

NB7VQ14M

**1.8V/2.5V/3.3V 8GHz /
14Gbps Differential 1:4
Clock / Data CML Fanout
Buffer w/ Selectable Input
Equalizer**

Multi-Level Inputs w/ Internal Termination

Description

The NB7VQ14M is a high performance differential 1:4 CML fanout buffer with a selectable Equalizer receiver. When placed in series with a Clock /Data path operating up to 8 GHz or 14 Gb/s, respectively, the NB7VQ14M inputs will compensate the degraded signal transmitted across a FR4 PCB backplane or cable interconnect and output four identical CML copies of the input signal with a 1.8 V, 2.5 V or 3.3 V power supply. Therefore, the serial data rate is increased by reducing Inter-Symbol Interference (ISI) caused by losses in copper interconnect or long cables. The Equalizer ENable pin (EQEN) allows the IN/IN inputs to either flow through or bypass the Equalizer section. Control of the Equalizer function is realized by setting EQEN; When EQEN is set Low, the IN/IN inputs bypass the Equalizer. When EQEN is set High, the IN/IN inputs flow through the Equalizer. The default state at start-up is LOW. As such, NB7VQ14M is ideal for SONET, GigE, Fiber Channel, Backplane and other Clock/Data distribution applications.

The differential inputs incorporate internal $50\ \Omega$ termination resistors that are accessed through the VT pin. This feature allows the NB7VQ14M to accept various logic level standards, such as LVPECL, CML or LVDS. The 1:4 fanout design was optimized for low output skew applications.

The NB7VQ14M is a member of the GigaComm™ family of high performance clock products.

Features

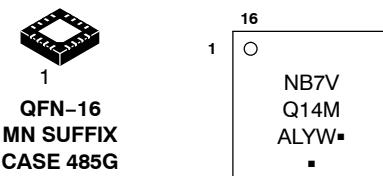
- Input Data Rate > 14 Gb/s, Typical
- Input Clock Frequency > 8 GHz, Typical
- 165 ps Typical Propagation Delay
- 30 ps Typical Rise and Fall Times
- < 15 ps Maximum Output Skew
- < 0.8 ps Maximum RMS Clock Jitter
- < 10 ps pp of Data Dependent Jitter
- Differential CML Outputs, 400 mV Peak-to-Peak, Typical
- Selectable Input Equalization
- Operating Range: $V_{CC} = 1.71\text{ V}$ to 3.6 V with $GND = 0\text{ V}$
- Internal Input Termination Resistors, $50\ \Omega$
- -40°C to $+85^\circ\text{C}$ Ambient Operating Temperature
- These are Pb-Free Devices



ON Semiconductor®

<http://onsemi.com>

MARKING DIAGRAM*

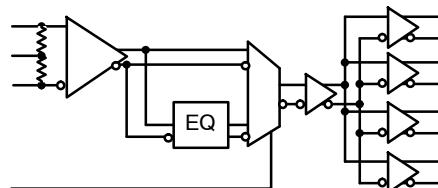


A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
■ = Pb-Free Package

(Note: Microdot may be in either location)

*For additional marking information, refer to Application Note AND8002/D.

SIMPLIFIED BLOCK DIAGRAM



ORDERING INFORMATION

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

NB7VQ14M

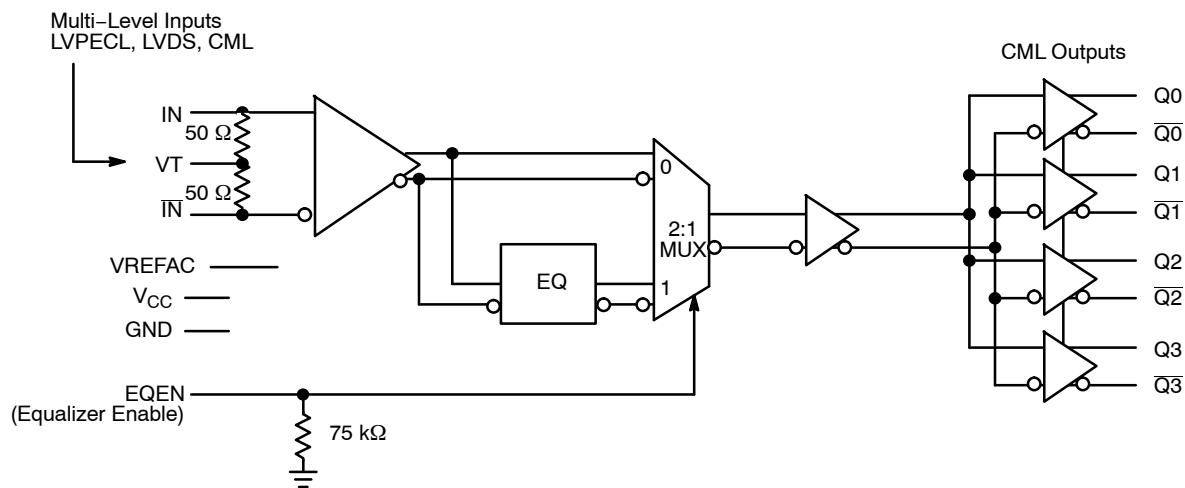


Figure 1. Detailed Block Diagram of NB7VQ14M

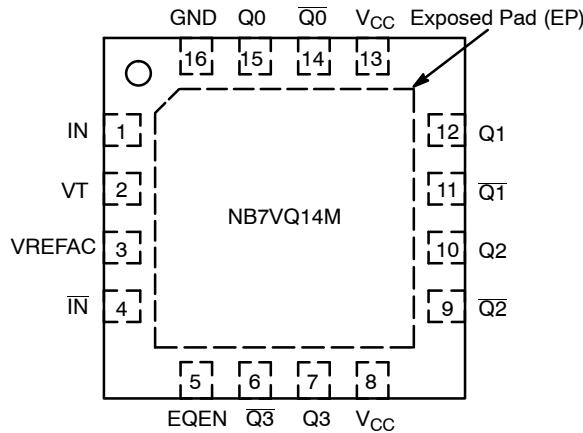


Table 1. EQUALIZER ENABLE FUNCTION

EQEN	Function
0	IN / IN-bar Inputs By-pass the Equalizer section
1	Inputs flow through the Equalizer

Figure 2. QFN-16 Pinout (Top View)

Table 2. PIN DESCRIPTION

Pin	Name	I/O	Description
1	IN	LVPECL, CML, LVDS Input	Non-inverted Differential Input. Note 1.
2	VT		Internal 100 Ω Center-tapped Termination Pin for IN / IN-bar
3	VREFAC		Output Voltage Reference for Capacitor-Coupled Inputs, only
4	IN-bar	LVPECL, CML, LVDS Input	Inverted Differential Input. Note 1.
5	EQEN	LVCMOS Input	Equalizer Enable Input; pin will default LOW when left open (has internal pull-down resistor)
6	Q3-bar	CML Output	Inverted Differential Output. Typically Terminated with 50 Ω Resistor to Vcc.
7	Q3	CML Output	Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to Vcc.
8	VCC	–	Positive Supply Voltage
9	Q2-bar	CML Output	Inverted Differential Output. Typically Terminated with 50 Ω Resistor to Vcc.
10	Q2	CML Output	Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to Vcc.
11	Q1-bar	CML Output	Inverted Differential Output. Typically Terminated with 50 Ω Resistor to Vcc.
12	Q1	CML Output	Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to Vcc.
13	VCC	–	Positive Supply Voltage
14	Q0-bar	CML Output	Inverted Differential Output. Typically Terminated with 50 Ω Resistor to Vcc.
15	Q0	CML Output	Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to Vcc.
16	GND	–	Negative Supply Voltage
–	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 pin (VT) is connected to a common termination voltage or left open, and if no signal is applied on IN / IN-bar input, then, the device will be susceptible to self-oscillation.
2. All VCC and GND pins must be externally connected to a power supply for proper operation.

Table 3. ATTRIBUTES

Characteristics		Value
ESD Protection	Human Body Model Machine Model	> 2 kV > 200V
R_{PD} – EQEN Input Pulldown Resistor		75 k Ω
Moisture Sensitivity (Note 3)	16-QFN	Level 1
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in
Transistor Count		210
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_{CC}	Positive Power Supply – Core	GND = 0 V		4.0	V
V_{IO}	Positive Input/Output Voltage	GND = 0 V		–0.5 to V_{CC} + 0.5	V
V_{INPP}	Differential Input Voltage $ IN - \bar{IN} $			1.89	V
I_{IN}	Input Current Through R_T (50 Ω Resistor)			± 40	mA
I_{OUT}	Output Current Through R_T (50 Ω Resistor)			± 40	mA
I_{VREFAC}	VREFAC Sink/Source Current			± 1.5	mA
T_A	Operating Temperature Range	16 QFN		–40 to +85	°C
T_{stg}	Storage Temperature Range			–65 to +150	°C
θ_{JA}	Thermal Resistance (Junction-to-Ambient) (Note 4)	0 lfpm 500 lfpm	16 QFN 16 QFN	42 35	°C/W °C/W
θ_{JC}	Thermal Resistance (Junction-to-Case) (Note 4)		16 QFN	4	°C/W
T_{sol}	Wave Solder Pb-Free			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.

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

NB7VQ14M

**Table 5. DC CHARACTERISTICS, MULTI-LEVEL INPUTS V_{CC} = 1.71 V to 3.6 V; GND = 0 V;
 T_A = -40°C to 85°C (Note 5)**

Symbol	Characteristic	Min	Typ	Max	Unit
POWER SUPPLY CURRENT					
V_{CC}	Power Supply Voltage V_{CC} = 3.3 V V_{CC} = 2.5 V V_{CC} = 1.8 V	3.135 2.375 1.71	3.3 2.5 1.8	3.6 2.625 1.89	V
I_{CC}	Power Supply Current (Inputs and Outputs Open)		170	210	mA

CML OUTPUTS (Note 6)

V_{OH}	Output HIGH Voltage V_{CC} = 3.3 V V_{CC} = 2.5 V V_{CC} = 1.8 V	$V_{CC} - 30$ 3270 2470 1770	$V_{CC} - 5$ 3295 2495 1795	V_{CC} 3300 2500 1800	mV
V_{OL}	Output LOW Voltage V_{CC} = 3.3 V V_{CC} = 2.5 V V_{CC} = 1.8 V	$V_{CC} - 525$ 2775 1975 1275	$V_{CC} - 425$ 2875 2075 1375	$V_{CC} - 325$ 2975 2175 1475	mV

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

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_{th}	Input Threshold Reference Voltage Range (Note 8)	1050		$V_{CC} - 100$	mV
V_{ISE}	Single-ended Input Voltage Amplitude ($V_{IH} - V_{IL}$)	200		2800	mV

VREFAC

V_{REFAC}	Output Reference Voltage @ 100 μ A for capacitor – coupled inputs, only (Note 9)	$V_{CC} - 650$ 2650 1850 1150	$V_{CC} - 500$ 2800 2000 1300	$V_{CC} - 350$ 2950 2150 1450	mV
-------------	---	--	--	--	----

DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY (see Figures 6 and 8) (Note 9)

V_{IHD}	Differential Input HIGH Voltage	1200		V_{CC}	mV
V_{ILD}	Differential Input LOW Voltage	0		$V_{IHD} - 100$	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 IN / \bar{IN} , (VT Open)	-150		150	μ A
I_{IL}	Input LOW Current IN / \bar{IN} , (VT Open)	-150		150	μ A

CONTROL INPUTS (EQEN)

V_{IH}	Input HIGH Voltage for Control Pins	$V_{CC} \times 0.65$		V_{CC}	V
V_{IL}	Input LOW Voltage for Control Pins	GND		$V_{CC} \times 0.35$	V
I_{IH}	Input HIGH Current	-150		150	μ A
I_{IL}	Input LOW Current	-150		150	μ A

TERMINATION RESISTORS

R_{TIN}	Internal Input Termination Resistor	45	50	55	Ω
R_{TOUT}	Internal Output Termination Resistor	45	50	55	Ω

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.

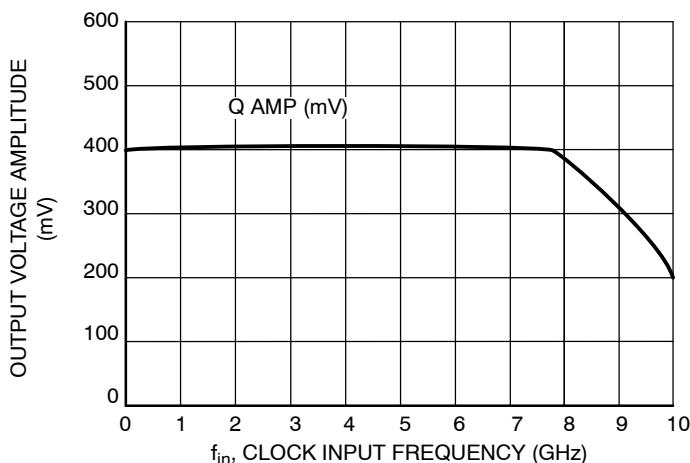
5. Input and output parameters vary 1:1 with V_{CC} .
6. CML outputs loaded with 50 Ω to V_{CC} for proper operation.
7. V_{th} , V_{IH} , V_{IL} , and V_{ISE} parameters must be complied with simultaneously.
8. V_{th} is applied to the complementary input when operating in single-ended mode.
9. V_{IHD} , V_{ILD} , V_{ID} and V_{CMR} parameters must be complied with simultaneously.
10. 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 crosspoint side of the differential input signal.

Table 6. AC CHARACTERISTICS $V_{CC} = 1.71$ V to 3.6 V; GND = 0 V; $T_A = -40^\circ\text{C}$ to 85°C (Note 11)

Symbol	Characteristic	Min	Typ	Max	Unit	
f_{MAX}	Maximum Input Clock Frequency; $V_{OUT} \geq 200$ mV	7	8.5		GHz	
$f_{DATAMAX}$	Maximum Operating Data Rate NRZ, (PRBS23)	10	14		Gbps	
V_{OUTPP}	Output Voltage Amplitude, EQEN = 0 or 1 (Note 15) (See Figure 10)	$f_{in} \leq 7\text{GHz}$	200	400	mV	
t_{PLH}, t_{PHL}	Propagation Delay IN to Q_x	125	175	225	ps	
t_{SKEW}	Duty Cycle Skew (Note 12) Output – Output Within Device Skew Device to Device Skew		3	15 15 50	ps	
t_{DC}	Output Clock Duty Cycle (Reference Duty Cycle = 50%) $f_{in} \leq 7\text{GHz}$	40	50	60	%	
Φ_N	Phase Noise, $f_{in} = 1$ GHz 10 kHz 100 kHz 1 MHz 10 MHz 20 MHz 40 MHz		-134 -136 -150 -151 -151 -151		dBc	
$t_{\phi N}$	Integrated Phase Jitter $f_{in} = 1$ GHz, 12 kHz – 20 MHz Offset (RMS)		35		fs	
t_{JITTER}	RMS Random Clock Jitter (Note 13) Peak-to-Peak Data Dependent Jitter (Note 14) $f_{in} \leq 7$ GHz $f_{in} \leq 14$ Gbps EQEN = 0 ($\leq 3''$ FR4) $f_{in} \leq 10$ Gbps EQEN = 1 ($12''$ FR4)		0.2	0.8 10 10	ps rms ps pk-pk ps pk-pk	
V_{INPP}	Input Voltage Swing/Sensitivity (Differential Configuration) (Note 15)	100		1200	mV	
t_r, t_f	Output Rise/Fall Times @ 1.0 GHz (20% – 80%)	Q_x, \bar{Q}_x	15	30	45	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.

11. Measured by forcing V_{INPP} 400mV from a 50% duty cycle clock source. All loading with an external $R_L = 50 \Omega$ to V_{CC} . Input edge rates 40 ps (20% – 80%).
12. Skew is measured between outputs under identical transitions and conditions @ 0.5 GHz. Duty cycle skew is measured between differential outputs using the deviations of the sum of T_{pw-} and T_{pw+} @ 0.5 GHz.
13. Additive RMS jitter with 50% duty cycle clock signal.
14. Additive peak-to-peak data dependent jitter with input NRZ data at PRBS23.
15. Input and output voltage swings are single-ended measurements operating in a differential mode.

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

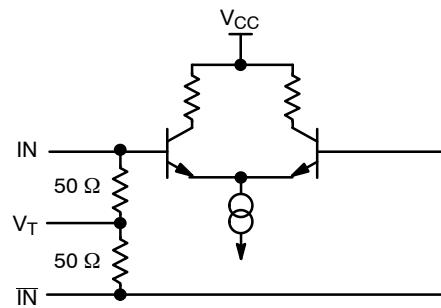


Figure 4. Input Structure

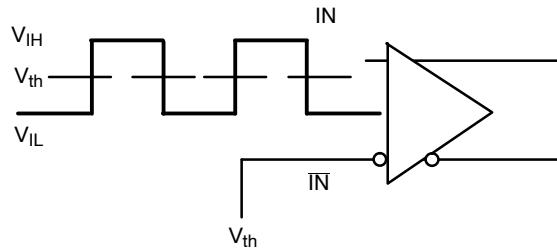


Figure 5. Differential Input Driven Single-Ended

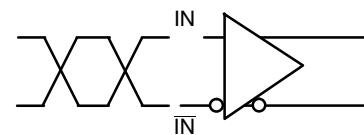


Figure 6. Differential Inputs Driven Differentially

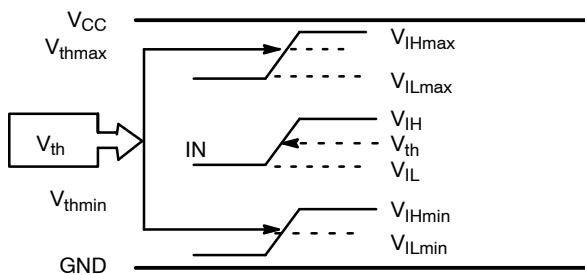


Figure 7. V_{th} Diagram

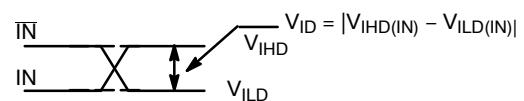


Figure 8. Differential Inputs Driven Differentially

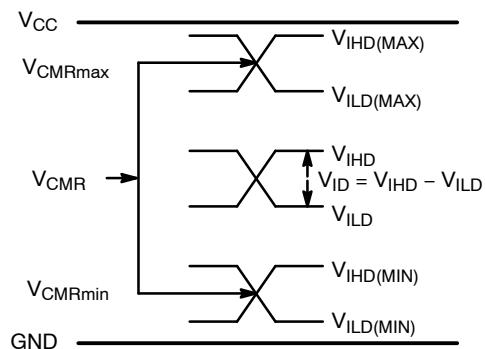


Figure 9. V_{CMR} Diagram

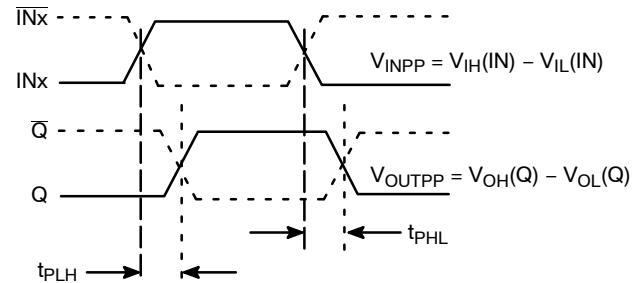


Figure 10. AC Reference Measurement

NB7VQ14M

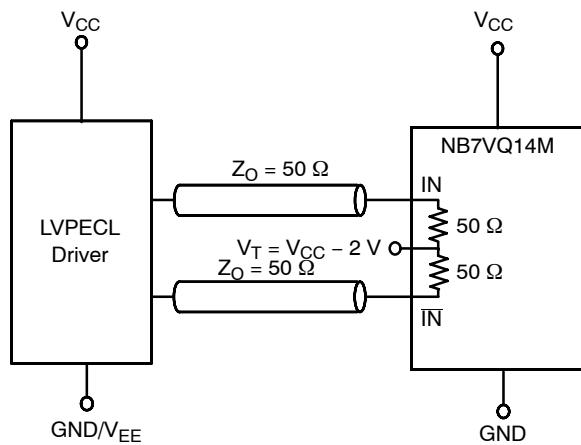


Figure 11. LVPECL Interface

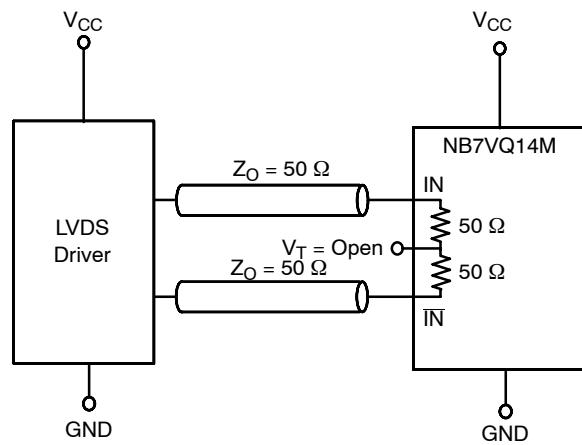


Figure 12. LVDS Interface

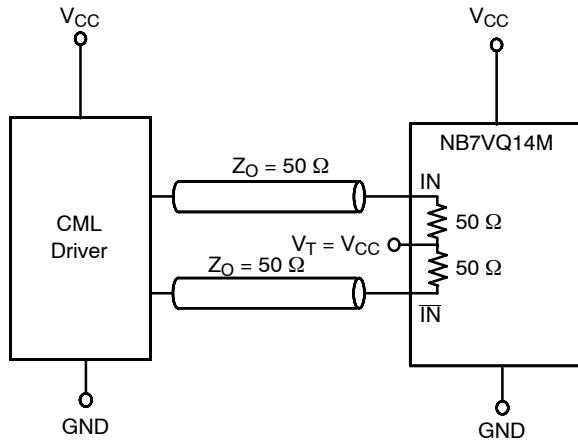


Figure 13. Standard 50 Ω Load CML Interface

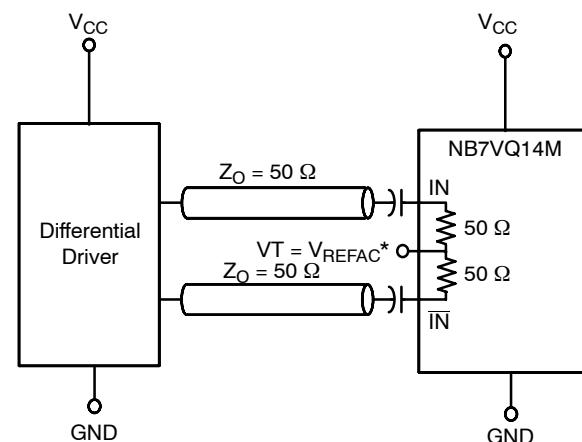


Figure 14. Capacitor-Coupled Differential Interface
(V_T Connected to V_{REFAC})

* V_{REFAC} bypassed to ground with a 0.01 μ F capacitor

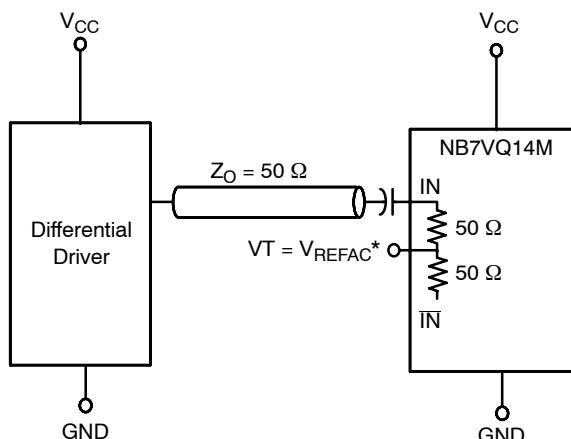


Figure 15. Capacitor-Coupled Single-Ended Interface
(V_T Connected to V_{REFAC})

NB7VQ14M

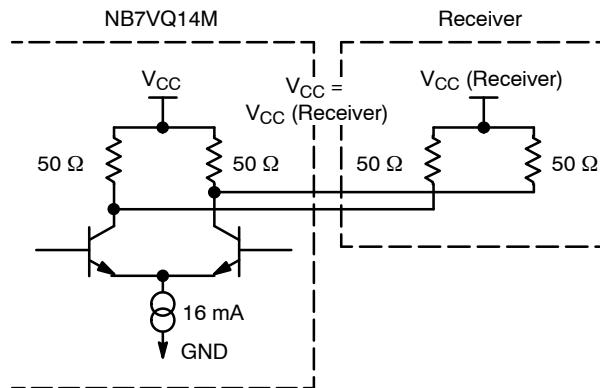


Figure 16. Typical CML Output Structure and Termination

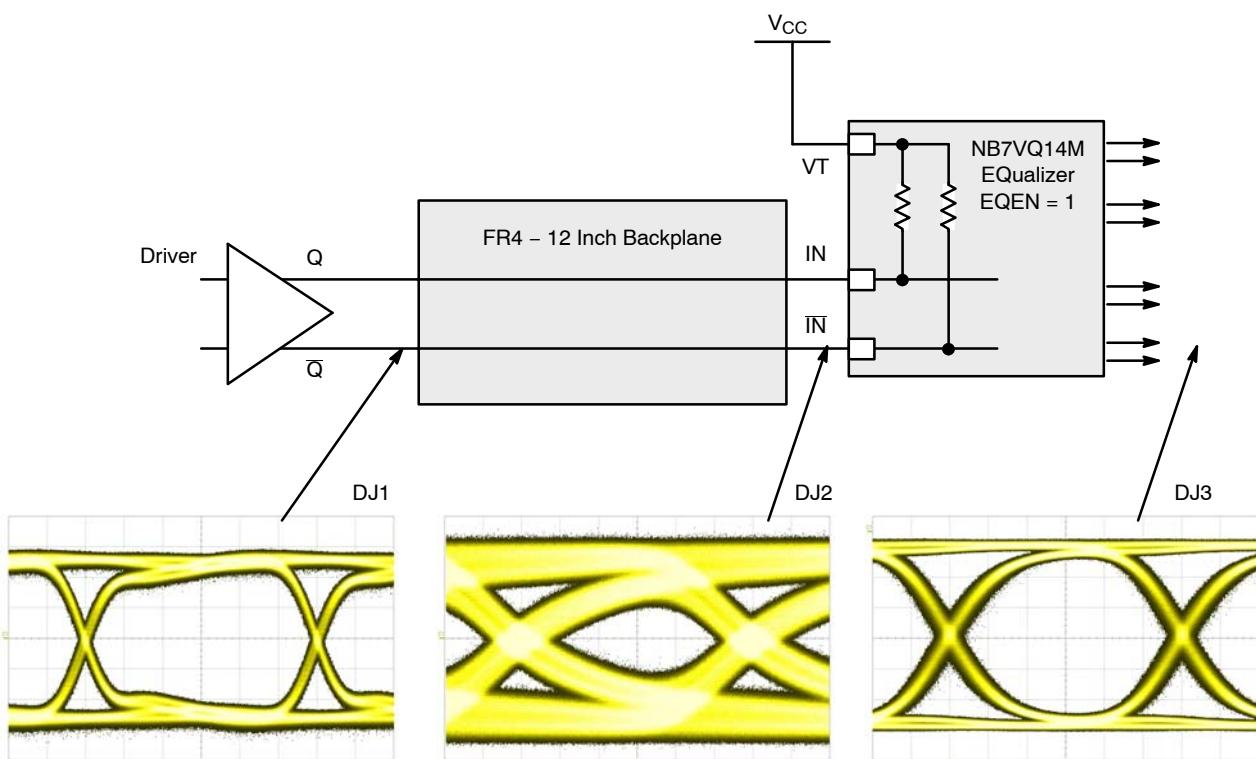


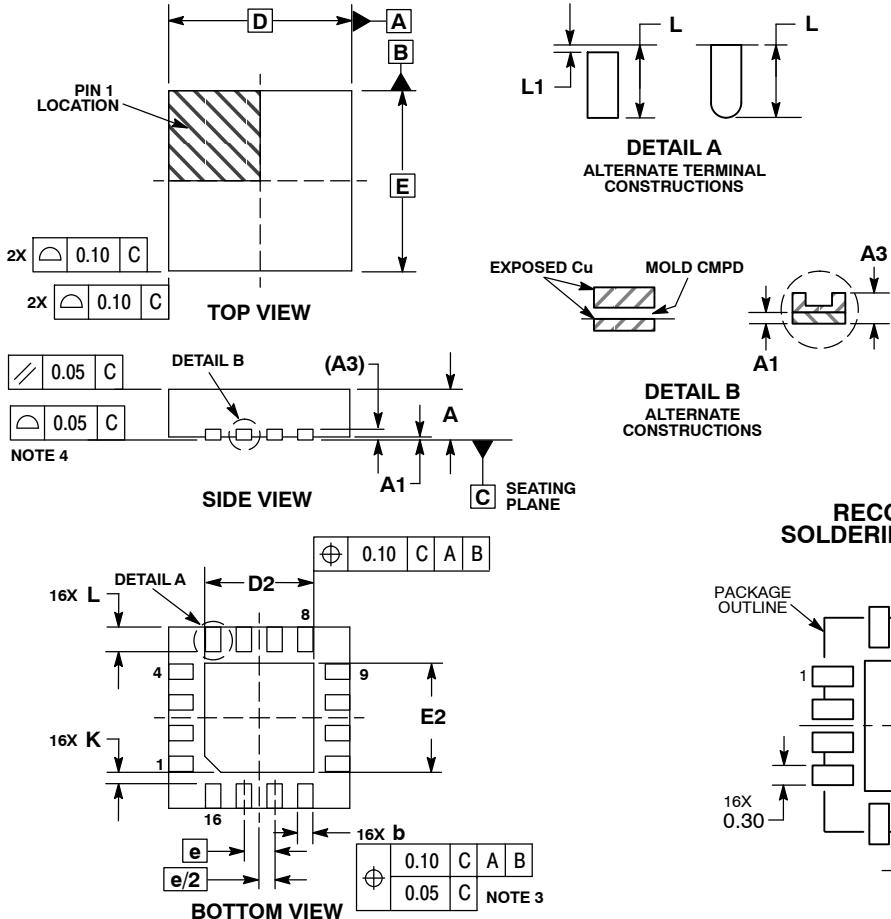
Figure 17. Typical NB7VQ14M Equalizer Application and Interconnect with PRBS23 pattern at 6.5 Gbps, EQEN = 1

ORDERING INFORMATION

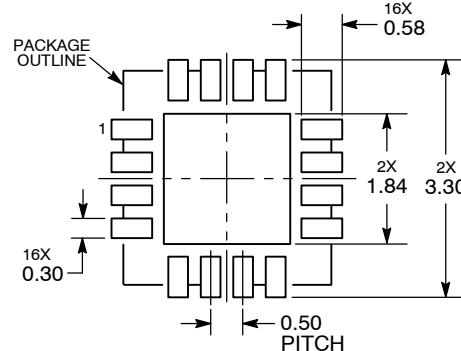
Device	Package	Shipping [†]
NB7VQ14MMNG	QFN-16 (Pb-Free)	123 Units / Rail
NB7VQ14MMNHTBG	QFN-16 (Pb-Free)	100 / Tape & Reel
NB7VQ14MMNTXG	QFN-16 (Pb-Free)	3000 / Tape & Reel

[†]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.

PACKAGE DIMENSIONS

QFN16 3x3, 0.5P
CASE 485G-01
ISSUE E

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
L1	0.00	0.15

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.

GigaComm is a trademark 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

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

For additional information, please contact your local
Sales Representative