

General Description

The 810001-22 is a PLL based synchronous clock generator that is optimized for digital video clock jitter attenuation and frequency translation. The device contains two internal frequency multiplication stages that are cascaded in series. The first stage is a VCXO PLL that is optimized to provide reference clock jitter attenuation, and to support the complex PLL multiplication ratios needed for video rate conversion.

The second stage is a FemtoClock™ frequency multiplier that provides the low jitter, high frequency video output clock.

Preset multiplication ratios are selected from internal lookup tables using device input selection pins. The multiplication ratios are optimized to support common video rates used in professional video system applications. The VCXO requires the use of an external, inexpensive pullable crystal. Two crystal connections are provided (pin selectable) so that both 60 and 59.94Hz base frame rates can be supported. The VCXO requires external passive loop filter components which are used to set the PLL loop bandwidth and damping characteristics.

Supported Input Frequencies

| $f_{VCXO} = 27\text{MHz}$ | $f_{VCXO} = 26.973\text{MHz}$ |
|---------------------------|-------------------------------|
| 67.5kHz | 67.4326 |
| 56.25kHz | 56.1938 |
| 45.0kHz | 44.955 |
| 37.5kHz | 37.4625 |
| 33.75kHz | 33.7163 |
| 31.4685kHz | 31.4371 |
| 31.25kHz | 31.2188 |
| 28.125kHz | 28.0969 |
| 27.0kHz | 26.973 |
| 22.5kHz | 22.4775 |
| 18.75kHz | 18.7313 |
| 18kHz | 17.982 |
| 15.7343kHz | 15.7185 |
| 15.625kHz | 15.6094 |

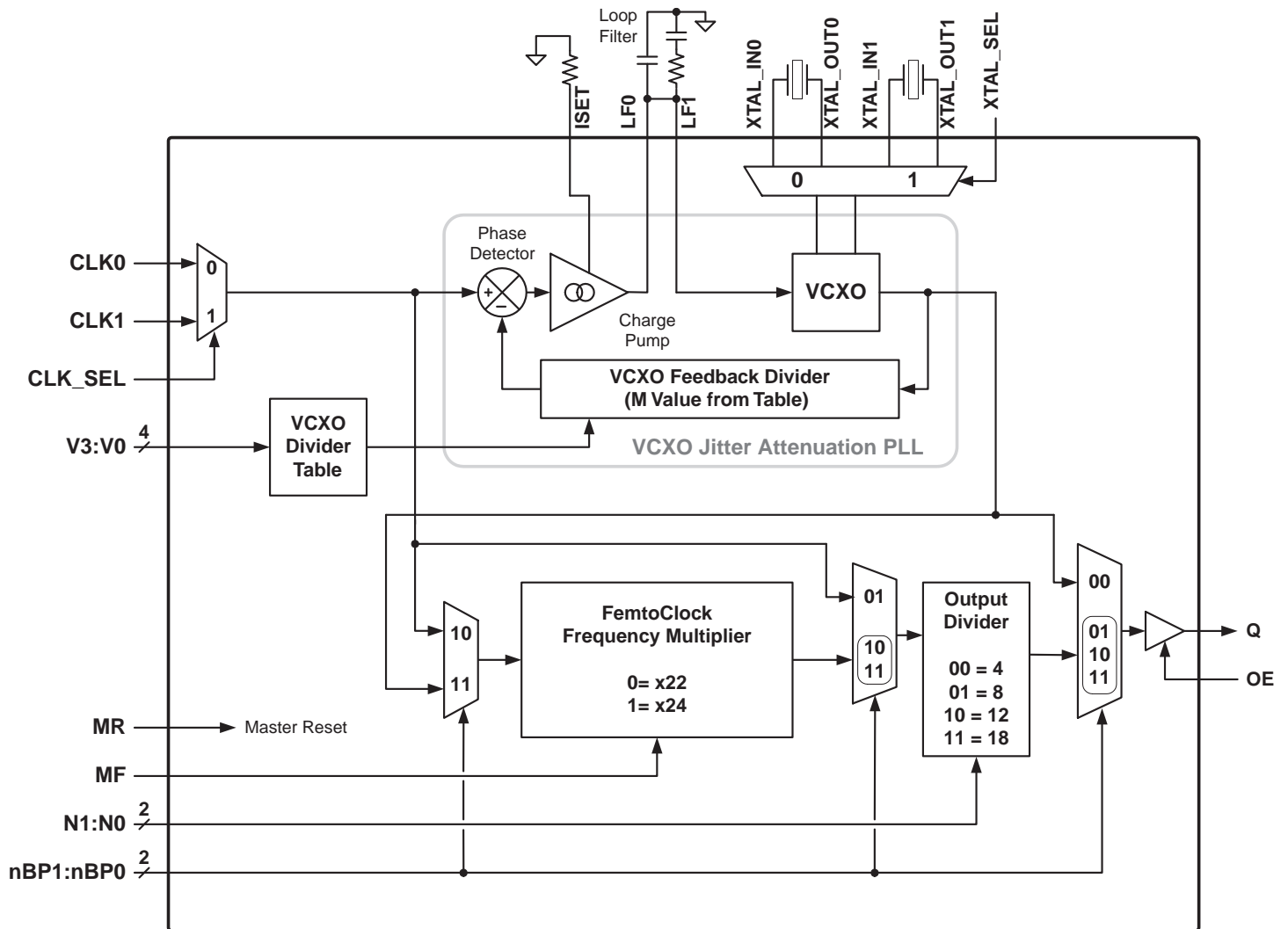
Features

- Jitter attenuation and frequency translation of video clock signals
- Supports SMTPE 292M, ITU-R Rec. 601/656 and MPEG-transport clocks
- Support of High-Definition (HD) and Standard-Definition (SD) pixel rates
- Dual VCXO-PLL supports both 60 and 59.94Hz base frame rates in one device
- Dual PLL mode for high-frequency clock generation (32.967MHz to 162MHz)
- VCXO-PLL mode for low-frequency clock generation (27MHz and 26.973MHz)
- One LVCMOS/LVTTL PLL clock output
- Two selectable LVCMOS/LVTTL input clocks
- LVCMOS/LVTTL compatible control signals
- RMS phase jitter @148.5MHz, using a 27MHz crystal (12kHz – 20MHz): 1.01ps (typical)
- 3.3V supply voltage
- 0°C to 70°C ambient operating temperature
- Available in a lead-free (RoHS 6) 32-VFQFN package
- **Use replacement part: 8T49N241-dddNLGI**

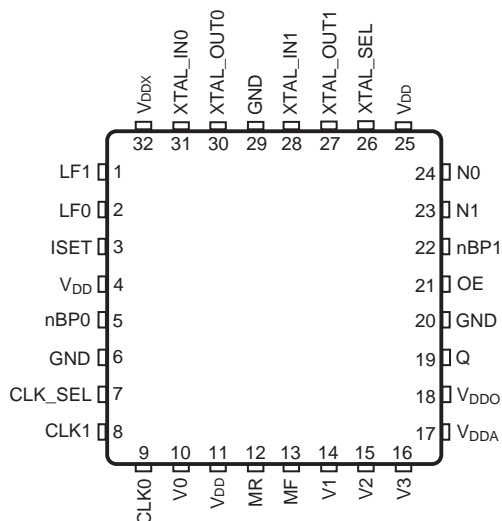
Supported Output Frequencies

| $f_{VCXO} = 27\text{MHz}$ | $f_{VCXO} = 26.973\text{MHz}$ |
|---------------------------|-------------------------------|
| 148.5 | 148.3516 |
| 74.25 | 74.1758 |
| 49.5 | 49.4505 |
| 33 | 32.967 |
| 162 | 161.8382 |
| 81 | 80.9191 |
| 54 | 53.9461 |
| 36 | 35.9640 |
| 27 | 26.973 |

Block Diagram



Pin Assignment



810001-22
32 Lead VFQFN
5mm x 5mm x 0.925mm package body
K Package
Top View

Table 1. Pin Descriptions

| Number | Name | Type | | Description |
|----------------|---------------------|---------------------|----------|---|
| 1, 2 | LF1, LF0 | Analog Input/Output | | Loop filter connection node pins. |
| 3 | ISSET | Analog Input/Output | | Charge pump current setting pin. |
| 4, 11, 25 | V _{DD} | Power | | Core supply pins. |
| 5, 22 | nBP0, nBP1 | Input | Pullup | PLL Bypass control pins. See block diagram. |
| 6, 20, 29 | GND | Power | | Power supply ground. |
| 7 | CLK_SEL | Input | Pulldown | Input clock select. When HIGH selects CLK1. When LOW, selects CLK0. LVCMOS / LVTTTL interface levels. |
| 8, 9 | CLK1, CLK0 | Input | Pulldown | Single-ended clock inputs. LVCMOS/LVTTTL interface levels. |
| 10, 14, 15, 16 | V0, V1, V2, V3 | Input | Pulldown | VCXO PLL divider selection pins. LVCMOS/LVTTTL interface levels. |
| 12 | MR | Input | Pulldown | Active HIGH Master Reset. When logic HIGH, the internal dividers are reset causing the output to go low. When logic LOW, the internal dividers and the output is enabled. LVCMOS/LVTTTL interface levels. |
| 13 | MF | Input | Pulldown | FemtoClock multiplication factor select pin. LVCMOS/LVTTTL interface levels. |
| 17 | V _{DDA} | Power | | Analog supply pin. |
| 18 | V _{DDO} | Power | | Output supply pin. |
| 19 | Q | Output | | Single-ended VCXO PLL clock output. LVCMOS/LVTTTL interface levels. |
| 21 | OE | Input | Pullup | Output enable. When logic LOW, the clock output is in high-impedance. When logic HIGH, the output is enabled. LVCMOS/LVTTTL interface levels. |
| 23, 24 | N1, N0 | Input | Pulldown | FemtoClock output divide select pins. LVCMOS/LVTTTL interface levels. |
| 26 | XTAL_SEL | Input | Pulldown | Crystal select. When HIGH, selects XTAL1. When LOW, selects XTAL0. LVCMOS/LVTTTL interface levels. |
| 27, 28 | XTAL_OUT1, XTAL_IN1 | Input | | Crystal oscillator interface. XTAL_IN1 is the input. XTAL_OUT1 is the output. |
| 30, 31 | XTAL_OUT0, XTAL_IN0 | Input | | Crystal oscillator interface. XTAL_IN0 is the input. XTAL_OUT0 is the output. |
| 32 | V _{DDX} | Power | | Power supply pin for VCXO charge pump. |

NOTE: *Pullup* and *Pulldown* refer to internal input resistors. See Table 2, *Pin Characteristics*, for typical values.

Table 2. Pin Characteristics

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------------------|-------------------------------|---|---------|---------|---------|-------|
| C _{IN} | Input Capacitance | | | 4 | | pF |
| C _{PD} | Power Dissipation Capacitance | V _{DD} = V _{DDO} = 3.465V | | 8.5 | | pF |
| R _{PULLUP} | Input Pullup Resistor | | | 51 | | kΩ |
| R _{PULLDOWN} | Input Pulldown Resistor | | | 51 | | kΩ |
| R _{OUT} | Output Impedance | | | 22.5 | | Ω |

Function Tables

Table 3A. VCXO PLL Feedback Divider and Input Frequency Function Table

| Input | | | | VCXO PLL Configuration Feedback-Divider M | Input frequency for crystal frequency (f_{VCXO}) in kHz | |
|-------------|-------------|-------------|-------------|--|---|-------------------------------|
| V3 | V2 | V1 | V0 | | $f_{VCXO} = 27\text{MHz}$ | $f_{VCXO} = 26.973\text{MHz}$ |
| 0 (default) | 0 (default) | 0 (default) | 0 (default) | 400 | 67.5 | 67.4326 |
| 0 | 0 | 0 | 1 | 480 | 56.25 | 56.1938 |
| 0 | 0 | 1 | 0 | 600 | 45.00 | 44.9550 |
| 0 | 0 | 1 | 1 | 720 | 37.50 | 37.4625 |
| 0 | 1 | 0 | 0 | 800 | 33.75 | 33.7163 |
| 0 | 1 | 0 | 1 | 858 | 31.4685 | 31.4371 |
| 0 | 1 | 1 | 0 | 864 | 31.25 | 31.2188 |
| 0 | 1 | 1 | 1 | 960 | 28.125 | 28.0969 |
| 1 | 0 | 0 | 0 | 1000 | 27.00 | 26.973 |
| 1 | 0 | 0 | 1 | 1200 | 22.50 | 22.4775 |
| 1 | 0 | 1 | 0 | 1440 | 18.75 | 18.7313 |
| 1 | 0 | 1 | 1 | 1500 | 18.00 | 17.9820 |
| 1 | 1 | 0 | 0 | 1716 | 15.7343 | 15.7185 |
| 1 | 1 | 0 | 1 | 1728 | 15.6250 | 15.6094 |
| 1 | 1 | 1 | 0 | 1716 | 15.7343 | 15.7185 |
| 1 | 1 | 1 | 1 | 960 | 28.125 | 28.0969 |

Table 3B. Output Frequency Table (Dual PLL Mode)

| f_{VCXO} | FemtoClock Look-up Table | | | Output Frequency f_Q (MHz) |
|------------|--------------------------|----|----|------------------------------|
| | MF | N1 | N0 | |
| 27MHz | 0 | 0 | 0 | 148.5000 |
| | 0 | 0 | 1 | 74.2500 |
| | 0 | 1 | 0 | 49.5000 |
| | 0 | 1 | 1 | 33.0000 |
| | 1 | 0 | 0 | 162.0000 |
| | 1 | 0 | 1 | 81.0000 |
| | 1 | 1 | 0 | 54.0000 |
| | 1 | 1 | 1 | 36.0000 |
| 26.973MHz | 0 | 0 | 0 | 148.3515 |
| | 0 | 0 | 1 | 74.1758 |
| | 0 | 1 | 0 | 49.4505 |
| | 0 | 1 | 1 | 32.9670 |
| | 1 | 0 | 0 | 161.8382 |
| | 1 | 0 | 1 | 80.9191 |
| | 1 | 1 | 0 | 53.9461 |
| | 1 | 1 | 1 | 35.9640 |

NOTE: Use the VCXO-PLL mode to achieve output frequencies of 27MHz or 26.973MHz. See Table 3G.

Table 3C. CLK_SEL Function Table

| Input | |
|-------------|--------------------------------------|
| CLK_SEL | Operation |
| 0 (default) | Selects CLK0 as PLL reference input. |
| 1 | Selects CLK1 as PLL reference input. |

Table 3D. MR Master Reset Function Table

| Input | |
|-------------|--|
| MR | Operation |
| 0 (default) | Normal operation, internal dividers and the output Q are enabled. |
| 1 | Internal dividers are reset. Q output is in logic low state (with OE = 1). |

Table 3E. FemtoClock PLL Feedback Divider Function Table

| Input | |
|-------------|--|
| MF | Operation |
| 0 (default) | Selects MF = 22. The 2nd stage PLL (FemtoClock. multiplies the output frequency of the VCXO-PLL by 22. |
| 1 | Selects MF = 24. The 2nd stage PLL (FemtoClock. multiplies the output frequency of the VCXO-PLL by 24. |

Table 3F. PLL Output Divider Function Table

| Input | | Operation |
|-------------|-------------|------------------------|
| N1 | N0 | |
| 0 (default) | 0 (default) | Output divider N = 4. |
| 0 | 1 | Output divider N = 8. |
| 1 | 0 | Output divider N = 12. |
| 1 | 1 | Output divider N = 18. |

Table 3G. PLL BYPASS Logic Function Table

| Input | | Operation |
|-------------|-------------|---|
| nBP1 | nBP0 | |
| 0 | 0 | VCXO-PLL mode: The input reference frequency is multiplied by the VCXO-PLL. $f_{OUT} = f_{REF} * M$. |
| 0 | 1 | Test mode: The input reference frequency is divided by the output divider N and bypasses both PLLs. $f_{OUT} = f_{REF} \div N$. |
| 1 | 0 | FemtoClock Mode: The input reference frequency is multiplied by the 2 nd PLL (FemtoClock, MF). The 1 st PLL (VCXO-PLL, M) is bypassed. This mode does not support jitter attenuation. $f_{OUT} = f_{REF} * MF \div N$. |
| 1 (default) | 1 (default) | Dual PLL Mode: both PLLs are cascaded for jitter attenuation and frequency multiplication. $f_{OUT} = f_{REF} * M * MF \div N$. |

Absolute Maximum Ratings

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.

| Item | Rating |
|--|---------------------------|
| Supply Voltage, V_{DD} | 4.6V |
| Inputs, V_I | -0.5V to $V_{DD} + 0.5V$ |
| Outputs, V_O | -0.5V to $V_{DDO} + 0.5V$ |
| Package Thermal Impedance, θ_{JA} | 37°C/W (0 mps) |
| Storage Temperature, T_{STG} | -65°C to 150°C |

DC Electrical Characteristics

Table 4A. Power Supply DC Characteristics, $V_{DD} = V_{DDO} = V_{DDX} = 3.3V \pm 5\%$, $T_A = 0^\circ C$ to $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|----------------------------|-----------------|-----------------|---------|----------|-------|
| V_{DD} | Core Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| V_{DDA} | Analog Supply Voltage | | $V_{DD} - 0.15$ | 3.3 | V_{DD} | V |
| V_{DDO} | Output Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| V_{DDX} | Charge Pump Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| I_{DD} | Power Supply Current | | | | 187 | mA |
| I_{DDA} | Analog Supply Current | | | | 15 | mA |
| I_{DDO} | Output Supply Current | No Load | | | 4 | mA |
| I_{DDX} | Charge Pump Supply Current | | | | 4 | mA |

Table 4B. LVCMOS/LVTTL DC Characteristics, $V_{DD} = V_{DDO} = V_{DDX} = 3.3V \pm 5\%$, $T_A = 0^\circ C$ to $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|---------------------|---|---------|---------|----------------|---------|
| V_{IH} | Input High Voltage | | 2 | | $V_{DD} + 0.3$ | V |
| V_{IL} | Input Low Voltage | | -0.3 | | 0.8 | V |
| I_{IH} | Input High Current | CLK[0:1], CLK_SEL, P[1:0], V[3:0], N[1:0], MR, MF, XTAL_SEL $V_{DD} = V_{IN} = 3.465V$ | | | 150 | μA |
| | | OE, nBP0, nBP1 $V_{DD} = V_{IN} = 3.465V$ | | | 5 | μA |
| I_{IL} | Input Low Current | CLK[0:1], CLK_SEL, P[1:0], V[3:0], N[1:0], MR, MF, XTAL_SEL $V_{DD} = 3.465V, V_{IN} = 0V$ | -5 | | | μA |
| | | OE, nBP0, nBP1 $V_{DD} = 3.465, V_{IN} = 0V$ | -150 | | | μA |
| V_{OH} | Output High Voltage | $I_{OH} = -24mA$ | 2.6 | | | V |
| V_{OL} | Output Low Voltage | $I_{OL} = 24mA$ | | | 0.5 | V |

AC Electrical Characteristics

Table 5. AC Characteristics, $V_{DD} = V_{DDO} = V_{DDX} = 3.3V \pm 5\%$, $T_A = 0^\circ\text{C}$ to 70°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------------------|--|---|---------|---------|---------|-------|
| f_{OUT} | Output Frequency | nBP0, nBP1 = 00 | 26 | | 28 | MHz |
| | | nBP1 = 1 | 31 | | 175 | MHz |
| $f_{jit}(\emptyset)$ | RMS Phase Jitter, (Random), NOTE 1 | 148.5MHz, Integration Range: 12kHz – 20MHz | | 1.01 | | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | 250 | | 750 | ps |
| odc | Output Duty Cycle | | 48 | | 52 | % |
| t_{LOCK} | VCXO & FemtoClock PLL Lock Time; NOTE 2 | | | | 5 | ms |

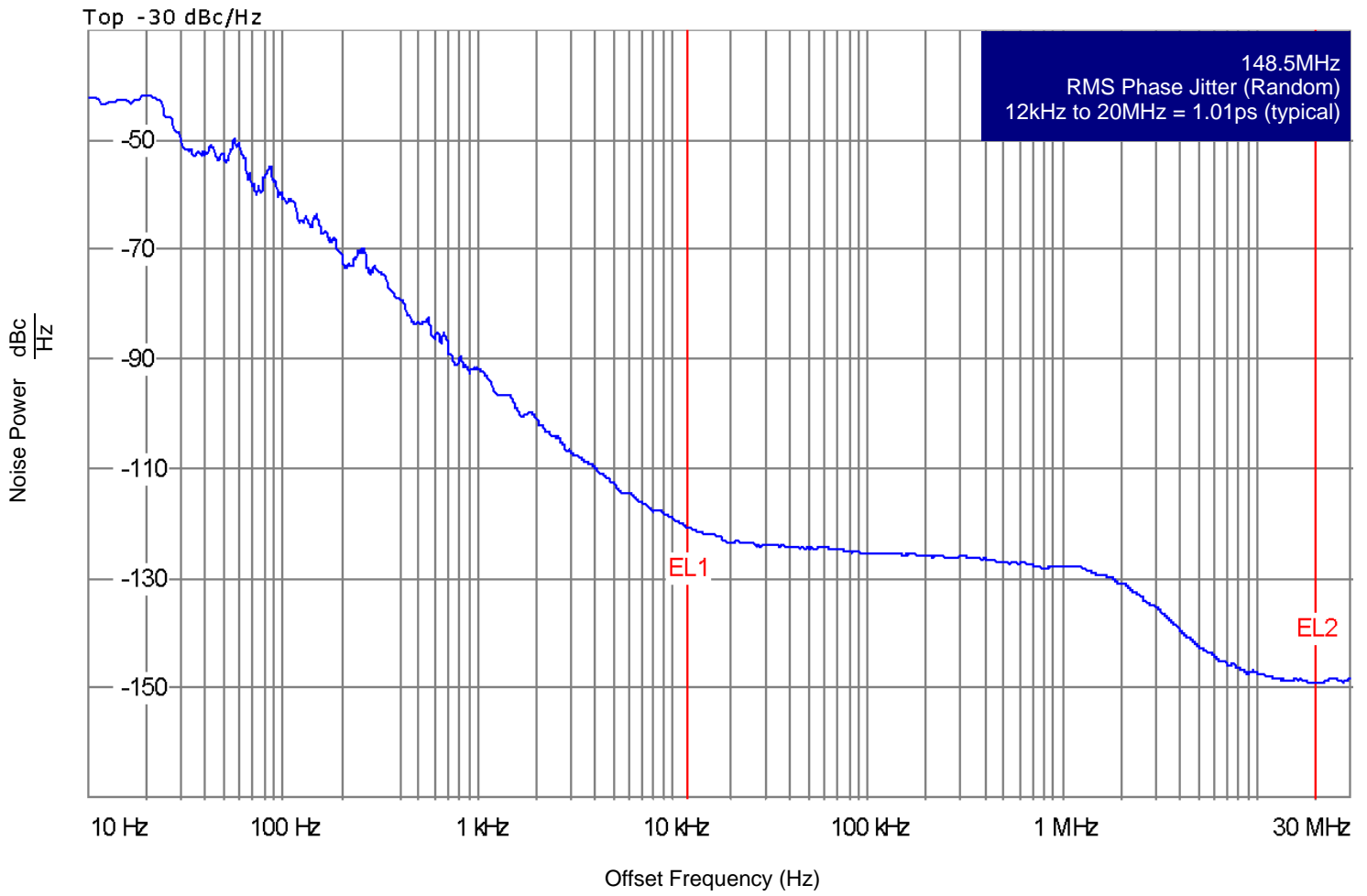
NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

See Parameter Measurement Information Section.

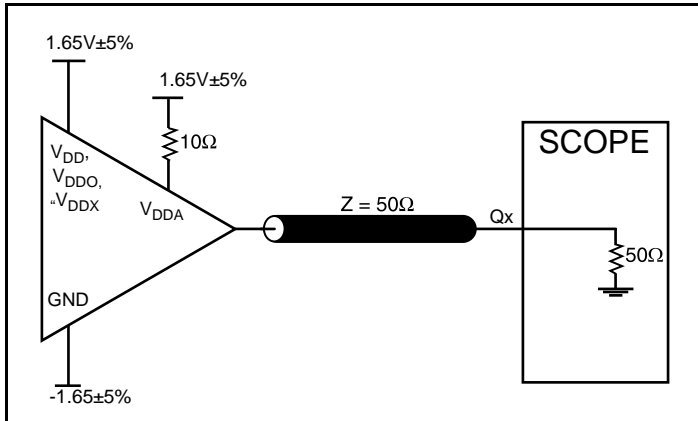
NOTE 1: Refer to the Phase Noise Plot.

NOTE 2: Lock Time measured from power-up to stable output frequency.

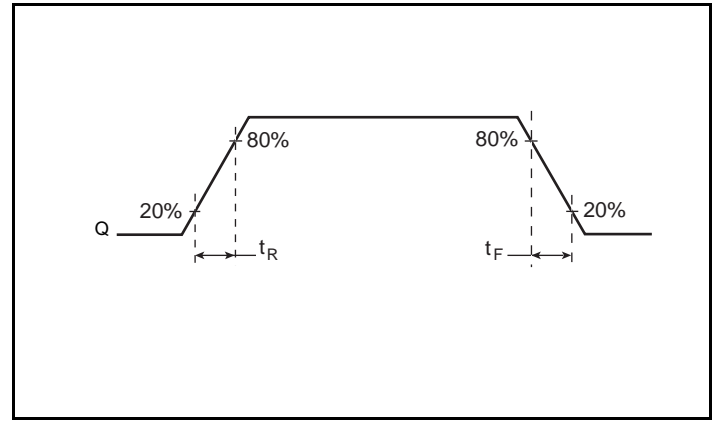
Typical Phase Noise at 148.3516MHz



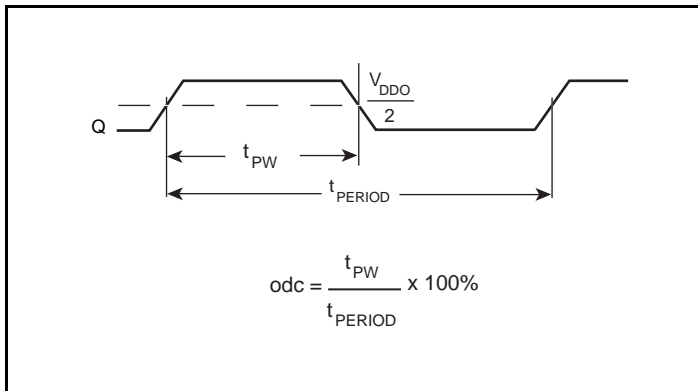
Parameter Measurement Information



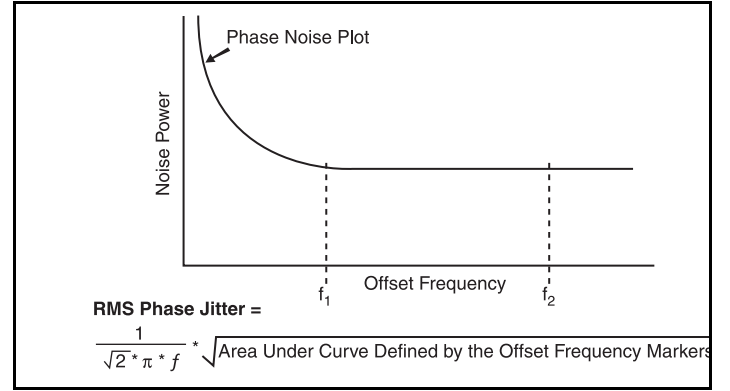
3.3V Output Load AC Test Circuit



Output Rise/Fall Time



Output Duty Cycle/Pulse Width/Period



Phase Jitter

Application Information

Recommendations for Unused Input Pins

Inputs:

CLK Inputs

For applications not requiring the use of a clock input, it can be left floating. Though not required, but for additional protection, a $1\text{k}\Omega$ resistor can be tied from the CLK input to ground.

LVC MOS Control Pins

All control pins have internal pullups or pulldowns; additional resistance is not required but can be added for additional protection. A $1\text{k}\Omega$ resistor can be used.

Power Supply Filtering Technique

As in any high speed analog circuitry, the power supply pins are vulnerable to random noise. To achieve optimum jitter performance, power supply isolation is required. The 810001-22 provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL. V_{DD} , V_{DDA} , V_{DDO} and V_{DDX} should be individually connected to the power supply plane through vias, and $0.01\mu\text{F}$ bypass capacitors should be used for each pin. *Figure 1* illustrates this for a generic V_{DD} pin and also shows that V_{DDA} requires that an additional 10Ω resistor along with a $10\mu\text{F}$ bypass capacitor be connected to the V_{DDA} pin.

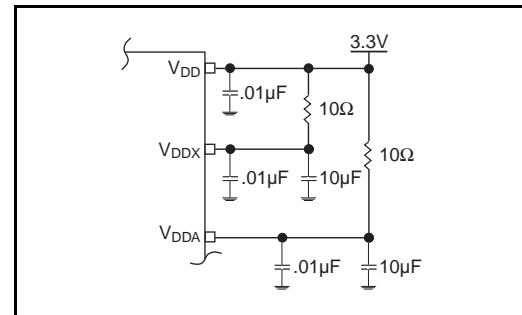


Figure 1. Power Supply Filtering

VFQFN EPAD Thermal Release Path

In order to maximize both the removal of heat from the package and the electrical performance, a land pattern must be incorporated on the Printed Circuit Board (PCB) within the footprint of the package corresponding to the exposed metal pad or exposed heat slug on the package, as shown in *Figure 2*. The solderable area on the PCB, as defined by the solder mask, should be at least the same size/shape as the exposed pad/slug area on the package to maximize the thermal/electrical performance. Sufficient clearance should be designed on the PCB between the outer edges of the land pattern and the inner edges of pad pattern for the leads to avoid any shorts.

While the land pattern on the PCB provides a means of heat transfer and electrical grounding from the package to the board through a solder joint, thermal vias are necessary to effectively conduct from the surface of the PCB to the ground plane(s). The land pattern must be connected to ground through these vias. The vias act as “heat pipes”. The number of vias (i.e. “heat pipes”) are application specific

and dependent upon the package power dissipation as well as electrical conductivity requirements. Thus, thermal and electrical analysis and/or testing are recommended to determine the minimum number needed. Maximum thermal and electrical performance is achieved when an array of vias is incorporated in the land pattern. It is recommended to use as many vias connected to ground as possible. It is also recommended that the via diameter should be 12 to 13mils (0.30 to 0.33mm) with 1oz copper via barrel plating. This is desirable to avoid any solder wicking inside the via during the soldering process which may result in voids in solder between the exposed pad/slug and the thermal land. Precautions should be taken to eliminate any solder voids between the exposed heat slug and the land pattern. Note: These recommendations are to be used as a guideline only. For further information, please refer to the Application Note on the Surface Mount Assembly of Amkor's Thermally/Electrically Enhance Leadframe Base Package, Amkor Technology.

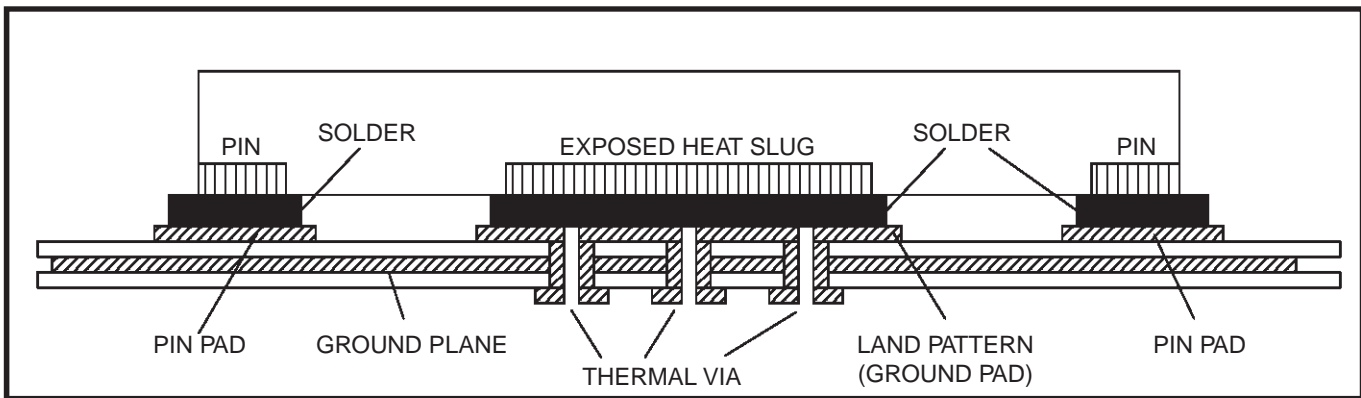


Figure 2. P.C. Assembly for Exposed Pad Thermal Release Path – Side View (drawing not to scale)

Figure 3 shows an example of the 810001-22 application schematic. In this example, the device is operated at $V_{DD} = V_{DDO} = 3.3V$. The decoupling capacitors should be located as close as possible to the power pin. The input is driven by a 3.3V LVPECL driver. An optional

The diagram illustrates a PCB layout for a logic control input example, featuring a microcontroller (U1) and various peripheral components.

Logic Control Input Examples:

- Set Logic Input to '1':** Shows a circuit with a 1K resistor (RU1) connected to VDD and a 1K resistor (RD1) connected to ground. The logic input pin is connected to the junction of these two resistors.
- Set Logic Input to '0':** Shows a circuit with a 1K resistor (RD2) connected to ground. The logic input pin is connected to the junction of this resistor and the input pin.

3-pole loop filter example - (optional): Shows a circuit with a 150k resistor (Rs), a 0.68nF capacitor (Cp), and a 220pF capacitor (C5). The input is connected to the junction of Rs and Cp, and the output is connected to the junction of Cp and C5.

2-pole loop filter with Mid LBW Setting: Shows a circuit with a 150k resistor (Rs), a 0.68nF capacitor (Cp), and a 0.18uF capacitor (Cs). The input is connected to the junction of Rs and Cp, and the output is connected to the junction of Cp and Cs.

Microcontroller (U1) Connections:

- XTAL_IN0, XTAL_OUT0, XTAL_IN1, XTAL_OUT1:** Connected to crystal oscillators (X1, X2) and capacitors (C1, C2, C3, C4).
- VDDX:** Connected to a 10uF capacitor (C7) and a 0.01uF capacitor (C8).
- VDD:** Connected to a 0.1uF capacitor (C6).
- VDDO:** Connected to a 0.1uF capacitor (C10) and a 10uF capacitor (C12).
- VDDA:** Connected to a 0.01uF capacitor (C11) and a 10uF capacitor (C13).
- CLK0:** Connected to a 50 Ohm transmission line (Zo = 50 Ohm) and a 10uF capacitor (C13).
- CLK1:** Connected to a 5.6K resistor (R4) and a 0.1uF capacitor (C9).
- CLK_SEL:** Connected to a 0.1uF capacitor (C9).
- CLK0_SEL:** Connected to a 0.1uF capacitor (C9).
- CLK1_SEL:** Connected to a 0.1uF capacitor (C9).
- CLK0_SEL:** Connected to a 0.1uF capacitor (C9).
- CLK1_SEL:** Connected to a 0.1uF capacitor (C9).
- CLK0_SEL:** Connected to a 0.1uF capacitor (C9).
- CLK1_SEL:** Connected to a 0.1uF capacitor (C9).

Receiver: The output of the CLK0 signal is connected to a receiver via a 50 Ohm transmission line (Zo = 50 Ohm).

Other Components:

- Q1:** A driver LVC MOSFET connected to VDD and ground.
- R9:** A 7 Ohm resistor connected to the output of Q1.
- R5:** A 10 Ohm resistor connected to VDDA.
- R3:** A 33 Ohm resistor connected to VDDO.

Power Supply: VDD = VDDO = 3.3V.

FEMTOCLOCK™ DUAL VCXO VIDEO PLL

VCXO-PLL EXTERNAL COMPONENTS

Choosing the correct external components and having a proper printed circuit board (PCB) layout is a key task for quality operation of the VCXO-PLL. In choosing a crystal, special precaution must be taken with the package and load capacitance (C_L). In addition, frequency, accuracy and temperature range must also be considered. Since the pulling range of a crystal also varies with the package, it is recommended that a metal-canned package like HC49 be used. Generally, a metal-canned package has a larger pulling range than a surface mounted device (SMD). For crystal selection information, refer to the *VCXO Crystal Selection Application Note*.

The crystal's load capacitance C_L characteristic determines its resonating frequency and is closely related to the VCXO tuning range. The total external capacitance seen by the crystal when installed on a board is the sum of the stray board capacitance, IC package lead capacitance, internal varactor capacitance and any installed tuning capacitors (C_{TUNE}).

If the crystal's C_L is greater than the total external capacitance, the VCXO will oscillate at a higher frequency than the crystal specification. If the crystal's C_L is lower than the total external capacitance, the VCXO will oscillate at a lower frequency than the crystal specification. In either case, the absolute tuning range is reduced. The correct value of C_L is dependent on the characteristics of the VCXO. The recommended C_L in the Crystal Parameter Table balances the tuning range by centering the tuning curve.

VCXO Characteristics Table

| Symbol | Parameter | Typical | Units |
|---------------|---------------------------|---------|-------|
| k_{VCXO} | VCXO Gain | 13.65 | kHz/V |
| C_{V_LOW} | Low Varactor Capacitance | 16 | pF |
| C_{V_HIGH} | High Varactor Capacitance | 33 | pF |

VCXO-PLL Loop Bandwidth Selection Table

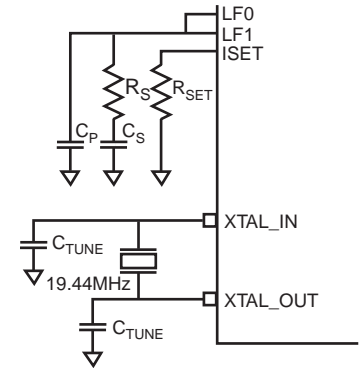
| Bandwidth | Crystal Frequency (MHz) | MF | R_S (k Ω) | C_S (μ F) | C_P (nF) | R_{SET} (k Ω) |
|--------------|-------------------------|------|---------------------|------------------|------------|-------------------------|
| 11Hz (Low) | 27, 26.973 | 1728 | 150 | 1 | 10 | 18 |
| 64Hz (Mid) | 27, 26.973 | 1000 | 150 | 0.18 | 0.68 | 5.6 |
| 597Hz (High) | 27, 26.973 | 400 | 220 | 0.022 | 0.12 | 2.2 |

Crystal Characteristics

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|------------------------------|-----------------|-------------|---------|------------------|--------------|
| | Mode of Oscillation | | Fundamental | | | |
| f_N | Frequency | | | 27 | | MHz |
| | | | | 26.973 | | MHz |
| f_T | Frequency Tolerance | | | | ± 20 | ppm |
| f_S | Frequency Stability | | | | ± 20 | ppm |
| | Operating Temperature Range | | 0 | | 70 | $^{\circ}$ C |
| C_L | Load Capacitance | | | 12 | | pF |
| C_O | Shunt Capacitance | | | 4 | | pF |
| C_O / C_1 | Pullability Ratio | | | 220 | 240 | |
| ESR | Equivalent Series Resistance | | | | 20 | Ω |
| | Drive Level | | | | 1 | mW |
| | Aging @ 25 $^{\circ}$ C | | | | ± 3 per year | ppm |

The frequency of oscillation in the third overtone mode is not necessarily at exactly three times the fundamental frequency. The mechanical properties of the quartz element dictate the position of the overtones relative to the fundamental. The oscillator circuit may excite both the fundamental and overtone modes simultaneously. This will cause a nonlinearity in the tuning curve. This potential problem is why VCXO crystals are required to be tested for absence of any activity inside a ± 200 ppm window at three times the fundamental frequency. Refer to F_{L_3OVT} and $F_{L_3OVT_spurs}$ in the crystal Characteristics table.

The crystal and external loop filter components should be kept as close as possible to the device. Loop filter and crystal traces should be kept short and separated from each other. Other signal traces should be kept separate and not run underneath the device, loop filter or crystal components.



Reliability Information

Table 6. θ_{JA} vs. Air Flow Table for a 32 Lead VFQFN

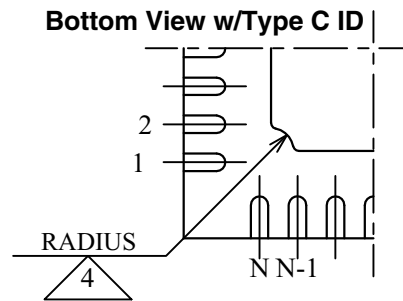
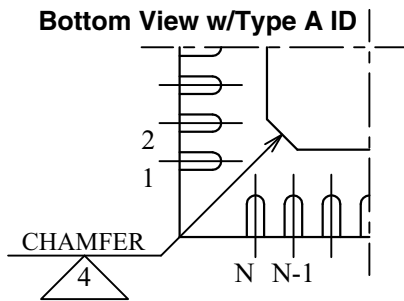
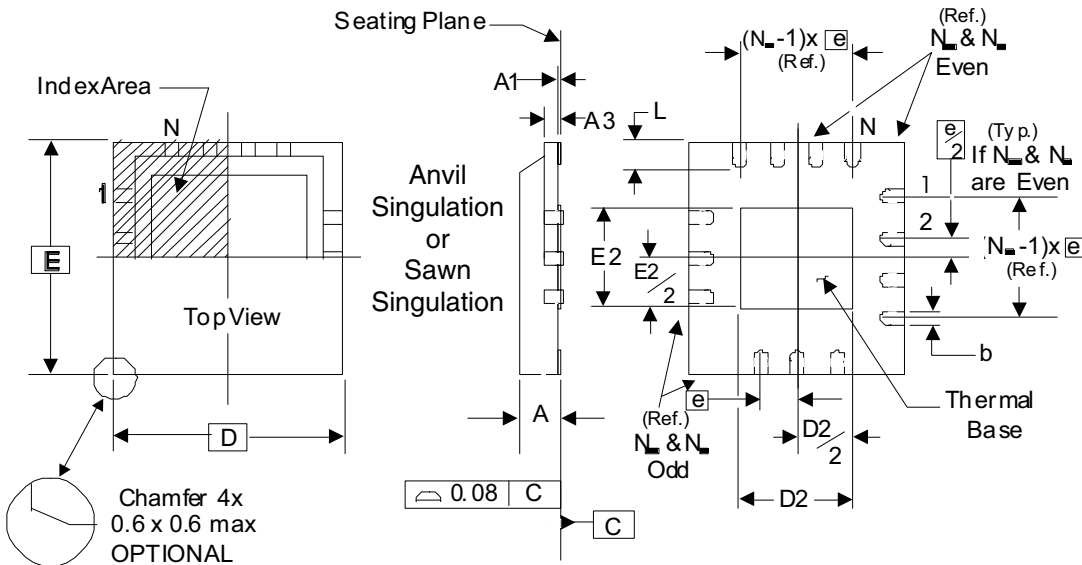
| θ_{JA} vs. Air Flow | | | |
|---|----------|----------|--------|
| Meters per Second | 0 | 1 | 2.5 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 37.0°C/W | 32.4°C/W | 29°C/W |

Transistor Count

The transistor count for 810001-22 is: 7283

Package Outline and Package Dimensions

Package Outline - K Suffix for 32 Lead VFQFN



There are 2 methods of indicating pin 1 corner at the back of the VFQFN package:

1. Type A: Chamfer on the paddle (near pin 1)
2. Type C: Mouse bite on the paddle (near pin 1)

Table 7. Package Dimensions

| JEDEC Variation: VHHD-2/-4 All Dimensions in Millimeters | | | |
|---|------------|---------|---------|
| Symbol | Minimum | Nominal | Maximum |
| N | 32 | | |
| A | 0.80 | | 1.00 |
| A1 | 0 | | 0.05 |
| A3 | 0.25 Ref. | | |
| b | 0.18 | 0.25 | 0.30 |
| N_D & N_E | | | 8 |
| D & E | 5.00 Basic | | |
| D2 & E2 | 3.0 | | 3.3 |
| e | 0.50 Basic | | |
| L | 0.30 | 0.40 | 0.50 |

Reference Document: JEDEC Publication 95, MO-220

NOTE: The following package mechanical drawing is a generic drawing that applies to any pin count VFQFN package. This drawing is not intended to convey the actual pin count or pin layout of this device. The pin count and pinout are shown on the front page. The package dimensions are in Table 7 below.

Ordering Information

Table 8. Ordering Information

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|-------------------|-------------|---------------------------|--------------------|-------------|
| 810001BK-22LF | ICS0001B22L | "Lead-Free" 32 Lead VFQFN | Tray | 0°C to 70°C |
| 810001BK-22LFT | ICS0001B22L | "Lead-Free" 32 Lead VFQFN | 2500 Tape & Reel | 0°C to 70°C |

NOTE: Parts that are ordered with an "LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.

Revision History Sheet

| Rev | Table | Page | Description of Change | Date |
|-----|-------|------|---|---------|
| A | | 1 | Product Discontinuation Notice - Last time buy expires August 14, 2016 PDN# CQ-15-04 | 8/14/15 |
| | | | | |



Corporate Headquarters
6024 Silver Creek Valley Road
San Jose, CA 95138 USA

Sales
1-800-345-7015 or 408-284-8200
Fax: 408-284-2775
www.IDT.com

Tech Support
email: clocks@idt.com

DISCLAIMER Integrated Device Technology, Inc. (IDT) and its subsidiaries reserve the right to modify the products and/or specifications described herein at any time and at IDT's sole discretion. All information in this document, including descriptions of product features and performance, is subject to change without notice. Performance specifications and the operating parameters of the described products are determined in the independent state and are not guaranteed to perform the same way when installed in customer products. The information contained herein is provided without representation or warranty of any kind, whether express or implied, including, but not limited to, the suitability of IDT's products for any particular purpose, an implied warranty of merchantability, or non-infringement of the intellectual property rights of others. This document is presented only as a guide and does not convey any license under intellectual property rights of IDT or any third parties.

IDT's products are not intended for use in applications involving extreme environmental conditions or in life support systems or similar devices where the failure or malfunction of an IDT product can be reasonably expected to significantly affect the health or safety of users. Anyone using an IDT product in such a manner does so at their own risk, absent an express, written agreement by IDT.

While the information presented herein has been checked for both accuracy and reliability, Integrated Device Technology (IDT) assumes no responsibility for either its use or for the infringement of any patents or other rights of third parties, which would result from its use. No other circuits, patents, or licenses are implied. This product is intended for use in normal commercial applications. Any other applications, such as those requiring extended temperature ranges, high reliability or other extraordinary environmental requirements are not recommended without additional processing by IDT. IDT reserves the right to change any circuitry or specifications without notice. IDT does not authorize or warrant any IDT product for use in life support devices or critical medical instruments.

Integrated Device Technology, IDT and the IDT logo are registered trademarks of IDT. Product specification subject to change without notice. Other trademarks and service marks used herein, including protected names, logos and designs, are the property of IDT or their respective third party owners.

Copyright ©2015 Integrated Device Technology, Inc.. All rights reserved.

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[IDT \(Integrated Device Technology\):](#)

[810001BK-22LF](#) [810001BK-22LFT](#)