# 2.5V / 3.3V Differential 4:1 Mux to 1:2 CML Clock/Data Fanout / Translator

# Multi-Level Inputs w/ Internal Termination

### Description

The NB6L572M is a high performance differential 4:1 Clock / Data input multiplexer and a 1:2 CML Clock / Data fanout buffer that operates up to 6 GHz / 8 Gbps respectively with a 2.5 V or 3.3 V power supply.

The differential Clock / Data inputs have internal 50  $\Omega$  termination resistors and will accept differential LVPECL, CML, or LVDS logic levels. The NB6L572M incorporates a pair of Select pins that will choose one of four differential inputs and will produce two identical CML output copies of Clock or Data.

As such, the NB6L572M is ideal for SONET, GigE, Fiber Channel, Backplane and other Clock/Data distribution applications.

The two differential CML outputs will swing 400 mV when externally loaded and terminated with a 50  $\Omega$  resistor to  $V_{CC}$  and are optimized for low skew and minimal jitter.

The NB6L572M is offered in a low profile 5x5mm 32-pin QFN Pb-Free package. Application notes, models, and support documentation are available at www.onsemi.com. The NB6L572M is a member of the ECLinPS MAX™ family of high performance clock products.



# ON Semiconductor®

http://onsemi.com



# QFN32 MN SUFFIX CASE 488AM

# MARKING DIAGRAM



A = Assembly Location

WL = Wafer Lot
YY = Year
WW = Work Week
= Pb-Free Package

(Note: Microdot may be in either location)

# **ORDERING INFORMATION**

See detailed ordering and shipping information on page 8 of this data sheet.

#### **Features**

- Input Data Rate > 8 Gb/s Typical
- Data Dependent Jitter < 10 ps
- Maximum Input Clock Frequency > 6 GHz Typical
- Random Clock Jitter < 0.8 ps RMS
- Low Skew 1:2 CML Outputs, < 15 ps max
- 4:1 Multi-Level Mux Inputs, accepts LVPECL, CML LVDS
- 200 ps Typical Propagation Delay
- 35 ps Typical Rise and Fall Times

- Differential CML Outputs, 400 mV Peak-to-Peak, Typical
- Operating Range:  $V_{CC} = 2.375 \text{ V}$  to 3.6 V with GND = 0 V
- Internal 50  $\Omega$  Input Termination Resistors
- V<sub>REFAC</sub> Reference Output
- QFN-32 Package, 5mm x 5mm
- 40°C to +85°C Ambient Operating Temperature
- These are Pb-Free Devices

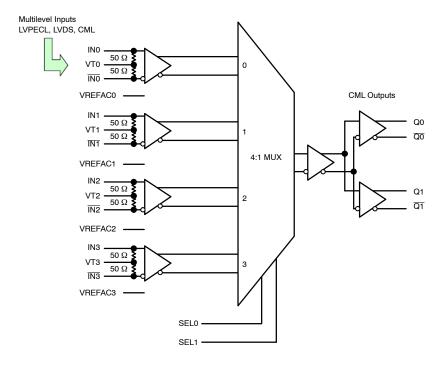


Figure 1. Simplified Block Diagram

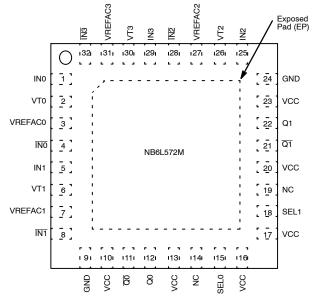


Figure 2. Pinout: QFN-32 (Top View)

**Table 1. INPUT SELECT FUNCTION TABLE** 

SEL1*	SEL0*	Clock / Data Input Selected	
0	0	IN0 Input Selected	
0	1	IN1 Input Selected	
1	0	IN2 Input Selected	
1	1	IN3 Input Selected	

<sup>\*</sup>Defaults HIGH when left open.

**Table 2. PIN DESCRIPTION** 

Pin Number	Pin Name	I/O	Pin Description
1, 4 5, 8 25, 28 29, 32	INO, <u>INO</u> IN1, <u>IN1</u> IN2, <u>IN2</u> IN3, <u>IN3</u>	LVPECL, CML, LVDS Input	Non-inverted, Inverted, Differential Clock or Data Inputs
2, 6 26, 30	VT0, VT1 VT2, VT3		Internal 100 $\Omega$ Center–tapped Termination Pin for INx/ $\overline{\text{INx}}$
15 18	SEL0 SEL1	LVTTL/LVCMOS Input	Input Select pins, default HIGH when left open through a 131 k $\Omega$ pullup resistor. Input logic threshold is V <sub>CC</sub> /2. See Select Function, Table 1.
14, 19	NC	-	No Connect
10, 13, 16 17, 20, 23	VCC	-	Positive Supply Voltage. All $V_{CC}$ pins must be connected to the positive power supply for correct DC and AC operation.
11, 12 21, 22	Q0, Q0 Q1, Q1	CML Output	Non-inverted, Inverted Differential Outputs.
9, 24	GND		Negative Supply Voltage, connected to Ground
3 7 27 31	VREF-AC0 VREF-AC1 VREF-AC2 VREF-AC3	-	Output Voltage Reference for Capacitor-Coupled Inputs
-	EP	-	The Exposed Pad (EP) on the QFN-32 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 connected to GND.

In the differential configuration when the input termination pins (VT0, VT1, VT2, VT3) are connected to a common termination voltage or left open, and if no signal is applied on INx/INx input, then the device will be susceptible to self–oscillation.
 All V<sub>CC</sub>, and GND pins must be externally connected to a power supply for proper operation.

**Table 3. ATTRIBUTES** 

Characteristi	Value				
ESD Protection	Human Body Model Machine Model	> 2 kV > 200 V			
R <sub>PU</sub> - SELx Input Pull-up Resistor	131 kΩ				
Moisture Sensitivity (Note 3)	QFN-32	Level 1			
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in			
Transistor Count	275				
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test					

<sup>3.</sup> 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		-0.5 V to +4.0	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  IN - INx			1.89	V
I <sub>out</sub>	Output Current Through R <sub>T</sub> (50 $\Omega$ Resistor)			±40	mA
I <sub>IN</sub>	Input current Through RT (50 Ω resistor)			±40	mA
I <sub>VREFAC</sub>	VREFAC Sink or 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
$\theta_{JA}$	Thermal Resistance (Junction-to-Ambient) (Note 4)	0 lfpm 500 lfpm	QFN32 QFN32	31 27	°C/W
$\theta$ JC	Thermal Resistance (Junction-to-Case) (Note 4)		QFN32	12	°C/W
T <sub>sol</sub>	Wave Solder	≤ 20 sec		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.

Table 5. DC CHARACTERISTICS CML OUTPUT  $V_{CC}$  = 2.375 V to 3.6 V , GND = 0 V,  $T_A$  = -40°C to +85°C (Note 5)

Symbol	Characteristic	Min	Тур	Max	Unit
POWER S	UPPLY	•		•	•
V <sub>CC</sub>	Power Supply Voltage $ \begin{array}{c} V_{CC} = 3.3 \ V \\ V_{CC} = 2.5 \ V \end{array} $	3.0 2.375	3.3 2.5	3.6 2.625	V
I <sub>CC</sub>	$ \begin{array}{lll} \mbox{Power Supply Current for V}_{CC} & \mbox{V}_{CC} = 3.3 \ \mbox{V} \\ \mbox{(Inputs and Outputs Open)} & \mbox{V}_{CC} = 2.5 \ \mbox{V} \\ \end{array} $		130 115	165 150	mA
CML OUT	PUTS (Note 6)				•
V <sub>OH</sub>	Output HIGH Voltage VCC = 3.3 V VCC = 2.5 V	V <sub>CC</sub> – 30 3270 2470	V <sub>CC</sub> – 10 3290 2490	V <sub>CC</sub> 3300 2500	mV
V <sub>OL</sub>	Output LOW Voltage $V_{\text{CC}} = 3.3 \text{ V} \\ V_{\text{CC}} = 2.5 \text{ V}$	V <sub>CC</sub> - 650 2650 V <sub>CC</sub> - 650 1850	V <sub>CC</sub> - 450 2850 V <sub>CC</sub> - 450 2050	V <sub>CC</sub> – 300 3000 V <sub>CC</sub> – 300 2200	mV
DIFFERE	NTIAL CLOCK INPUTS DRIVEN SINGLE-ENDED (Figures 5 & 6)	(Note 8)			
V <sub>IH</sub>	Single-ended Input HIGH Voltage	V <sub>th</sub> + 100		V <sub>CC</sub>	mV
V <sub>IL</sub>	Single-ended Input LOW Voltage	GND		V <sub>th</sub> – 100	mV
V <sub>th</sub>	Input Threshold Reference Voltage Range (Note 8)	1100		V <sub>CC</sub> – 100	mV
V <sub>ISE</sub>	Single-ended Input Voltage (V <sub>IH</sub> - V <sub>IL</sub> )	200		1200	mV
VREFAC					
V <sub>REF-AC</sub>	Output Reference Voltage (100 μA Load)	1050	V <sub>CC</sub> – 1250	V <sub>CC</sub> – 1050	mV
DIFFERE	NTIAL INPUTS DRIVEN DIFFERENTIALLY (Figures 7 & 8) (Note 9	9)			
V <sub>IHD</sub>	Differential Input HIGH Voltage (IN, ĪN)	1200		V <sub>CC</sub>	mV
V <sub>ILD</sub>	Differential Input LOW Voltage (IN, IN)	0		V <sub>IHD</sub> – 100	mV
V <sub>ID</sub>	Differential Input Voltage (IN, IN) (V <sub>IHD</sub> - V <sub>ILD</sub> )	100		1200	mV
V <sub>CMR</sub>	Input Common Mode Range (Differential Configuration, Note 10) (Figure 9)	1050		V <sub>CC</sub> – 50	mV
I <sub>IH</sub>	Input HIGH Current IN / INx (VTIN / VTINx Open)	-150		150	μΑ
I <sub>IL</sub>	Input LOW Current IN / INx (VTIN / VTINx Open)	-150		150	μΑ
CONTRO	LINPUT (SELx Pin)				
V <sub>IH</sub>	Input HIGH Voltage for Control Pin	V <sub>CC</sub> x 0.65		V <sub>CC</sub>	V
V <sub>IL</sub>	Input LOW Voltage for Control Pin	GND		V <sub>CC</sub> x 0.35	V
I <sub>IH</sub>	Input HIGH Current	-150		150	μΑ
I <sub>IL</sub>	Input LOW Current	-150		150	μΑ
TERMINA	TION RESISTORS				
R <sub>TIN</sub>	Internal Input Termination Resistor (Measured from INx to VTx)	45	50	55	Ω
R <sub>TOUT</sub>	Internal Output Termination Resistor	45	50	55	Ω
			1		

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. 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<sub>CC</sub>.
- 6. CML outputs loaded with 50  $\Omega$  to  $V_{CC}$  for proper operation.

  7.  $V_{th}$  is applied to the complementary input when operating in single–ended mode.
- 8.  $V_{th}$ ,  $V_{lH}$ ,  $V_{lL}$ , and  $V_{lSE}$  parameters must be complied with simultaneously. 9.  $V_{lHD}$ ,  $V_{lLD}$ ,  $V_{lD}$  and  $V_{CMR}$  parameters must be complied with simultaneously.
- 10. V<sub>CMR</sub> min varies 1:1 with GND, V<sub>CMR</sub> max varies 1:1 with V<sub>CC</sub>. The V<sub>CMR</sub> range is referenced to the most positive side of the differential input signal.

Table 6. AC CHARACTERISTICS  $V_{CC} = 2.375 \text{ V}$  to 3.6 V, GND = 0 V,  $T_A = -40^{\circ}\text{C}$  to +85°C (Note 11)

Symbol	Characteristic			Тур	Max	Unit
f <sub>MAX</sub>	Maximum Input Clock Frequency V <sub>OUT</sub> ≥ 250 mV			6		GHz
f <sub>DATAMAX</sub>	Maximum Operating Data Rate NRZ, (PRBS23	)	6.5	8		Gbps
f <sub>SEL</sub>	Maximum Toggle Frequency, SELx		20	40		MHz
V <sub>OUTPP</sub>	Output Voltage Amplitude (@ $V_{INPPmin}$ ) $f_{in} \le 5$ GHz (Note 12) (Figure 10)		250	400		mV
t <sub>PLH</sub> , t <sub>PHL</sub>	Propagation Delay to Differential Outputs Measured at Differential Crosspoint  @ 1 GHz INx/INx to Qx/Qx @ 50 MHz SELx to Qx			200 4	250 10	ps ns
t <sub>PD</sub> Tempco	Differential Propagation Delay Temperature Coefficient			100		∆fs/°C
tskew	Output – Output skew (within device) (Note 13) Device – Device skew (tpdmax – tpdmin)			0 5	15 25	ps
t <sub>DC</sub>	Output Clock Duty Cycle (Reference Duty Cycle = 50%) fin = 1 GHz		45	50	55	%
ΦΝ	Phase Noise, fin = 1 GHz  10 kHz  100 kHz  1 MHz  10 MHz  20 MHz  40 MHz			-134 -136 -149 -150 -150		dBc
t <sub>∫ΦN</sub>	Integrated Phase Jitter (Figure x) fin = 1 GHz, 12 kHz - 20 MHz Offset (RMS)			35		fs
<sup>t</sup> JITTER	$\begin{array}{ll} \text{Random Clock Jitter, RJ(RMS) (Note 14)} & \text{$f_{in} \leq 5$ GHz} \\ \text{Deterministic Jitter, DJ (Note 15) (FR4} \leq 12\text{'}) & \text{$f_{in} \leq 6.5$ Gbps} \end{array}$			0.2 1	0.8 5	ps RMS ps pk-pk
	Crosstalk Induced Jitter (Adjacent Channel) (Note 16)			0.35	0.7	ps RMS
V <sub>INPP</sub>	Input Voltage Swing (Differential Configuration) (Note 17)		100		1200	mV
t <sub>r,</sub> , t <sub>f</sub>	Output Rise/Fall Times @ 1 GHz; (20% - 80%), V <sub>IN</sub> = 400 mV Qx, $\overline{\text{Qx}}$		20	35	50	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 lfpm. 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 using a 100 mVpk-pk source, 50% duty cycle clock source. All output loading with external 50  $\Omega$  to V<sub>CC</sub>. Input edge rates 40 ps (20% 80%).
- 12. Output voltage swing is a single-ended measurement operating in differential mode.
- 13. 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 cross-point of the inputs to the cross-point of the outputs.
- 14. Additive RMS jitter with 50% duty cycle clock signal.
- 15. Additive Peak-to-Peak data dependent jitter with input NRZ data at PRBS23.
- 16. Crosstalk is measured at the output while applying two similar clock frequencies that are asynchronous with respect to each other at the inputs.
- 17. Input voltage swing is a single-ended measurement operating in differential mode.

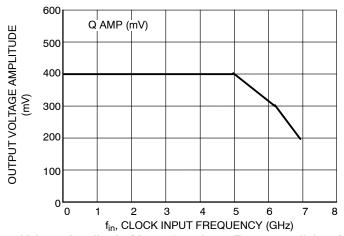


Figure 3. Clock Output Voltage Amplitude (VOUTPP) vs. Input Frequency (fin) at Ambient Temperature (Typical)

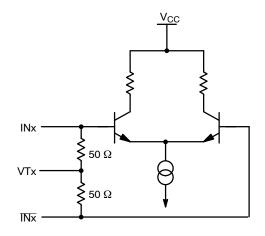


Figure 4. Input Structure

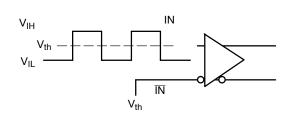


Figure 5. Differential Input Driven Single-Ended

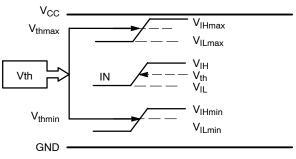


Figure 6. V<sub>th</sub> Diagram

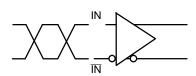


Figure 7. Differential Inputs Driven Differentially

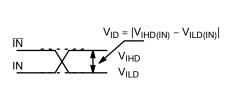


Figure 8. Differential Inputs Driven Differentially

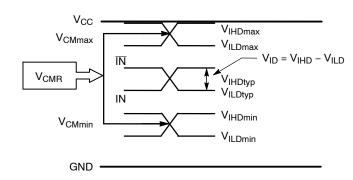


Figure 9. VCMR Diagram

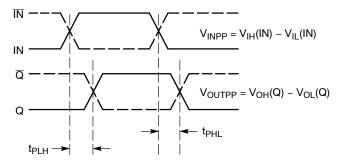


Figure 10. AC Reference Measurement

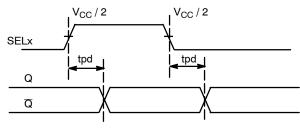


Figure 11. SELx to Qx Timing Diagram

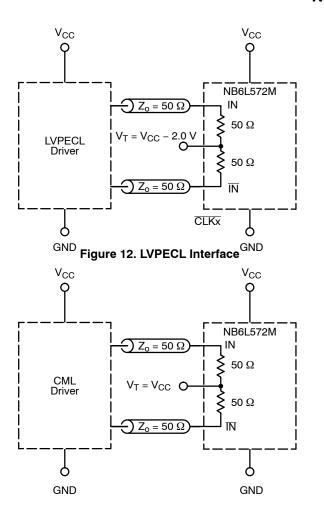


Figure 14. Standard 50  $\Omega$  Load CML Interface

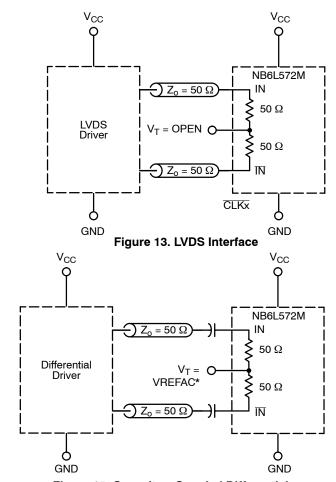


Figure 15. Capacitor–Coupled Differential Interface (V<sub>T</sub> Connected to External V<sub>REFAC</sub>)

\*VREFAC bypassed to ground with a 0.01  $\mu\text{F}$  capacitor.

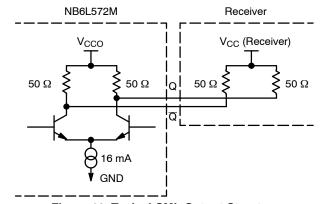


Figure 16. Typical CML Output Structure and Termination (V<sub>CC</sub> = 2.5 V or 3.3 V)

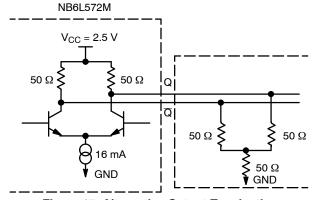


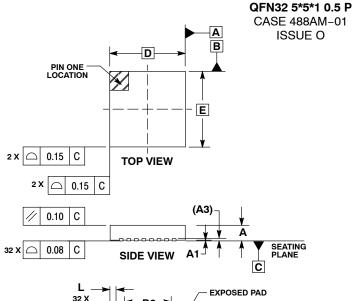
Figure 17. Alternative Output Termination  $(V_{CC} = 2.5 \text{ V}, \text{Only})$ 

#### **DEVICE ORDERING INFORMATION**

Device	Package	Shipping <sup>†</sup>
NB6L572MMNG	QFN-32 (Pb-Free)	74 Units / Rail
NB6L572MMNR4G	QFN-32 (Pb-Free)	1000 / 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.

#### PACKAGE DIMENSIONS



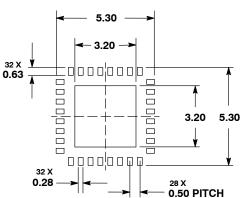
#### NOTES:

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- DIMENSIONS AND TOLEHANCING PEH
  ASME Y14.5M, 1994.
  CONTROLLING DIMENSION: MILLIMETERS.
  DIMENSION b APPLIES TO PLATED
  TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM TERMINAL
- COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

	MILLIMETERS				
DIM	MIN	NOM	MAX		
Α	0.800	0.900	1.000		
A1	0.000	0.025	0.050		
А3	0.	0.200 REF			
b	0.180	0.250	0.300		
D	5.00 BSC				
D2	2.950	3.100	3.250		
Е	5.00 BSC				
E2	2.950	3.100	3.250		
е	0.500 BSC				
K	0.200		-		
L	0.300	0.400	0.500		

#### **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.

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**BOTTOM VIEW** 

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