

# NB3N501

## 3.3V / 5.0V 13 MHz to 160 MHz PLL Clock Multiplier



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### Description

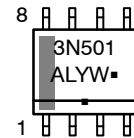
The NB3N501 is a clock multiplier that will generate one of nine selectable output multiples of an input frequency via two 3-level select inputs (S0, S1). It accepts a standard fundamental mode crystal or an external reference clock signal. Phase-Locked-Loop (PLL) design techniques are used to produce a low jitter, TTL level clock output up to 160 MHz with a 50% duty cycle. An Output Enable (OE) pin is provided, and when asserted low, the clock output goes into tri-state (high impedance). The NB3N501 is commonly used in electronic systems as a cost efficient replacement for crystal oscillators

### Features

- Clock Output Frequencies up to 160 MHz
- Nine Selectable Multipliers of the Input Frequency
- Operating Range:  $V_{DD} = 3.3\text{ V} \pm 10\%$  or  $5.0\text{ V} \pm 5\%$
- Low Jitter Output of 25 ps One Sigma (rms)
- Zero ppm Clock Multiplication Error
- 45% – 55% Output Duty Cycle
- TTL/CMOS Output with 25 mA TTL Level Drive
- Crystal Reference Input Range of 5 – 27 MHz
- Input Clock Frequency Range of 2 – 50 MHz
- OE, Output Enable with Tri-State Output
- 8-Pin SOIC
- Industrial Temperature Range  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- These are Pb-Free Devices

### MARKING DIAGRAM

8  
1  
SOIC-8  
D SUFFIX  
CASE 751



3N501 = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 5 of this data sheet.

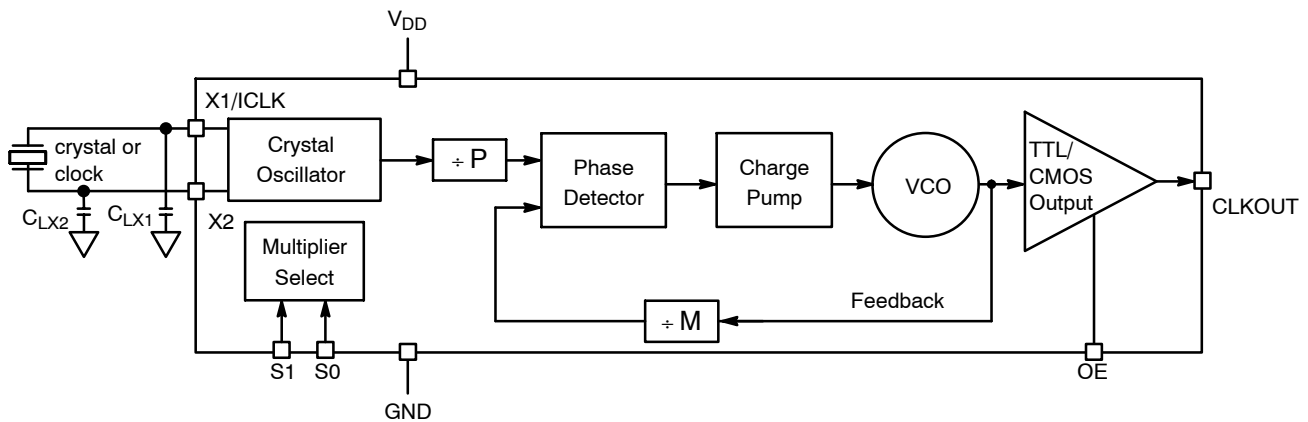


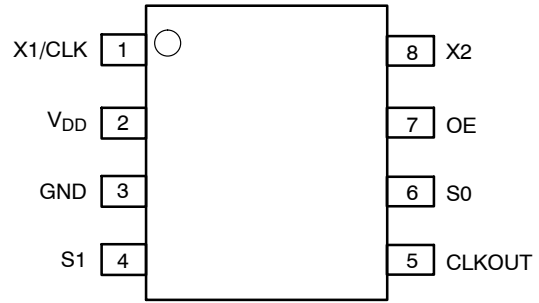
Figure 1. NB3N501 Logic Diagram

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**Table 1. CLOCK MULTIPLIER SELECT TABLE**

S1*	S0*	CLKOUT Multiplier
L	L	4X Input
L	M	5.3125X Input
L	H	5X Input
M	L	6.25X Input
M	M	2X Input
M	H	3.125X Input
H	L	6X Input
H	M	3X Input
H	H	8X Input

\*Pins S1 and S0 default to M when open  
 L = GND  
 H = VDD  
 M = OPEN (unconnected; will default to VDD/2)



**Figure 2. NB3N501 Package Pinout, 8-Pin (150 mil) SOIC**

**Table 2. PIN DESCRIPTION**

Pin #	Name	I/O	Description
1	X1/CLK	Input	Crystal or external reference clock input
2	VDD	Power supply	Positive supply voltage
3	GND	Power supply	0 V. Ground.
4	S1	Three level Input	Multiplier select pin – connect to V <sub>DD</sub> , GND or float
5	CLKOUT	CMOS/TTL Output	Clock output
6	S0	Three level Input	Multiplier select pin – connect to V <sub>DD</sub> , GND or float
7	OE	CMOS/TTL Input	Output Enable. CLKOUT is high impedance when OE is low. Internal pullup
8	X2	Crystal	Crystal input – Leave open when providing an external clock reference

**Table 3. COMMON OUTPUT FREQUENCY EXAMPLES**

Output Frequency (MHz)	Input Frequency (MHz)	S1, S0
20	10	M, M
24	12	M, M
30	10	1, M
32	16	M, M
33.33	16.66	M, M
37.5	12	M, 1
40	10	0, 0
48	12	0, 0
50	16.66	1, M
60	10	1, 0
62.5	20	M, 1

**Table 3. COMMON OUTPUT FREQUENCY EXAMPLES**

Output Frequency (MHz)	Input Frequency (MHz)	S1, S0
64	16	0, 0
66.66	16.66	0, 0
72	12	1, 0
75	12	M, 0
80	10	1, 1
83.33	16.66	0, 1
90	15	1, 0
100	20	0, 1
106.25	20	0, M
120	15	1, 1
125	20	M, 0

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**Table 4. ATTRIBUTES**

Characteristics		Value
ESD Protection	Human Body Model	> 1 kV
	Machine Model	> 150 V
	Charged Device Model	> 1 kV
Moisture Sensitivity (Note 1)	SOIC-8	Level 1
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V 0 @ 0.125 in
Transistor Count		9727
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test		

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

**Table 5. MAXIMUM RATINGS**

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
$V_{DD}$	Positive Power Supply	GND = 0 V		7	V
$V_{IO}$	Input and Output Voltages			$-0.5\text{ V} \leq V_{IO} \leq V_{DD} + 0.5$	V
$T_A$	Operating Temperature Range			-40 to +85	°C
$T_{stg}$	Storage Temperature Range			-65 to +150	°C
$\theta_{JA}$	Thermal Resistance (Junction-to-Ambient)	0 lfpm	SOIC-8	190	°C/W
		500 lfpm	SOIC-8	130	
$\theta_{JC}$	Thermal Resistance (Junction-to-Case)	(Note 2)	SOIC-8	41 to 44	°C/W
$T_{sol}$	Wave Solder			265	°C
	Pb-Free				

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.

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

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**Table 6. DC CHARACTERISTICS**  $V_{DD} = 3.3\text{ V} \pm 10\%$  or  $5.0\text{ V} \pm 5\%$  unless otherwise noted,  $GND = 0\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$

Symbol	Characteristic	Min	Typ	Max	Unit
$V_{DD}$	Operating Voltage at 100 MHz (with 20 MHz crystal) $V_{CC} = 5\text{ V}$ $V_{CC} = 3.3\text{ V}$	4.75 3.0		5.25 3.6	V
$I_{DD}$	Power Supply Current – Inputs and outputs open, CLKOUT operating at 100 MHz (with 20 MHz crystal) $V_{CC} = 5\text{ V}$ $V_{CC} = 3.3\text{ V}$		20 15		mA
$V_{OH}$	Output HIGH Voltage $I_{OH} = -4\text{ mA}$ CMOS High	$V_{DD} - 0.4$			V
$V_{OH}$	Output HIGH Voltage $I_{OH} = -25\text{ mA}$ TTL High	2.4			V
$V_{OL}$	Output LOW Voltage $I_{OL} = 25\text{ mA}$			0.4	V
$V_{IH}$	Input HIGH Voltage, CLK only (pin 1)	$(V_{DD} / 2) + 1$			V
$V_{IL}$	Input LOW Voltage, CLK only (pin 1)			$(V_{DD} / 2) - 1$	V
$V_{IH}$	Input HIGH Voltage, S0, S1	$V_{DD} - 0.5$			V
$V_{IL}$	Input LOW Voltage, S0, S1			0.5	V
$V_{IH}$	Input HIGH Voltage, OE (pin 7)	2.0			V
$V_{IL}$	Input LOW Voltage, OE (pin 7)			0.8	V
$C_{in}$	Input Capacitance, S0, S1 and OE		4		pF
$I_{SC}$	Output Short Circuit Current		$\pm 70$		mA
RPU	On Chip Pullup Resistor		270		k $\Omega$
	Nominal Output Impedance		20		$\Omega$

3. The crystal should be fundamental mode, parallel resonant. Do not use third overtone. For exact tuning when using a crystal, capacitors should be connected from pins X1/CLK to GND and X2 to GND. The value of these capacitors is given by the following equation, where  $C_L$  is the specified crystal load capacitance: Crystal capacitance (pF) =  $(C_L - 5) \times 2$ . So, for a crystal with 16 pF load capacitance, use two 22 pF capacitors.

**Table 7. AC CHARACTERISTICS**  $V_{DD} = 3.3\text{ V} \pm 10\%$  or  $5.0\text{ V} \pm 5\%$  unless otherwise noted,  $GND = 0\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$

Symbol	Characteristic	Min	Typ	Max	Unit
$f_{Xtal}$	Crystal Input Frequency (Note 4)	5		27	MHz
$f_{CLKIN}$	Clock Input Frequency	2		50	MHz
$f_{OUT}$	Output Frequency Range $f_{OUTMIN} \leq f_{IN} \times \text{Multiplier} \leq f_{OUTMAX}$ $V_{DD} = 4.75\text{ to }5.25\text{ V (}5.0\text{ V} \pm 5\%)$ $V_{DD} = 3.0\text{ to }3.6\text{ V (}3.3\text{ V} \pm 10\%)$	13 13		160 100	MHz
DC	Output Clock Duty Cycle at $V_{DD} / 2$	45	50	55	%
$OE_H$	Output enable time, OE high to output on		50		ns
$OE_L$	Output disable time, OE low to tri-state		50		ns
$t_{jitter (rms)}$	Period Jitter (rms, 1 $\sigma$ )		25		ps
$t_{jitter (pk-to-pk)}$	Total Period Jitter, (peak-to-peak)		$\pm 70$		ps
$t_r/t_f$	Output rise/fall time (0.8 V to 2.0 V) (measured with 15 pF load)		1		ns

4. The crystal should be fundamental mode, parallel resonant. Do not use third overtone. For exact tuning when using a crystal, capacitors should be connected from pins X1/CLK to GND and X2 to GND. The value of these capacitors is given by the following equation, where  $C_L$  is the specified crystal load capacitance: Crystal capacitance (pF) =  $(C_L - 5) \times 2$ . So, for a crystal with 16 pF load capacitance, use two 22 pF capacitors.

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## APPLICATIONS INFORMATION

### High Frequency CMOS/TTL Oscillators

The NB3N501, along with a low frequency fundamental mode crystal, can build a high frequency TTL output oscillator. For example, a 20 MHz crystal connected to the NB3N501 with the 5X output selected (S1 = L, S0 = H) produces an 100 MHz CMOS/TTL output clock.

### Decoupling and External Components

The NB3N501 requires a 0.01  $\mu$ F decoupling capacitor to be connected between  $V_{DD}$  and GND on pins 2 and 3. It must be connected close to the NB3N501 to minimize lead inductance. Control input pins can be connected to device pins  $V_{DD}$  or GND, or to the  $V_{DD}$  and GND planes on the board.

### Series Termination Resistor

A 33  $\Omega$  terminating resistor can be used next to the CLK pin for trace lengths over one inch.

### Crystal Load Capacitors

The total on chip capacitance is approximately 12 pF. A parallel resonant, fundamental mode crystal should be used. The device crystal connections should include pads for small capacitors from X1 to ground and from X2 to ground. These capacitors are used to adjust the stray capacitance of the board to match the nominally required crystal load capacitance. Because load capacitance can only be increased in this trimming process, it is important to keep stray capacitance to a minimum by using very short PCB traces (and no vias) between the crystal and device. Crystal capacitors, if needed, must be connected from each of the pins X1 and X2 to ground. The value (in pF) of these crystal caps should equal  $(C_L - 12 \text{ pF}) * 2$ . In this equation,  $C_L$  = crystal load capacitance in pF. Example: For a crystal with a 16 pF load capacitance, each crystal capacitor would be 8 pF  $[(16 - 12) * 2 = 8]$ .

## ORDERING INFORMATION

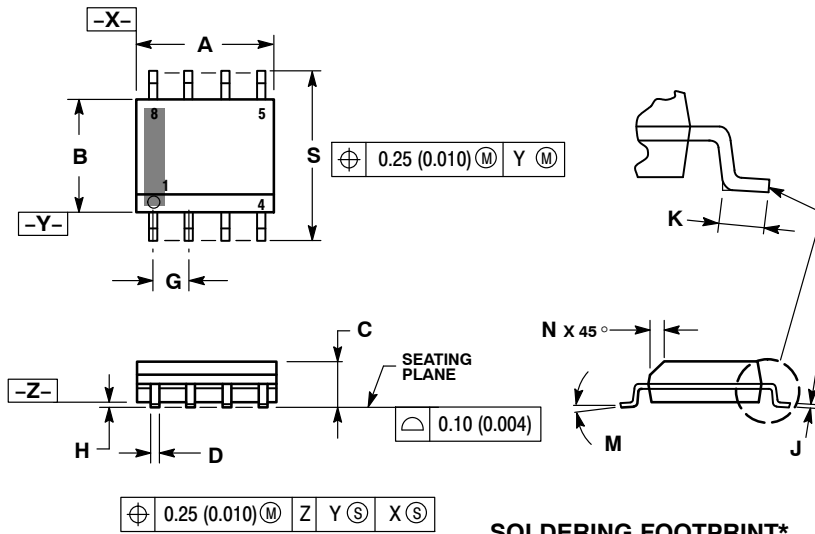
Device	Package	Shipping <sup>†</sup>
NB3N501DG	SOIC-8 (Pb-Free)	98 Units / Rail
NB3N501DR2G	SOIC-8 (Pb-Free)	2500 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

# NB3N501

## PACKAGE DIMENSIONS

### SOIC-8 NB CASE 751-07 ISSUE AK

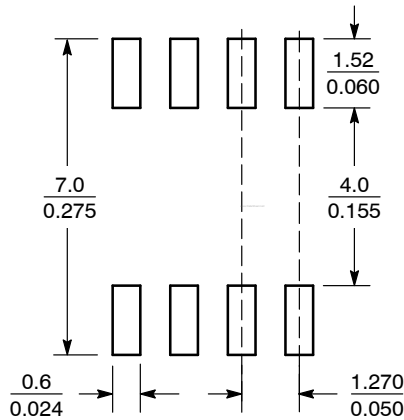


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

### SOLDERING FOOTPRINT\*



SCALE 6:1  $\left( \frac{\text{mm}}{\text{inches}} \right)$

\*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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