

3.3 V/5 V Programmable PLL Synthesized Clock Generator

25 MHz to 400 MHz



ON Semiconductor®

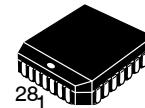
www.onsemi.com

Description

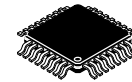
The NBC12429 and NBC12429A are general purpose, Phase-Lock-Loop (PLL) based synthesized clock sources. The VCO will operate over a frequency range of 200 MHz to 400 MHz. The VCO frequency is sent to the N-output divider, where it can be configured to provide division ratios of 1, 2, 4, or 8. The VCO and output frequency can be programmed using the parallel or serial interfaces to the configuration logic. Output frequency steps of 125 kHz, 250 kHz, 500 kHz, or 1.0 MHz can be achieved using a 16 MHz crystal, depending on the output dividers. The PLL loop filter is fully integrated and does not require any external components.

Features

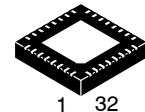
- Best-in-Class Output Jitter Performance, ± 20 ps Peak-to-Peak
- 25 MHz to 400 MHz Programmable Differential PECL Outputs
- Fully Integrated Phase-Lock-Loop with Internal Loop Filter
- Parallel Interface for Programming Counter and Output Dividers During Powerup
- Minimal Frequency Overshoot
- Serial 3-Wire Programming Interface
- Crystal Oscillator Interface
- Operating Range: $V_{CC} = 3.135$ V to 5.25 V
- CMOS and TTL Compatible Control Inputs
- Pin and Function Compatible with Motorola MC12429 and MPC9229
- 0°C to 70°C Ambient Operating Temperature (NBC12429)
- -40°C to 85°C Ambient Operating Temperature (NBC12429A)
- These Devices are Pb-Free and are RoHS Compliant



PLCC-28
FN SUFFIX
CASE 776

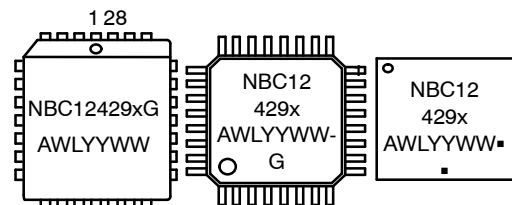


LQFP-32
FA SUFFIX
CASE 561AB



QFN32
MN SUFFIX
CASE 488AM

MARKING DIAGRAMS



x = Blank or A
 A = Assembly Location
 WL, L = Wafer Lot
 YY, Y = Year
 WW, W = Work Week
 G or ■ = Pb-Free Package
 (Note: Microdot may be in either location)

ORDERING INFORMATION

| Device | Package | Shipping† |
|----------------|-------------------|--------------------|
| NBC12429FAG | LQFP-32 (Pb-Free) | 250 Units / Tube |
| NBC12429FAR2G | LQFP-32 (Pb-Free) | 2000 / Tape & Reel |
| NBC12429FNR2G | PLCC-28 (Pb-Free) | 500 Units / Tube |
| NBC12429AFNG | PLCC-28 (Pb-Free) | 37 Units / Tube |
| NBC12429AFNR2G | PLCC-28 (Pb-Free) | 500 Units / Tube |
| NBC12429AMNR4G | QFN-32 (Pb-Free) | 1000 / 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.

NBC12429, NBC12429A

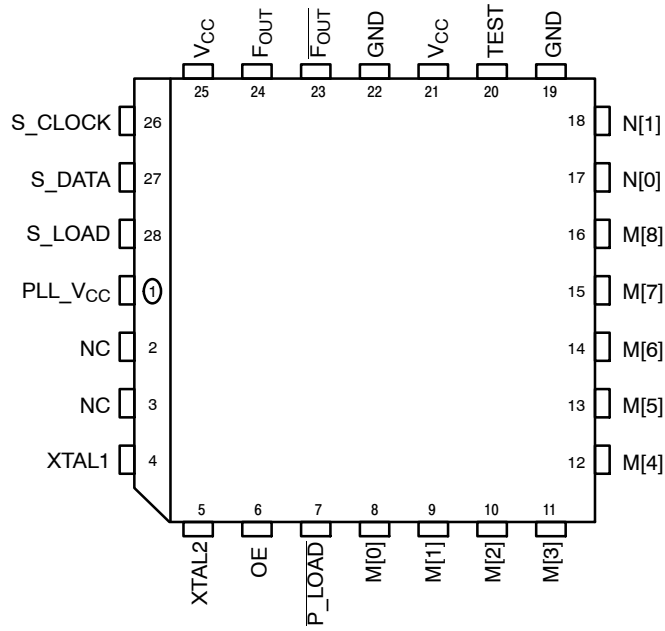


Figure 2. PLCC-28 (Top View)

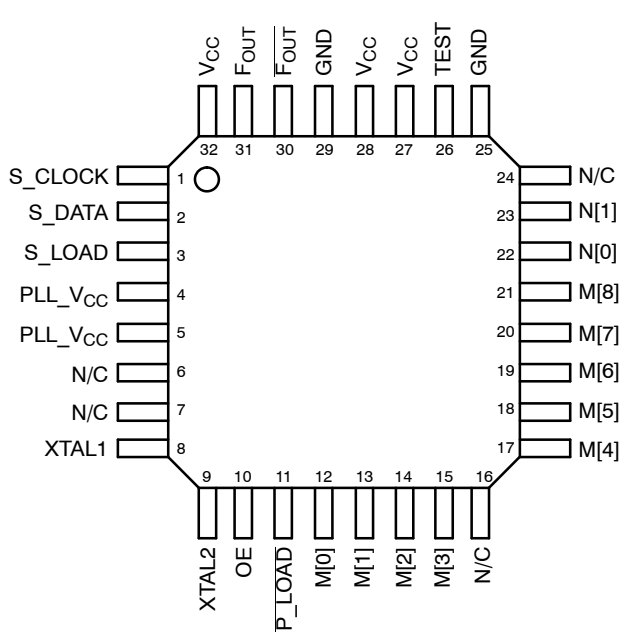


Figure 3. LQFP-32 (Top View)

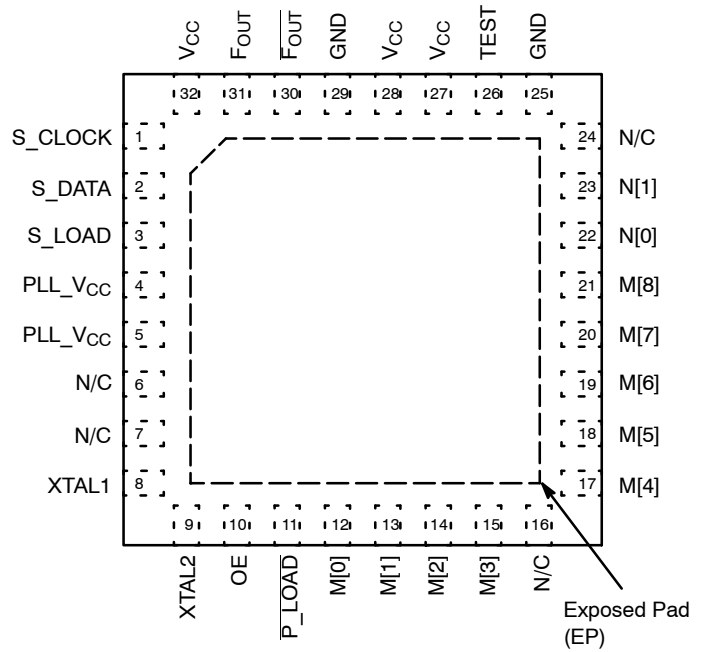


Figure 4. 32-Lead QFN (Top View)

NBC12429, NBC12429A

The following gives a brief description of the functionality of the NBC12429 and NBC12429A Inputs and Outputs. Unless explicitly stated, all inputs are CMOS/TTL compatible with either pullup or pulldown resistors. The PECL outputs are capable of driving two series terminated 50 Ω transmission lines on the incident edge.

Table 3. PIN FUNCTION DESCRIPTION

| Pin Name | Function | Description |
|-----------------------------|---|---|
| INPUTS | | |
| XTAL1, XTAL2 | Crystal Inputs | These pins form an oscillator when connected to an external series-resonant crystal. |
| S_LOAD* | CMOS/TTL Serial Latch Input (Internal Pulldown Resistor) | This pin loads the configuration latches with the contents of the shift registers. The latches will be transparent when this signal is HIGH; thus, the data must be stable on the HIGH-to-LOW transition of S_LOAD for proper operation. |
| S_DATA* | CMOS/TTL Serial Data Input (Internal Pulldown Resistor) | This pin acts as the data input to the serial configuration shift registers. |
| S_CLOCK* | CMOS/TTL Serial Clock Input (Internal Pulldown Resistor) | This pin serves to clock the serial configuration shift registers. Data from S_DATA is sampled on the rising edge. |
| P_LOAD** | CMOS/TTL Parallel Latch Input (Internal Pullup Resistor) | This pin loads the configuration latches with the contents of the parallel inputs. The latches will be transparent when this signal is LOW; therefore, the parallel data must be stable on the LOW-to-HIGH transition of P_LOAD for proper operation. |
| M[8:0]** | CMOS/TTL PLL Loop Divider Inputs (Internal Pullup Resistor) | These pins are used to configure the PLL loop divider. They are sampled on the LOW-to-HIGH transition of P_LOAD. M[8] is the MSB, M[0] is the LSB. |
| N[1:0]** | CMOS/TTL Output Divider Inputs (Internal Pullup Resistor) | These pins are used to configure the output divider modulus. They are sampled on the LOW-to-HIGH transition of P_LOAD. |
| OE** | CMOS/TTL Output Enable Input (Internal Pullup Resistor) | Active HIGH Output Enable. The Enable is synchronous to eliminate possibility of runt pulse generation on the F_OUT output. |
| OUTPUTS | | |
| F_OUT, $\overline{F_{OUT}}$ | PECL Differential Outputs | These differential, positive-referenced ECL signals (PECL) are the outputs of the synthesizer. |
| TEST | CMOS/TTL Output | The function of this output is determined by the serial configuration bits T[2:0]. |
| POWER | | |
| V _{CC} | Positive Supply for the Logic | The positive supply for the internal logic and output buffer of the chip, and is connected to +3.3 V or +5.0 V. |
| PLL_V _{CC} | Positive Supply for the PLL | This is the positive supply for the PLL and is connected to +3.3 V or +5.0 V. |
| GND | Negative Power Supply | These pins are the negative supply for the chip and are normally all connected to ground. |
| - | Exposed Pad for QFN-32 only | 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 GND. |

* When left Open, these inputs will default LOW.

** When left Open, these inputs will default HIGH.

NBC12429, NBC12429A

Table 4. ATTRIBUTES

| Characteristics | Value |
|---|-------------------------------|
| Internal Input Pulldown Resistor | 75 k Ω |
| Internal Input Pullup Resistor | 37.5 k Ω |
| ESD Protection Human Body Model Machine Model Charged Device Model | > 2 kV > 150 V > 1 kV |
| Moisture Sensitivity (Note 1) | Pb-Free Pkg |
| PLCC LQFP QFN | Level 3 Level 2 Level 1 |
| Flammability Rating Oxygen Index: 28 to 34 | UL 94 V-0 @ 0.125 in |
| Transistor Count | 2035 |
| 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 _{CC} | Positive Supply | GND = 0 V | | 6 | V |
| V _I | Input Voltage | GND = 0 V | V _I ≤ V _{CC} | 6 | V |
| I _{out} | Output Current | Continuous Surge | | 50 100 | mA mA |
| T _A | Operating Temperature Range NBC12429 NBC12429A | | | 0 to 70 -40 to +85 | °C |
| T _{stg} | Storage Temperature Range | | | -65 to +150 | °C |
| θ_{JA} | Thermal Resistance (Junction-to-Ambient) | 0 lfpm 500 lfpm | PLCC-28 PLCC-28 | 63.5 43.5 | °C/W °C/W |
| θ_{JC} | Thermal Resistance (Junction-to-Case) | Standard Board | PLCC-28 | 22 to 26 | °C/W |
| θ_{JA} | Thermal Resistance (Junction-to-Ambient) | 0 lfpm 500 lfpm | LQFP-32 LQFP-32 | 80 55 | °C/W °C/W |
| θ_{JC} | Thermal Resistance (Junction-to-Case) | Standard Board | LQFP-32 | 12 to 17 | °C/W |
| θ_{JA} | Thermal Resistance (Junction-to-Ambient) | 0 lfpm 500 lfpm | QFN-32 QFN-32 | 31 27 | °C/W °C/W |
| θ_{JC} | Thermal Resistance (Junction-to-Case) | 2S2P | QFN-32 | 12 | °C/W |
| T _{sol} | Wave Solder (Pb-Free) | <3 sec @ 260°C | | 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.

NBC12429, NBC12429A

Table 6. DC CHARACTERISTICS ($V_{CC} = 3.3\text{ V} \pm 5\%$; $T_A = 0^\circ\text{C}$ to 70°C (NBC12429), $T_A = -40^\circ\text{C}$ to 85°C (NBC12429A))

| Symbol | Characteristic | Condition | Min | Typ | Max | Unit |
|-------------------------------|---|---|----------|----------|----------|----------|
| V_{IH} LVCMOS/ LVTTTL | Input HIGH Voltage | $V_{CC} = 3.3\text{ V}$ | 2.0 | | | V |
| V_{IL} LVCMOS/ LVTTTL | Input LOW Voltage | $V_{CC} = 3.3\text{ V}$ | | | 0.8 | V |
| I_{IN} | Input Current | | | | 1.0 | mA |
| V_{OH} | Output HIGH Voltage TEST | $I_{OH} = -0.8\text{ mA}$ | 2.5 | | | V |
| V_{OL} | Output LOW Voltage TEST | $I_{OL} = 0.8\text{ mA}$ | | | 0.4 | V |
| V_{OH} PECL | Output HIGH Voltage $\frac{F_{OUT}}{F_{OUT}}$ | $V_{CC} = 3.3\text{ V}$ (Notes 2, 3) | 2.155 | | 2.405 | V |
| V_{OL} PECL | Output LOW Voltage $\frac{F_{OUT}}{F_{OUT}}$ | $V_{CC} = 3.3\text{ V}$ (Notes 2, 3) | 1.355 | | 1.605 | V |
| I_{CC} | Power Supply Current V_{CC} PLL_ V_{CC} | | 48 18 | 58 22 | 70 26 | mA mA |

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.

2. $F_{OUT}/\overline{F_{OUT}}$ output levels will vary 1:1 with V_{CC} variation.
3. $F_{OUT}/\overline{F_{OUT}}$ outputs are terminated through a $50\ \Omega$ resistor to $V_{CC} - 2.0\text{ V}$.

Table 7. DC CHARACTERISTICS ($V_{CC} = 5.0\text{ V} \pm 5\%$; $T_A = 0^\circ\text{C}$ to 70°C (NBC12429), $T_A = -40^\circ\text{C}$ to 85°C (NBC12429A))

| Symbol | Characteristic | Condition | Min | Typ | Max | Unit |
|--------------------------|---|---|----------|----------|----------|----------|
| V_{IH} CMOS/ TTL | Input HIGH Voltage | $V_{CC} = 5.0\text{ V}$ | 2.0 | | | V |
| V_{IL} CMOS/ TTL | Input LOW Voltage | $V_{CC} = 5.0\text{ V}$ | | | 0.8 | V |
| I_{IN} | Input Current | | | | 1.0 | mA |
| V_{OH} | Output HIGH Voltage TEST | $I_{OH} = -0.8\text{ mA}$ | 2.5 | | | V |
| V_{OL} | Output LOW Voltage TEST | $I_{OL} = 0.8\text{ mA}$ | | | 0.4 | V |
| V_{OH} PECL | Output HIGH Voltage $\frac{F_{OUT}}{F_{OUT}}$ | $V_{CC} = 5.0\text{ V}$ (Notes 4, 5) | 3.855 | | 4.105 | V |
| V_{OL} PECL | Output LOW Voltage $\frac{F_{OUT}}{F_{OUT}}$ | $V_{CC} = 5.0\text{ V}$ (Notes 4, 5) | 3.055 | | 3.305 | V |
| I_{CC} | Power Supply Current V_{CC} PLL_ V_{CC} | | 50 19 | 60 23 | 75 27 | mA mA |

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.

4. $F_{OUT}/\overline{F_{OUT}}$ output levels will vary 1:1 with V_{CC} variation.
5. $F_{OUT}/\overline{F_{OUT}}$ outputs are terminated through a $50\ \Omega$ resistor to $V_{CC} - 2.0\text{ V}$.

NBC12429, NBC12429A

Table 8. AC CHARACTERISTICS ($V_{CC} = 3.125\text{ V to }5.25\text{ V}$; $T_A = 0^\circ\text{C to }70^\circ\text{C}$ (NBC12429), $T_A = -40^\circ\text{C to }85^\circ\text{C}$ (NBC12429A))
(Note 6)

| Symbol | Characteristic | Condition | Min | Max | Unit | |
|--|--|--|-----------|------------|---------|--------|
| F_{MAXI} | Maximum Input Frequency S_CLOCK Xtal Oscillator | (Note 7) | 10 | 10 20 | MHz | |
| F_{MAXO} | Maximum Output Frequency VCO (Internal) F_{OUT} | | 200 25 | 400 400 | MHz | |
| $t_{jitter(pd)}$ | Period Jitter @ 3.3 V 10000 WFMS (See Table 13 for Typical Values) | 25 MHz < f_{OUT} < 100 MHz, M = 200 | | 25 | $pSRMS$ | |
| | | 25 MHz < f_{OUT} < 100 MHz, M = 300 | | 9.0 | | |
| | Period Jitter @ 5.0 V 10000 WFMS (See Table 13 for Typical Values) | 25 MHz < f_{OUT} < 100 MHz, M = 400 | | 6.0 | $pSRMS$ | |
| | | 100 MHz < f_{OUT} < 400 MHz, M = 200 | | 9.0 | | |
| | | 100 MHz < f_{OUT} < 400 MHz, M = 300 | | 5.0 | | |
| | | 100 MHz < f_{OUT} < 400 MHz, M = 400 | | 4.0 | | |
| Period Jitter @ 3.3 V 10000 WFMS (See Table 13 for Typical Values) | 25 MHz < f_{OUT} < 100 MHz, M = 200 | | 146 | $pSPp$ | | |
| | 25 MHz < f_{OUT} < 100 MHz, M = 300 | | 71 | | | |
| $t_{jitter(cyc-cyc)}$ | Cycle-to-Cycle @ 3.3 V 1000 WFMS (See Table 13 for Typical Values) | 25 MHz < f_{OUT} < 100 MHz, M = 200 | | 25 | $pSRMS$ | |
| | | 25 MHz < f_{OUT} < 100 MHz, M = 300 | | 9.0 | | |
| | Cycle-to-Cycle @ 5.0 V 1000 WFMS (See Table 13 for Typical Values) | 25 MHz < f_{OUT} < 100 MHz, M = 400 | | 6.0 | $pSRMS$ | |
| | | 100 MHz < f_{OUT} < 400 MHz, M = 200 | | 10 | | |
| | | 100 MHz < f_{OUT} < 400 MHz, M = 300 | | 6.0 | | |
| | | 100 MHz < f_{OUT} < 400 MHz, M = 400 | | 5.0 | | |
| Cycle-to-Cycle @ 3.3 V 1000 WFMS (See Table 13 for Typical Values) | 25 MHz < f_{OUT} < 100 MHz, M = 200 | | 168 | $pSPp$ | | |
| | 25 MHz < f_{OUT} < 100 MHz, M = 300 | | 69 | | | |
| t_{LOCK} | Maximum PLL Lock Time | 25 MHz < f_{OUT} < 100 MHz, M = 400 | | 57 | $pSPp$ | |
| | | 100 MHz < f_{OUT} < 400 MHz, M = 200 | | 133 | | |
| | Maximum PLL Lock Time | 100 MHz < f_{OUT} < 400 MHz, M = 300 | | 49 | $pSPp$ | |
| | | 100 MHz < f_{OUT} < 400 MHz, M = 400 | | 108 | | |
| | | 25 MHz < f_{OUT} < 100 MHz, M = 200 | | 150 | | $pSPp$ |
| | | 25 MHz < f_{OUT} < 100 MHz, M = 300 | | 105 | | |
| Cycle-to-Cycle @ 3.3 V 1000 WFMS (See Table 13 for Typical Values) | 25 MHz < f_{OUT} < 100 MHz, M = 400 | | 77 | $pSPp$ | | |
| | 100 MHz < f_{OUT} < 400 MHz, M = 200 | | 208 | | | |
| t_{LOCK} | Maximum PLL Lock Time | 100 MHz < f_{OUT} < 400 MHz, M = 300 | | 94 | $pSPp$ | |
| | | 100 MHz < f_{OUT} < 400 MHz, M = 400 | | 89 | | |
| | Maximum PLL Lock Time | 25 MHz < f_{OUT} < 100 MHz, M = 200 | | 192 | $pSPp$ | |
| | | 25 MHz < f_{OUT} < 100 MHz, M = 300 | | 131 | | |
| | | 25 MHz < f_{OUT} < 100 MHz, M = 400 | | 76 | | |
| | | 100 MHz < f_{OUT} < 400 MHz, M = 200 | | 164 | | |
| Maximum PLL Lock Time | 100 MHz < f_{OUT} < 400 MHz, M = 300 | | 128 | $pSPp$ | | |
| | 100 MHz < f_{OUT} < 400 MHz, M = 400 | | 186 | | | |

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.

6. $F_{OUT}/\overline{F_{OUT}}$ outputs are terminated through a 50 Ω resistor to $V_{CC} - 2.0\text{ V}$.
7. 10 MHz is the maximum frequency to load the feedback divide registers. S_CLOCK can be switched at higher frequencies when used as a test clock in TEST_MODE 6.

NBC12429, NBC12429A

Table 8. AC CHARACTERISTICS ($V_{CC} = 3.125\text{ V to }5.25\text{ V}$; $T_A = 0^\circ\text{C to }70^\circ\text{C}$ (NBC12429), $T_A = -40^\circ\text{C to }85^\circ\text{C}$ (NBC12429A))
(Note 6)

| Symbol | Characteristic | Condition | Min | Max | Unit |
|-------------|--|-----------|----------------|------|------|
| t_s | Setup Time S_DATA to S_CLOCK S_CLOCK to S_LOAD M, N to P_LOAD | | 20 20 20 | | ns |
| t_h | Hold Time S_DATA to S_CLOCK M, N to P_LOAD | | 20 20 | | ns |
| t_{pwMIN} | Minimum Pulse Width S_LOAD P_LOAD | | 50 50 | | ns |
| DCO | Output Duty Cycle | | 47.5 | 52.5 | % |
| t_r, t_f | Output Rise/Fall F_OUT | 20%–80% | 175 | 425 | 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.

6. F_{OUT}/F_{OUT} outputs are terminated through a $50\ \Omega$ resistor to $V_{CC} - 2.0\text{ V}$.

7. 10 MHz is the maximum frequency to load the feedback divide registers. S_CLOCK can be switched at higher frequencies when used as a test clock in TEST_MODE 6.

FUNCTIONAL DESCRIPTION

The internal oscillator uses the external quartz crystal as the basis of its frequency reference. The output of the reference oscillator is divided by 16 before being sent to the phase detector. With a 16 MHz crystal, this provides a reference frequency of 1 MHz. Although this data sheet illustrates functionality only for a 16 MHz crystal, Table 9, any crystal in the 10 MHz – 20 MHz range can be used, Table 11.

The VCO within the PLL operates over a range of 200 to 400 MHz. Its output is scaled by a divider that is configured by either the serial or parallel interfaces. The output of this loop divider is also applied to the phase detector.

The phase detector and the loop filter force the VCO output frequency to be M times the reference frequency by adjusting the VCO control voltage. Note that for some values of M (either too high or too low), the PLL will not achieve loop lock.

The output of the VCO is also passed through an output divider before being sent to the PECL output driver. This output divider (N divider) is configured through either the serial or the parallel interfaces and can provide one of four division ratios (1, 2, 4, or 8). This divider extends the performance of the part while providing a 50% duty cycle.

The output driver is driven differentially from the output divider and is capable of driving a pair of transmission lines terminated into $50\ \Omega$ to $V_{CC} - 2.0\text{ V}$. The positive reference

for the output driver and the internal logic is separated from the power supply for the PLL to minimize noise induced jitter.

The configuration logic has two sections: serial and parallel. The parallel interface uses the values at the M[8:0] and N[1:0] inputs to configure the internal counters. Normally upon system reset, the P_LOAD input is held LOW until sometime after power becomes valid. On the LOW-to-HIGH transition of P_LOAD, the parallel inputs are captured. The parallel interface has priority over the serial interface. Internal pullup resistors are provided on the M[8:0] and N[1:0] inputs to reduce component count in the application of the chip.

The serial interface logic is implemented with a fourteen bit shift register scheme. The register shifts once per rising edge of the S_CLOCK input. The serial input S_DATA must meet setup and hold timing as specified in the AC Characteristics section of this document. With P_LOAD held high, the configuration latches will capture the value of the shift register on the HIGH-to-LOW edge of the S_LOAD input. See the programming section for more information.

The TEST output reflects various internal node values and is controlled by the T[2:0] bits in the serial data stream. See the programming section for more information.

NBC12429, NBC12429A

Table 9. PROGRAMMING VCO FREQUENCY FUNCTION TABLE WITH 16 MHZ CRYSTAL

| VCO Frequency (MHz) | M _{Count} Divisor | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---------------------|----------------------------|-----|-----|----|----|----|----|----|----|----|
| | | M8 | M7 | M6 | M5 | M4 | M3 | M2 | M1 | M0 |
| 200 | 200 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 201 | 201 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 202 | 202 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 203 | 203 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| • | • | • | • | • | • | • | • | • | • | • |
| • | • | • | • | • | • | • | • | • | • | • |
| • | • | • | • | • | • | • | • | • | • | • |
| 397 | 397 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 398 | 398 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 399 | 399 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 400 | 400 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

PROGRAMMING INTERFACE

Programming the NBC12429 and NBC12429A is accomplished by properly configuring the internal dividers to produce the desired frequency at the outputs. The output frequency can be represented by this formula:

$$F_{OUT} = (F_{XTAL} \div 16) \times M \div N \quad (\text{eq. 1})$$

where F_{XTAL} is the crystal frequency, M is the loop divider modulus, and N is the output divider modulus. Note that it is possible to select values of M such that the PLL is unable to achieve loop lock. To avoid this, always make sure that M is selected to be $200 \leq M \leq 400$ for a 16 MHz input reference.

Assuming that a 16 MHz reference frequency is used the above equation reduces to:

$$F_{OUT} = M \div N \quad (\text{eq. 2})$$

Substituting the four values for N (1, 2, 4, 8) yields:

Table 10. Programmable Output Divider Function

| N1 | N0 | N Divider | F _{OUT} | Output Frequency Range (MHz)* | F _{OUT} Step |
|----|----|-----------|------------------|-------------------------------|-----------------------|
| 0 | 0 | ÷ 1 | M | 200–400 | 1 MHz |
| 0 | 1 | ÷ 2 | M ÷ 2 | 100–200 | 500 kHz |
| 1 | 0 | ÷ 4 | M ÷ 4 | 50–100 | 250 kHz |
| 1 | 1 | ÷ 8 | M ÷ 8 | 25–50 | 125 kHz |

*For crystal frequency of 16 MHz.

The user can identify the proper M and N values for the desired frequency from the above equations. The four output frequency ranges established by N are 200 MHz – 400 MHz, 100 MHz – 200 MHz, 50 MHz – 100 MHz and 25 MHz – 50 MHz, respectively. From these ranges, the user will establish the value of N required. The value of M can then be calculated based on Equation 1. For example, if an output frequency of

131 MHz was desired, the following steps would be taken to identify the appropriate M and N values. 131 MHz falls within the frequency range set by an N value of 2; thus, N [1:0] = 01. For N = 2, $F_{OUT} = M \div 2$ and $M = 2 \times F_{OUT}$. Therefore,

$$M = 131 \times 2 = 262, \text{ so } M[8:0] = 100000110.$$

Following this same procedure, a user can generate any whole frequency desired between 25 and 400 MHz. Note that for $N > 2$, fractional values of F_{OUT} can be realized. The size of the programmable frequency steps (and thus, the indicator of the fractional output frequencies achievable) will be equal to $F_{XTAL} \div 16 \div N$.

For input reference frequencies other than 16 MHz, see Table 11, which shows the usable VCO frequency and M divider range.

The input frequency and the selection of the feedback divider M is limited by the VCO frequency range and F_{XTAL} . M must be configured to match the VCO frequency range of 200 MHz to 400 MHz in order to achieve stable PLL operation.

$$M_{min} = f_{VCOmin} \div (f_{XTAL} \div 16) \quad \text{and} \quad (\text{eq. 3})$$

$$M_{max} = f_{VCOmax} \div (f_{XTAL} \div 16) \quad (\text{eq. 4})$$

The value for M falls within the constraints set for PLL stability. If the value for M fell outside of the valid range, a different N value would be selected to move M in the appropriate direction.

The M and N counters can be loaded either through a parallel or serial interface. The parallel interface is controlled via the $\overline{P_LOAD}$ signal such that a LOW to HIGH transition will latch the information present on the M[8:0] and N[1:0] inputs into the M and N counters. When the $\overline{P_LOAD}$ signal is LOW, the input latches will be transparent and any changes on the M[8:0] and N[1:0] inputs will affect the F_{OUT} output pair. To use the serial port, the

S_CLOCK signal samples the information on the S_DATA line and loads it into a 14 bit shift register. Note that the P_LOAD signal must be HIGH for the serial load operation to function. The Test register is loaded with the first three bits, the N register with the next two, and the M register with the final nine bits of the data stream on the S_DATA input. For each register, the most significant bit is loaded first (T2, N1, and M8). A pulse on the S_LOAD pin after the shift register is fully loaded will transfer the divide values into the counters. The HIGH to LOW transition on the S_LOAD input will latch the new divide values into the counters. Figures 5 and 6 illustrate the timing diagram for both a parallel and a serial load of the device synthesizer.

M[8:0] and N[1:0] are normally specified once at powerup through the parallel interface, and then possibly

again through the serial interface. This approach allows the application to come up at one frequency and then change or fine-tune the clock as the ability to control the serial interface becomes available.

The TEST output provides visibility for one of the several internal nodes as determined by the T[2:0] bits in the serial configuration stream. It is not configurable through the parallel interface. The T2, T1, and T0 control bits are preset to '000' when P_LOAD is LOW so that the PECL F_{OUT} outputs are as jitter-free as possible. Any active signal on the TEST output pin will have detrimental affects on the jitter of the PECL output pair. In normal operations, jitter specifications are only guaranteed if the TEST output is static. The serial configuration port can be used to select one of the alternate functions for this pin.

NBC12429, NBC12429A

Table 11. FREQUENCY OPERATING RANGE

| VCO Frequency Range for a Crystal Frequency of: | | | | | | | | Output Frequency for F _{XTAL} = 16 MHz and for N = | | | |
|---|-----------|--------|-------|--------|-----|--------|-------|--|-----|------|-------|
| M | M[8:0] | 10 | 12 | 14 | 16 | 18 | 20 | ÷ 1 | ÷ 2 | ÷ 4 | ÷ 8 |
| 160 | 010100000 | | | | | | 200 | | | | |
| 170 | 010101010 | | | | | | 212.5 | | | | |
| 180 | 010110100 | | | | | 202.5 | 225 | | | | |
| 190 | 010111110 | | | | | 213.75 | 237.5 | | | | |
| 200 | 011001000 | | | | 200 | 225 | 250 | 200 | 100 | 50 | 25 |
| 210 | 011010010 | | | | 210 | 236.25 | 262.5 | 210 | 105 | 52.5 | 26.25 |
| 220 | 011011100 | | | | 220 | 247.5 | 275 | 220 | 110 | 55 | 27.5 |
| 230 | 011100110 | | | 201.25 | 230 | 258.75 | 287.5 | 230 | 115 | 57.5 | 28.75 |
| 240 | 011110000 | | | 210 | 240 | 270 | 300 | 240 | 120 | 60 | 30 |
| 250 | 011111010 | | | 218.75 | 250 | 281.25 | 312.5 | 250 | 125 | 62.5 | 31.25 |
| 260 | 100000100 | | | 227.5 | 260 | 292.5 | 325 | 260 | 130 | 65 | 32.5 |
| 270 | 100001110 | | 202.5 | 236.25 | 270 | 303.75 | 337.5 | 270 | 135 | 67.5 | 33.75 |
| 280 | 100011000 | | 210 | 245 | 280 | 315 | 350 | 280 | 140 | 70 | 35 |
| 290 | 100100010 | | 217.5 | 253.75 | 290 | 326.25 | 362.5 | 290 | 145 | 72.5 | 36.25 |
| 300 | 100101100 | | 225 | 262.5 | 300 | 337.5 | 375 | 300 | 150 | 75 | 37.5 |
| 310 | 100110110 | | 232.5 | 271.25 | 310 | 348.75 | 387.5 | 310 | 155 | 77.5 | 38.75 |
| 320 | 101000000 | 200 | 240 | 280 | 320 | 360 | 400 | 320 | 160 | 80 | 40 |
| 330 | 101001010 | 206.25 | 247.5 | 288.75 | 330 | 371.25 | | 330 | 165 | 82.5 | 41.25 |
| 340 | 101010100 | 212.5 | 255 | 297.5 | 340 | 382.5 | | 340 | 170 | 85 | 42.5 |
| 350 | 101011110 | 218.75 | 262.5 | 306.25 | 350 | 393.75 | | 350 | 175 | 87.5 | 43.75 |
| 360 | 101101000 | 225 | 270 | 315 | 360 | | | 360 | 180 | 90 | 45 |
| 370 | 101110010 | 231.25 | 277.5 | 323.75 | 370 | | | 370 | 185 | 92.5 | 46.25 |
| 380 | 101111100 | 237.5 | 285 | 332.5 | 380 | | | 380 | 190 | 95 | 47.5 |
| 390 | 110000110 | 243.75 | 292.5 | 341.25 | 390 | | | 390 | 195 | 97.5 | 48.75 |
| 400 | 110010000 | 250 | 300 | 350 | 400 | | | 400 | 200 | 100 | 50 |
| 410 | 110011010 | 256.25 | 307.5 | 358.75 | | | | | | | |
| 420 | 110100100 | 262.5 | 315 | 367.5 | | | | | | | |
| 430 | 110101110 | 268.75 | 322.5 | 376.25 | | | | | | | |
| 440 | 110111000 | 275 | 330 | 385 | | | | | | | |
| 450 | 111000010 | 281.25 | 337.5 | 393.75 | | | | | | | |
| 460 | 111001100 | 287.5 | 345 | | | | | | | | |
| 470 | 111010110 | 293.75 | 352.5 | | | | | | | | |
| 480 | 111100000 | 300 | 360 | | | | | | | | |
| 490 | 111101010 | 306.25 | 367.5 | | | | | | | | |
| 500 | 111110100 | 312.5 | 375 | | | | | | | | |
| 510 | 111111110 | 318.75 | 382.5 | | | | | | | | |

Most of the signals available on the TEST output pin are useful only for performance verification of the device itself. However, the PLL bypass mode may be of interest at the board level for functional debug. When T[2:0] is set to 110, the device is placed in PLL bypass mode. In this mode the S_CLOCK input is fed directly into the M and N dividers. The N divider drives the F_{OUT} differential pair and the M counter drives the TEST output pin. In this mode the S_CLOCK input could be used for low speed board level functional test or debug. Bypassing the PLL and driving F_{OUT} directly gives the user more control on the test clocks sent through the clock tree. Figure 7 shows the functional setup of the PLL bypass mode. Because the S_CLOCK is a CMOS level the input frequency is limited to 250 MHz or less. This means the fastest the F_{OUT} pin can be toggled via the S_CLOCK is 250 MHz as the minimum divide ratio of the N counter is 1. Note that the M counter output on the TEST output will not be a 50% duty cycle due to the way the divider is implemented.

| T2 | T1 | T0 | TEST (Pin 20) |
|----|----|----|----------------------|
| 0 | 0 | 0 | SHIFT REGISTER OUT |
| 0 | 0 | 1 | HIGH |
| 0 | 1 | 0 | F _{REF} |
| 0 | 1 | 1 | M COUNTER OUT |
| 1 | 0 | 0 | F _{OUT} |
| 1 | 0 | 1 | LOW |
| 1 | 1 | 0 | PLL BYPASS |
| 1 | 1 | 1 | F _{OUT} ÷ 4 |

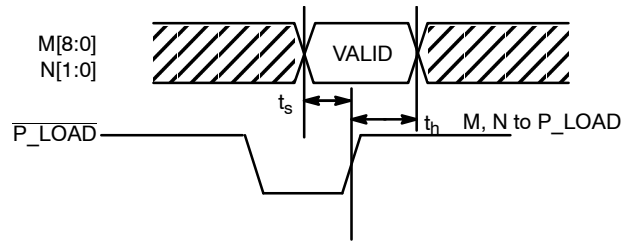


Figure 5. Parallel Interface Timing Diagram

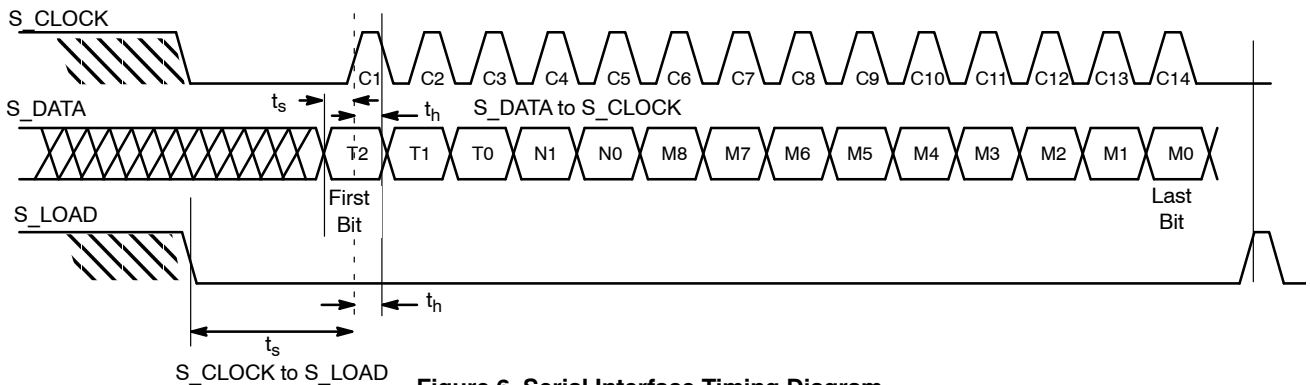
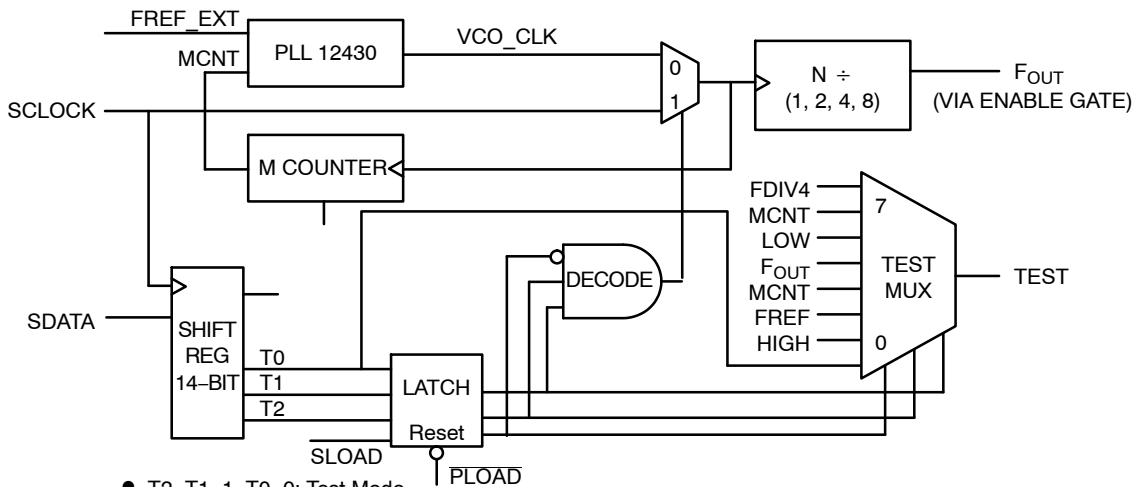


Figure 6. Serial Interface Timing Diagram



- T2=T1=1, T0=0: Test Mode
 - SCLOCK is selected, MCNT is on TEST output, SCLOCK ÷ N is on F_{OUT} pin.
- PLOAD acts as reset for test pin latch. When latch reset, T2 data is shifted out TEST pin.

Figure 7. Serial Test Clock Block Diagram

APPLICATIONS INFORMATION

Using the On-Board Crystal Oscillator

The NBC12429 and NBC12429A feature a fully integrated on-board crystal oscillator to minimize system implementation costs. The oscillator is a series resonant, multivibrator type design as opposed to the more common parallel resonant oscillator design. The series resonant design provides better stability and eliminates the need for large load capacitors per Figure 8 (do not use crystal load caps). The oscillator is totally self contained so that the only external component required is the crystal. As the oscillator is somewhat sensitive to loading on its inputs, the user is advised to mount the crystal as close to the device as possible to avoid any board level parasitics. To facilitate co-location, surface mount crystals are recommended, but not required. Because the series resonant design is affected by capacitive loading on the crystal terminals, loading variation introduced by crystals from different vendors could be a potential issue. For crystals with a higher shunt capacitance, it may be required to place a resistance, optional R_{shunt} , across the terminals to suppress the third harmonic. Although typically not required, it is a good idea to layout the PCB with the provision of adding this external resistor. The resistor value will typically be between 500 Ω and 1 k Ω .

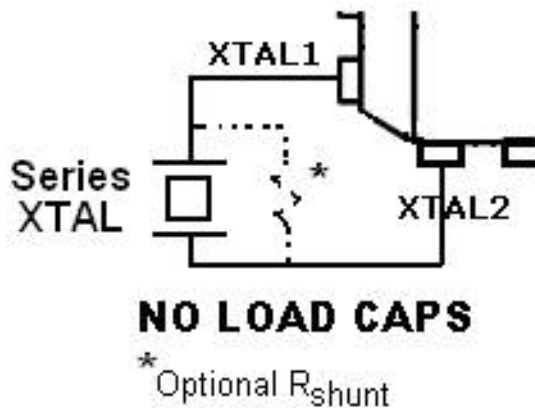


Figure 8. Crystal Application

The oscillator circuit is a series resonant circuit and thus, for optimum performance, a series resonant crystal should be used. Unfortunately, most crystals are characterized in a parallel resonant mode. Fortunately, there is no physical difference between a series resonant and a parallel resonant crystal. The difference is purely in the way the devices are characterized. As a result, a parallel resonant crystal can be used with the device with only a minor error in the desired frequency. A parallel resonant mode crystal used in a series resonant circuit will exhibit a frequency of oscillation a few hundred ppm lower than specified (a few hundred ppm translates to kHz inaccuracies). In a general computer application, this level of inaccuracy is immaterial. Table 12 below specifies the performance requirements of the crystals to be used with the device.

Table 12. Crystal Specifications

| Parameter | Value |
|------------------------------------|--------------------------|
| Crystal Cut | Fundamental AT Cut |
| Resonance | Series Resonance* |
| Frequency Tolerance | ± 75 ppm at 25°C |
| Frequency/Temperature Stability | ± 150 ppm 0 to 70°C |
| Operating Range | 0 to 70°C |
| Shunt Capacitance | 5–7 pF |
| Equivalent Series Resistance (ESR) | 50 to 80 Ω |
| Correlation Drive Level | 100 μ W |
| Aging | 5 ppm/Yr (First 3 Years) |

*See accompanying text for series versus parallel resonant discussion.

Power Supply Filtering

The NBC12429 and NBC12429A are mixed analog/digital products and as such, exhibit some sensitivities that would not necessarily be seen on a fully digital product. Analog circuitry is naturally susceptible to random noise, especially if this noise is seen on the power supply pins. The NBC12429 and NBC12429A provide separate power supplies for the digital circuitry (V_{CC}) and the internal PLL (PLL_V_{CC}) of the device. The purpose of this design technique is to try and isolate the high switching noise of the digital outputs from the relatively sensitive internal analog PLL. In a controlled environment such as an evaluation board, this level of isolation is sufficient. However, in a digital system environment where it is more difficult to minimize noise on the power supplies, a second level of isolation may be required. The simplest form of isolation is a power supply filter on the PLL_V_{CC} pin for the NBC12429 and NBC12429A.

Figure 9 illustrates a typical power supply filter scheme. The NBC12429 and NBC12429A are most susceptible to noise with spectral content in the 1 kHz to 1 MHz range. Therefore, the filter should be designed to target this range. The key parameter that needs to be met in the final filter design is the DC voltage drop that will be seen between the V_{CC} supply and the PLL_V_{CC} pin of the NBC12429 and NBC12429A. From the data sheet, the PLL_V_{CC} current (the current sourced through the PLL_V_{CC} pin) is typically 23 mA (27 mA maximum). Assuming that a minimum of 2.8 V must be maintained on the PLL_V_{CC} pin, very little DC voltage drop can be tolerated when a 3.3 V V_{CC} supply is used. The resistor shown in Figure 9 must have a resistance of 10 – 15 Ω to meet the voltage drop criteria. The RC filter pictured will provide a broadband filter with approximately 100:1 attenuation for noise whose spectral content is above 20 kHz. As the noise frequency crosses the series resonant point of an individual capacitor, it's overall

impedance begins to look inductive and thus increases with increasing frequency. The parallel capacitor combination shown ensures that a low impedance path to ground exists for frequencies well above the bandwidth of the PLL.

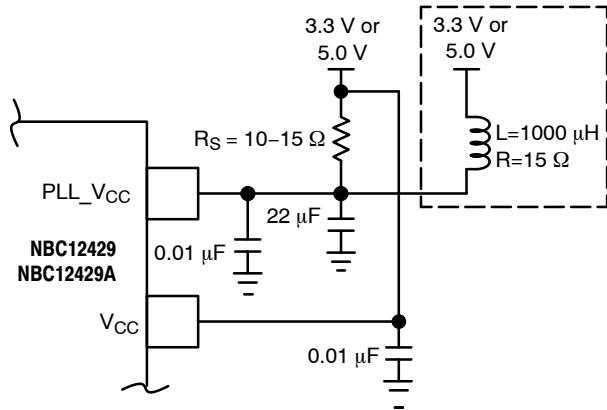


Figure 9. Power Supply Filter

A higher level of attenuation can be achieved by replacing the resistor with an appropriate valued inductor. Figure 9 shows a 1000 μH choke. This value choke will show a significant impedance at 10 kHz frequencies and above. Because of the current draw and the voltage that must be maintained on the PLL_VCC pin, a low DC resistance inductor is required (less than 15 Ω). Generally, the resistor/capacitor filter will be cheaper, easier to implement, and provide an adequate level of supply filtering.

The NBC12429 and NBC12429A provide sub-nanosecond output edge rates and therefore a good power supply bypassing scheme is a must. Figure 10 shows a representative board layout for the NBC12429 and NBC12429A. There exists many different potential board layouts and the one pictured is but one. The important aspect of the layout in Figure 10 is the low impedance connections between VCC and GND for the bypass capacitors. Combining good quality general purpose chip capacitors with good PCB layout techniques will produce effective capacitor resonances at frequencies adequate to supply the instantaneous switching current for the NBC12429 and NBC12429A outputs. It is imperative that low inductance chip capacitors are used. It is equally important that the board layout not introduce any of the inductance saved by using the leadless capacitors. Thin interconnect traces between the capacitor and the power plane should be avoided and multiple large vias should be used to tie the capacitors to the buried power planes. Fat interconnect and large vias will help to minimize layout induced inductance and thus maximize the series resonant point of the bypass capacitors.

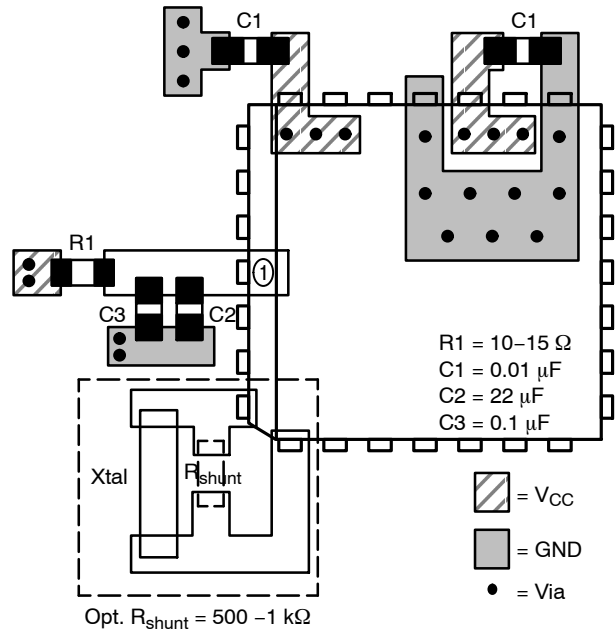


Figure 10. PCB Board Layout (PLCC-28)

Note the dotted lines circling the crystal oscillator connection to the device. The oscillator is a series resonant circuit and the voltage amplitude across the crystal is relatively small. It is imperative that no actively switching signals cross under the crystal as crosstalk energy coupled to these lines could significantly impact the jitter of the device. Special attention should be paid to the layout of the crystal to ensure a stable, jitter free interface between the crystal and the on-board oscillator. Note the provisions for placing a resistor across the crystal oscillator terminals as discussed in the crystal oscillator section of this data sheet.

Although the NBC12429 and NBC12429A have several design features to minimize the susceptibility to power supply noise (isolated power and grounds and fully differential PLL), there still may be applications in which overall performance is being degraded due to system power supply noise. The power supply filter and bypass schemes discussed in this section should be adequate to eliminate power supply noise-related problems in most designs.

Jitter Performance

Jitter is a common parameter associated with clock generation and distribution. Clock jitter can be defined as the deviation in a clock's output transition from its ideal position.

Cycle-to-Cycle Jitter is the period variation between two adjacent cycles over a defined number of observed cycles. The number of cycles observed is application

dependent but the JEDEC specification is 1000 cycles. Both Peak-to-Peak and RMS statistical values were measured.

Period Jitter is the edge placement deviation observed over a long period of consecutive cycles compared to the position of the perfect reference clock's edge and is specified by the number of cycles over which the jitter is measured. The number of cycles used to look for the maximum jitter varies by application but the JEDEC spec is 10,000 observed cycles. Both Peak-to-Peak and RMS value statistical values were measured.

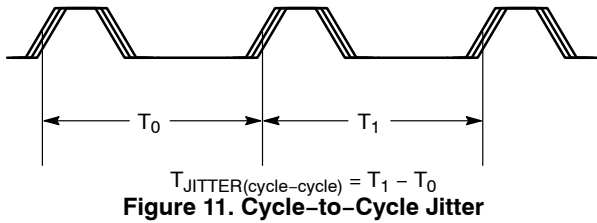


Table 13 shows the typical Period and Cycle-to-Cycle jitter as a function of the output frequency for selected M and N values using a 16 MHz crystal. Typical jitter values for other M and N registers settings may be linearly interpolated. The general trend is that as the VCO output frequency is increased, primarily determined by the M register setting, the output jitter will decrease. Alternate combinations of M and N register values may produce the same output frequency but with significantly different jitter performance.

NBC12429, NBC12429A

Table 13. TYPICAL JITTER PERFORMANCE, 3.3 V, 25°C with 16 MHz Crystal Input at Selected M and N Values

| JITTER | M Value | 200 | 200 | 200 | 200 | 300 | 300 | 300 | 300 | 400 | 400 | 400 | 400 |
|-------------------------------------|-------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | N Value | 1 | 2 | 4 | 8 | 1 | 2 | 4 | 8 | 1 | 2 | 4 | 8 |
| | F _{OUT} in MHz | | | | | | | | | | | | |
| Cycle-to-Cycle (ps _{pp}) | 25 | | | | 106 | | | | | | | | |
| | 37.5 | | | | | | | | 67 | | | | |
| | 50 | | | 91 | | | | | | | | | 44 |
| | 75 | | | | | | | 55 | | | | | |
| | 100 | | 105 | | | | | | | | | 51 | |
| | 150 | | | | | | 59 | | | | | | |
| | 200 | 98 | | | | | | | | | 52 | | |
| | 300 | | | | | 58 | | | | | | | |
| | 400 | | | | | | | | | 43 | | | |
| Cycle-to-Cycle (ps _{RMS}) | 25 | | | | 17 | | | | | | | | |
| | 37.5 | | | | | | | | 10 | | | | |
| | 50 | | | 13 | | | | | | | | | 7 |
| | 75 | | | | | | | 9 | | | | | |
| | 100 | | 13 | | | | | | | | | 8 | |
| | 150 | | | | | | 9 | | | | | | |
| | 200 | 11 | | | | | | | | | 8 | | |
| | 300 | | | | | 6 | | | | | | | |
| | 400 | | | | | | | | | 6 | | | |
| Period (ps _{pp}) | 25 | | | | 106 | | | | | | | | |
| | 37.5 | | | | | | | | 56 | | | | |
| | 50 | | | 79 | | | | | | | | | 35 |
| | 75 | | | | | | | 42 | | | | | |
| | 100 | | 66 | | | | | | | | | 32 | |
| | 150 | | | | | | 39 | | | | | | |
| | 200 | 65 | | | | | | | | | 31 | | |
| | 300 | | | | | 38 | | | | | | | |
| | 400 | | | | | | | | | 33 | | | |
| Period (ps _{RMS}) | 25 | | | | 14 | | | | | | | | |
| | 37.5 | | | | | | | | 7 | | | | |
| | 50 | | | 10 | | | | | | | | | |
| | 75 | | | | | | | 6 | | | | | 5 |
| | 100 | | 7 | | | | | | | | | 4 | |
| | 150 | | | | | | 5 | | | | | | |
| | 200 | 6 | | | | | | | | | 4 | | |
| | 300 | | | | | 4 | | | | | | | |
| | 400 | | | | | | | | | 4 | | | |

NBC12429, NBC12429A

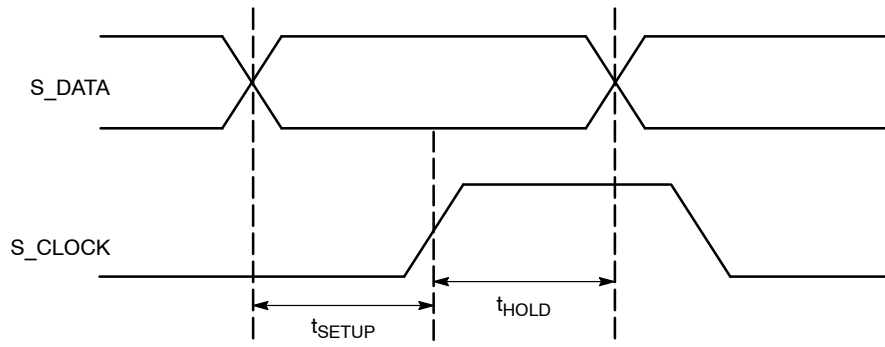


Figure 12. Setup and Hold

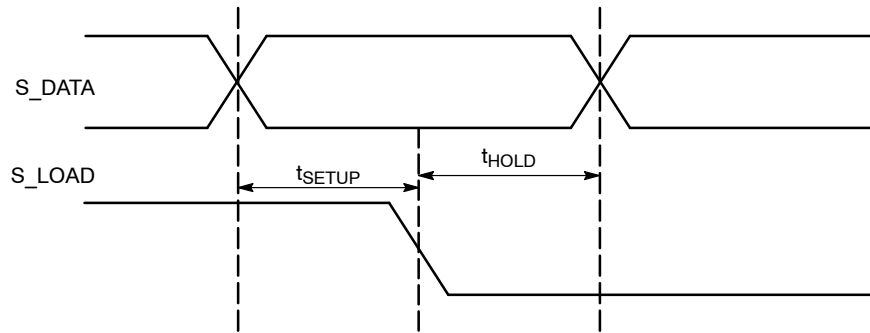


Figure 13. Setup and Hold

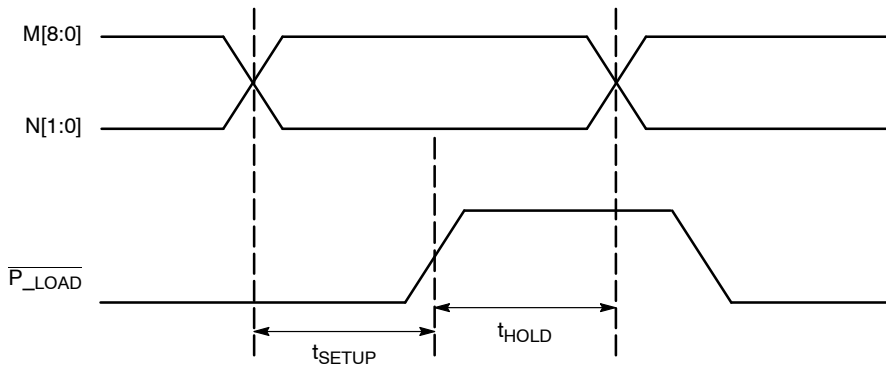


Figure 14. Setup and Hold

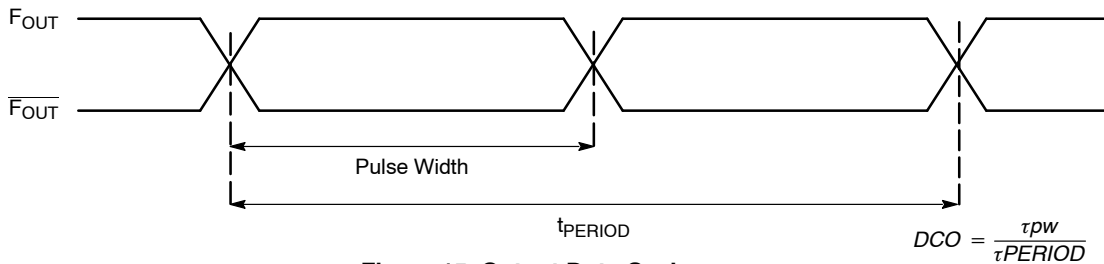


Figure 15. Output Duty Cycle

NBC12429, NBC12429A

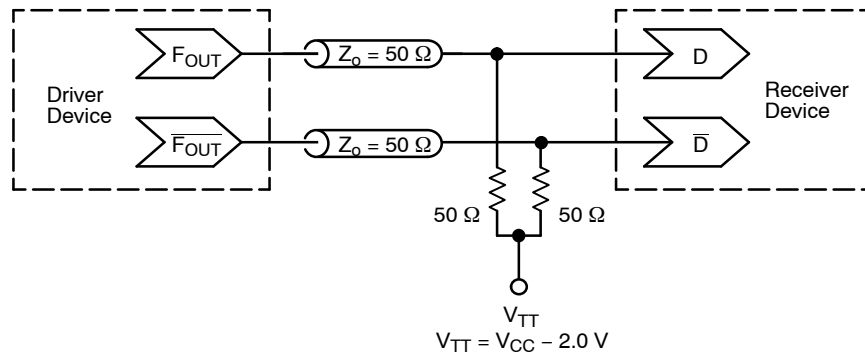


Figure 16. Typical Termination for Output Driver and Device Evaluation
(See Application Note [AND8020/D](#) – Termination of ECL Logic Devices.)

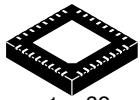
Resource Reference of Application Notes

- 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

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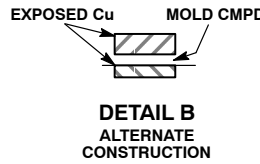
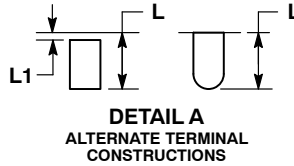
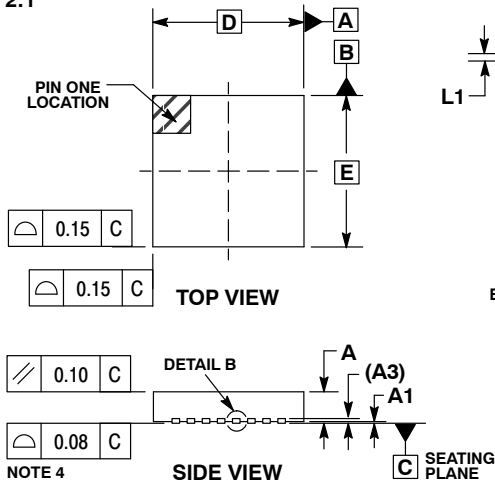


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SCALE 2:1

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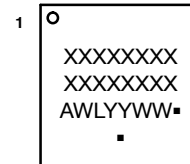


NOTES:

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2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30MM FROM THE TERMINAL TIP. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

| MILLIMETERS | | |
|-------------|------|------|
| DIM | MIN | MAX |
| A | 0.80 | 1.00 |
| A1 | --- | 0.05 |
| A3 | 0.20 | REF |
| b | 0.18 | 0.30 |
| D | 5.00 | BSC |
| D2 | 2.95 | 3.25 |
| E | 5.00 | BSC |
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| e | 0.50 | BSC |
| K | 0.20 | --- |
| L | 0.30 | 0.50 |
| L1 | --- | 0.15 |

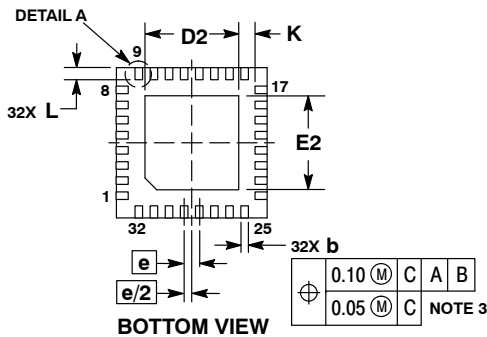
GENERIC MARKING DIAGRAM*



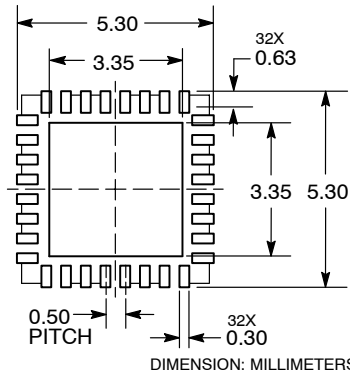
- XXXXXX = Specific Device Code
- A = Assembly Location
- WL = Wafer Lot
- YY = Year
- WW = Work Week
- = Pb-Free Package

(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.



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*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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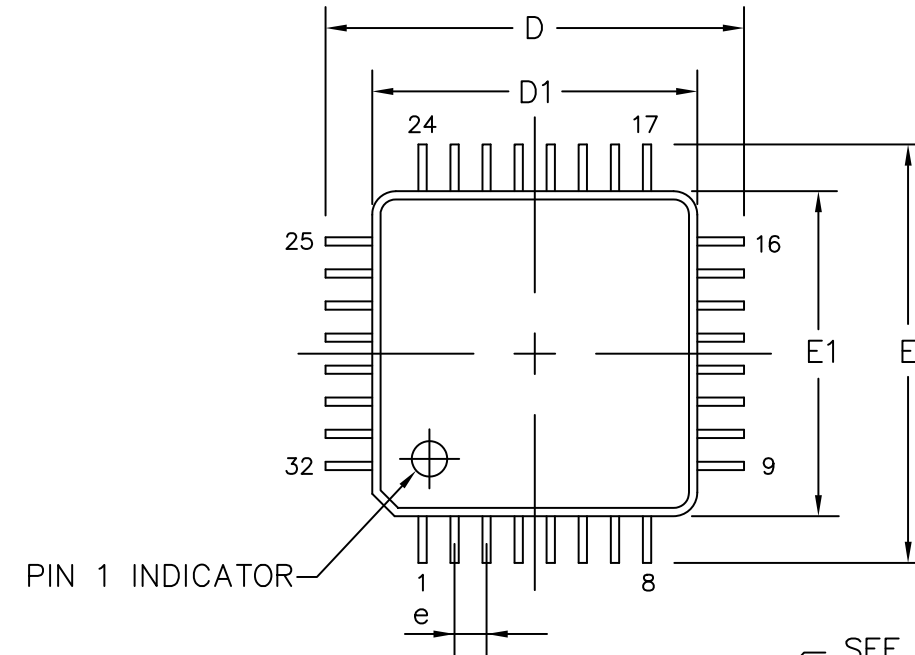
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PACKAGE DIMENSIONS

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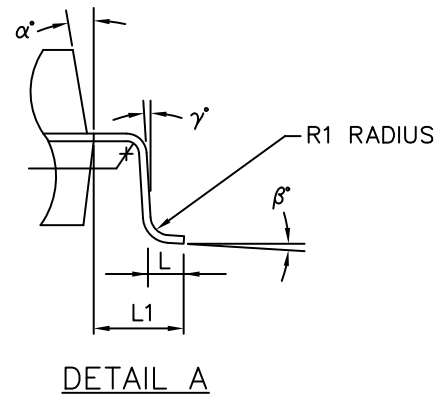
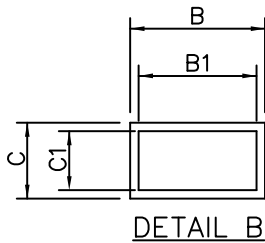
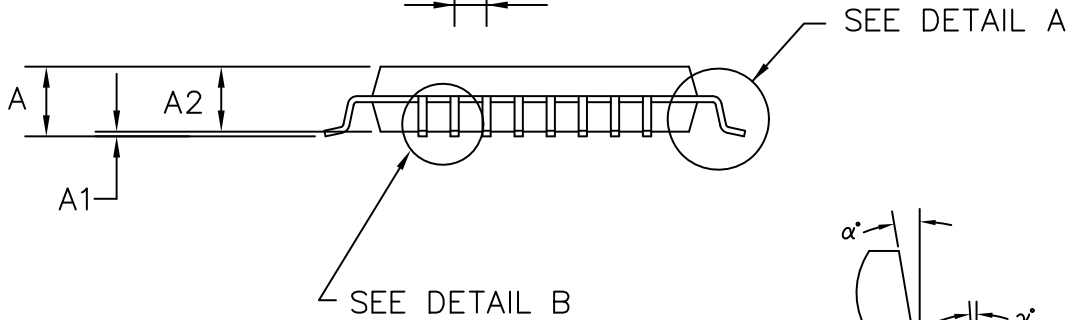


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DATE 19 JUN 2008



| SYMBOL | MIN | NOM | MAX |
|----------------|----------|------|------|
| A | — | — | 1.60 |
| A1 | 0.05 | — | 0.15 |
| A2 | 1.35 | 1.40 | 1.45 |
| B | 0.30 | 0.37 | 0.45 |
| B1 | 0.30 | 0.35 | 0.40 |
| C | 0.09 | — | 0.20 |
| C1 | 0.09 | — | 0.16 |
| D | 9.00 BSC | | |
| D1 | 7.00 BSC | | |
| E | 9.00 BSC | | |
| E1 | 7.00 BSC | | |
| e | 0.80 BSC | | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | 1.00 | | |
| R1 | 0.08 | — | 0.20 |
| α° | 11 | — | 13 |
| β° | 0 | — | 7 |
| γ° | 0 | — | — |



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