MHz to 622.08 MHz Outputs
- Internal 50  $\Omega$  Termination Provided
- Random Clock Jitter < 1 ps RMS
- QA  $\div 1$  Edge Aligned to QB  $\div n$  Edge
- Operating Range:  $V_{CC} = 2.375$  V to 3.465 V with  $V_{EE} = 0$  V
- Master Reset for Synchronization of Multiple Chips
- $V_{BBAC}$  Reference Output
- Synchronous Output Enable/Disable
- Pb-Free Packages are Available



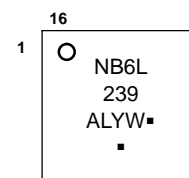
ON Semiconductor®

<http://onsemi.com>

### MARKING DIAGRAM\*



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.

# NB6L239

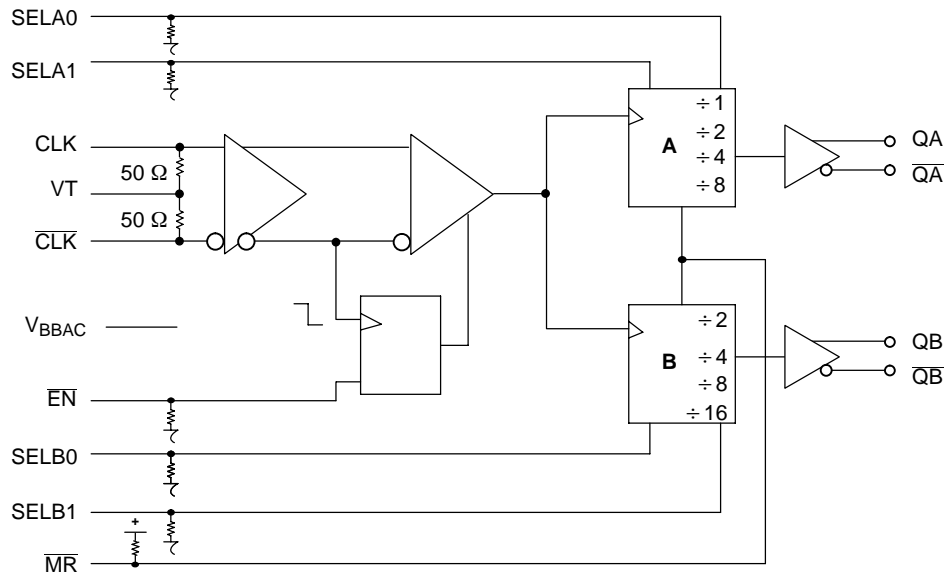


Figure 1. Simplified Logic Diagram

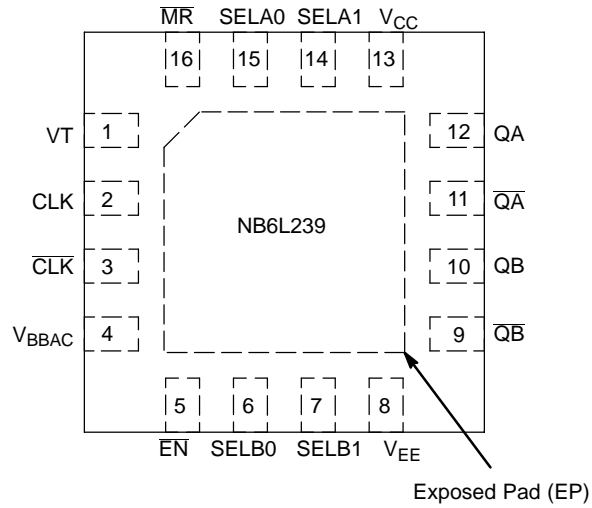


Figure 2. Pinout: QFN-16 (Top View)

# NB6L239

**Table 1. PIN DESCRIPTION**

Pin	Name	I/O	Description
1	VT		Internal 100 $\Omega$ Center-Tapped Termination Pin for CLK and $\overline{\text{CLK}}$ .
2	CLK	LVPECL, CML, LVDS, HSTL Input	Noninverted Differential CLOCK Input.
3	$\overline{\text{CLK}}$	LVPECL, CML, LVDS, HSTL Input	Inverted Differential CLOCK Input.
4	$V_{\text{BBAC}}$		Output Voltage Reference for Capacitor Coupled Inputs, Only.
5	$\overline{\text{EN}}^*$	LVC MOS/LVTTL Input	Synchronous Output Enable
6	SELB0*	LVC MOS/LVTTL Input	Clock Divide Select Pin
7	SELB1*	LVC MOS/LVTTL Input	Clock Divide Select Pin
8	$V_{\text{EE}}$	Power Supply	Negative Supply Voltage
9	$\overline{\text{QB}}$	LVPECL Output	Inverted Differential Output. Typically terminated with 50 $\Omega$ resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
10	QB	LVPECL Output	Noninverted Differential Output. Typically terminated with 50 $\Omega$ resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
11	$\overline{\text{QA}}$	LVPECL Output	Inverted Differential Output. Typically terminated with 50 $\Omega$ resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
12	QA	LVPECL Output	Noninverted Differential Output. Typically terminated with 50 $\Omega$ resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
13	$V_{\text{CC}}$	Power Supply	Positive Supply Voltage.
14	SELA1*	LVC MOS/LVTTL Input	Clock Divide Select Pin
15	SELA0*	LVC MOS/LVTTL Input	Clock Divide Select Pin
16	$\overline{\text{MR}}^{**}$	LVC MOS/LVTTL Input	Master Reset Asynchronous, Default Open High, Asserted LOW
	EP	Power Supply (OPT)	The Exposed Pad on the QFN-16 package bottom is thermally connected to the die for improved heat transfer out of package. The pad is not electrically connected to the die, but is recommended to be electrically and thermally connected to $V_{\text{EE}}$ on the PC board.

\*Pins will default LOW when left OPEN.

\*\*Pins will default HIGH when left OPEN.

# NB6L239

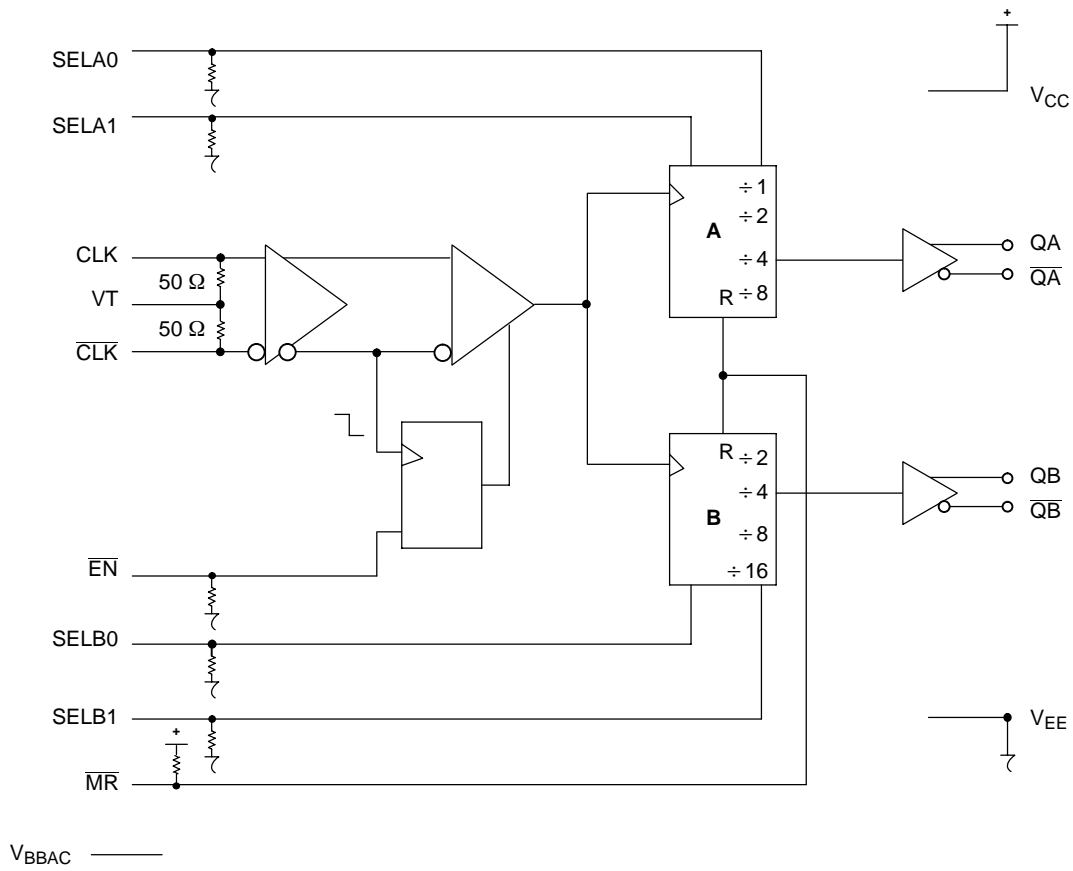


Figure 3. Logic Diagram

Table 2. FUNCTION TABLE

CLK	EN*	MR**	FUNCTION
⌋	L	H	Divide
⌋	H	H	Hold Q
X	X	L	Reset Q

Table 3. CLOCK DIVIDE SELECT, QA OUTPUTS

SELA1*	SELA0*	QA Outputs
L	L	Divide by 1
L	H	Divide by 2
H	L	Divide by 4
H	H	Divide by 8

Table 4. CLOCK DIVIDE SELECT, QB OUTPUTS

SELB1*	SELB0*	QB Outputs
L	L	Divide by 2
L	H	Divide by 4
H	L	Divide by 8
H	H	Divide by 16

⌋ = Low-to-High Transition

⌋ = High-to-Low Transition

X = Don't Care

\*Pins will default LOW when left OPEN.

\*\*Pins will default HIGH when left OPEN.

# NB6L239

**Table 5. ATTRIBUTES**

Characteristics		Value	
Internal Input Pulldown Resistor		75 kΩ	
Internal Input Pullup Resistor		75 kΩ	
ESD Protection	Human Body Model Machine Model Charged Device Model	> 1500 V > 150 V > 1000 V	
Moisture Sensitivity, Indefinite Time Out of Drypack (Note 1)		Pb Pkg	Pb-Free Pkg
QFN-16		Level 1	Level 1
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in	
Transistor Count		367	
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test			

1. For additional Moisture Sensitivity information, refer to Application Note AND8003/D.

## MAXIMUM RATINGS

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
V <sub>CC</sub>	Positive Mode Power Supply	V <sub>EE</sub> = 0 V		3.6	V
V <sub>I</sub>	Input Voltage	V <sub>EE</sub> = 0 V	V <sub>EE</sub> ≤ V <sub>I</sub> ≤ V <sub>CC</sub>	3.6	V
I <sub>out</sub>	Output Current	Continuous Surge		50 100	mA mA
I <sub>BB</sub>	V <sub>BBAC</sub> Sink/Source Current			± 0.5	mA
T <sub>A</sub>	Operating Temperature Range			-40 to +85	°C
T <sub>stg</sub>	Storage Temperature Range			-65 to +150	°C
θ <sub>JA</sub>	Thermal Resistance (Junction-to-Ambient)	0 lfpm 500 lfpm		41.6 35.2	°C/W °C/W
θ <sub>JC</sub>	Thermal Resistance (Junction-to-Case)	Standard Board		4.0	°C/W
T <sub>sol</sub>	Wave Solder	Pb Pb-Free		265 265	°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.

# NB6L239

**Table 6. DC CHARACTERISTICS, CLOCK INPUTS, LVPECL OUTPUTS**

( $V_{CC} = 2.375\text{ V to }3.465\text{ V}$ ,  $V_{EE} = 0\text{ V}$ )

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Power Supply Current	30	40	50	30	40	50	30	40	50	mA
$V_{OH}$	Output HIGH Voltage (Notes 2, 3) $V_{CC} = 3.3\text{ V}$ $V_{CC} = 2.5\text{ V}$	$V_{CC}-1150$ 2150 1350	$V_{CC}-1060$ 2240 1440	$V_{CC}-950$ 2350 1550	$V_{CC}-1100$ 2200 1400	$V_{CC}-1015$ 2285 1485	$V_{CC} - 900$ 2400 1600	$V_{CC}-1050$ 2250 1450	$V_{CC}-980$ 2320 1520	$V_{CC} - 850$ 2450 1650	mV
$V_{OL}$	Output LOW Voltage (Notes 2, 3) $V_{CC} = 3.3\text{ V}$ $V_{CC} = 2.5\text{ V}$	$V_{CC}-1935$ 1365 565	$V_{CC}-1775$ 1525 725	$V_{CC}-1630$ 1670 870	$V_{CC}-1875$ 1430 630	$V_{CC}-1735$ 1565 765	$V_{CC}-1580$ 1720 920	$V_{CC}-1810$ 1490 690	$V_{CC}-1675$ 1625 825	$V_{CC}-1530$ 1770 970	mV

**DIFFERENTIAL INPUT DRIVEN SINGLE-ENDED** (Figures 7, 10)

$V_{th}$	Input Threshold Reference Voltage (Note 4)	100		$V_{CC} - 100$	100		$V_{CC} - 100$	100		$V_{CC} - 100$	mV
$V_{IH}$	Single-ended Input HIGH Voltage	$V_{th} + 100$		$V_{CC}$	$V_{th} + 100$		$V_{CC}$	$V_{th} + 100$		$V_{CC}$	mV
$V_{IL}$	Single-ended Input LOW Voltage	$V_{EE}$		$V_{th} - 100$	$V_{EE}$		$V_{th} - 100$	$V_{EE}$		$V_{th} - 100$	mV
$V_{BBAC}$	Output Voltage Reference @ 100 $\mu\text{A}$ (Note 7) $V_{CC} = 3.3\text{ V}$ $V_{CC} = 2.5\text{ V}$	$V_{CC}-1460$ 1840 1040	$V_{CC}-1330$ 1970 1170	$V_{CC}-1200$ 2100 1300	$V_{CC}-1460$ 1840 1040	$V_{CC}-1340$ 1960 1160	$V_{CC}-1200$ 2100 1300	$V_{CC}-1460$ 1840 1040	$V_{CC}-1350$ 1950 1150	$V_{CC}-1200$ 2100 1300	mV

**DIFFERENTIAL INPUT DRIVEN DIFFERENTIALLY** (Figures 8, 9, 11) (Note 6)

$V_{IHD}$	Differential Input HIGH Voltage	100		$V_{CC}$	100		$V_{CC}$	100		$V_{CC}$	mV
$V_{ILD}$	Differential Input LOW Voltage	$V_{EE}$		$V_{CC} - 100$	$V_{EE}$		$V_{CC} - 100$	$V_{EE}$		$V_{CC} - 100$	mV
$V_{CMR}$	Input Common Mode Range (Differential Cross-point Voltage) (Note 5)	50		$V_{CC} - 50$	50		$V_{CC} - 50$	50		$V_{CC} - 50$	mV
$V_{ID}$	Differential Input Voltage ( $V_{IHD(CLK)} - V_{ILD(CLK)}$ ) and ( $V_{IHD(CLK)} - V_{ILD(CLK)}$ )	100		$V_{CC} - V_{EE}$	100		$V_{CC} - V_{EE}$	100		$V_{CC} - V_{EE}$	mV
$R_{TIN}$	Internal Input Termination Resistor	45	50	55	45	50	55	45	50	55	$\Omega$

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. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

- Input and output parameters vary 1:1 with  $V_{CC}$ .
- Outputs loaded with 50  $\Omega$  to  $V_{CC} - 2.0\text{ V}$  for proper operation.
- $V_{th}$  is applied to the complementary input when operating in single-ended mode.
- $V_{CMR_{MIN}}$  varies 1:1 with  $V_{EE}$ ,  $V_{CMR_{MAX}}$  varies 1:1 with  $V_{CC}$ .
- Input and output voltage swing is a single-ended measurement operating in differential mode.
- $V_{BBAC}$  used to rebias capacitor-coupled inputs only (see Figures 16 and 17).

# NB6L239

**Table 7. DC CHARACTERISTICS, LVTTTL/LVCMOS INPUTS** ( $V_{CC} = 2.375\text{ V to }3.465\text{ V}$ ,  $V_{EE} = 0\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ )

Symbol	Characteristic	Min	Typ	Max	Unit
$V_{IH}$	Input HIGH Voltage (LVCMOS/LVTTTL)	2.0		$V_{CC}$	V
$V_{IL}$	Input LOW Voltage (LVCMOS/LVTTTL)	$V_{EE}$		0.8	V
$I_{IH}$	Input HIGH Current	-150		150	$\mu\text{A}$
$I_{IL}$	Input LOW Current	-150		150	$\mu\text{A}$

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. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

**Table 8. AC CHARACTERISTICS**  $V_{CC} = 2.375\text{ V to }3.465\text{ V}$ ;  $V_{EE} = 0\text{ V}$  (Note 8)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$f_{inMAX}$	Maximum Input CLOCK Frequency	3.0			3.0			3.0			GHz
$V_{OUTPP}$	Output Voltage Amplitude (Notes 10, 11) QA(÷2, 4, 8), QB(÷n) QA(÷1), QB(÷n) QA(÷1), QB(÷n) 2.5 GHz < $f_{in} \leq 3.0\text{ GHz}$	$f_{in} \leq 3.0\text{ GHz}$ 450	650		450	650		450	650		mV
$t_{PLH}$ , $t_{PHL}$	Propagation Delay to Output Differential @ 50 MHz CLK, Qn MR, Qn	370 330	470 370	570 430	370 330	470 380	570 430	400 330	500 400	600 480	ps
$t_{RR}$	Reset Recovery	0	-90		0	-90		0	-90		ps
$t_s$	Setup Time @ 50 MHz EN, CLK SELA/B, CLK	0 0	-60 -300		0 0	-60 -300		0 0	-60 -300		ps
$t_h$	Hold Time @ 50 MHz CLK, EN CLK, SELA/B	150 700	65 200		150 700	65 200		150 700	65 200		ps
$t_{skew}$	Within-Device Skew @ 50 MHz Device-to-Device Skew Duty Cycle Skew (Note 9) (Note 9) (Note 9)		5 25 25	30 80 40		5 30 30	30 90 45		6 30 30	35 90 45	ps
$t_{PW}$	Minimum Pulse Width MR	550			550			550			ps
$t_{JITTER}$	RMS Random Clock Jitter (See Figure 20. $F_{max}/JITTER$ )			< 1			< 1			< 1	ps
$V_{INPP}$	Input Voltage Swing (Differential Configuration) (Note 10)	100		$V_{CC}$ $-V_{EE}$	100		$V_{CC}$ $-V_{EE}$	100		$V_{CC}$ $-V_{EE}$	mV
$t_r$ $t_f$	Output Rise/Fall Times @ 50 MHz (20% – 80%) Qn, Qn	30	60	120	30	65	120	30	70	120	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. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

8. Measured using a 750 mV, 50% duty cycle clock source. All loading with  $50\ \Omega$  to  $V_{CC} - 2.0\text{ V}$ .
9. Skew is measured between outputs under identical transitions and conditions. Duty cycle skew is defined only for differential operation when the delays are measured from the cross point of the inputs to the cross point of the outputs.
10. Input and output voltage swing is a single-ended measurement operating in differential mode.
11. Output Voltage Amplitude ( $V_{OHCLK} - V_{OLCLK}$ ) at input CLOCK frequency,  $f_{in}$ . The output frequency,  $f_{out}$ , is the input CLOCK frequency divided by n,  $f_{out} = f_{in} \div n$ . Input CLOCK frequency is  $\leq 3.0\text{ GHz}$ .

Application Information

The NB6L239 is a high-speed, low skew clock divider with two divider circuits, each having selectable clock divide ratios;  $\div 1/2/4/8$  and  $\div 2/4/8/16$ . Both divider circuits drive a pair of differential LVPECL outputs. The internal dividers are synchronous to each other. Therefore, the common output edges are precisely aligned.

The NB6L239 clock inputs can be driven by a variety of differential signal level technologies including LVDS, LVPECL, HSTL, or CML. The differential clock input buffer employs a pair of internal 50  $\Omega$  termination resistors in a 100  $\Omega$  center-tapped configuration and accessible via the VT pin. This feature provides transmission line termination on-chip, at the receiver end, eliminating external components. The  $V_{BBAC}$  reference output can be used to rebias capacitor-coupled differential or

single-ended input CLOCK signals. For the capacitor-coupled CLK and/or  $\overline{CLK}$  inputs,  $V_{BBAC}$  should be connected to the  $V_T$  pin and bypassed to ground with a 0.01  $\mu F$  capacitor. Inputs CLK and  $\overline{CLK}$  must be signal driven or auto oscillation may result.

The common enable ( $\overline{EN}$ ) is synchronous so that the internal divider flip-flops will only be enabled/disabled when the internal clock is in the LOW state. This avoids any chance of generating a runt pulse on the internal clock when the device is enabled/disabled, as can happen with an asynchronous control. The internal enable flip-flop is clocked on the falling edge of the input clock. Therefore, all associated specification limits are referenced to the negative edge of the clock input.

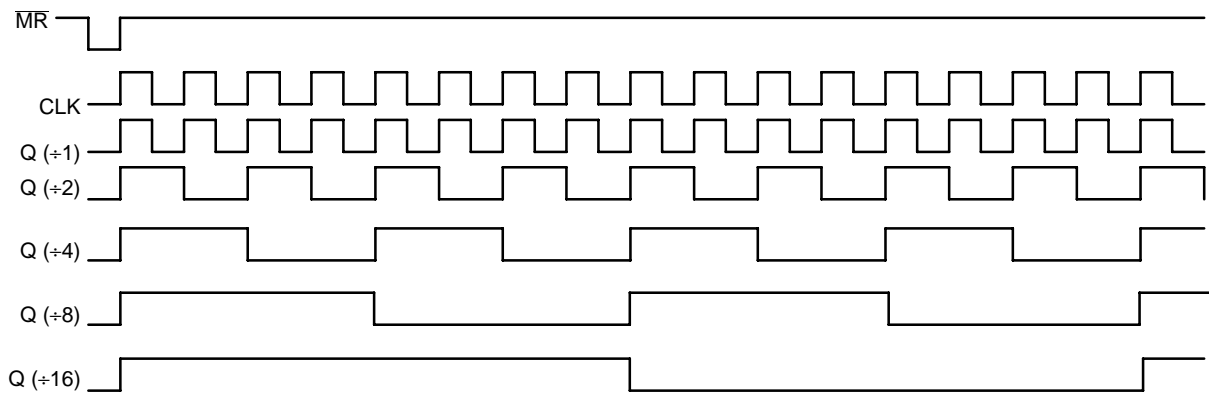


Figure 4. Timing Diagram

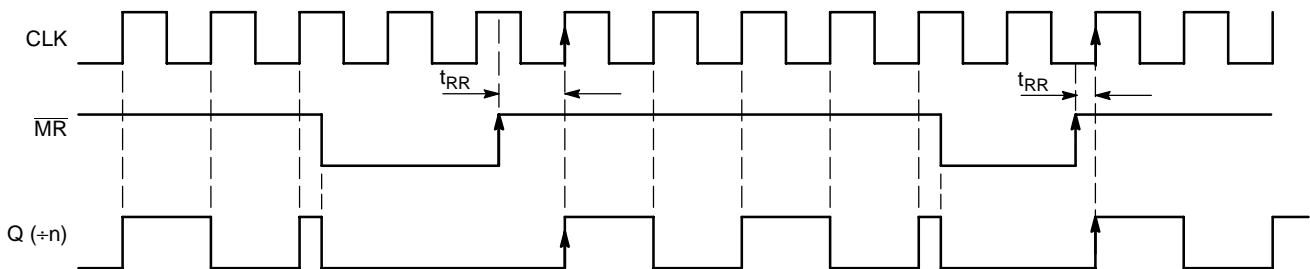


Figure 5. Master Reset Timing Diagram

NOTE: On the rising edge of  $\overline{MR}$ , Q goes HIGH after the first rising edge of CLK.

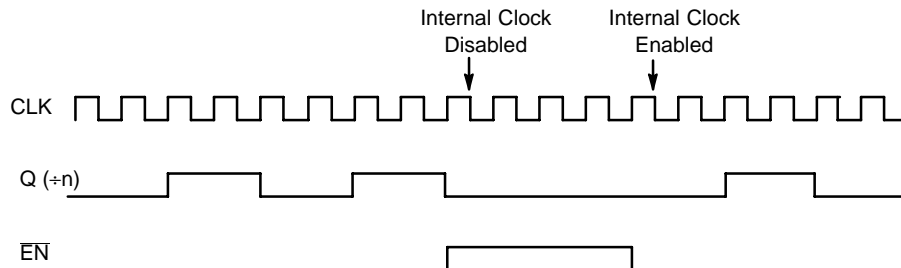


Figure 6. Output Enable Timing Diagrams

The  $\overline{EN}$  signal will “freeze” the internal divider flip-flops on the first falling edge of CLK after its assertion. The internal divider flip-flops will maintain their state during the freeze. When  $\overline{EN}$  is deasserted (LOW), and after the next falling edge of CLK, then the internal divider flip-flops will “unfreeze” and continue to their next state count with proper phase relationships.



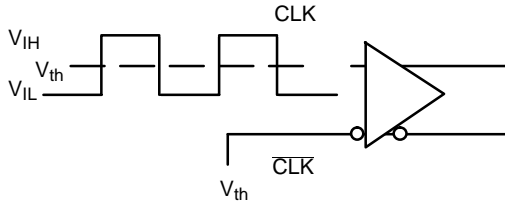


Figure 7. Differential Input Driven Single-Ended

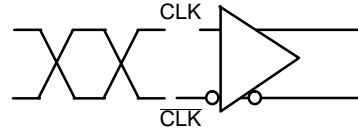


Figure 8. Differential Inputs Driven Differentially

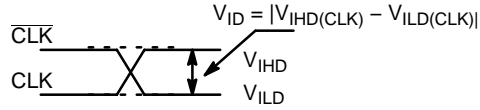


Figure 9. Differential Inputs Driven Differentially

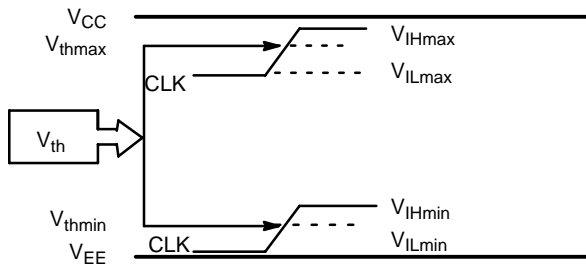


Figure 10.  $V_{th}$  Diagram

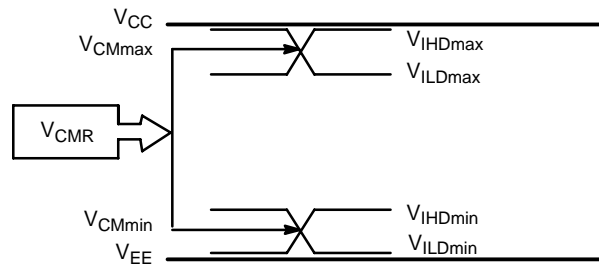


Figure 11.  $V_{CMR}$  Diagram

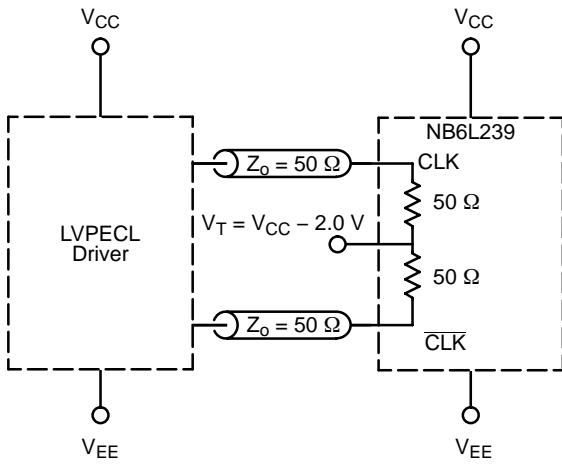


Figure 12. LVPECL Interface

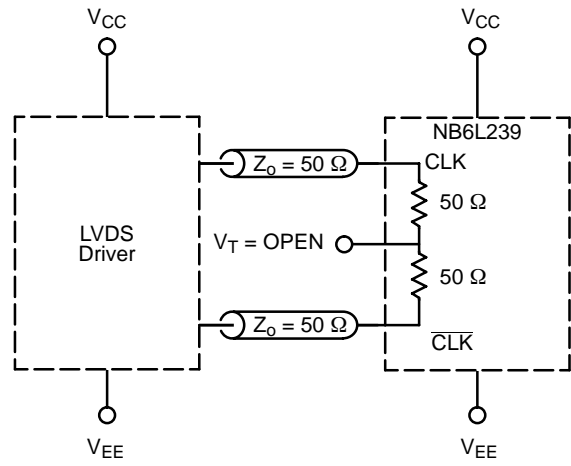


Figure 13. LVDS Interface

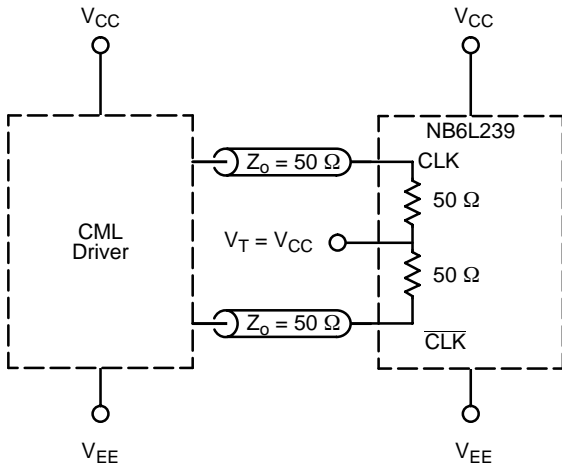


Figure 14. Standard 50  $\Omega$  Load CML Interface

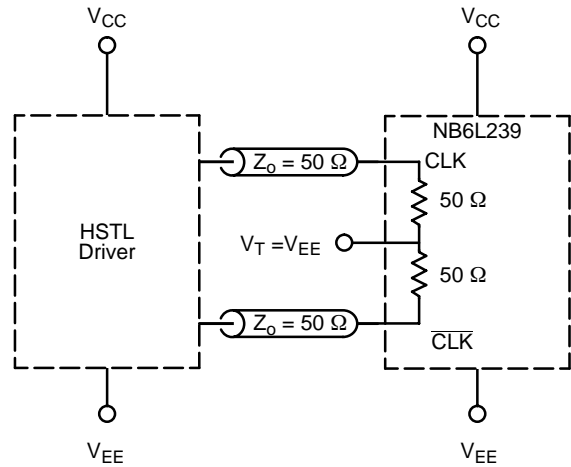


Figure 15. Standard 50  $\Omega$  Load HSTL Interface

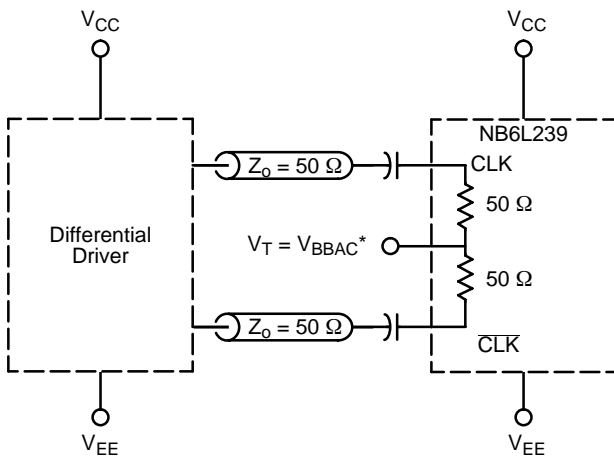


Figure 16. Capacitor-Coupled Differential Interface ( $V_T$  Connected to  $V_{BBAC}$ )

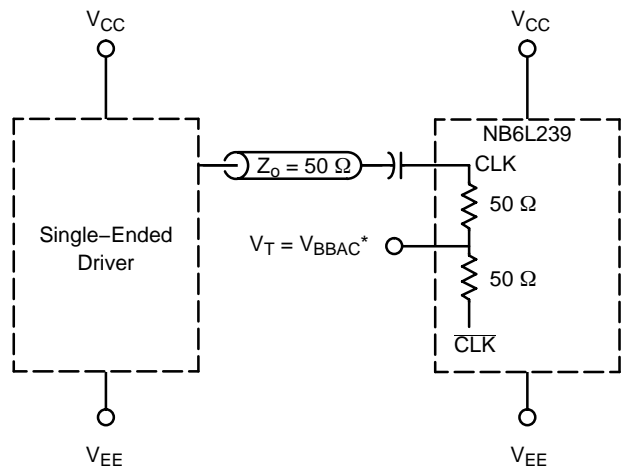
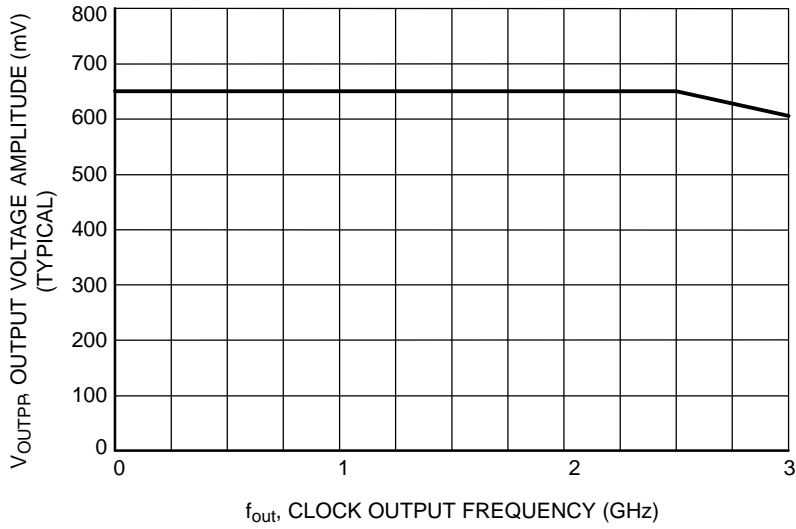


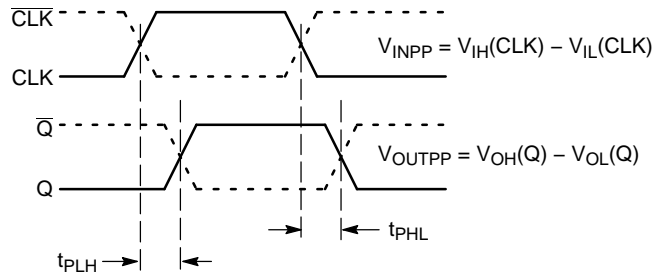
Figure 17. Capacitor-Coupled Single-Ended Interface ( $V_T$  Connected to  $V_{BBAC}$ )

\* $V_{BBAC}$  bypassed to ground with a 0.01  $\mu$ F capacitor.

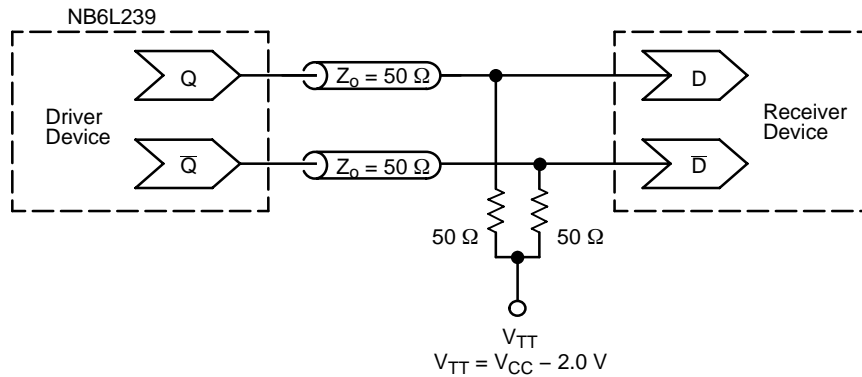
# NB6L239



**Figure 18. Output Voltage Amplitude ( $V_{OUTPP}$ ) versus Clock Output Frequency at Ambient Temperature (Typical) ( $f_{out\ QA/QB} = f_{in} \div n$ ;  $f_{in} \leq 3.0$  GHz).**



**Figure 19. AC Reference Measurement**



**Figure 20. Typical Termination for Output Driver and Device Evaluation (See Application Note AND8020/D – Termination of ECL Logic Devices.)**

# NB6L239

## ORDERING INFORMATION

Device	Package	Shipping†
NB6L239MN	QFN-16, 3 x 3 mm	123 Units / Rail
NB6L239MNG	QFN-16, 3 x 3 mm (Pb-Free)	123 Units / Rail
NB6L239MNR2	QFN-16, 3 x 3 mm	3000 / Tape & Reel
NB6L239MNR2G	QFN-16, 3 x 3 mm (Pb-Free)	3000 / 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.

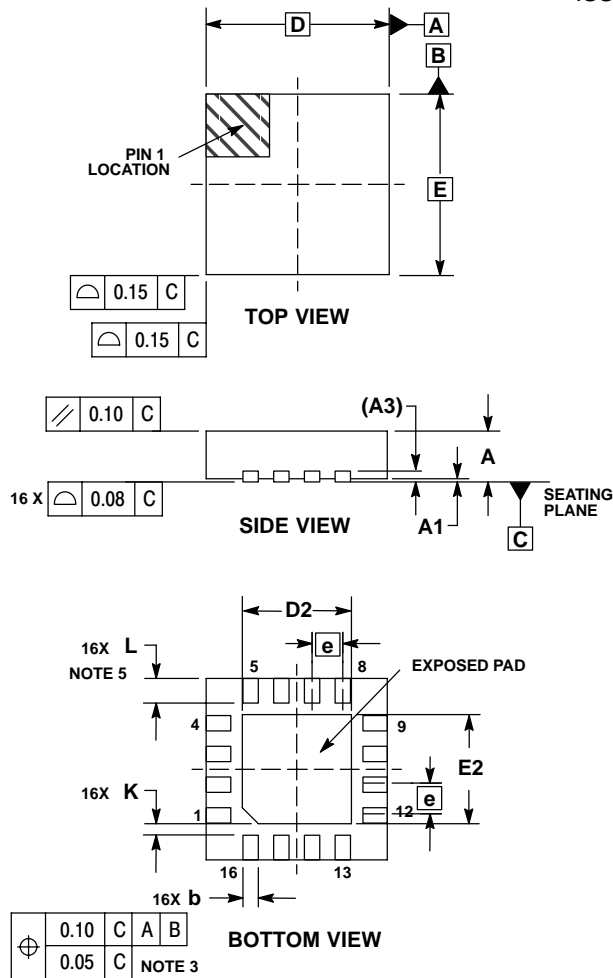
### Resource Reference of Application Notes

- AN1405/D** – ECL Clock Distribution Techniques
- AN1406/D** – Designing with PECL (ECL at +5.0 V)
- AN1503/D** – ECLinPS I/O SPICE Modeling Kit
- AN1504/D** – Metastability and the ECLinPS Family
- AN1568/D** – Interfacing Between LVDS and ECL
- AN1672/D** – The ECL Translator Guide
- AND8001/D** – Odd Number Counters Design
- AND8002/D** – Marking and Date Codes
- AND8020/D** – Termination of ECL Logic Devices
- AND8066/D** – Interfacing with ECLinPS
- AND8090/D** – AC Characteristics of ECL Devices

# NB6L239

## PACKAGE DIMENSIONS

16 PIN QFN  
CASE 485G-01  
ISSUE C

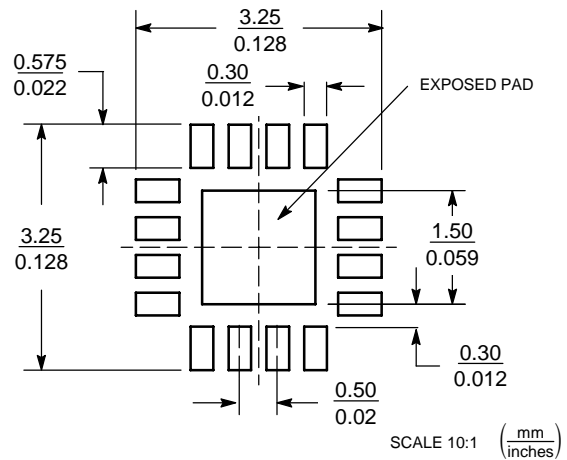


NOTES:

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<sub>max</sub> CONDITION CAN NOT VIOLATE 0.2 MM MINIMUM SPACING BETWEEN LEAD TIP AND FLAG

DIM	MILLIMETERS	
	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.

ECLinPS and ECLinPS MAX are trademarks of Semiconductor Components Industries, LLC (SCILLC).

ON Semiconductor and are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

**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: 81-3-5773-3850

ON Semiconductor Website: [www.onsemi.com](http://www.onsemi.com)  
Order Literature: <http://www.onsemi.com/orderlit>  
For additional information, please contact your local Sales Representative