

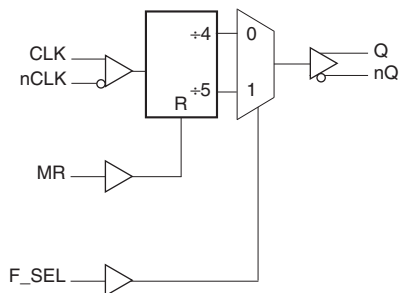
GENERAL DESCRIPTION

The 87354 is a high performance ÷4/÷5 Differential-to-3.3V LVPECL Clock Generator. The CLK, nCLK pair can accept most standard differential input levels. The 87354 is characterized to operate from a 3.3V power supply. Guaranteed output and part-to-part skew characteristics make the 87354 ideal for those clock distribution applications demanding well defined performance and repeatability.

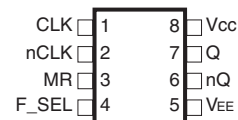
FEATURES

- One differential 3.3V LVPECL output
- One CLK, nCLK input pair
- CLK, nCLK pair can accept the following differential input levels: LVPECL, LVDS, LVHSTL, SSTL, HCSL
- Maximum clock input frequency: 1GHz
- Translates any single ended input signal (LVCMOS, LVTTTL, GTL) to LVPECL levels with resistor bias on nCLK input
- Part-to-part skew: 300ps (maximum)
- Propagation delay: 2.1ns (maximum)
- LVPECL mode operating voltage supply range: $V_{CC} = 3.0V$ to $3.465V$, $V_{EE} = 0V$
- $-40^{\circ}C$ to $85^{\circ}C$ ambient operating temperature
- Available in lead-free RoHS compliant package

BLOCK DIAGRAM



PIN ASSIGNMENT



87354
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 | CLK | Input | Pulldown | Non-inverting differential clock input. |
| 2 | nCLK | Input | Pullup | Inverting differential clock input. |
| 3 | MR | Input | Pulldown | Active High Master Reset. When logic HIGH, the internal dividers are reset causing the true output (Q) to go low and the inverted output (nQ) to go high. When logic LOW, the internal dividers and the output are enabled. LVCMOS / LVTTTL interface levels. See Table 3. |
| 4 | F_SEL | Input | Pulldown | Selects divider value for Q, nQ outputs as described in Table 3. LVCMOS / LVTTTL interface levels. |
| 5 | V _{EE} | Power | | Negative supply pin. |
| 6, 7 | nQ, Q | Output | | Differential output pair. LVPECL interface levels. |
| 8 | V _{CC} | Power | | Positive supply pin. |

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 |
| R _{PULLUP} | Input Pullup Resistor | | | 51 | | kΩ |
| R _{PULLDOWN} | Input Pulldown Resistor | | | 51 | | kΩ |

TABLE 3. FUNCTION TABLE

| MR | F_SEL | Divide Value |
|----|-------|-------------------------------------|
| 1 | X | Reset: Q output low, nQ output high |
| 0 | 0 | ÷4 |
| 0 | 1 | ÷5 |

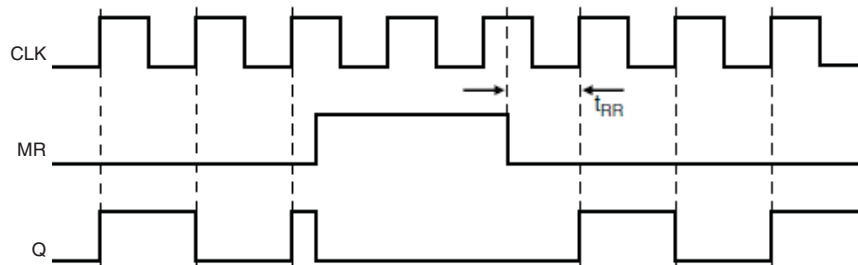


FIGURE 1. TIMING DIAGRAM

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, θ_{JA} | 112.7°C/W (0 lfpm) |
| 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 4A. POWER SUPPLY DC CHARACTERISTICS, $V_{CC} = 3.0V$ TO $3.465V$, $V_{EE} = 0$, $T_A = -40^\circ C$ TO $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|-------------------------|-----------------|---------|---------|---------|-------|
| V_{CC} | Positive Supply Voltage | | 3.0 | 3.3 | 3.465 | V |
| I_{EE} | Power Supply Current | | | | 104 | mA |

TABLE 4B. LVCMOS/LVTTL DC CHARACTERISTICS, $V_{CC} = 3.0V$ TO $3.465V$, $V_{EE} = 0$, $T_A = -40^\circ C$ TO $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|--------------------|---|---------|---------|----------------|---------|
| V_{IH} | Input High Voltage | | 2 | | $V_{CC} + 0.3$ | V |
| V_{IL} | Input Low Voltage | | -0.3 | | 0.8 | V |
| I_{IH} | Input High Current | MR, F_SEL $V_{CC} = V_{IN} = 3.465V$ | | | 150 | μA |
| I_{IL} | Input Low Current | MR, F_SEL $V_{CC} = 3.465V, V_{IN} = 0V$ | -5 | | | μA |

TABLE 4C. DIFFERENTIAL DC CHARACTERISTICS, $V_{CC} = 3.0V$ TO $3.465V$, $V_{EE} = 0$, $T_A = -40^\circ C$ TO $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|---|-----------------|--------------------------------|---------|-----------------|---------|
| I_{IH} | Input High Current | CLK | $V_{CC} = V_{IN} = 3.465V$ | | 150 | μA |
| | | nCLK | $V_{CC} = V_{IN} = 3.465V$ | | 5 | μA |
| I_{IL} | Input Low Current | CLK | $V_{CC} = 3.465V, V_{IN} = 0V$ | -5 | | μA |
| | | nCLK | $V_{CC} = 3.465V, V_{IN} = 0V$ | -150 | | μA |
| V_{PP} | Peak-to-Peak Input Voltage | | 0.15 | | 1.3 | V |
| V_{CMR} | Common Mode Input Voltage; NOTE 1, 2 | | $V_{EE} + 0.5$ | | $V_{CC} - 0.85$ | V |

NOTE 1: Common mode voltage is defined as V_{IH} .

NOTE 2: For single ended applications, the maximum input voltage for CLK, nCLK is $V_{CC} + 0.3V$.

TABLE 4D. LVPECL DC CHARACTERISTICS, $V_{CC} = 3.0V$ TO $3.465V$, $V_{EE} = 0$, $T_A = -40^{\circ}C$ TO $85^{\circ}C$

| 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 5. AC CHARACTERISTICS, $V_{CC} = 3.0V$ TO $3.465V$, $V_{EE} = 0$, $T_A = -40^{\circ}C$ TO $85^{\circ}C$

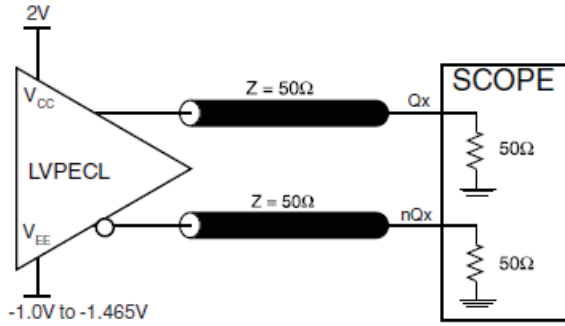
| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|------------------------------|-----------------|---------|---------|---------|-------|
| f_{CLK} | Clock Input Frequency | | | | 1 | GHz |
| t_{PD} | Propagation Delay; NOTE 1 | CLK to Q (Dif) | 1.7 | | 2.1 | ns |
| tsk(pp) | Part-to-Part Skew; NOTE 2, 3 | | | | 300 | ps |
| t_{RR} | Reset Recovery Time | | | | 400 | ps |
| t_{PW} | Minimum Input Pulse Width | CLK | 550 | | | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | 300 | | 600 | ps |
| odc | Output Duty Cycle | | 48 | | 52 | % |

NOTE 1: Measured from the differential input crossing point to the differential output crossing point.

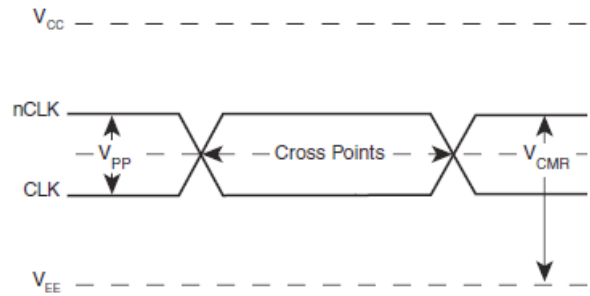
NOTE 2: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.

NOTE 3: This parameter is defined in accordance with JEDEC Standard 65.

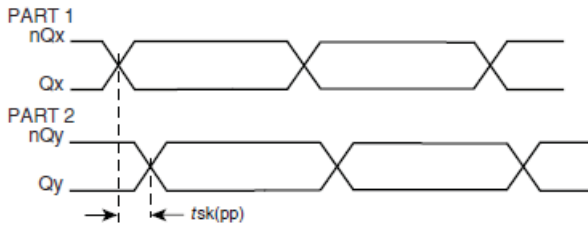
PARAMETER MEASUREMENT INFORMATION



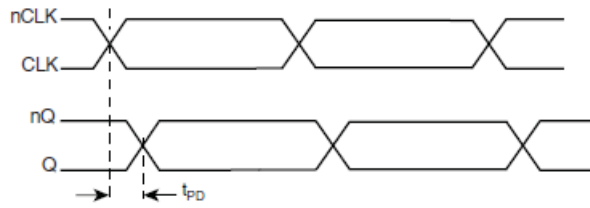
3.3V OUTPUT LOAD AC TEST CIRCUIT



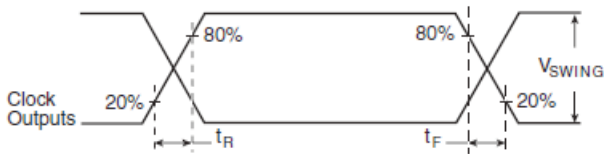
DIFFERENTIAL INPUT LEVEL



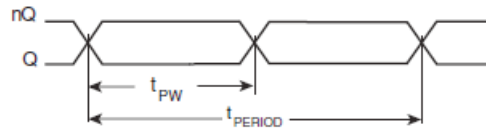
PART-TO-PART SKEW



PROPAGATION DELAY



OUTPUT RISE/FALL TIME



$$\text{odc} = \frac{t_{PW}}{t_{PERIOD}} \times 100\%$$

OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD

APPLICATION INFORMATION

WIRING THE DIFFERENTIAL INPUT TO ACCEPT SINGLE ENDED LEVELS

Figure 1 shows how the differential input can be wired to accept single ended levels. The reference voltage $V_{REF} = V_{CC}/2$ is generated by the bias resistors R1, R2 and C1. This bias circuit should be located as close as possible to the input pin.

The ratio of R1 and R2 might need to be adjusted to position the V_{REF} in the center of the input voltage swing. For example, if the input clock swing is only 2.5V and $V_{CC} = 3.3V$, V_{REF} should be 1.25V and $R2/R1 = 0.609$.

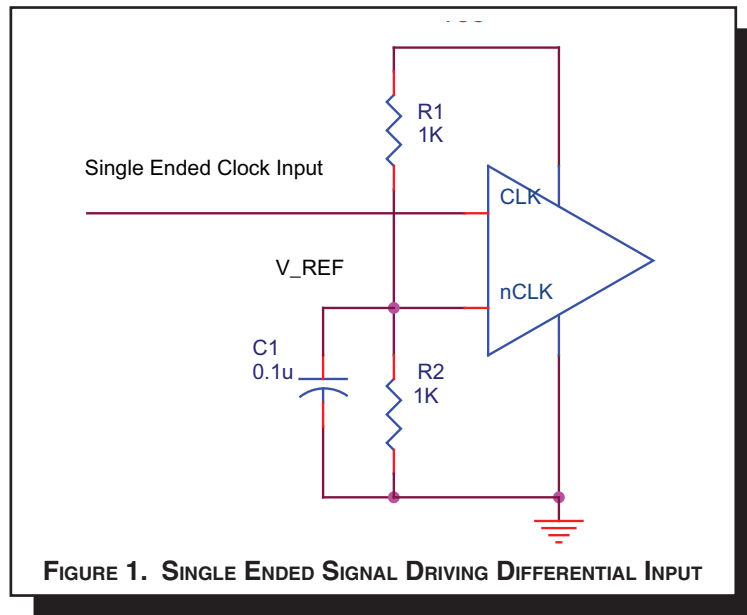


FIGURE 1. SINGLE ENDED SIGNAL DRIVING DIFFERENTIAL INPUT

RECOMMENDATIONS FOR UNUSED INPUT PINS

INPUTS:

LVC MOS CONTROL PINS:

All control pins have internal pull-ups or pull-downs; additional resistance is not required but can be added for additional protection. A 1kΩ resistor can be used.

DIFFERENTIAL CLOCK INPUT INTERFACE

The CLK/nCLK accepts LVDS, LVPECL, LVHSTL, SSTL, HCSL and other differential signals. Both V_{SWING} and V_{OH} must meet the V_{PP} and V_{CMR} input requirements. Figures 2A to 2E show interface examples for the CLK/nCLK input driven by the most common driver types. The input interfaces suggested here are

examples only. Please consult with the vendor of the driver component to confirm the driver termination requirements. For example in *Figure 2A*, the input termination applies for LVHSTL drivers. If you are using an LVHSTL driver from another vendor, use their termination recommendation.

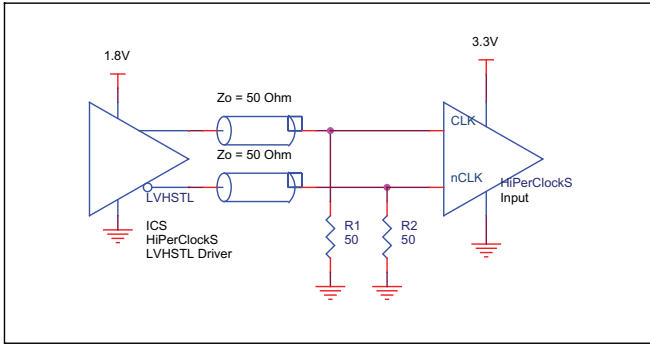


FIGURE 2A. CLK/nCLK INPUT DRIVEN BY LVHSTL DRIVER

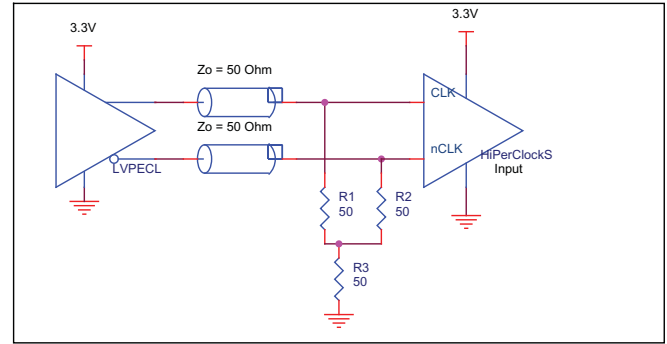


FIGURE 2B. CLK/nCLK INPUT DRIVEN BY 3.3V LVPECL DRIVER

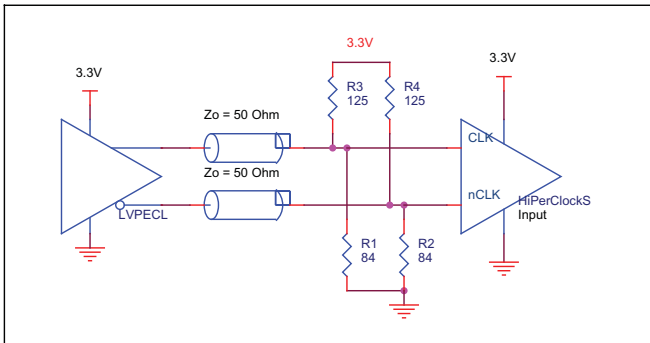


FIGURE 2C. CLK/nCLK INPUT DRIVEN BY 3.3V LVPECL DRIVER

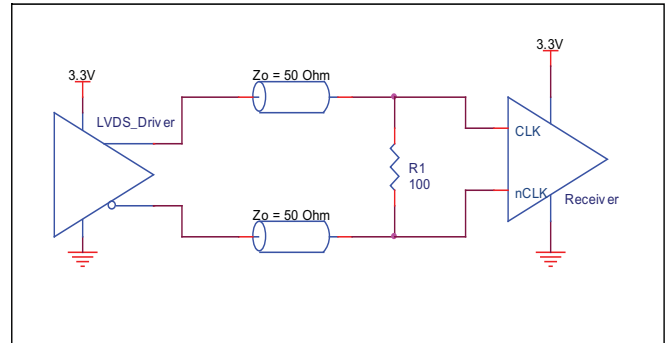


FIGURE 2D. CLK/nCLK INPUT DRIVEN BY 3.3V LVDS DRIVER

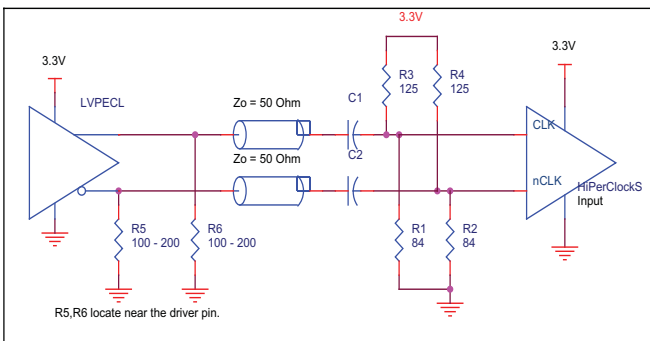


FIGURE 2E. CLK/nCLK INPUT DRIVEN BY 3.3V LVPECL DRIVER WITH AC COUPLE

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.

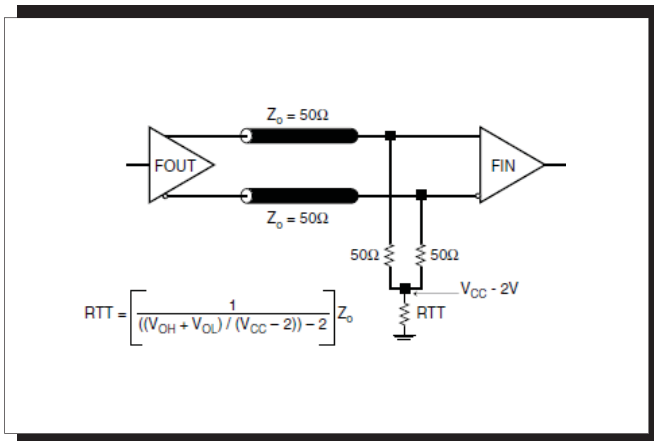


FIGURE 3A. LVPECL OUTPUT TERMINATION

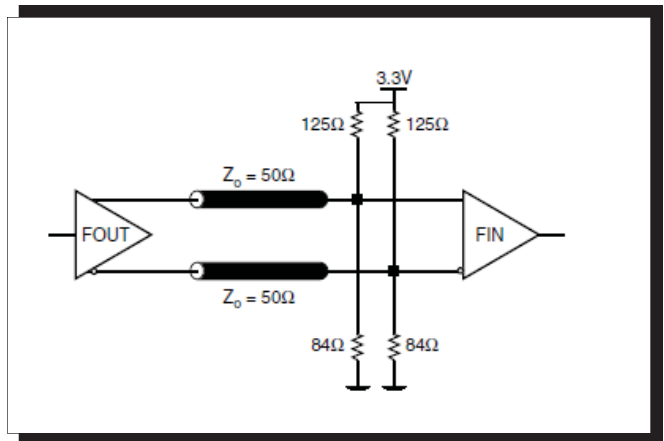


FIGURE 3B. LVPECL OUTPUT TERMINATION

POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the 87354. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 87354 is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for $V_{CC} = 3.465V$, which gives worst case results.

NOTE: Please refer to Section 3 for details on calculating power dissipated in the load.

- Power (core)_{MAX} = $V_{CC_MAX} * I_{EE_MAX} = 3.465V * 104mA = 360mW$
- Power (outputs)_{MAX} = **3.465mW/Loaded Output pair**

Total Power_{MAX} (3.465V, with all outputs switching) = 360mW + 30mW = **390mW**

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 for the devices is 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 200 linear feet per minute and a multi-layer board, the appropriate value is 103.3°C/W per Table 6 below.

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

$$85^\circ C + 0.390W * 103.3^\circ C/W = 125^\circ C.$$

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 (single layer or multi-layer).

TABLE 6. THERMAL RESISTANCE θ_{JA} FOR 8-PIN SOIC, FORCED CONVECTION

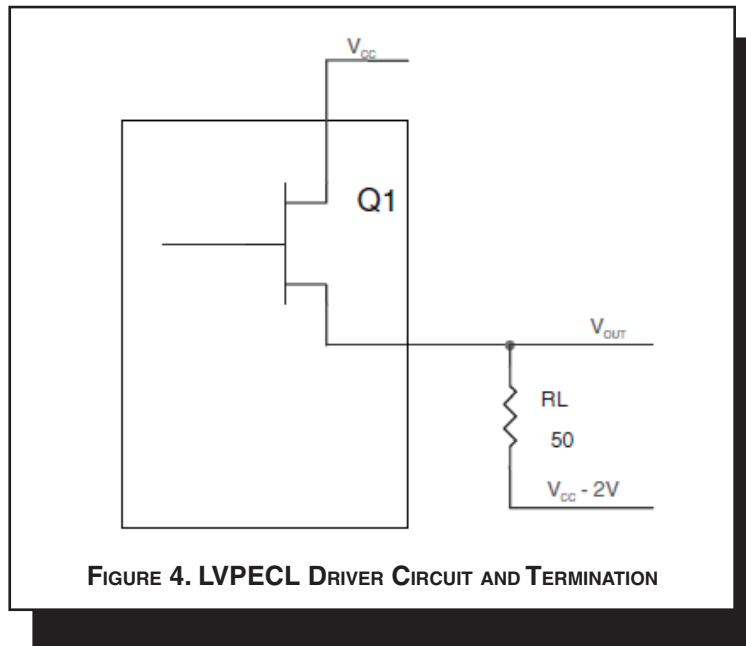
| θ_{JA} by Velocity (Linear Feet per Minute) | | | |
|--|-----------|-----------|-----------|
| | 0 | 200 | 500 |
| Single-Layer PCB, JEDEC Standard Test Boards | 153.3°C/W | 128.5°C/W | 115.5°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards | 112.7°C/W | 103.3°C/W | 97.1°C/W |

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

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.



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, $V_{OUT} = V_{OH_MAX} = V_{CC_MAX} - 0.9V$
 $(V_{CC_MAX} - V_{OH_MAX}) = 0.9V$
- For logic low, $V_{OUT} = V_{OL_MAX} = V_{CC_MAX} - 1.7V$
 $(V_{CC_MAX} - V_{OL_MAX}) = 1.7V$

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

$$Pd_H = [(V_{OH_MAX} - (V_{CC_MAX} - 2V))/R_L] * (V_{CC_MAX} - V_{OH_MAX}) = [(2V - (V_{CC_MAX} - V_{OH_MAX}))/R_L] * (V_{CC_MAX} - V_{OH_MAX}) = [(2V - 0.9V)/50\Omega] * 0.9V = \mathbf{19.8mW}$$

$$Pd_L = [(V_{OL_MAX} - (V_{CC_MAX} - 2V))/R_L] * (V_{CC_MAX} - V_{OL_MAX}) = [(2V - (V_{CC_MAX} - V_{OL_MAX}))/R_L] * (V_{CC_MAX} - V_{OL_MAX}) = [(2V - 1.7V)/50\Omega] * 1.7V = \mathbf{10.2mW}$$

Total Power Dissipation per output pair = $Pd_H + Pd_L = \mathbf{30mW}$

RELIABILITY INFORMATION

TABLE 6. θ_{JA} VS. AIR FLOW TABLE FOR 8 LEAD SOIC

| θ_{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.

TRANSISTOR COUNT

The transistor count for 87354 is: 1745

PACKAGE OUTLINE - M SUFFIX FOR 8 LEAD SOIC

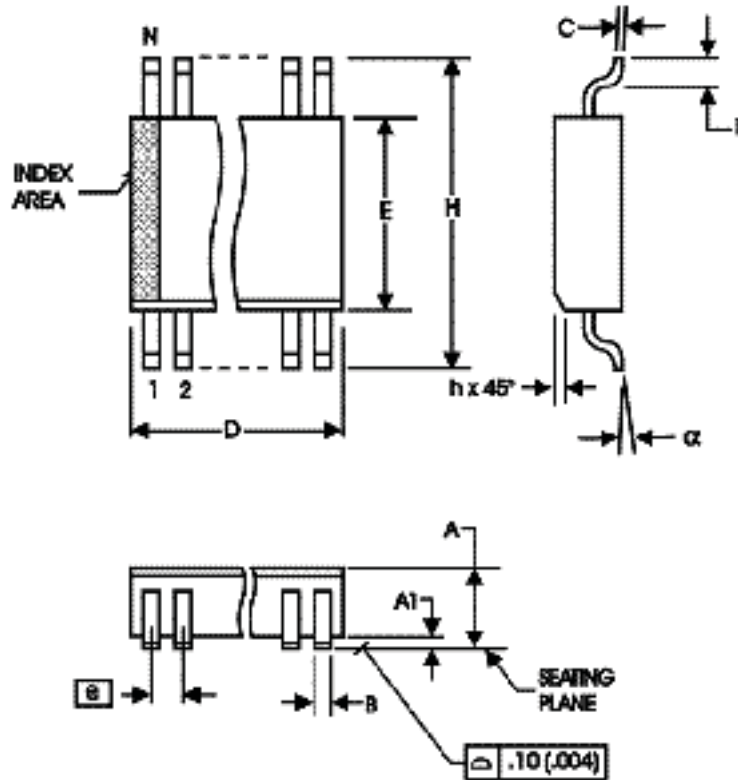


TABLE 7. PACKAGE DIMENSIONS

| SYMBOL | Millimeters | |
|--------|-------------|---------|
| | MINIMUM | 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 8. ORDERING INFORMATION

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|--------------------------|----------------|-------------------------|---------------------------|--------------------|
| 87354AMILF | 87354AIL | 8 lead "Lead-Free" SOIC | tube | -40°C to 85°C |
| 87354AMILFT | 87354AIL | 8 lead "Lead-Free" SOIC | tape & reel | -40°C to 85°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 | T1 | 2 | Pin Description - corrected pins 6 & 7 from Q, nQ to nQ. Added <i>Recommendations for Unused Input Pins</i> . | 5/22/06 |
| A | T8 | 13 15 | Updated datasheet's header/footer with IDT from ICS. Removed ICS prefix from Part/Order Number column. Added Contact Page. | 8/5/10 |
| A | T8 | 13 | Ordering information - removed leaded devices - PDN CQ-13-01 | 2/12/15 |
| | | | | |

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