

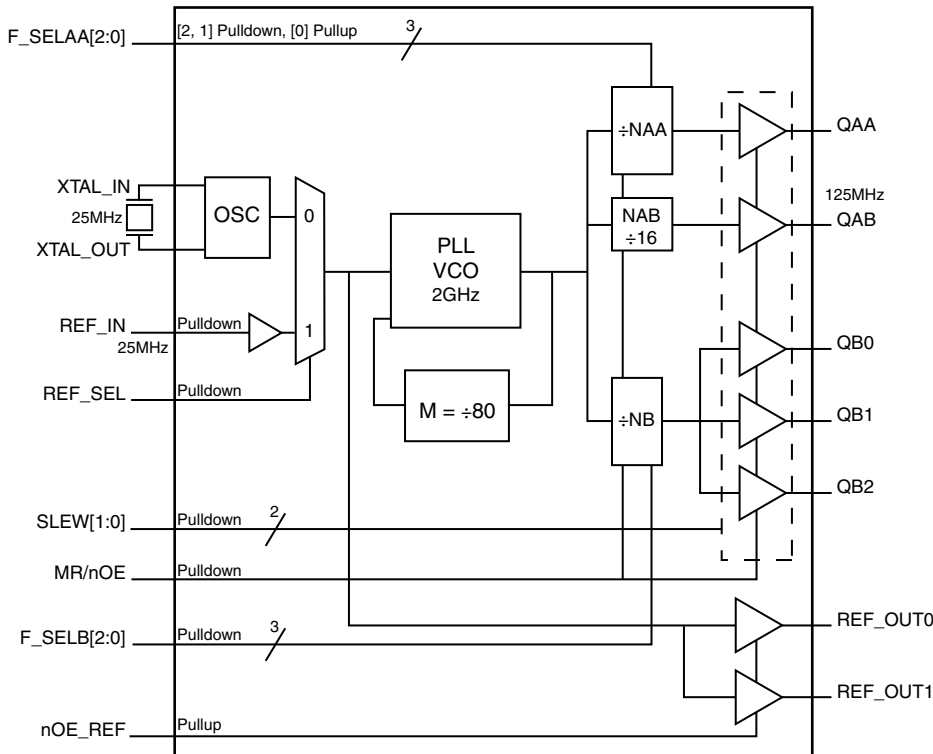
General Description

The 840S071 is a seven output LVCMOS/LVTTL Frequency Synthesizer accepting crystal or single-ended reference clock inputs. The 840S071 uses a 25MHz parallel resonant crystal to generate 33.33MHz – 166.67MHz clock signals, replacing solutions requiring multiple oscillator and fanout buffer solutions. The device supports output slew rate control with two slew select pins (SLEW[1:0]). The VCO operates at a frequency of 2GHz. The device has 3 output banks, output QAA with one 33.33MHz – 166.67MHz LVCMOS/LVTTL output, output QAB with one 125MHz LVCMOS/LVTTL output and Bank B with three 33.33MHz – 166.67MHz LVCMOS/LVTTL outputs.

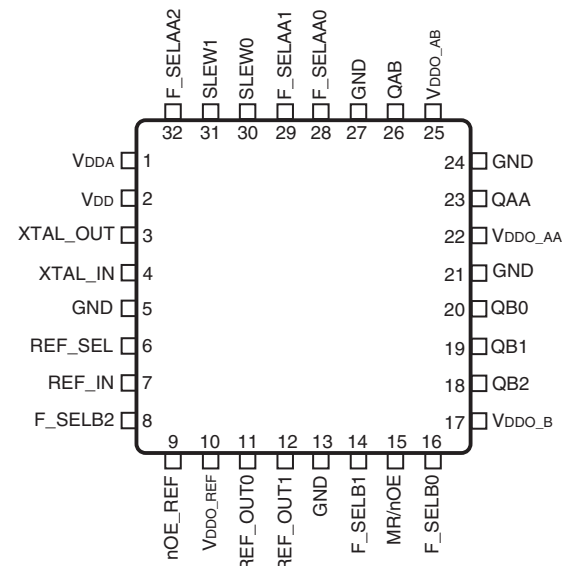
Output QAA and Bank B have their own dedicated frequency select pins and can be independently set for the frequencies mentioned above. Designed for networking and industrial applications, the 840S071 can also drive the high-speed clock inputs of communication processors, DSPs, switches and bridges.

Features

- Five single-ended LVCMOS/LVTTL outputs
- Two REF_OUT LVCMOS/LVTTL clock outputs
- Selectable crystal oscillator interface, 25MHz, 18pF parallel resonant crystal or LVCMOS/LVTTL single-ended reference input
- Supports the following output frequencies:
Output QAA/Bank B: 33.33MHz, 50MHz, 66.67MHz, 83.33MHz, 100MHz, 125MHz, 133.33MHz and 166.67MHz
Output QAB: 125MHz
- VCO frequency: 2GHz
- Slew rate control
- Voltage supply modes:
 Core/Output
 3.3V/3.3V
 3.3V/2.5V
- -40°C to 85°C ambient operating temperature
- Available in lead-free (RoHS 6) package



Pin Assignment



840S071

32-Lead TQFP, E-Pad
7mm x 7mm x1mm package body
Y Package
Top View

Table 1. Pin Descriptions

| Number | Name | Type | | Description |
|----------------------|---------------------------------|--------|----------|--|
| 1 | V _{DDA} | Power | | Analog supply pin. |
| 2 | V _{DD} | Power | | Core supply pin. |
| 3, 4 | XTAL_OUT, XTAL_IN | Input | | Crystal oscillator interface. XTAL_IN is the input. XTAL_OUT is the output. |
| 5, 13, 21, 24, 27 | GND | Power | | Power supply ground. |
| 6 | REF_SEL | Input | Pulldown | Reference select pin. When HIGH selects REF_IN. When LOW, selects crystal. See Table 3D. LVCMOS/LVTTL interface levels. |
| 7 | REF_IN | Input | Pulldown | Single-ended reference clock input. Table 3B. LVCMOS/LVTTL interface levels. |
| 8, 14, 16 | F_SELB2, F_SELB1, F_SELB0 | Input | Pulldown | Frequency select pins for Bank B outputs. See Table 3C. LVCMOS/LVTTL interface levels. |
| 9 | nOE_REF | Input | Pullup | Active low REF_OUT enable/disable pin. See Table 3F. LVCMOS/LVTTL interface levels. |
| 10 | V _{DDO_REF} | Power | | Output supply pin for REF_OUTx clock outputs. |
| 11, 12 | REF_OUT0, REF_OUT1 | Output | | Single-ended reference clock outputs. LVCMOS/LVTTL interface levels. |
| 15 | MR/nOE | Input | Pulldown | Active HIGH Master Reset. Active LOW output enable. When logic HIGH, the internal dividers are reset and the outputs are in high impedance (HI-Z). When logic LOW, the internal dividers and the outputs are enabled. See Table 3E. LVCMOS/LVTTL interface levels. |
| 17 | V _{DDO_B} | Power | | Output supply pin for QBx outputs. |
| 18, 19, 20 | QB2, QB1, QB0 | Output | | Single-ended Bank QBx clock outputs. LVCMOS/ LVTTTL interface levels. |
| 22 | V _{DDO_AA} | Power | | Output supply pin for QAA output. |
| 23 | QAA | Output | | Single-ended QAA clock output. LVCMOS/LVTTL interface levels. |
| 25 | V _{DDO_AB} | Power | | Output supply pin for QAB output. |
| 26 | QAB | Output | | Single-ended QAB clock output. LVCMOS/LVTTL interface levels. |
| 28 | F_SELAA0 | Input | Pullup | Frequency select pin for QAA output. See Table 3A. LVCMOS/LVTTL interface levels. |
| 29, 32 | F_SELAA1, F_SELAA2 | Input | Pulldown | Frequency select pins for QAA output. See Table 3A. LVCMOS/LVTTL interface levels. |
| 30, 31 | SLEW0, SLEW1 | Input | Pulldown | Slew rate select pins for LVCMOS/LVTTL clock output. LVCMOS/LVTTL interface levels. |

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 | | | 2 | | pF |
| C_{PD} | Power Dissipation Capacitance | SLEW[1:0] = 00 $V_{DD}, V_{DDO_REF}, V_{DDO_AA}, V_{DDO_AB}, V_{DDO_B} = 3.465V$ | | 4 | | pF |
| | | SLEW[1:0] = 11 $V_{DD}, V_{DDO_REF}, V_{DDO_AA}, V_{DDO_AB}, V_{DDO_B} = 3.465V$ | | 10 | | pF |
| | | SLEW[1:0] = 00, $V_{DD} = 3.465V$, $V_{DDO_REF}, V_{DDO_AA}, V_{DDO_AB}, V_{DDO_B} = 2.625V$ | | 2.65 | | pF |
| | | SLEW[1:0] = 11, $V_{DD} = 3.465V$, $V_{DDO_REF}, V_{DDO_AA}, V_{DDO_AB}, V_{DDO_B} = 2.625V$ | | 3 | | pF |
| R_{PULLUP} | Input Pullup Resistor | | | 51 | | k Ω |
| $R_{PULLDOWN}$ | Input Pulldown Resistor | | | 51 | | k Ω |
| R_{OUT} | Output Impedance | QAA, QAB, QBx $V_{DDO_AA}, V_{DDO_AB}, V_{DDO_B} = 3.3V$ | | 26 | | Ω |
| | | $V_{DDO_AA}, V_{DDO_AB}, V_{DDO_B} = 2.5V$ | | 28 | | Ω |
| | | REF_OUTx $V_{DDO_REF} = 3.3V$ | | 35 | | Ω |
| | | $V_{DDO_REF} = 2.5V$ | | 34 | | Ω |

Function Tables

Table 3A. Output QAA Frequency Select Function Table

| Inputs | | | | Output Frequencies |
|----------|----------|----------|-------------------|--------------------|
| F_SELAA2 | F_SELAA1 | F_SELAA0 | NAA Divider Value | QAA (MHz) |
| L | L | L | 60 | 33.33 |
| L | L | H | 40 | 50 (default) |
| L | H | L | 30 | 66.67 |
| L | H | H | 24 | 83.33 |
| H | L | L | 20 | 100 |
| H | L | H | 16 | 125 |
| H | H | L | 15 | 133.33 |
| H | H | H | 12 | 166.67 |

NOTE: Using 25MHz reference.

Table 3B. Output QAB Frequency Select Function Table

| Inputs | | | Output Frequency |
|-----------------------|-----------------|-------------------|------------------|
| XTAL_IN, REF_IN (MHz) | M Divider Value | NAB Divider Value | QAB (MHz) |
| 25 | 80 | 16 | 125 |

Table 3C. Bank QB Frequency Select Function Table

| Inputs | | | | Output Frequencies |
|---------|---------|---------|------------------|--------------------|
| F_SELB2 | F_SELB1 | F_SELB0 | NB Divider Value | QB[0:2] (MHz) |
| L | L | L | 60 | 33.33 (default) |
| L | L | H | 40 | 50 |
| L | H | L | 30 | 66.67 |
| L | H | H | 24 | 83.33 |
| H | L | L | 20 | 100 |
| H | L | H | 16 | 125 |
| H | H | L | 15 | 133.33 |
| H | H | H | 12 | 166.67 |

NOTE: Using 25MHz reference.

Table 3D. REF_SEL Function Table

| Input | |
|-------------|-----------------|
| REF_SEL | Input Reference |
| 0 (default) | XTAL_IN |
| 1 | REF_IN |

Table 3E. MR/nOE Function Table

| Input | |
|-------------|--------------------------------------|
| MR/nOE | Function |
| 0 (default) | Output Enabled |
| 1 | Device reset, outputs disabled (LOW) |

NOTE: The device requires a reset signal after power-up to function properly.

Table 3F. nOE_REF Function Table

| Input | |
|-------------|------------------------------|
| nOE_REF | Function |
| 0 | REF_OUT [1:0] enabled |
| 1 (default) | REF_OUT [1:0] disabled (LOW) |

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 XTAL_IN Other Inputs | 0V to V_{DD} -0.5V to $V_{DD} + 0.5V$ |
| Outputs, V_O | -0.5V to $V_{DD} + 0.5V$ |
| Package Thermal Impedance, θ_{JA} | 36.2°C/W (0 mps) |
| Storage Temperature, T_{STG} | -65°C to 150°C |

DC Electrical Characteristics

Table 4A. Power Supply DC Characteristics, $V_{DD} = V_{DDO_REF} = V_{DDO_AA} = V_{DDO_AB} = V_{DDO_B} = 3.3V \pm 5\%$, $T_A = -40^\circ\text{C}$ to 85°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 | | $V_{DD} - 0.23$ | 3.3 | V_{DD} | V |
| V_{DDO_X} | Output Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| I_{DD} | Power Supply Current | SLEW[1:0] = 11, QAA = QB[0:2] = 166.67MHz, QAB = 125MHz, REF_OUT[0:1] = 25MHz, Outputs Not Loaded | | | 180 | mA |
| I_{DDA} | Analog Supply Current | | | | 23 | mA |
| I_{DDO_X} | Output Supply Current | | | | 71 | mA |

NOTE: V_{DDO_X} denotes V_{DDO_AA} , V_{DDO_AB} , V_{DDO_B} , V_{DDO_REF} .

NOTE: I_{DDO_X} denotes $I_{DDO_AA} + I_{DDO_AB} + I_{DDO_B} + I_{DDO_REF}$.

Table 4B. Power Supply DC Characteristics, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO_REF} = V_{DDO_AA} = V_{DDO_AB} = V_{DDO_B} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ to 85°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 | | $V_{DD} - 0.23$ | 3.3 | V_{DD} | V |
| V_{DDO_X} | Output Supply Voltage | | 2.375 | 2.5 | 2.625 | V |
| I_{DD} | Power Supply Current | SLEW[1:0] = 11, QAA = QB[0:2] = 166.67MHz, QAB = 125MHz, REF_OUT[0:1] = 25MHz, Outputs Not Loaded | | | 180 | mA |
| I_{DDA} | Analog Supply Current | | | | 23 | mA |
| I_{DDO_X} | Output Supply Current | | | | 21 | mA |

NOTE: V_{DDO_X} denotes V_{DDO_AA} , V_{DDO_AB} , V_{DDO_B} , V_{DDO_REF} .

NOTE: I_{DDO_X} denotes $I_{DDO_AA} + I_{DDO_AB} + I_{DDO_B} + I_{DDO_REF}$.

Table 4C. LVC MOS/LVTTL DC Characteristics, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 3.3V \pm 5\%$ or $2.5V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|-----------------------------|---|---|---------|----------------|---------|
| V_{IH} | Input High Voltage | $V_{DD} = 3.465V$ | 2.2 | | $V_{DD} + 0.3$ | V |
| V_{IL} | Input Low Voltage | $V_{DD} = 3.465V$ | -0.3 | | 0.8 | V |
| I_{IH} | Input High Current | nOE_REF, F_SELAA0 | $V_{DD} = V_{IN} = 3.465V$ | | 10 | μA |
| | | F_SELB[2:0], F_SELAA[1:2], REF_IN, REF_SEL, SLEW[1:0], MR/nOE | $V_{DD} = V_{IN} = 3.465V$ | | 150 | μA |
| I_{IL} | Input Low Current | nOE_REF, F_SELAA0 | $V_{DD} = 3.465V, V_{IN} = 0V$ | -150 | | μA |
| | | F_SELB[2:0], F_SELAA[1:2], REF_IN, REF_SEL, SLEW[1:0], MR/nOE | $V_{DD} = 3.465V, V_{IN} = 0V$ | -10 | | μA |
| V_{OH} | Output High Voltage; NOTE 1 | QAA, QB[0:2], REF_OUT[0:1] | SLEW[1:0] = 00, QAA, QB[0:2] = 33.33MHz, REF_OUT[0:1] = 25MHz | 2.45 | | V |
| | | | 1.8 | | V | |
| V_{OL} | Output Low Voltage; NOTE 1 | QAA, QB[0:2], REF_OUT[0:1] | SLEW[1:0] = 00, QAA, QB[0:2] = 33.33MHz, REF_OUT[0:1] = 25MHz | | 0.8 | V |
| | | | | | 0.65 | V |

NOTE: V_{DDO_X} denotes V_{DDO_AA} , V_{DDO_AB} , V_{DDO_B} , V_{DDO_REF} .

NOTE 1: Outputs terminated with 50Ω to $V_{DDO_X}/2$. See Parameter Measurement Information Section, *Load Test Circuit diagrams*.

Table 5. Crystal Characteristics

| Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|------------------------------------|-----------------|-------------|---------|---------|----------|
| Mode of Oscillation | | Fundamental | | | |
| Frequency | | | 25 | | MHz |
| Equivalent Series Resistance (ESR) | | | | 50 | Ω |
| Shunt Capacitance | | | | 7 | pF |

NOTE: Characterized using an 18pF parallel resonant crystal.

AC Electrical Characteristics

Table 6A. AC Characteristics, $V_{DD} = V_{DDO_REF} = V_{DDO_AA} = V_{DDO_AB} = V_{DDO_B} = 3.3V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------------|--|--|---|---------|---------|-------|
| f_{OUT} | Output Frequency | QAB | | 125 | | MHz |
| | | QAA, QB[0:2] | | | 166.67 | MHz |
| $t_{sk(o)}$ | Output Skew; NOTE 1, 2 | $f_{OUT} = 125MHz$; SLEW[1:0] = 00 | | | 485 | ps |
| $t_{sk(b)}$ | Bank Skew; NOTE 2, 3 | QB[0:2] $f_{OUT} = 125MHz$; SLEW[1:0] = 00 | | | 110 | ps |
| $t_{jit(per)}$ | Period Jitter, RMS; NOTE 4 | $f_{OUT} = 125MHz$; SLEW[1:0] = 00 | | | 7 | ps |
| $t_{jit(cc)}$ | Cycle-to-Cycle Jitter; NOTE 2 | $f_{OUT} = 125MHz$; SLEW[1:0] = 00 | | | 90 | ps |
| t_{SLEW} | Slew Rate, Single-ended Output Clock; NOTE 5 | QAA | SLEW[1:0] = 00, Rise/Fall Time: 20% to 80% | 1.93 | 3.0 | V/ns |
| | | QAB | | 2.84 | 4.75 | V/ns |
| | | QB[0:2] | | 2.59 | 4.25 | V/ns |
| | | QAA | SLEW[1:0] = 01, Rise/Fall Time: 20% to 80% | 1.76 | 2.75 | V/ns |
| | | QAB | | 2.45 | 4.25 | V/ns |
| | | QB[0:2] | | 2.23 | 3.75 | V/ns |
| | | QAA | SLEW[1:0] = 10, Rise/Fall Time: 20% to 80% | 1.58 | 2.50 | V/ns |
| | | QAB | | 1.88 | 3.0 | V/ns |
| | | QB[0:2] | | 1.80 | 2.95 | V/ns |
| | | QAA | SLEW[1:0] = 11, Rise/Fall Time: 20% to 80% | 0.98 | 1.65 | V/ns |
| | | QAB | | 1.03 | 1.75 | V/ns |
| | | QB[0:2] | | 1.01 | 1.75 | V/ns |
| t_{LOCK} | PLL Lock Time | SLEW[1:0] = 00 | | | 20 | ms |
| odc | Output Duty Cycle | $f_{OUT} \leq 125MHz$; SLEW[1:0] = 00 | 47 | | 53 | % |
| | | $f_{OUT} > 125MHz$; SLEW[1:0] = 00 | 45 | | 55 | % |

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

NOTE 1: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at $V_{DDO_X}/2$.

NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.

NOTE 3: Defined as skew within a bank of outputs at the same supply voltage and with equal load conditions.

NOTE 4: Jitter performance using XTAL inputs.

NOTE 5: A slew rate of 2V/ns or greater should be selected for output frequencies of 100MHz and higher.

Table 6B. AC Characteristics, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO_REF} = V_{DDO_AA} = V_{DDO_AB} = V_{DDO_B} = 2.5V \pm 5\%$, $T_A = -40^{\circ}C$ to $85^{\circ}C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------------|---|--|---|---------|---------|-------|
| f_{OUT} | Output Frequency | QAB | | 125 | | MHz |
| | | QAA, QB[0:2] | 33.33 | | 166.67 | MHz |
| $t_{sk(o)}$ | Output Skew; NOTE 1, 2 | $f_{OUT} = 125MHz$; $SLEW[1:0] = 00$ | | | 435 | ps |
| $t_{sk(b)}$ | Bank Skew; NOTE 2, 3 | QB[0:2] $f_{OUT} = 125MHz$; $SLEW[1:0] = 00$ | | | 115 | ps |
| $t_{jit(per)}$ | Period Jitter, RMS; NOTE 4 | $f_{OUT} = 125MHz$; $SLEW[1:0] = 00$ | | | 12 | ps |
| $t_{jit(cc)}$ | Cycle-to-Cycle Jitter; NOTE 2 | $f_{OUT} = 125MHz$; $SLEW[1:0] = 00$ | | | 96 | ps |
| t_{SLEW} | Slew Rate, Single-ended Output Clocks; NOTE 5 | QAA | SLEW[1:0] = 00, Rise/Fall Time: 20% to 80% | 1.36 | 2.15 | V/ns |
| | | QAB | | 1.89 | 3.25 | V/ns |
| | | QB[0:2] | | 1.81 | 2.85 | V/ns |
| | | QAA | SLEW[1:0] = 01, Rise/Fall Time: 20% to 80% | 1.12 | 1.85 | V/ns |
| | | QAB | | 1.43 | 2.50 | V/ns |
| | | QB[0:2] | | 1.44 | 2.50 | V/ns |
| | | QAA | SLEW[1:0] = 10, Rise/Fall Time: 20% to 80% | 0.88 | 1.55 | V/ns |
| | | QAB | | 1.06 | 1.85 | V/ns |
| | | QB[0:2] | | 1.03 | 1.85 | V/ns |
| | | QAA | SLEW[1:0] = 11, Rise/Fall Time: 20% to 80% | 0.59 | 1.15 | V/ns |
| | | QAB | | 0.66 | 1.15 | V/ns |
| | | QB[0:2] | | 0.61 | 1.15 | V/ns |
| t_{LOCK} | PLL Lock Time | SLEW[1:0] = 00 | | | 25 | ms |
| odc | Output Duty Cycle | $f_{OUT} \leq 125MHz$; $SLEW[1:0] = 00$ | 45 | | 55 | % |
| | | $f_{OUT} > 125MHz$; $SLEW[1:0] = 00$ | 43 | | 57 | % |

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

NOTE 1: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at $V_{DDO_X}/2$.

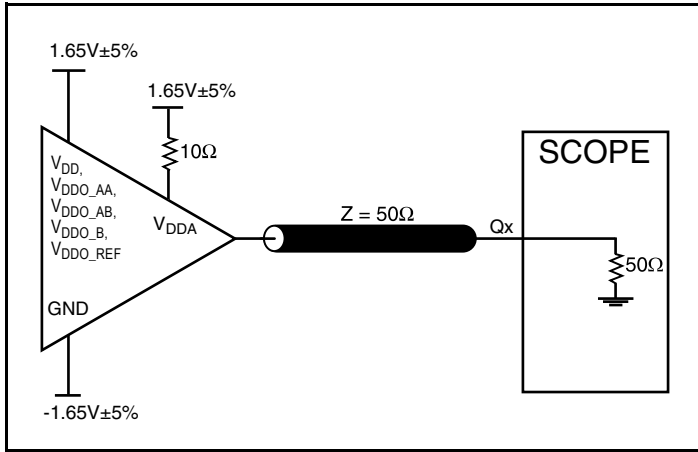
NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.

NOTE 3: Defined as skew within a bank of outputs at the same supply voltage and with equal load conditions.

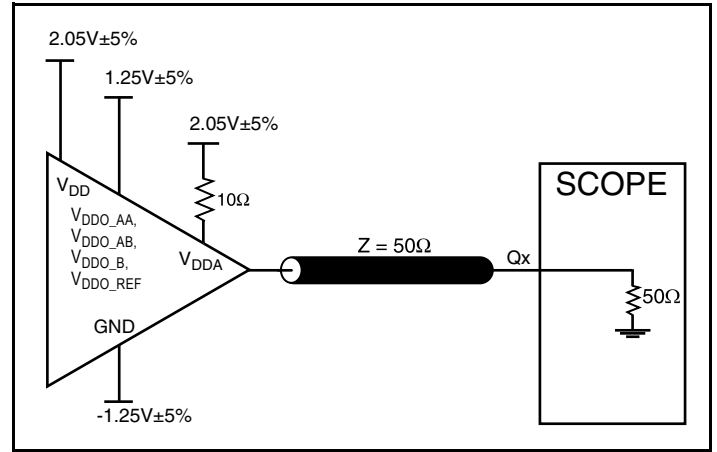
NOTE 4: Jitter performance using XTAL inputs.

NOTE 5: A slew rate of 2V/ns or greater should be selected for output frequencies of 100MHz and higher.

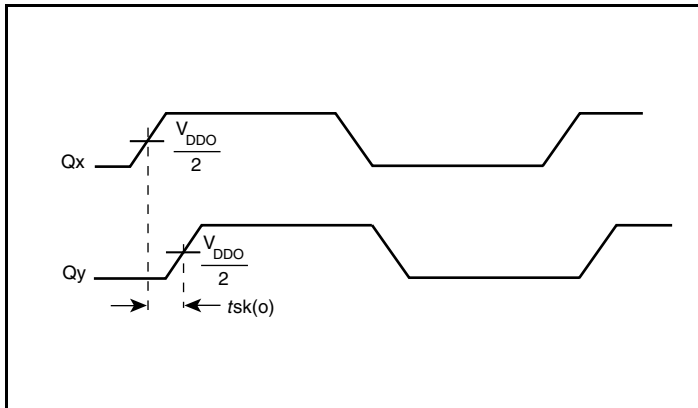
Parameter Measurement Information



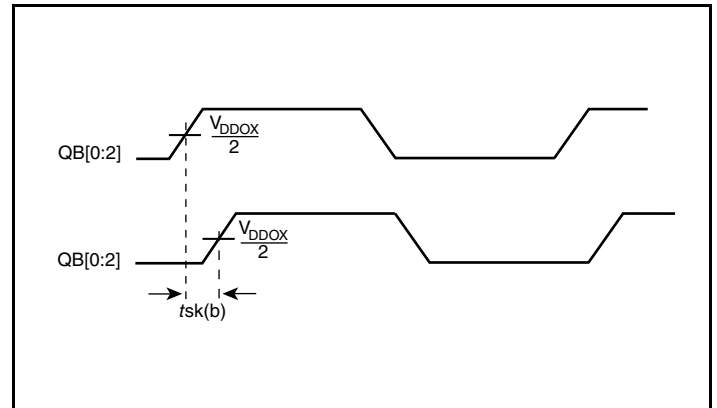
3.3V Core/3.3V LVCMOS Output Load AC Test Circuit



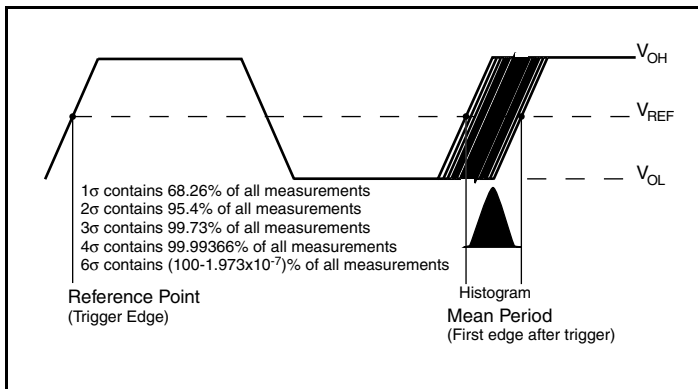
3.3V Core/2.5V LVCMOS Output Load AC Test Circuit



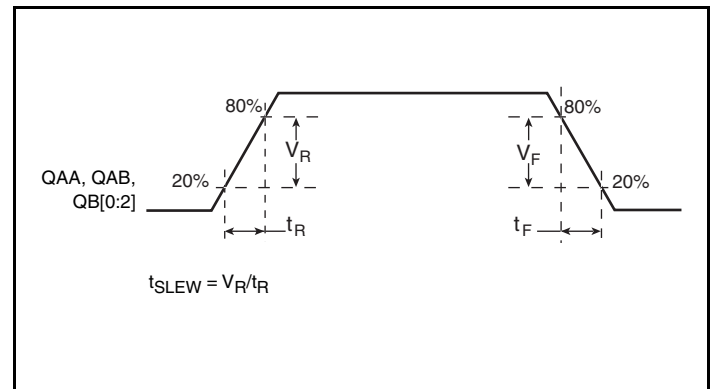
Output Skew



Bank Skew

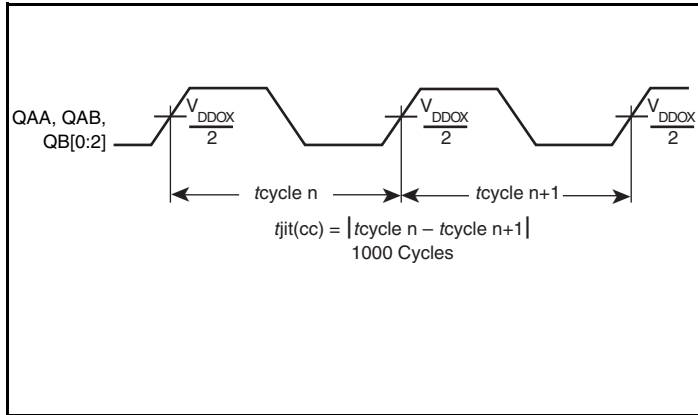


RMS Period Jitter

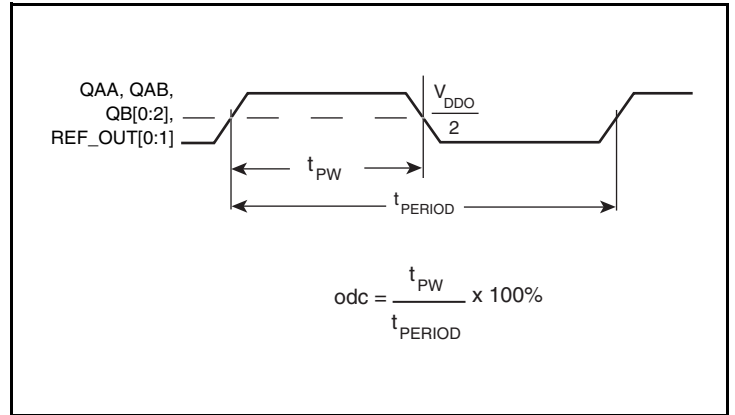


Output Slew Rate

Parameter Measurement Information, continued



Cycle-to-Cycle Jitter



Output Duty Cycle/Pulse Width/Period

Applications Information

Recommendations for Unused Input and Output Pins

Inputs:

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 1kΩ resistor can be used.

Crystal Inputs

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.

REF_IN Input

For applications not requiring the use of the reference clock, it can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from the REF_IN to ground.

Outputs:

LVC MOS Outputs

All unused LVC MOS output can be left floating. There should be no trace attached.

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 840S071 provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL. V_{DD} , V_{DDA} and V_{DDO_X} 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.

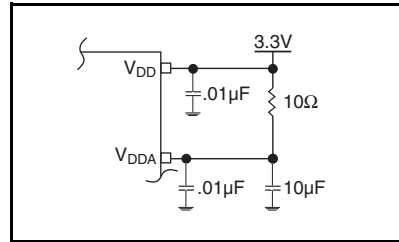


Figure 1. Power Supply Filtering

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, refer to the Application Note on the *Surface Mount Assembly* of Amkor’s Thermally/Electrically Enhance Leadframe Base Package, Amkor Technology.

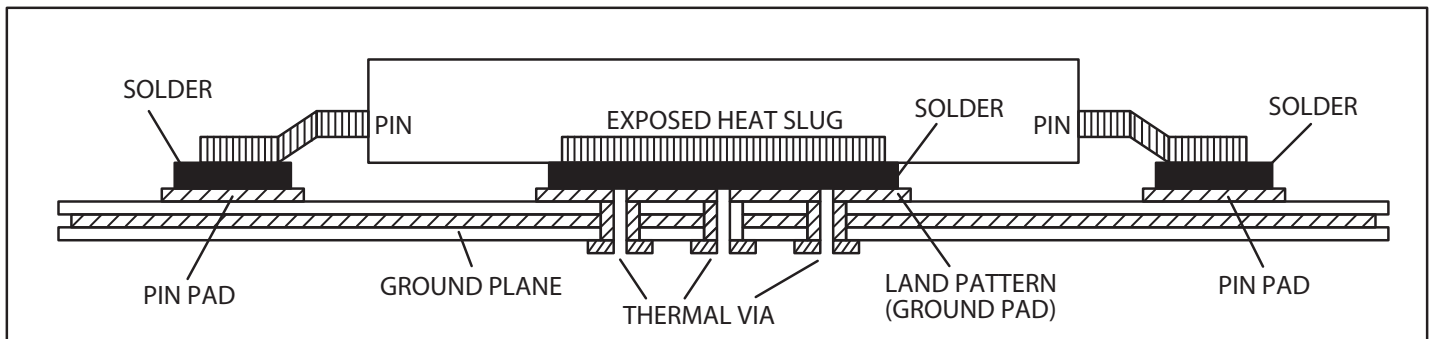


Figure 2. Assembly for Exposed Pad Thermal Release Path - Side View (drawing not to scale)

Crystal Input Interface

The 840S071 has been characterized with 18pF parallel resonant crystals. The capacitor values shown in *Figure 3* below were determined using a 25MHz, 18pF parallel resonant crystal and were chosen to minimize the ppm error.

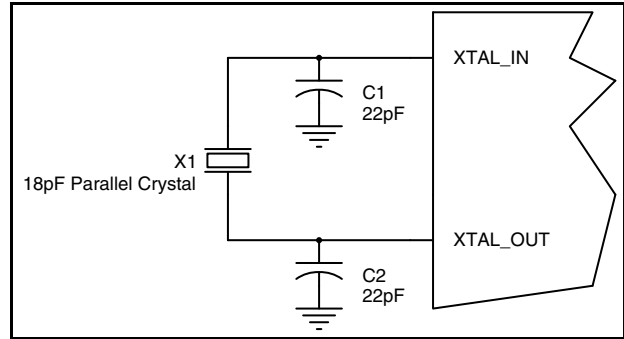


Figure 3. Crystal Input Interface

Overdriving the XTAL Interface

The XTAL_IN input can accept a single-ended LVCMOS signal through an AC coupling capacitor. A general interface diagram is shown in *Figure 4A*. The XTAL_OUT pin can be left floating. The maximum amplitude of the input signal should not exceed 2V and the input edge rate can be as slow as 10ns. This configuration requires that the output impedance of the driver (R_o) plus the series resistance (R_s) equals the transmission line impedance. In addition,

matched termination at the crystal input will attenuate the signal in half. This can be done in one of two ways. First, R_1 and R_2 in parallel should equal the transmission line impedance. For most 50Ω applications, R_1 and R_2 can be 100Ω. This can also be accomplished by removing R_1 and making R_2 50Ω. By overdriving the crystal oscillator, the device will be functional, but note, the device performance is guaranteed by using a quartz crystal.

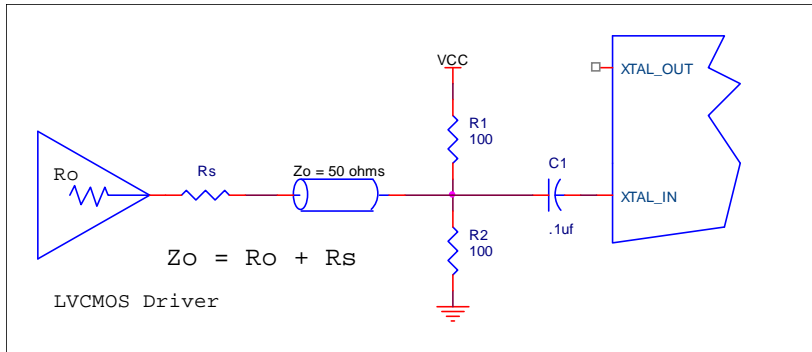


Figure 4A. General Diagram for LVCMOS Driver to XTAL Input Interface

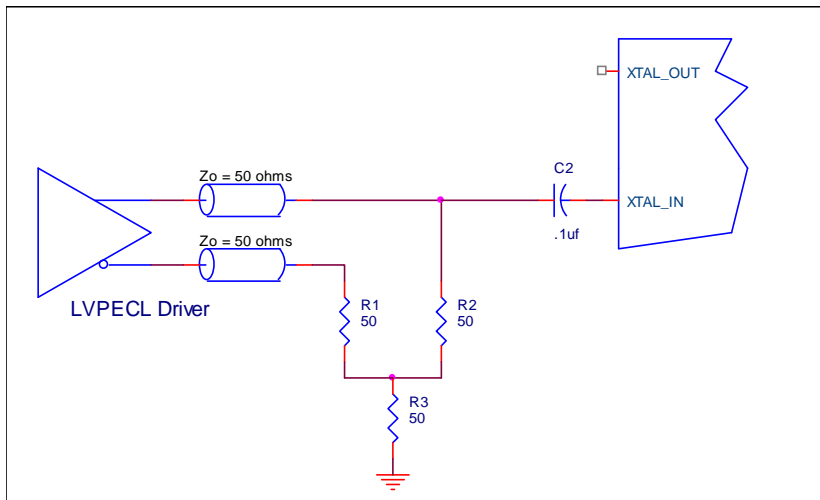


Figure 4B. General Diagram for LVPECL Driver to XTAL Input Interface

Schematic Example

Figure 5 shows an example of the 840S071 application schematic. In this example, the device is operated at $V_{DD} = V_{DDO_AA} = V_{CCO_AB} = V_{CCO_B} = V_{CCO_REF} = 3.3V$. The 18pF parallel resonant 25MHz crystal is used. The $C1 = 22pF$ and $C2 = 22pF$ are recommended for frequency accuracy. For different board layouts, the $C1$ and $C2$ may

be slightly adjusted for optimizing frequency accuracy. Two examples of LVCMOS termination are shown in this schematic. The decoupling capacitors should be located as close as possible to the power pin.

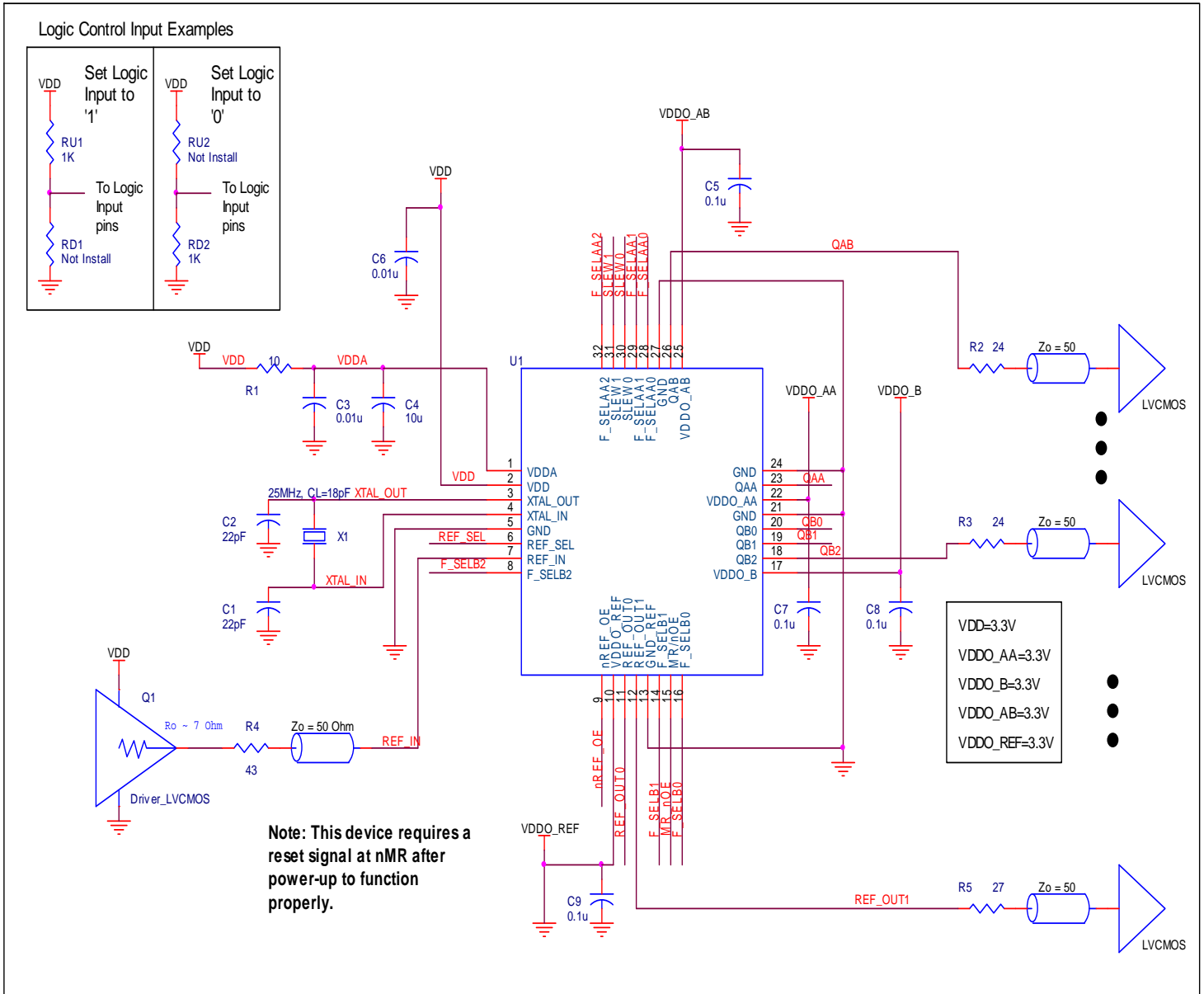


Figure 5. 840S071 Schematic Layout

Power Considerations

This section provides information on power dissipation and junction temperature for the 840S071. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 840S071 is the sum of the core power plus the analog power plus the power dissipation in the load(s). The following is the power dissipation for $V_{DD} = 3.3V + 5\% = 3.465V$, which gives worst case results.

The maximum current at 85°C is as follows:

$$I_{DD_MAX} = 168.5\text{mA}$$

$$I_{DDA_MAX} = 20.96\text{mA}$$

$$I_{DDO_MAX} = 74.11\text{mA}$$

Core Output Power Dissipation

- Power (core)_{MAX} = $V_{DD_MAX} * (I_{DD} + I_{DDA}) = 3.465V * (168.5\text{mA} + 20.96\text{mA}) = \mathbf{656.51\text{mW}}$
- Power (output)_{MAX} = $V_{DDO_MAX} * I_{DDO} = 3.465V * 74.11\text{mA} = \mathbf{256.80\text{mW}}$

LVC MOS Output Power Dissipation

- Output Impedance R_{OUT} Power Dissipation due to Loading 50Ω to $V_{DD}/2$
Output Current $I_{OUT} = V_{DD_MAX} / [2 * (50\Omega + R_{OUT})] = 3.465V / [2 * (50\Omega + 35\Omega)] = \mathbf{20.38\text{mA}}$
- Power Dissipation on the R_{OUT} per LVC MOS output
Power (R_{OUT}) = $R_{OUT} * (I_{OUT})^2 = 35\Omega * (20.38\text{mA})^2 = \mathbf{14.54\text{mW per output}}$
- Total Power Dissipation on the R_{OUT}
Total Power (R_{OUT}) = $14.54\text{mW} * 7 = \mathbf{101.8\text{mW}}$
- Dynamic Power Dissipation at 25MHz
Power (25MHz) = $C_{PD} * \text{Frequency} * (V_{DDO})^2 = 10\text{pF} * 25\text{MHz} * (3.465V)^2 = \mathbf{3\text{mW per output}}$
Total Power (25MHz) = $3\text{mW} * 2 = \mathbf{6\text{mW}}$
- Dynamic Power Dissipation at 166.67MHz
Power (166.67MHz) = $C_{PD} * \text{Frequency} * (V_{DDO})^2 = 10\text{pF} * 166.67\text{MHz} * (3.465V)^2 = \mathbf{20\text{mW per output}}$
Total Power (166.67MHz) = $20\text{mW} * 5 = \mathbf{100.1\text{mW}}$

Total Power Dissipation

- **Total Power**
= Power (core) + Power (output) + Total Power (25MHz) + Total Power (166.67MHz)
= $656.51\text{mW} + 256.80\text{mW} + 101.8\text{mW} + 6.0\text{mW} + 100.1\text{mW}$
= **1121.15mW**

2. Junction Temperature.

Junction temperature, T_j , 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 is 125°C. Limiting the internal transistor junction temperature, T_j , to 125°C ensures that the bond wire and bond pad temperature remains below 125°C.

The equation for T_j is as follows: $T_j = \theta_{JA} * Pd_{total} + T_A$

T_j = Junction Temperature

θ_{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 θ_{JA} must be used. Assuming a moderate air flow of 1 meter per second and a multi-layer board, the appropriate value is 30.6°C/W per Table 7 below.

Therefore, T_j for an ambient temperature of 85°C with all outputs switching is:

$$85^\circ\text{C} + 1.121\text{W} * 30.6^\circ\text{C/W} = 119.3^\circ\text{C}. \text{ This is below the limit of } 125^\circ\text{C}.$$

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

Table 7. Thermal Resistance θ_{JA} for 32 Lead TQFP, E-Pad, Forced Convection

| θ_{JA} by Velocity | | | |
|---|----------|----------|----------|
| Meters per Second | 0 | 1 | 2.5 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 36.2°C/W | 30.6°C/W | 29.2°C/W |

Reliability Information

Table 8. θ_{JA} vs. Air Flow Table for a 32 Lead TQFP, E-Pad

| θ_{JA} vs. Air Flow | | | |
|---|----------|----------|----------|
| Meters per Second | 0 | 1 | 2.5 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 36.2°C/W | 30.6°C/W | 29.2°C/W |

Transistor Count

The transistor count for 840S07I is: 2349

Package Outline and Package Dimensions

Package Outline - G Suffix for 32 Lead TQFP, E-Pad

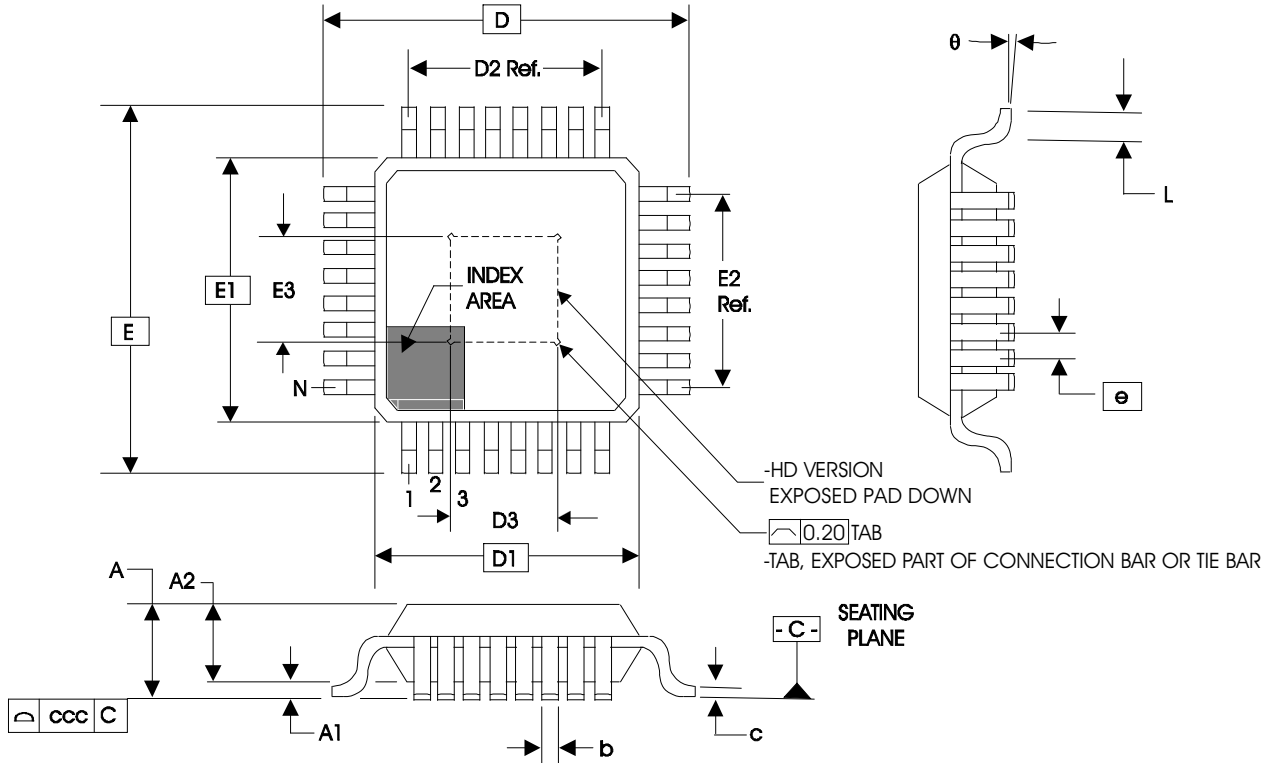


Table 9. Package Dimensions 32 Lead TQFP, E-Pad

| JEDEC Variation: ABC - HD | | | |
|-------------------------------|------------|---------|---------|
| All Dimensions in Millimeters | | | |
| Symbol | Minimum | Nominal | Maximum |
| N | 32 | | |
| A | | | 1.20 |
| A1 | 0.05 | 0.10 | 0.15 |
| A2 | 0.95 | 1.00 | 1.05 |
| b | 0.30 | 0.35 | 0.40 |
| c | 0.09 | | 0.20 |
| D & E | 9.00 Basic | | |
| D1 & E1 | 7.00 Basic | | |
| D2 & E2 | 5.60 Ref. | | |
| D3 & E3 | 3.0 | | 4.0 |
| e | 0.80 Basic | | |
| L | 0.45 | 0.60 | 0.75 |
| θ | 0° | | 7° |
| ccc | | | 0.10 |

Reference Document: JEDEC Publication 95, MS-026

Ordering Information

Table 9. Ordering Information

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|-------------------|--------------|--------------------------------|--------------------|---------------|
| 840S07BYILF | ICS840S07BIL | Lead-Free, 32 Lead TQFP, E-Pad | Tray | -40°C to 85°C |
| 840S07BYILFT | ICS840S07BIL | Lead-Free, 32 Lead TQFP, E-Pad | Tape & Reel | -40°C to 85°C |

Revision History

| Revision Date | Description of Change |
|----------------|---|
| April 14, 2016 | <ul style="list-style-type: none">▪ Removed ICS from part number where needed.▪ Ordering Information - removed quantity from tape and reel. Deleted LF note below table.▪ Updated data sheet header and footer. |

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01 Jan 2024)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit www.renesas.com/contact-us/.