## General Description

The NV021 is a Fibre Channel Clock Generator and a member of the family of high performance devices from IDT. The NV021 can synthesize 98.304MHz, 100MHz, and 106.25MHz from a 24.576MHz, 25MHz, and 26.5625MHz crystals respectively. The NV021 is packaged in a small 8-pin SOIC, making it ideal for use in systems with limited board space.

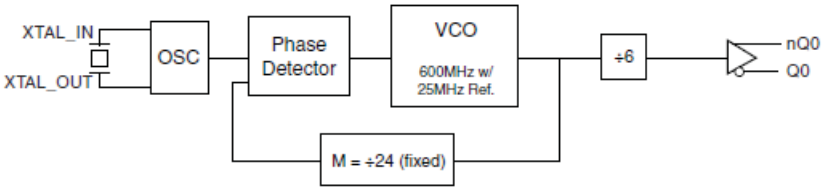
## Features

- 1 differential 3.3V LVPECL output
- Crystal frequency range: 23.33MHz - 28.33MHz
- Output frequencies: 98.304MHz, 100MHz. 106.25MHz
- VCO range: 560MHz - 680MHz
- Low RMS phase jitter
- 3.3V operating supply
- Available in RoHS/Lead-Free compliant package
- -30°C to 85°C ambient operating temperature

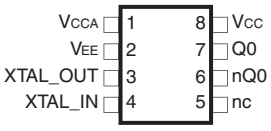
### Frequency Table

| Crystal (MHz) | Output Frequency (MHz) |
|---|---|
| 24.576 | 98.304 |
| 25 | 100 |
| 26.5625 | 106.25 |

## Block Diagram




## Pin Assignment




**NV021**
**8-Lead SOIC**
3.90mm x 4.90mm x 1.37mm
package body
**M Package**
Top View

**Table 1. Pin Descriptions**

| Number | Name | Type | | Description |
|---|---|---|---|---|
| 1 | $V_{CCA}$ | Power | | Analog supply pin. |
| 2 | $V_{EE}$ | Power | | Negative supply pin. |
| 3, 4 | XTAL_OUT, XTAL_IN | Input | | Crystal oscillator interface. XTAL_IN is the input, XTAL_OUT is the output. |
| 5 | nc | Unused | | No connect. |
| 6, 7 | nQ0, Q0 | Output | | Differential clock outputs. LVPECL interface levels. |
| 8 | $V_{CC}$ | Power | | Core supply pin. |

**Table 2. Pin Characteristics**

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | | | 4 | | pF |

### Absolute Maximum Ratings

| | |
|---|---|
| Supply Voltage, $V_{CC}$ | 4.6V |
| Inputs, $V_I$ | -0.5V to $V_{CC}$ + 0.5V |
| Outputs, $I_O$ | |
| Continuous Current | 50mA |
| Surge Current | 100mA |
| Package Thermal Impedance, $\theta_{JA}$ | |
| 8 Lead SOIC | 112.7°C/W (0 lfpm) |
| 8 Lead TSSOP | 101.7°C/W (0 mps) |
| Storage Temperature, $T_{STG}$ | -65°C to 150°C |

NOTE: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These ratings are stress specifications only. Functional operation of product at these conditions or any conditions beyond those listed in the *DC Characteristics* or *AC Characteristics* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

**Table 3A. Power Supply DC Characteristics,** $V_{CC} = V_{CCA} = 3.3V \pm 5\%$, $T_A$ = -30°C to 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| $V_{CC}$ | Core Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| $V_{CCA}$ | Analog Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| $I_{EE}$ | Power Supply Current | | | | 90 | mA |

**Table 3B. LVPECL DC Characteristics,** $V_{CC} = V_{CCA} = 3.3V \pm 5\%$, $T_A$ = -30°C to 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| $V_{OH}$ | Output High Voltage; NOTE 1 | | $V_{CC}$ - 1.4 | | $V_{CC}$ - 0.9 | V |
| $V_{OL}$ | Output Low Voltage; NOTE 1 | | $V_{CC}$ - 2.0 | | $V_{CC}$ - 1.7 | V |
| $V_{SWING}$ | Peak-to-Peak Output Voltage Swing | | 0.6 | | 1.0 | V |

NOTE 1: Outputs terminated with 50Ω to $V_{CC}$ - 2V.

**Table 4. Crystal Characteristics**

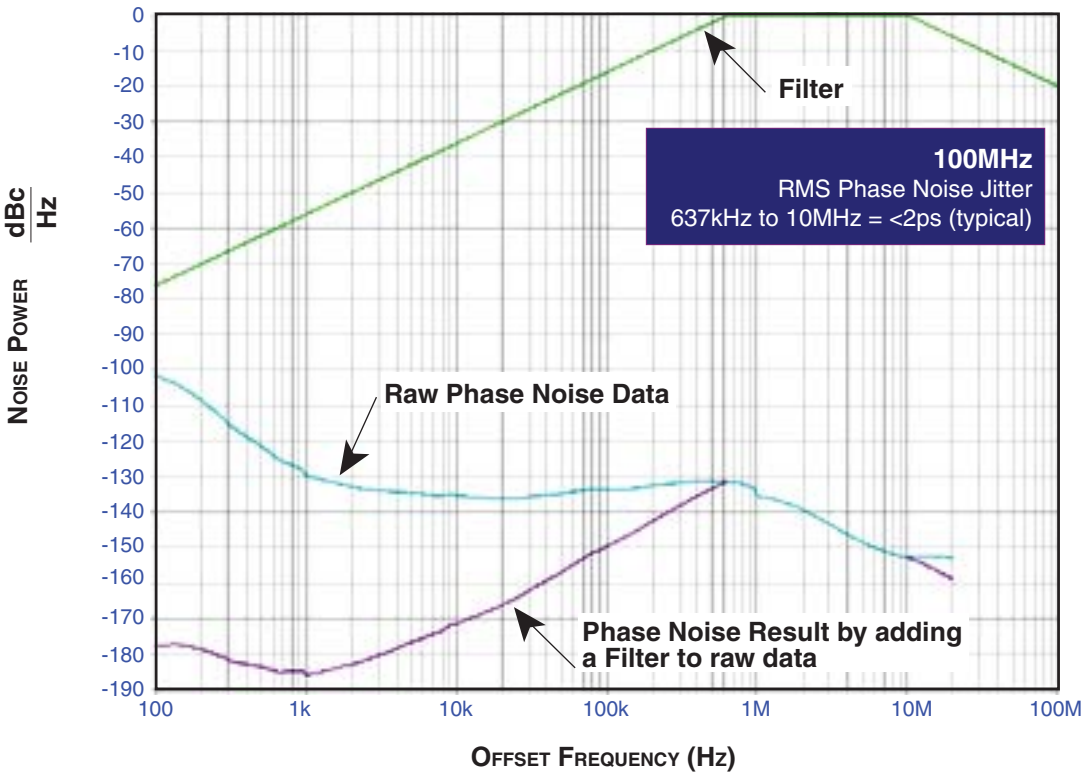
| Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|
| Mode of Oscillation | | Fundamental | | | |
| Frequency | | 23.33 | | 28.33 | MHz |
| Equivalent Series Resistance (ESR) | | | | 50 | Ω |
| Shunt Capacitance | | | | 7 | pF |
| Drive Level | | | | 1 | mW |

**Table 5. AC Characteristics,** $V_{CC} = V_{CCA} = 3.3V \pm 5\%$, $T_A$ = -30°C to 85°C

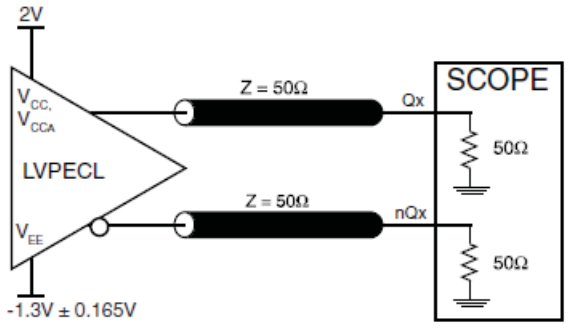
| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| $F_{OUT}$ | Output Frequency | | 93.33 | | 113.33 | MHz |
| $t_{jit}(\emptyset)$ | RMS Phase Jitter (Random); NOTE 1 | 98.304MHz; Integration Range: 12kHz - 20MHz | | <1 | | ps |
| | | 100MHz; Integration Range: 637kHz - 10MHz | | <1 | | ps |
| | | 106.25MHz; Integration Range: 637kHz - 5MHz | | <1 | | ps |
| $t_R$ / $t_F$ | Output Rise/Fall Time | 20% to 80% | 300 | | 600 | ps |
| odc | Output Duty Cycle | | 48 | | 52 | % |

NOTE 1: Please refer to the Phase Noise Plot.

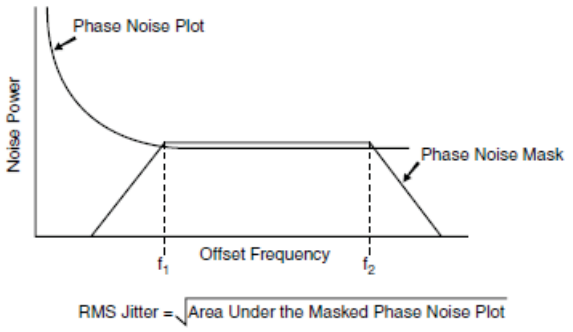
## Typical Phase Noise at 100MHz



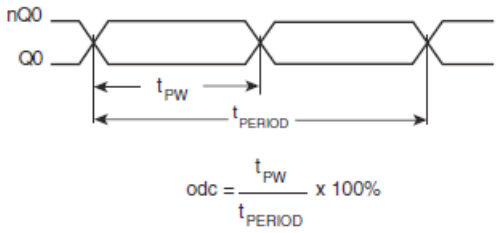
# PARAMETER MEASUREMENT INFORMATION



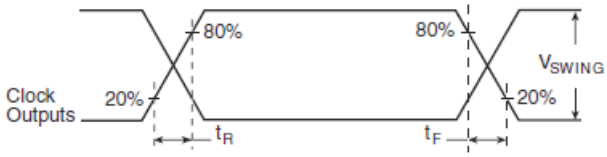

**3.3V OUTPUT LOAD AC TEST CIRCUIT**




**RMS PHASE JITTER**




**OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD**




**OUTPUT RISE/FALL TIME**

# Application Information

## Power Supply Filtering Techniques

As in any high speed analog circuitry, the power supply pins are vulnerable to random noise. The NV021 provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL. $V_{CC}$ and $V_{CCA}$ should be individually connected to the power supply plane through vias, and bypass capacitors should be used for each pin. To achieve optimum jitter performance, power supply isolation is required. *Figure 1* illustrates how a 10Ω resistor along with a 10µF and a .01µF bypass capacitor should be connected to each $V_{CCA}$ pin.

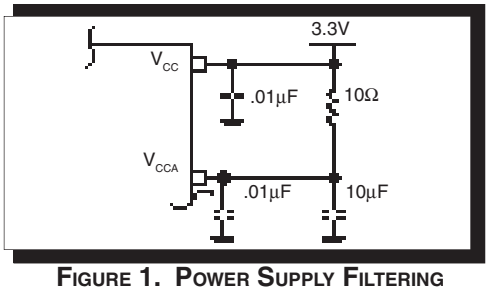



Figure 1. Power Supply Filtering

## Crystal Input Interface

The NV021 has been characterized with 18pF parallel resonant crystals. The capacitor values, C1 and C2, shown in *Figure 2* below were determined using a 25MHz, 18pF parallel resonant crystal and were chosen to minimize the ppm error. The optimum C1 and C2 values can be slightly adjusted for different board layouts.

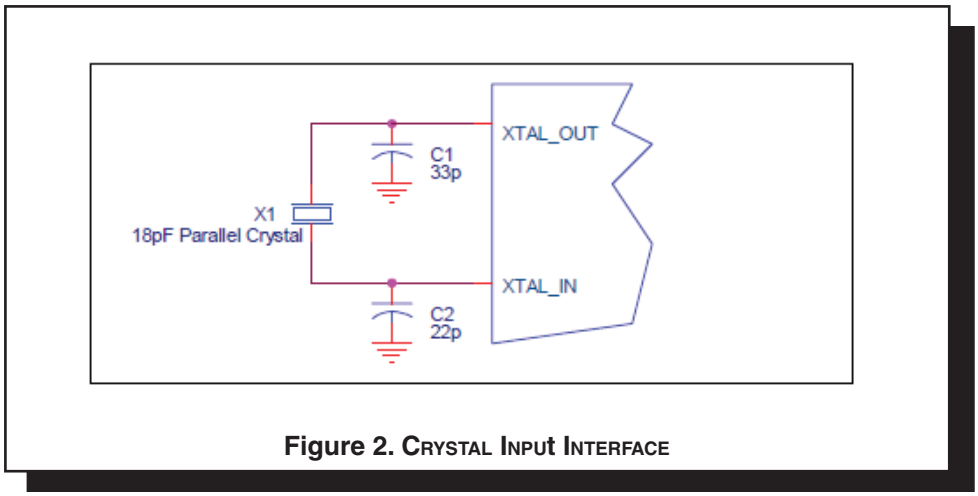



**Figure 2. Crystal Input Interface**

## Recommendations for Unused Input and Output Pins

### Inputs:

**Crystal Input:**
For applications not requiring the use of the crystal oscillator input, both XTAL_IN and XTAL_OUT can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from XTAL_IN to ground.

### Outputs:

**LVPECL Output**
All unused LVPECL outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

## Termination for 3.3V LVPECL Output

The clock layout topology shown below is a typical termination for LVPECL outputs. The two different layouts mentioned are recommended only as guidelines.

FOUT and nFOUT are low impedance follower outputs that generate ECL/LVPECL compatible outputs. Therefore, terminating resistors (DC current path to ground) or current sources must be used for functionality. These outputs are designed to drive 50Ω transmission lines. Matched impedance techniques should be used to maximize operating frequency and minimize signal distortion. *Figures 3A and 3B* show two different layouts which are recommended only as guidelines. Other suitable clock layouts may exist and it would be recommended that the board designers simulate to guarantee compatibility across all printed circuit and clock component process variations.

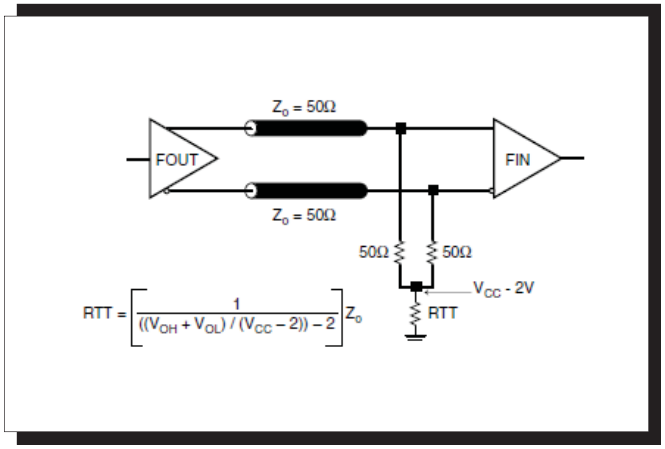



**Figure 3A. LVPECL Output Termination**

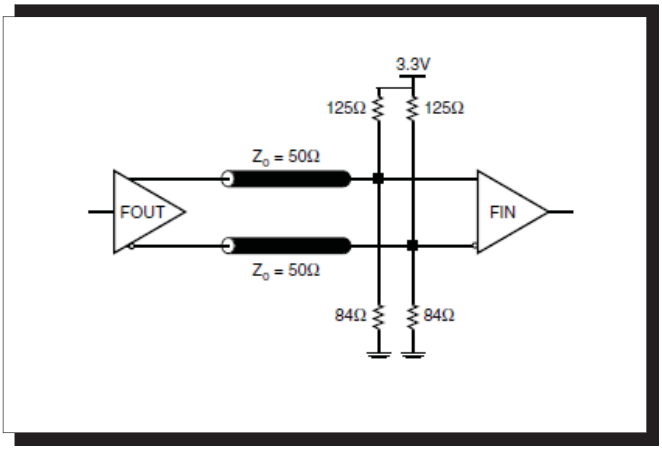



**Figure 3B. LVPECL Output Termination**

# POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the NV021.
Equations and example calculations are also provided.

*1. Power Dissipation.*
The total power dissipation for the NV021 is the sum of the core power plus the power dissipated in the load(s).
The following is the power dissipation for $V_{CC}$ = 3.3V + 5% = 3.465V, which gives worst case results.
**NOTE:** Please refer to Section 3 for details on calculating power dissipated in the load.

- Power (core)$_{MAX}$ = $V_{CC\_MAX}$ * $I_{EE\_MAX}$ = 3.465V * 90mA = **311.85mW**
- Power (outputs)$_{MAX}$ = **30mW/Loaded Output pair**

**Total Power$_{_MAX}$** (3.465V, with all outputs switching) = 311.85mW + 30mW = **341.85mW**

*2. Junction Temperature.*
Junction temperature, Tj, is the temperature at the junction of the bond wire and bond pad and directly affects the reliability of the device. The maximum recommended junction temperature for HiPerClockS™ devices is 125°C.

The equation for Tj is as follows: $Tj = \theta_{JA} * Pd\_total + T_A$

Tj = Junction Temperature

$\theta_{JA}$ = Junction-to-Ambient Thermal Resistance

Pd_total = Total Device Power Dissipation (example calculation is in section 1 above)
$T_A$ = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance $\theta_{JA}$ must be used. Assuming a moderate air flow of 200 linear feet per minute and a multi-layer board, the appropriate value is 103.3°C/W per Table 6A below.

Therefore, Tj for an ambient temperature of 85°C with all outputs switching is:
85°C + 0.342W * 103.3°C/W = 120.3°C. This is below the limit of 125°C.

This calculation is only an example. Tj will obviously vary depending on the number of loaded outputs, supply voltage, air flow, and the type of board (single layer or multi-layer).

**TABLE 6A. THERMAL RESISTANCE $\theta_{JA}$ FOR 8-PIN SOIC, FORCED CONVECTION**

| $\theta_{JA}$ by Velocity (Linear Feet per Minute) | 0 | 200 | 500 |
|---|---|---|---|
| Single-Layer PCB, JEDEC Standard Test Boards | 153.3°C/W | 128.5°C/W | 115.5°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards | 112.7°C/W | 103.3°C/W | 97.1°C/W |

**NOTE:** Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

**TABLE 6B. THERMAL RESISTANCE $\theta_{JA}$ FOR 8-PIN TSSOP, FORCED CONVECTION**

| $\theta_{JA}$ by Velocity (Meters per Second) | 0 | 1 | 2.5 |
|---|---|---|---|
| Multi-Layer PCB, JEDEC Standard Test Boards | 101.7°C/W | 90.5°C/W | 89.8°C/W |

*3. Calculations and Equations.*

The purpose of this section is to derive the power dissipated into the load.

LVPECL output driver circuit and termination are shown in *Figure 4.*

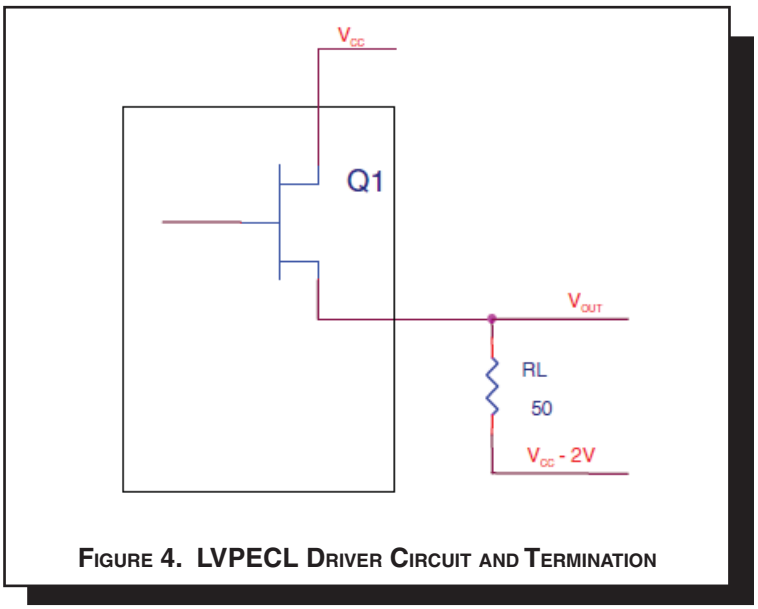



**FIGURE 4. LVPECL DRIVER CIRCUIT AND TERMINATION**

To calculate worst case power dissipation into the load, use the following equations which assume a 50Ω load, and a termination
voltage of $V_{CC}$- 2V.

- For logic high, $V_{OUT} = V_{OH\_MAX} =$ **$V_{CC\_MAX}$ – 0.9V**

  ($V_{CCO\_MAX}$ - $V_{OH\_MAX}$) = **0.9V**

- For logic low, $V_{OUT} = V_{OL\_MAX} =$ **$V_{CC\_MAX}$ – 1.7V**

  ($V_{CCO\_MAX}$ - $V_{OL\_MAX}$) = **1.7V**

Pd_H is power dissipation when the output drives high.
Pd_L is the power dissipation when the output drives low.

Pd_H = [($V_{OH\_MAX}$ – ($V_{CC\_MAX}$ - 2V))/$R_L$] * ($V_{CC\_MAX}$ - $V_{OH\_MAX}$) = [(2V - ($V_{CC\_MAX}$ - $V_{OH\_MAX}$))/$R_L$] * ($V_{CC\_MAX}$ - $V_{OH\_MAX}$) =
[(2V - 0.9V)/50Ω] * 0.9V = **19.8mW**

Pd_L = [($V_{OL\_MAX}$ – ($V_{CC\_MAX}$ - 2V))/$R_L$] * ($V_{CC\_MAX}$ - $V_{OL\_MAX}$) = [(2V - ($V_{CC\_MAX}$ - $V_{OL\_MAX}$))/$R_L$] * ($V_{CC\_MAX}$ - $V_{OL\_MAX}$) =
[(2V - 1.7V)/50Ω] * 1.7V = **10.2mW**

Total Power Dissipation per output pair = Pd_H + Pd_L = **30mW**

# Reliability Information

**Table 7A. $\theta_{JA}$ vs. Air Flow Table for 8 Lead SOIC**

| $\theta_{JA}$ by Velocity (Linear Feet per Minute) | 0 | 200 | 500 |
|---|---|---|---|
| Single-Layer PCB, JEDEC Standard Test Boards | 153.3°C/W | 128.5°C/W | 115.5°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards | 112.7°C/W | 103.3°C/W | 97.1°C/W |

**NOTE:** Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

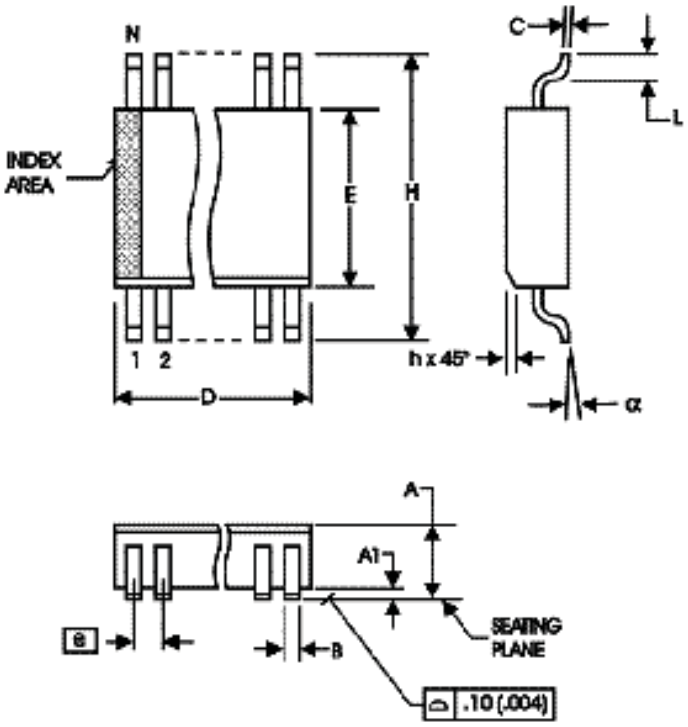
**Table 7B. $\theta_{JA}$ vs. Air Flow Table for 8 Lead TSSOP**

| $\theta_{JA}$ by Velocity (Meters per Second) | 0 | 1 | 2.5 |
|---|---|---|---|
| Multi-Layer PCB, JEDEC Standard Test Boards | 101.7°C/W | 90.5°C/W | 89.8°C/W |

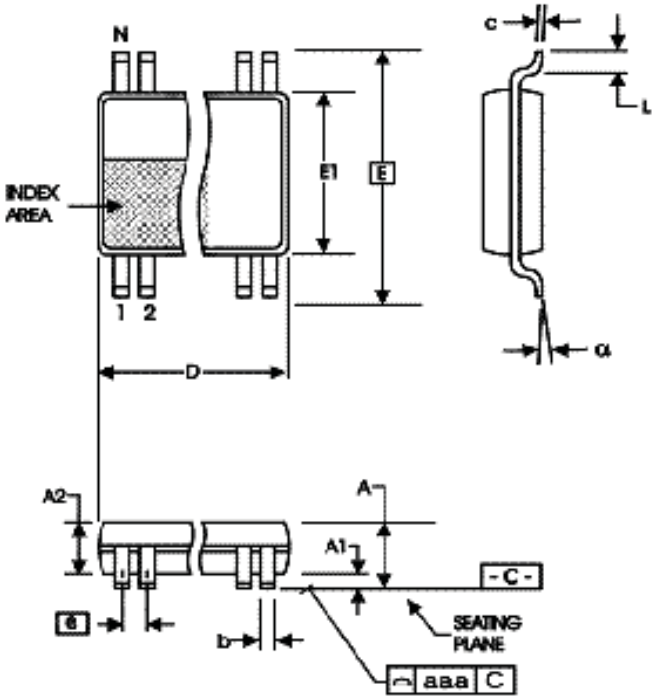
### Transistor Count

The transistor count for NV021 is: 1839

### Package Outline - M Suffix for 8 Lead SOIC




### Package Outline - G Suffix for 8 Lead TSSOP




### Table 8A. Package Dimensions

| SYMBOL | Millimeters | |
|---|---|---|
| | MINIMUN | MAXIMUM |
| N | 8 | |
| A | 1.35 | 1.75 |
| A1 | 0.10 | 0.25 |
| B | 0.33 | 0.51 |
| C | 0.19 | 0.25 |
| D | 4.80 | 5.00 |
| E | 3.80 | 4.00 |
| e | 1.27 BASIC | |
| H | 5.80 | 6.20 |
| h | 0.25 | 0.50 |
| L | 0.40 | 1.27 |
| α | 0° | 8° |

Reference Document: JEDEC Publication 95, MS-012

### Table 8B. Package Dimensions

| SYMBOL | Millimeters | |
|---|---|---|
| | Minimum | Maximum |
| N | 8 | |
| A | -- | 1.20 |
| A1 | 0.05 | 0.15 |
| A2 | 0.80 | 1.05 |
| b | 0.19 | 0.30 |
| c | 0.09 | 0.20 |
| D | 2.90 | 3.10 |
| E | 6.40 BASIC | |
| E1 | 4.30 | 4.50 |
| e | 0.65 BASIC | |
| L | 0.45 | 0.75 |
| α | 0° | 8° |
| aaa | -- | 0.10 |

Reference Document: JEDEC Publication 95, MO-153

**TABLE 8. ORDERING INFORMATION**

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|---|---|---|---|---|
| NV021AMLF | NV021AML | 8 lead “Lead-Free” SOIC | tube | -30°C to 85°C |
| NV021AMLFT | NV021AML | 8 lead “Lead-Free” SOIC | tape & reel | -30°C to 85°C |

| REVISION HISTORY SHEET | | | | |
|---|---|---|---|---|
| **Rev** | **Table** | **Page** | **Description of Change** | **Date** |
| B | T4<br>T5 | 1<br><br>3<br>3<br>7 | Features section and Frequency Table - added 98.304MHz and 106.25MHz output frequencies, and added 24.576MHz and 26.5625MHz crystal frequencies.<br>Crystal Characteristics - added Drive Level.<br>AC Characteristics - added 98.304MHz and 106.25MHz to RMS Phase Jitter.<br>Added *Recommendations for Unused Input and Output Pins.* | 7/26/05 |
| B | T8 | 1<br>12 | Updated datasheet format to IDT.<br>Removed TSSOP package information.<br>Table 8, Ordering Information - removed leaded and TSSOP devices. | 4/2/14 |
| B | T8 | 1<br>12 | Removed reference to leaded package.<br>Ordering Information - removed quantity from tape and reel. Deleted LF note below the table.<br>Updated header and footer. | 1/26/16 |

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