

# 1.8 V/2.5 V, 10 GHz ÷4 Clock Divider with CML Outputs

Multi-Level Inputs w/ Internal Termination

## NB7V33M

### Description

The NB7V33M is a differential ÷4 Clock divider with asynchronous reset. The differential Clock inputs incorporate internal 50 Ω termination resistors and will accept LVPECL, CML and LVDS logic levels. The NB7V33M produces a ÷4 output copy of an input Clock operating up to 10 GHz with minimal jitter. The Reset pin is asserted on the rising edge. Upon powerup, the internal flip-flops will attain a random state; the Reset allows for the synchronization of multiple NB7V33M's in a system. The 16 mA differential CML output provides matching internal 50 Ω termination which guarantees 400 mV output swing when externally receiver terminated with 50 Ω to V<sub>CC</sub>.

The NB7V33M is the ÷4 version of the NB7V32M (÷2) and is offered in a low profile 3 mm x 3 mm 16-pin QFN package.

The NB7V33M is a member of the GigaComm™ family of high performance clock products. Application notes, models, and support documentation are available at www.onsemi.com.

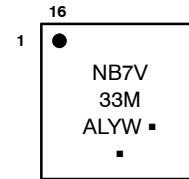
### Features

- Maximum Input Clock Frequency > 10 GHz, typical
- 260 ps Typical Propagation Delay
- 35 ps Typical Rise and Fall Times
- Differential CML Outputs, 400 mV Peak-to-Peak, Typical
- Operating Range: V<sub>CC</sub> = 1.71 V to 2.625 V with GND = 0 V
- Internal 50 Ω Input Termination Resistors
- Random Clock Jitter < 0.8 ps RMS
- QFN-16 Package, 3 mm x 3 mm
- -40°C to +85°C Ambient Operating Temperature
- These are Pb-Free Devices



QFN16  
MN SUFFIX  
CASE 485G

### MARKING DIAGRAM\*



- 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](#).

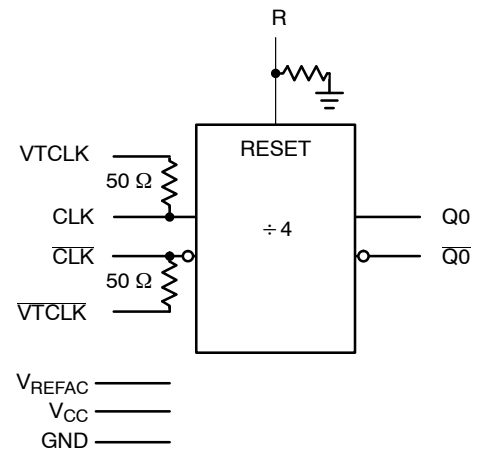


Figure 1. Simplified Logic Diagram

### ORDERING INFORMATION

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

# NB7V33M

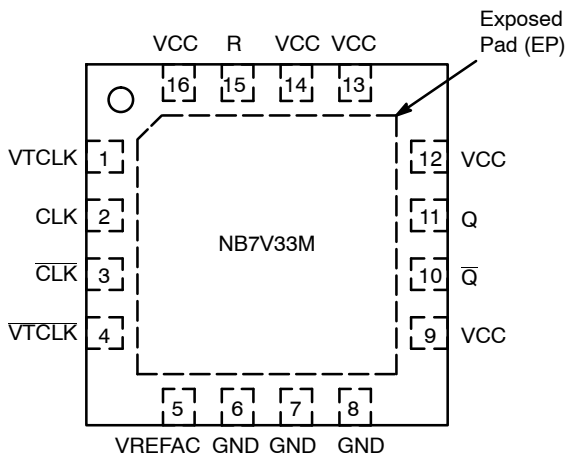


Figure 2. Pin Configuration (Top View)

Table 1. TRUTH TABLE

CLK	CLK	R	Q	Q
x	x	H	L	H
Z	W	L	CLK ÷ 4	CLK ÷ 4

Z = Low to High Transition  
W = High to Low Transition  
X = Don't Care

Table 2. PIN DESCRIPTION

Pin	Name	I/O	Description
1	VTCLK	-	Internal 50 Ω Termination Pin for CLK
2	CLK	LVPECL, CML, LVDS Input	Non-inverted Differential CLK Input. Note 1.
3	CLK	LVPECL, CML, LVDS Input	Inverted Differential CLK Input. Note 1.
4	VTCLK	-	Internal 50 Ω Termination Pin for CLK
5	VREFAC	-	Internally Generated Output Voltage Reference for Capacitor-Coupled Inputs, Only
6	GND	-	Negative Supply Voltage
7	GND	-	Negative Supply Voltage
8	GND	-	Negative Supply Voltage
9	VCC	-	Positive Supply Voltage. Note 2.
10	Q	CML Output	Inverted Differential Output
11	Q	CML Output	Non-Inverted Differential Output
12	VCC	-	Positive Supply Voltage. Note 2.
13	VCC	-	Positive Supply Voltage. Note 2.
14	VCC	-	Positive Supply Voltage. Note 2.
15	R	LVC MOS Input	Asynchronous Reset Input. Internal 75 kΩ pulldown to GND.
16	VCC	-	Positive Supply Voltage. Note 2.
-	EP	-	The Exposed Pad (EP) on 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 electrically connected to the die, and must be electrically and thermally connected to GND on the PC board.

1. In the differential configuration when the input termination pins (VTCLK/VTCLK) are connected to a common termination voltage or left open, and if no signal is applied on CLK/CLK input, then the device will be susceptible to self-oscillation. Q/Q outputs have internal 50 Ω source termination resistors.
2. All VCC and GND pins must be externally connected to a power supply for proper operation.

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**Table 3. ATTRIBUTES**

Characteristics		Value
ESD Protection	Human Body Model Machine Model	> 4 kV > 200 V
R <sub>PD</sub> – Reset Input Pulldown Resistor		75 kΩ
Moisture Sensitivity (Note 3)	QFN16	Level 1
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in
Transistor Count		190
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test		

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

**Table 4. MAXIMUM RATINGS**

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
V <sub>CC</sub>	Positive Power Supply	GND = 0 V		3.0	V
V <sub>IN</sub>	Positive Input Voltage	GND = 0 V		-0.5 to V <sub>CC</sub> +0.5	V
V <sub>INPP</sub>	Differential Input Voltage  D – $\bar{D}$			1.89	V
I <sub>IN</sub>	Input Current Through R <sub>T</sub> (50 Ω Resistor)			± 40	mA
I <sub>OUT</sub>	Output Current Through R <sub>T</sub> (50 Ω Resistor)			± 40	mA
I <sub>VREFAC</sub>	VREFAC Sink/Source Current			± 1.5	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) (Note 4)	0 lfpm 500 lfpm	QFN-16 QFN-16	42 35	°C/W
θ <sub>JC</sub>	Thermal Resistance (Junction-to-Case) (Note 4)		QFN-16	4	°C/W
T <sub>sol</sub>	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.

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

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**Table 5. DC CHARACTERISTICS POSITIVE CML OUTPUT**  $V_{CC} = 1.71\text{ V to }2.625\text{ V}$ ;  $GND = 0\text{ V}$ ;  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (Note 5)

Symbol	Characteristic	Min	Typ	Max	Unit	
<b>POWER SUPPLY CURRENT</b>						
$I_{CC}$	Power Supply Current (Inputs and Outputs Open)	$V_{CC} = 2.5\text{ V} \pm 5\%$ $V_{CC} = 1.8\text{ V} \pm 5\%$	95 85	115 100	mA	
<b>CML OUTPUTS</b>						
$V_{OH}$	Output HIGH Voltage (Note 6)	$V_{CC} = 2.5\text{ V}$ $V_{CC} = 1.8\text{ V}$	$V_{CC} - 30$ 2470 1770	$V_{CC} - 10$ 2490 1790	$V_{CC}$ 2500 1800	mV
$V_{OL}$	Output LOW Voltage (Note 6)	$V_{CC} = 2.5\text{ V}$ $V_{CC} = 1.8\text{ V}$	$V_{CC} - 650$ 1850 $V_{CC} - 600$ 1200	$V_{CC} - 550$ 1950 $V_{CC} - 500$ 1300	$V_{CC} - 450$ 2050 $V_{CC} - 400$ 1400	mV
<b>DIFFERENTIAL INPUTS DRIVEN SINGLE-ENDED</b> (Note 7) (Figures 5 & 6)						
$V_{th}$	Input Threshold Reference Voltage Range (Note 8)		1050		$V_{CC} - 100$	mV
$V_{IH}$	Single-ended Input HIGH Voltage		$V_{th} + 100$		$V_{CC}$	mV
$V_{IL}$	Single-ended Input LOW Voltage		GND		$V_{th} - 100$	mV
$V_{ISE}$	Single-ended Input Voltage ( $V_{IH} - V_{IL}$ )		200		1200	mV
<b>VREFAC</b>						
$V_{REFAC}$	Output Reference Voltage @100 $\mu\text{A}$ for Capacitor- Coupled Inputs, Only	$V_{CC} = 2.5\text{ V}$ $V_{CC} = 1.8\text{ V}$	$V_{CC} - 850$ $V_{CC} - 750$		$V_{CC} - 500$ $V_{CC} - 450$	mV
<b>DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY</b> (Figures 7 & 8) (Note 9)						
$V_{IHD}$	Differential Input HIGH Voltage		1100		$V_{CC}$	mV
$V_{ILD}$	Differential Input LOW Voltage		GND		$V_{CC} - 100$	mV
$V_{ID}$	Differential Input Voltage ( $V_{IHD} - V_{ILD}$ )		100		1200	mV
$V_{CMR}$	Input Common Mode Range (Differential Configuration, Note 10) (Figure 9)		1050		$V_{CC} - 50$	mV
$I_{IH}$	Input HIGH Current ( $V_{TX}/\sqrt{T_X}$ Open)		-150		150	$\mu\text{A}$
$I_{IL}$	Input LOW Current ( $V_{TX}/\sqrt{T_X}$ Open)		-150		150	$\mu\text{A}$
<b>CONTROL INPUT</b> (Reset pin)						
$V_{IH}$	Input HIGH Voltage for Control Pin		$V_{CC} - 200$		$V_{CC}$	mV
$V_{IL}$	Input LOW Voltage for Control Pin		GND		200	mV
$I_{IH}$	Input HIGH Current		-150		150	$\mu\text{A}$
$I_{IL}$	Input LOW Current		-150		150	$\mu\text{A}$
<b>TERMINATION RESISTORS</b>						
$R_{TIN}$	Internal Input Termination Resistor		45	50	55	$\Omega$
$R_{TOUT}$	Internal Output Termination Resistor		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 lpm.

- Input and output parameters vary 1:1 with  $V_{CC}$ .
- CML outputs loaded with  $50\text{-}\Omega$  to  $V_{CC}$  for proper operation.
- $V_{th}$ ,  $V_{IH}$ ,  $V_{IL}$ , and  $V_{ISE}$  parameters must be complied with simultaneously.
- $V_{th}$  is applied to the complementary input when operating in single-ended mode.
- $V_{IHD}$ ,  $V_{ILD}$ ,  $V_{ID}$  and  $V_{CMR}$  parameters must be complied with simultaneously.
- $V_{CMR}$  min varies 1:1 with GND,  $V_{CMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{CMR}$  range is referenced to the most positive side of the differential input signal.

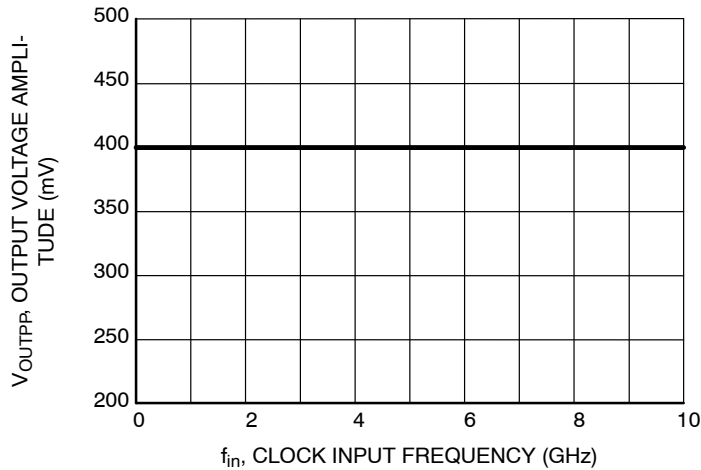
# NB7V33M

**Table 6. AC CHARACTERISTICS**  $V_{CC} = 1.71\text{ V to }2.625\text{ V}$ ;  $GND = 0\text{ V}$ ;  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (Note 11)

Symbol	Characteristic	Min	Typ	Max	Unit	
$f_{MAX}$	Maximum Input Clock Frequency	10	11		GHz	
$V_{OUTPP}$	Output Voltage Amplitude (@ $V_{INPPmin}$ ) $f_{in} \leq 10\text{ GHz}$ (Note 12) (Figure 3)	260	400		mV	
$t_{PLH}$ , $t_{PHL}$	Propagation Delay to Differential Outputs, @ 1 GHz, measured at differential crosspoint	CLK/ $\overline{CLK}$ to Q, $\overline{Q}$ R to Q, $\overline{Q}$	150 500	200 600	350 700	ps
$t_{PLH\ TC}$	Propagation Delay Temperature Coefficient		50		$\Delta\text{fs}/^\circ\text{C}$	
$t_{skew}$	Duty Cycle Skew (Note 13) Device – Device skew ( $t_{pdmax} - t_{pdmin}$ )			20 50	ps	
$t_{RR}$	Reset Recovery (See Figure 16)	550	135		ps	
$t_{PW}$	Minimum Pulse Width R	500	200		ps	
$t_{DC}$	Output Clock Duty Cycle (Reference Duty Cycle = 50%) $f_{in} \leq 10\text{ GHz}$	45	50	55	%	
$\phi_N$	Phase Noise, $f_c = 1\text{ GHz}$		10 kHz 100 kHz 1 MHz 10 MHz 20 MHz 40 MHz	-144 -147 -152 -152 -152 -153	dBc	
$t_{j\phi N}$	Integrated Phase Jitter (Figure x) $f_c = 1\text{ GHz}$ , 12 kHz – 20 MHz Offset		35		fs	
$t_{JITTER}$	RJ – Output Random Jitter (Note 14) $f_{in} \leq 10.0\text{ GHz}$		0.2	0.8	ps RMS	
$V_{INPP}$	Input Voltage Swing (Differential Configuration) (Figure 11) (Note 15)	200		1200	mV	
$t_r$ , $t_f$	Output Rise/Fall Times @ 1 GHz (20% – 80%), Q, $\overline{Q}$	20	35	60	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.

11. Measured using a 1 GHz,  $V_{INPPmin}$ , 50% duty-cycle clock source. All output loading with external  $50\ \Omega$  to  $V_{CC}$ . Input edge rates 40 ps (20% – 80%).
12. Output voltage swing is a single-ended measurement operating in differential mode.
13. Duty cycle skew is defined only for differential operation when the delays are measured from cross-point of the inputs to the cross-point of the outputs. Duty cycle skew is measured between differential outputs using the deviations of the sum of  $T_{pw-}$  and  $T_{pw+}$  @ 1 GHz. Skew is measured between outputs under identical transitions and conditions.
14. Additive RMS jitter with 50% duty cycle clock signal.
15. Input voltage swing is a single-ended measurement operating in differential mode.



**Figure 3. Output Voltage Amplitude ( $V_{OUTPP}$ ) vs. Input Frequency ( $f_{in}$ ) at Ambient Temperature (Typical)**

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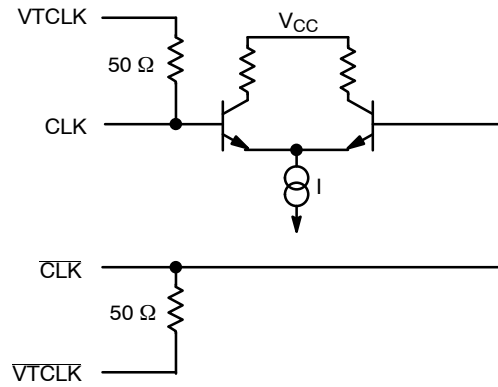


Figure 4. Input Structure

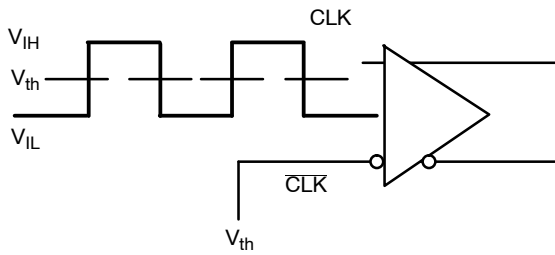


Figure 5. Differential Input Driven Single-Ended

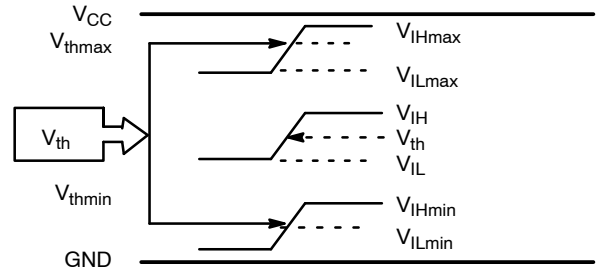


Figure 6.  $V_{th}$  Diagram

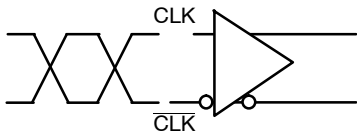


Figure 7. Differential Inputs Driven Differentially

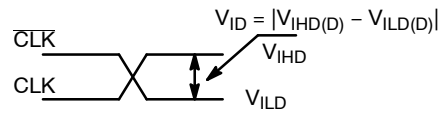


Figure 8. Differential Inputs Driven Differentially

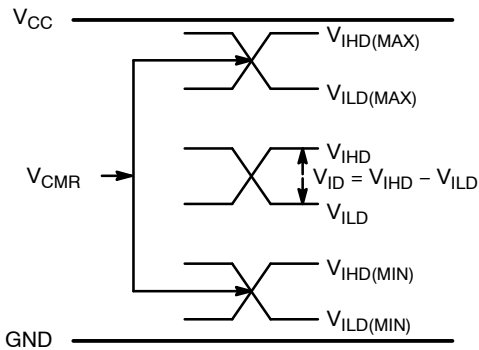


Figure 9.  $V_{CMR}$  Diagram

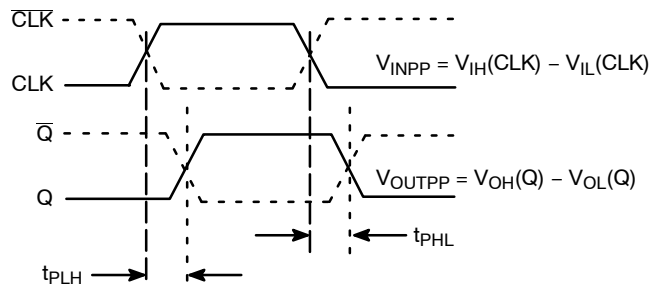


Figure 10. AC Reference Measurement

# NB7V33M

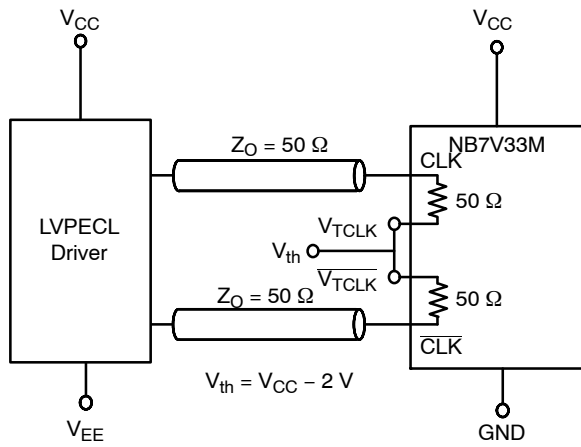


Figure 11. LVPECL Interface

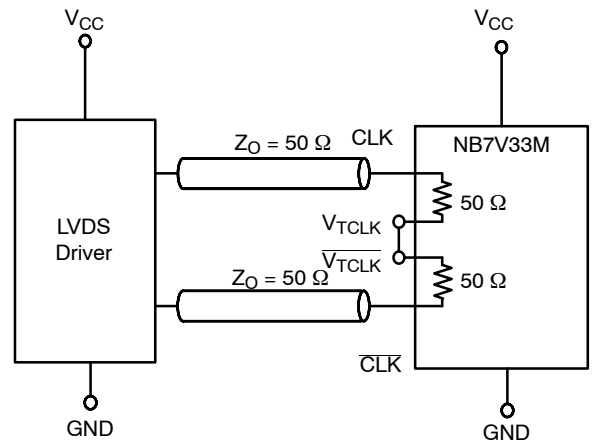


Figure 12. LVDS Interface

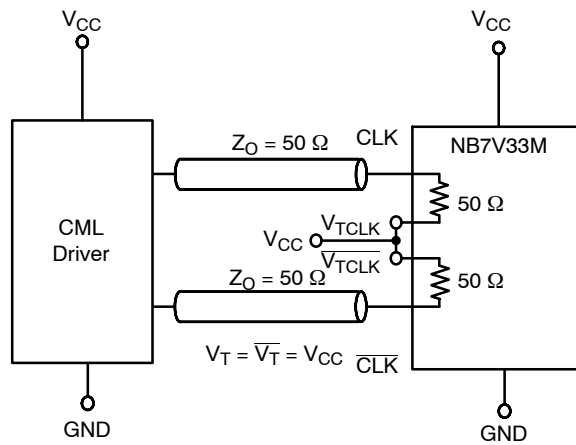


Figure 13. Standard 50  $\Omega$  Load CML Interface

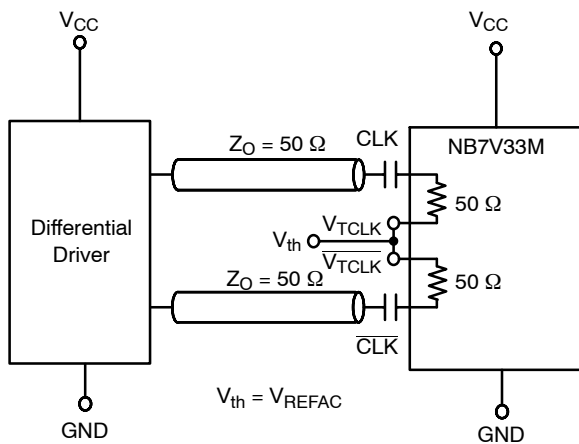


Figure 14. Capacitor-Coupled Differential Interface ( $V_{TCLK}/\sqrt{V_{TCLK}}$  Connected to  $V_{REFAC}$ ;  $V_{REFAC}$  Bypassed to Ground with 0.1  $\mu$ F Capacitor)

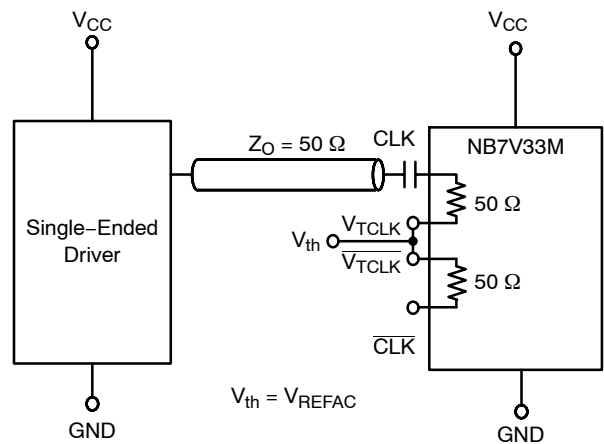


Figure 15. Capacitor-Coupled Single-Ended Interface ( $V_{TCLK}/\sqrt{V_{TCLK}}$  Connected to  $V_{REFAC}$ ;  $V_{REFAC}$  Bypassed to Ground with 0.1  $\mu$ F Capacitor)

# NB7V33M

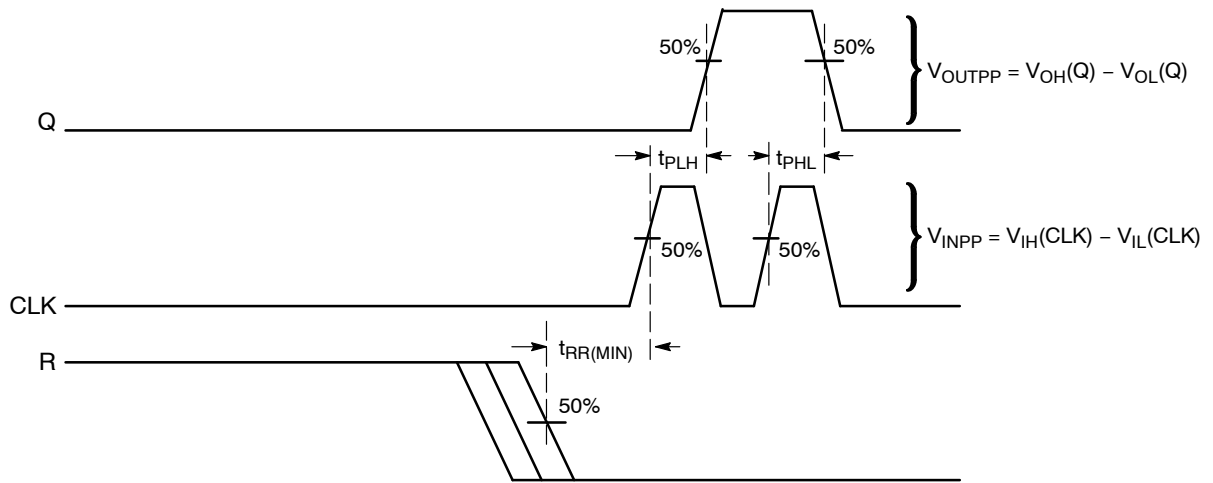


Figure 16. AC Reference Measurement (Timing Diagram)

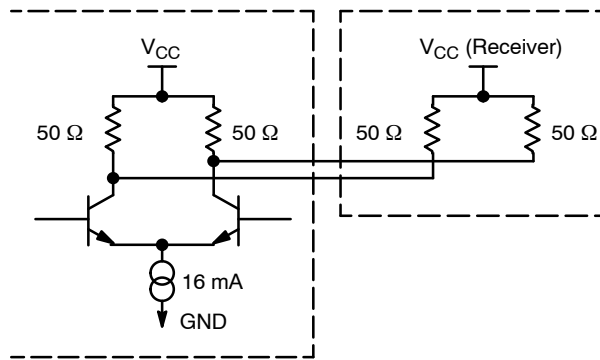


Figure 17. Typical CML Output Structure and Termination

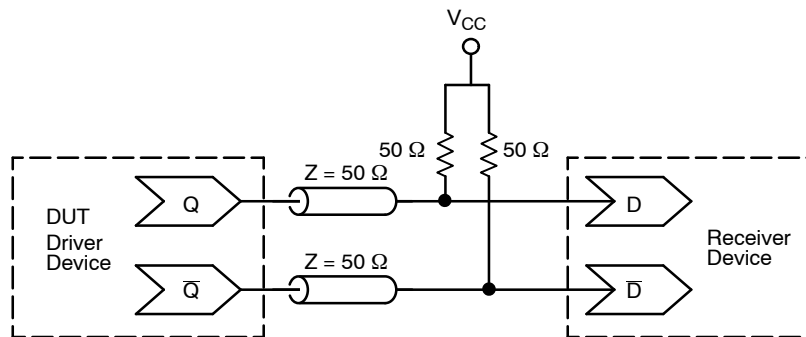


Figure 18. Typical Termination for CML Output Driver and Device Evaluation



# NB7V33M

## DEVICE ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
NB7V33MMNG	QFN-16 (Pb-Free)	123 Units / Rail
NB7V33MMNHTBG	QFN-16 (Pb-Free)	100 / Tape & Reel
NB7V33MMNTXG	QFN-16 (Pb-Free)	3,000 / Tape & Reel

<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.

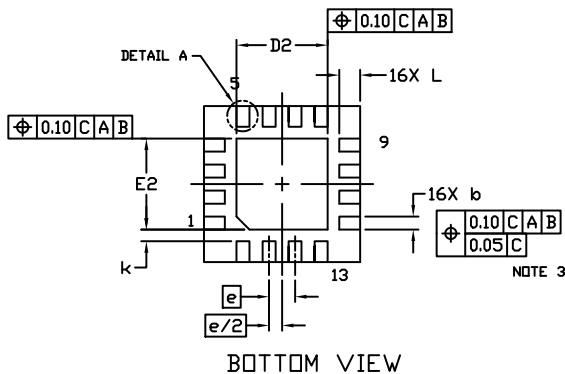
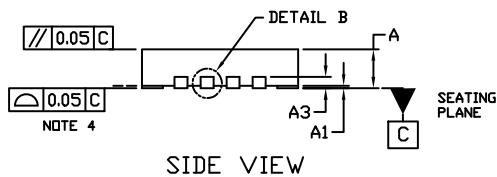
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SCALE 2:1

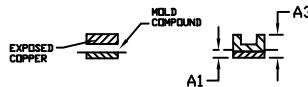
QFN16 3x3, 0.5P  
CASE 485G  
ISSUE G

DATE 08 OCT 2021

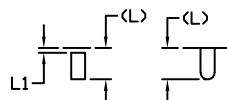


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.



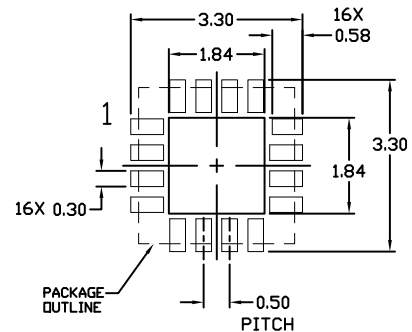
DETAIL B  
ALTERNATE  
CONSTRUCTIONS



DETAIL A  
ALTERNATE TERMINAL  
CONSTRUCTIONS

DIM	MILLIMETERS		
	MIN.	NDM.	MAX.
A	0.80	0.90	1.00
A1	0.00	0.03	0.05
A3	0.20 REF		
b	0.18	0.24	0.30
D	3.00 BSC		
D2	1.65	1.75	1.85
E	3.00 BSC		
E2	1.65	1.75	1.85
e	0.50 BSC		
k	0.18 TYP		
L	0.30	0.40	0.50
L1	0.00	0.08	0.15

MOUNTING FOOTPRINT



GENERIC  
MARKING DIAGRAM\*



- XXXXX = Specific Device Code
- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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DESCRIPTION:	QFN16 3X3, 0.5P	PAGE 1 OF 1

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