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2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer

FEATURES

- Ten differential 2.5V/3.3V LVPECL output pairs.
- Output Frequency: ≤ 700 MHz.
- Two selectable differential input pairs.
- Translates any standard single-ended or differential input format to LVPECL output. It can accept the following standard input formats and more:
 - LVPECL, LVCMOS, LVDS, HCSL, SSTL, LVHSTL, CML.
- Output Skew: 25ps (typ.).
- Part-to-part skew: 140ps (typ.).
- Propagation delay: 1.5ns (typ.).
- Additive Jitter: <100 fs (typ.).
- Operating Supply Voltage: 2.375V ~ 3.63V.
- Operating temperature range from -40°C to 85°C .
- Package availability: 32-pin LQFP.

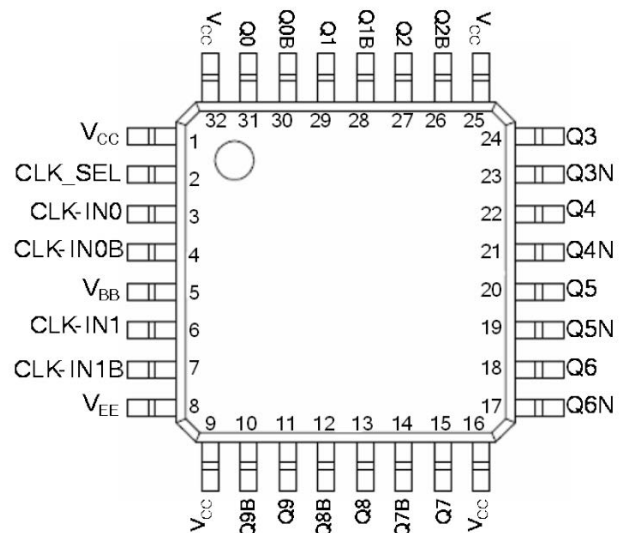
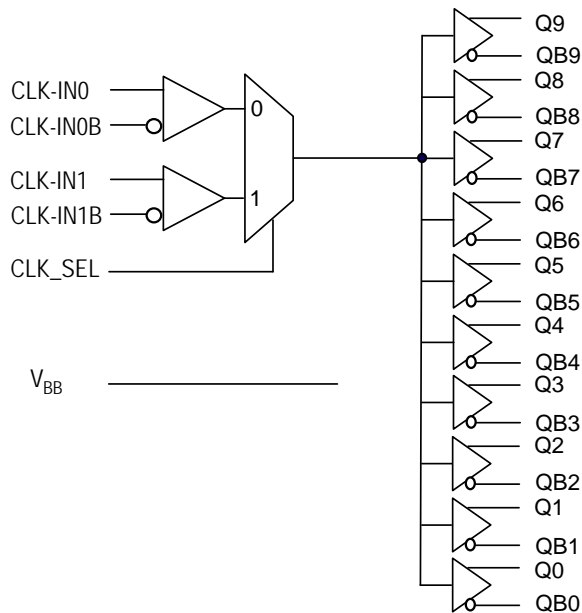
DESCRIPTION

The PL138-18 family is a high performance low-cost 1: 10 outputs Differential LVPECL fanout buffer.

The family of Differential LVPECL buffers are designed to operate from a single power supply of $2.5\text{V} \pm 5\%$ or $3.3\text{V} \pm 10\%$. The differential input pairs are designed to accept most standard input signal levels, using an appropriate resistor bias network, and produce a high quality set of outputs with the lowest possible skew on the outputs, which is guaranteed for part-to-part or lot-to lot skew.

Designed to fit in a small form-factor package, PL138 family offers up to 1GHz of output operation with very low-power consumption, and lowest additive jitter of any comparable device. The Output Enable feature, when activated, allows the IC to consume less than $10\mu\text{A}$ of current.

BLOCK DIAGRAM



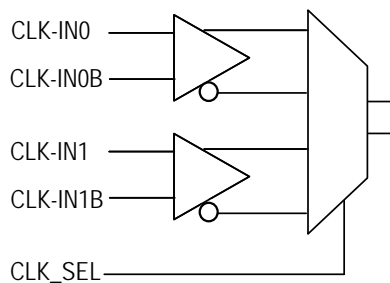
32-Pin LQFP Package

2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer

PIN DESCRIPTIONS

| Name | Package Pin # | Type | Description |
|-----------------|---|------|---|
| | LQFP-32 | | |
| V _{CC} | 1, 9, 16, 25, 32 | P | Power Supply pin connection |
| CLK_SEL | 2 | P | Clock select input. See table below for functional spec. and Single Ended signal interface. |
| CLK-IN0 | 3 | I | True part of differential clock input signal. |
| CLK-IN0B | 4 | I | Complementary part of differential clock input signal. |
| V _{BB} | 5 | O | Bias Reference Output |
| CLK-IN1 | 6 | I | True part of differential clock input signal. |
| CLK-IN1B | 7 | I | Complementary part of differential clock input signal. |
| V _{EE} | 8 | P | Power Supply pin connection |
| Q0 ~ Q9 | 11, 13, 15, 18, 20, 22, 24, 27, 29, 31 | O | LVPECL True output |
| QB0 ~ QB9 | 10, 12, 14, 17, 19, 21, 23, 26, 28, 30 | O | LVPECL Complementary output |

INPUT LOGIC BLOCK DIAGRAM



INPUT PIN CHARACTERISTICS

| Parameter | Min. | Typ. | Max. | Units |
|---------------------------|------|------|------|------------|
| Input Pulldown Resistor | | 75 | | k Ω |
| Pullup/Pulldown Resistors | | 50 | | k Ω |

INPUT CLOCK CONTROL SELECTION

| CLK_SEL | Selected Source |
|---------|-------------------|
| 0 | CLK-IN0, CLK-IN0B |
| 1 | CLK-IN1, CLK-IN1B |

INPUT CLOCK FUNCTION

| Inputs | | Outputs | | Input to Output Mode | Polarity |
|--------------------|-----------------------------------|---------|---------|------------------------------|---------------|
| CLK-IN0 or CLK-IN1 | CLK-IN0B or CLK-IN1B | Q0:Q7 | QB0:QB7 | | |
| 0 | 1 | Low | High | Differential to Differential | Non Inverting |
| 1 | 0 | High | Low | Differential to Differential | Non Inverting |
| 0 | See page 8 for accepting SE input | Low | High | Single Ended to Differential | Non Inverting |
| 1 | | High | Low | Single Ended to Differential | Non Inverting |

2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer
ELECTRICAL SPECIFICATIONS
Absolute Maximum Ratings

| PARAMETERS | SYMBOL | MIN. | MAX. | UNITS |
|-----------------------------------|----------|------|--------------|-------|
| Supply Voltage | V_{DD} | | 4.6 | V |
| Input Voltage, dc | V_I | -0.5 | $V_{DD}+0.5$ | V |
| Output Voltage, dc | V_O | -0.5 | $V_{DD}+0.5$ | V |
| Storage Temperature | T_S | -65 | 150 | °C |
| Ambient Operating Temperature* | T_A | -40 | 85 | °C |
| Junction Temperature | T_J | | 110 | °C |
| Lead Temperature (soldering, 10s) | | | 260 | °C |
| ESD Protection, Human Body Model | 2 | | | kV |

Exposure of the device under conditions beyond the limits specified by Maximum Ratings for extended periods may cause permanent damage to the device and affect product reliability. These conditions represent a stress rating only, and functional operations of the device at these or any other conditions above the operational limits noted in this specification is not implied.

* Note: Operating Temperature is guaranteed by design for all parts (COMMERCIAL and INDUSTRIAL), but tested for COMMERCIAL grade only.

DC CHARACTERISTICS, $V_{CC} = 3.3V$; $V_{EE} = 0V$

| Parameter | Symbol | -40°C | | | 25°C | | | 80°C | | | Units |
|---|-----------------------|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Output High Voltage* | V_{OH} | 2.215 | 2.320 | 2.420 | 2.275 | 2.350 | 2.420 | 2.275 | 2.35 | 2.420 | V |
| Output Low Voltage* | V_{OL} | 1.470 | 1.610 | 1.745 | 1.490 | 1.585 | 1.680 | 1.490 | 1.585 | 1.680 | V |
| Input High Voltage | V_{IH} | 2.075 | | 2.420 | 2.135 | | 2.420 | 2.135 | | 2.420 | V |
| Input Low Voltage | V_{IL} | 1.470 | | 1.890 | 1.490 | | 1.825 | 1.490 | | 1.825 | V |
| Output Voltage Reference** | V_{BB} | 1.86 | | 1.98 | 1.92 | | 2.04 | 1.92 | | 2.04 | V |
| Peak-to-Peak Input Voltage | V_{PP} | 150 | 800 | 1200 | 150 | 800 | 1200 | 150 | 800 | 1200 | V |
| Input High Voltage Common Mode Range ^{† †} | V_{CMR} | 1.2 | | 3.3 | 1.2 | | 3.3 | 1.2 | | 3.3 | V |
| Input High Current | CLK-IN0, CLK-IN1 | I_{IH} | | 75 | | | 75 | | | 75 | μA |
| Input Low Current | CLK-IN0B, CLK-IN1B | I_{IL} | -75 | | -75 | | | -75 | | | μA |

Input and output parameters vary 1:1 with V_{CC} . V_{EE} can vary +0.925V to -0.5V.

* Outputs terminated with 50Ω to V_{CC} - 2V.

** Single-ended input operation is limited. $V_{CC} \geq 3V$ in LVPECL mode.

† Common mode voltage is defined as V_{IH} .

†† For single-ended applications, the maximum input voltage for CLK-INx, CLK-INxB is $V_{CC} + 0.3V$

2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer
DC CHARACTERISTICS, V_{CC} = 2.5V; V_{EE} = 0V

| Parameter | | Symbol | -40°C | | | 25°C | | | 80°C | | | Units |
|---------------------------------------|-----------------------|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Output High Voltage* | | V _{OH} | 1.415 | 1.520 | 1.620 | 1.475 | 1.550 | 1.620 | 1.475 | 1.55 | 1.620 | V |
| Output Low Voltage* | | V _{OL} | 0.670 | 0.810 | 0.945 | 0.690 | 0.785 | 0.880 | 0.690 | 0.785 | 0.880 | V |
| Input High Voltage | | V _{IH} | 1.275 | | 1.620 | 1.335 | | 1.620 | 1.335 | | 1.620 | V |
| Input Low Voltage | | V _{IL} | 0.670 | | 1.090 | 0.690 | | 1.025 | 0.690 | | 1.025 | V |
| Peak-to-Peak Input Voltage | | V _{PP} | 150 | 800 | 1200 | 150 | 800 | 1200 | 150 | 800 | 1200 | V |
| Input High Voltage Common Mode Range† | | V _{CMR} | 1.2 | | 2.5 | 1.2 | | 2.5 | 1.2 | | 2.5 | V |
| Input High Current | CLK-IN0, CLK-IN1 | I _{IH} | | | 60 | | | 60 | | | 60 | μA |
| Input Low Current | CLK-IN0B, CLK-IN1B | I _{IL} | -60 | | | -60 | | | -60 | | | μA |

Input and output parameters vary 1:1 with V_{CC}. V_{EE} can vary +0.925V to -0.5V.

* Outputs terminated with 50Ω to V_{CCO} - 2V.

** Common mode voltage is defined as V_{IH}.

† For single-ended applications, the maximum input voltage for CLK-IN_x, CLK-IN_xB is V_{CC} + 0.3V

AC Electrical Characteristics

V_{CC} = -3.8V to -2.375V or, V_{CC} = 2.375V to 3.8V; V_{EE} = 0V, T_A = -40°C to 85°C

| Parameter | | Symbol | -40°C | | | 25°C | | | 80°C | | | Units |
|---|------------|---------------------------------|-------|------|-----|------|------|-----|------|------|-----|-------|
| | | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Output Frequency | | f _{MAX} | | | 700 | | | 700 | | | 700 | MHz |
| Propagation Delay* | | t _{PD} | 600 | 680 | 750 | 650 | 725 | 790 | 690 | 790 | 890 | ps |
| Output Skew ** † | | tsk(o) | | 25 | 37 | | 25 | 37 | | 25 | 37 | ps |
| Part-to-Part Skew *** † | | tsk(pp) | | 85 | 225 | | 85 | 225 | | 85 | 225 | ps |
| Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | | t _{APJ} | | 0.10 | | | 0.10 | | | 0.10 | | ps |
| Output Rise/Fall Time | 20% to 80% | t _R / t _F | 200 | | 700 | 200 | | 700 | 200 | | 700 | ps |

All parameters are measured at f ≤ 700MHz, unless otherwise noted.

* Measured from the differential input crossing point to the differential output crossing point.

** Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at the output differential cross points.

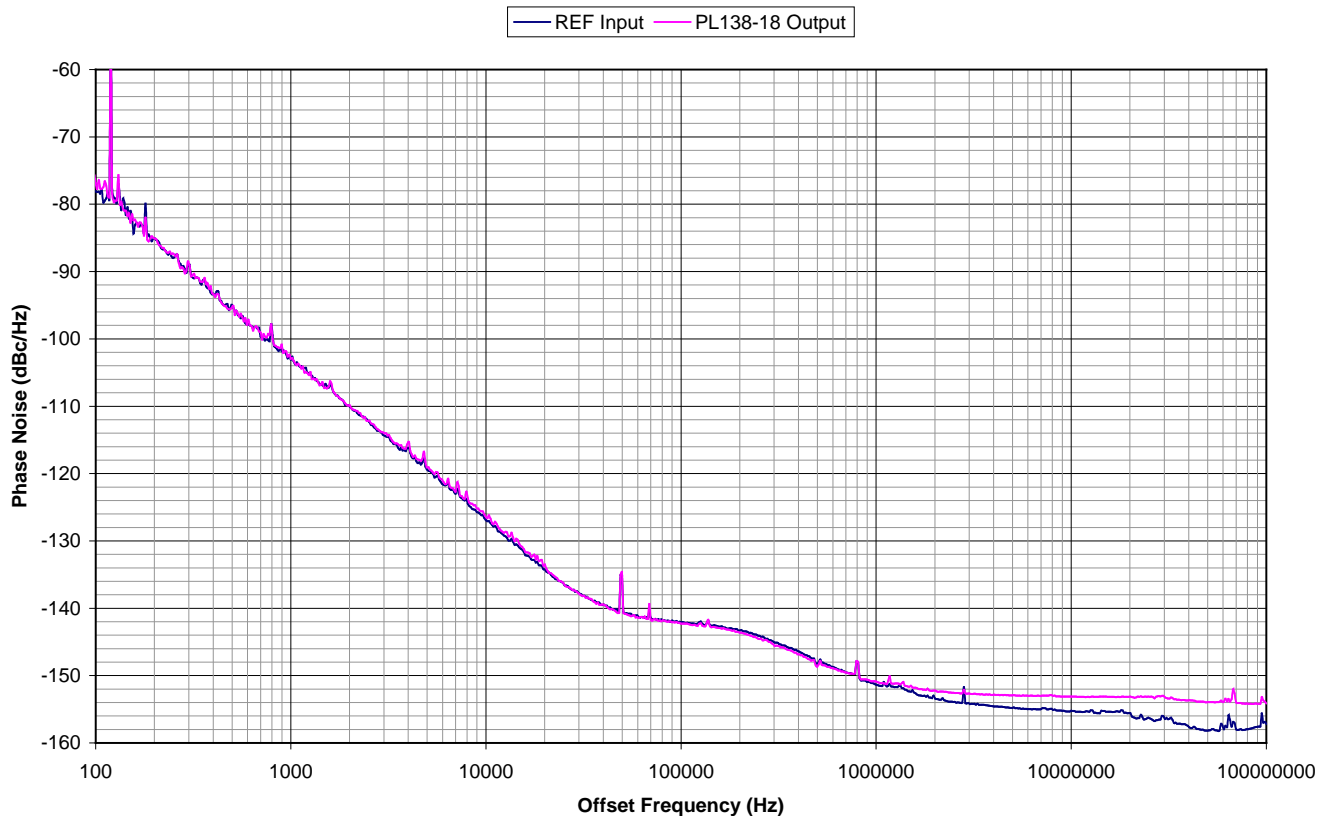
*** Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.

† This parameter is defined in accordance with JEDEC Standard 65.

2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer

NOISE CHARACTERISTICS (Commercial and Industrial Temperature Devices)

| Parameter | Description | Test Conditions | Min. | Typ. | Max. | Unit |
|------------------|-----------------------|---|------|------|------|------|
| t _{APJ} | Additive Phase Jitter | V _{CC} = 3.3V, Frequency = 622.08MHz Offset = 12KHz ~ 20MHz | | 21 | | fs |

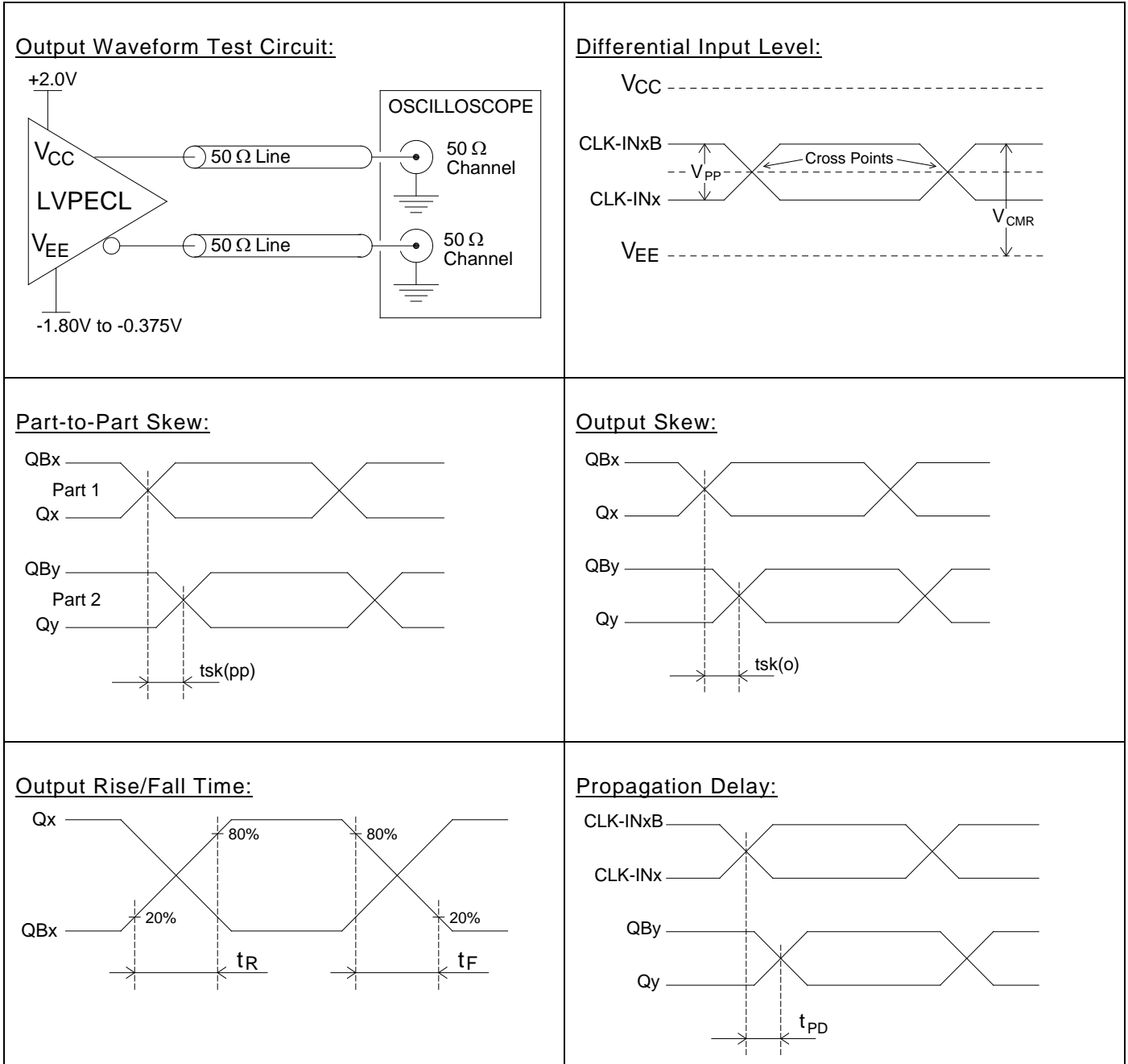


When a buffer is used to pass a signal then the buffer will add a little bit of its own noise. The phase noise on the output of the buffer will be a little bit more than the phase noise in the input signal. To quantify the noise addition in the buffer we compare the Phase Jitter numbers from the input and the output. The difference is called "Additive Phase Jitter". The formula for the Additive Phase Jitter is as follows:

$$\text{Additive Phase Jitter} = \sqrt{(\text{Output Phase Jitter})^2 - (\text{Input Phase Jitter})^2}$$

2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer

PARAMETER MEASUREMENT INFORMATION

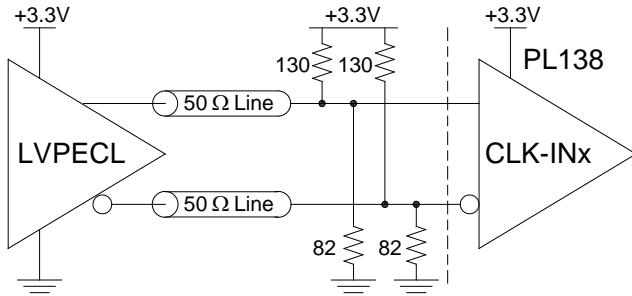


2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer

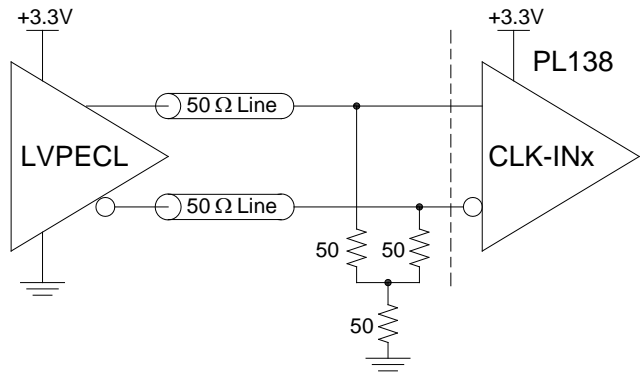
APPLICATION INFORMATION

The following circuits show different configurations for different input logic type signals. For good signal integrity at the PL138 input, the signals need to be properly terminated according to the logic type requirements. The signals need to be presented at the PL138 input according to V_{CMR} , V_{PP} and other input requirements.

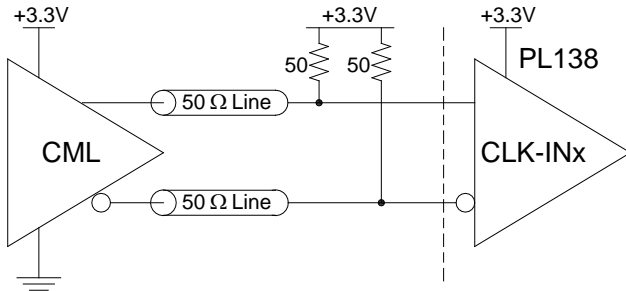
CLK-IN Input Driven by a 3.3V LVPECL Driver:



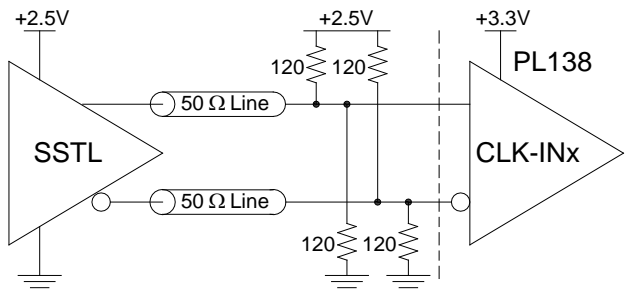
3.3V LVPECL Driver, Alternative Termination:



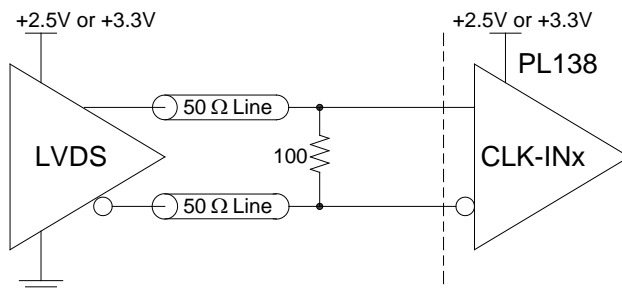
CLK-IN Input Driven by a CML Driver:



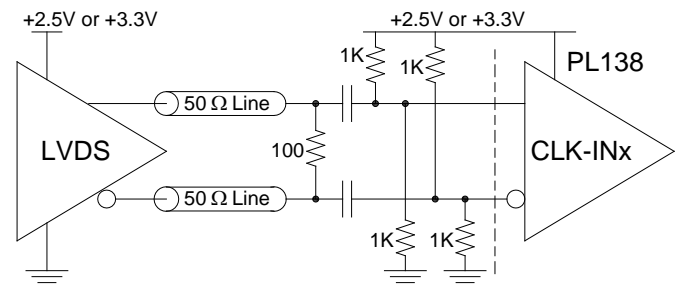
CLK-IN Input Driven by an SSTL Driver:



CLK-IN Input Driven by an LVDS Driver:



LVDS Driver, Alternative AC Coupling:



This circuit is for compatibility only. AC coupling is not really required for LVDS. The V_{CMR} range of the PL138 reaches low enough that LVDS signals can be connected directly to the PL138 input like in the circuit to the left.

2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer

| | |
|--|--|
| <p><u>CLK-IN Input Driven by a CMOS Driver:</u></p> | <p><u>CLK-IN Input Driven by Single Ended LVPECL:</u></p> |
| <p><u>CLK-IN Input Driven by an HCSL Driver:</u></p> | <p>HCSL presents its signals very close to the ground rail, below the V_{CMR} range, so the HCSL signals can not be connected to the PL138 input directly. AC coupling is required for HCSL signals on the PL138 input.</p> |

TERMINATION FOR LVPECL OUTPUTS

The required termination for LVPECL is 50Ω to a $V_{CC}-2V$ DC voltage level. Below are two schematics to implement this termination.

| | |
|---|--|
| <p><u>LVPECL Termination Schematic #1:</u></p> | <p><u>LVPECL Termination Schematic #2:</u></p> |
| <p>VCC=3.3V, Ideal values: $R1=127\Omega$, $R2=82.5\Omega$ Commercial values (E24): $R1=130\Omega$, $R2=82\Omega$ VCC=2.5V, Ideal values: $R1=250\Omega$, $R2=62.5\Omega$ Commercial values (E24): $R1=240\Omega$, $R2=62\Omega$</p> | <p>Schematic #2 is an alternative simplified termination. VCC=3.3V, Ideal value: $RT=48.7\Omega$ Commercial value: $RT=50\Omega$ (E24: 51Ω) VCC=2.5V, Ideal value: $RT=18.7\Omega$ Commercial value: $RT=18\Omega$</p> |

2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer

POWER CONSIDERATIONS

Driving LVPECL outputs requires an amount of power that can warm up the chip significantly. For driving 10 outputs we need to use the PCB as a heat sink. The LQFP package has a Thermal Relief pad on the bottom and it is advised to layout a PCB solder pad for the thermal relief pad with vias to the ground plane layer inside the PCB.

The general requirement for the chip is that the junction temperature should not exceed +110°C.

The power consumption can be divided into two parts:

- 1) Core power dissipation
- 2) Output buffers power dissipation

CORE POWER DISSIPATION

The chip core power is equal to $VCC \times IEE$. With a worst case VCC and IEE the power dissipation in the core is $3.63V \times 88mA = 319mW$.

OUTPUT BUFFER POWER DISSIPATION

The output buffers are not exposed to the full VCC-VEE voltage. On the differential output, one line is at logic 1 with a small voltage across the buffer and a large output current. The other line is at logic 0 with a larger voltage across the buffer and a smaller output current. The power dissipation per output buffer is 32mW. Only buffers that are loaded will have power dissipation. With all 10 buffers loaded the worst case output buffer power dissipation will be 320mW.

Total Chip Power Dissipation, worst case, is $319mA + 320mW = 639mW$.

JUNCTION TEMPERATURE

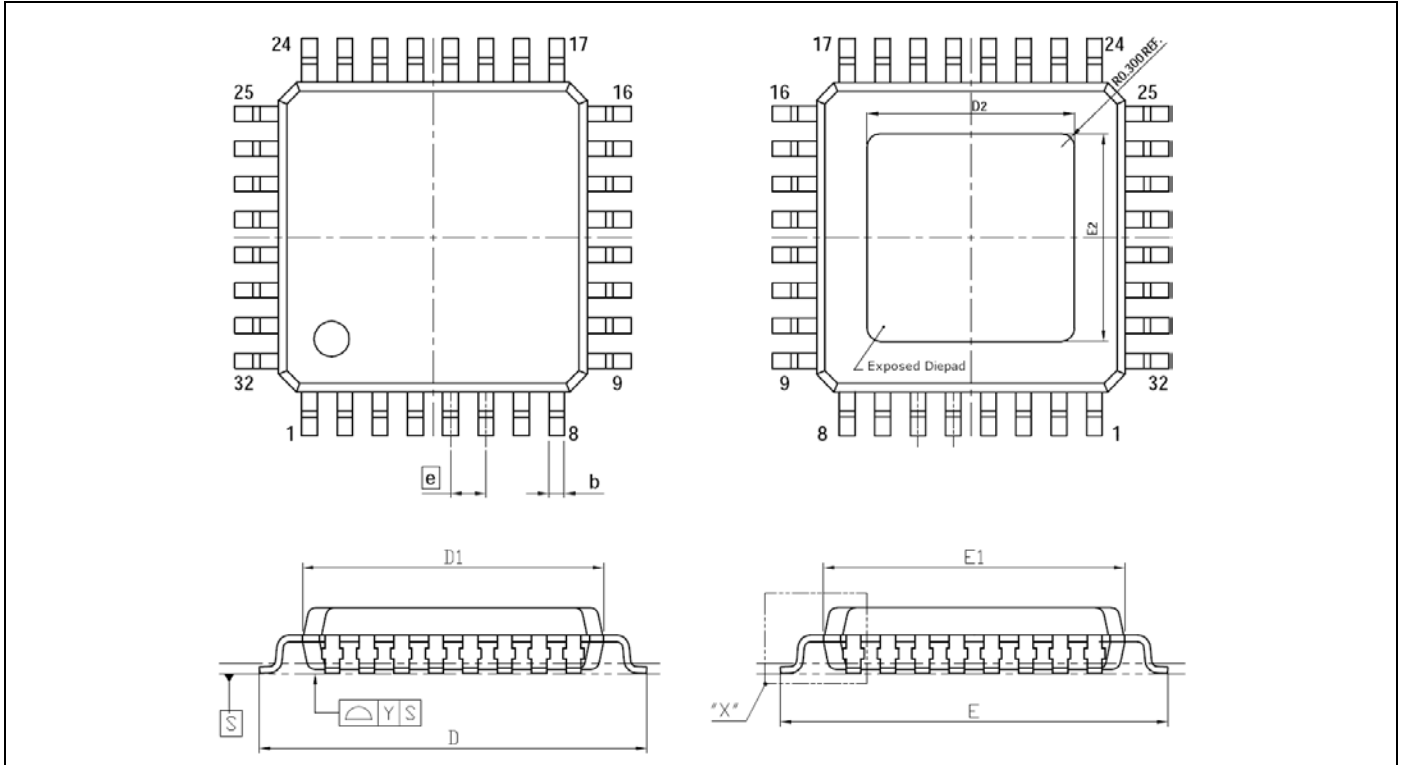
How much the chip is warmed up from the power dissipation depends upon the thermal resistance from the chip to the environment, also known as "junction to ambient". The thermal resistance depends upon the type of package, how the package is assembled to the PCB and if there is additional air flow for improved cooling. For the LQFP package with use of the Thermal Relief pad, the thermal resistance is as follows:

| LQFP-ep 32-pin Package | Air Flow Velocity in Linear Feet per Minute | | |
|--------------------------------|---|---------------------------------|---------------------------------|
| | 0 | 200 | 500 |
| JEDEC Standard Multi Layer PCB | $\theta_{JA} = 34.6^{\circ}C/W$ | $\theta_{JA} = 29.1^{\circ}C/W$ | $\theta_{JA} = 27.2^{\circ}C/W$ |

The temperature of the chip (junction) will be higher than the environment (ambient) with an amount equal to $\theta_{JA} \times$ Power. For an ambient temperature of +85°C, all outputs loaded and no air flow, the junction temperature $T_J = 85^{\circ}C + 34.6 \times 0.639 = 107^{\circ}C$.

2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer

PACKAGE DRAWING (GREEN PACKAGE COMPLIANT)



| SYMBOL | DIMENSION (mm) | | | DIMENSION (mil) | | |
|------------|----------------|------|------|-----------------|-------|-------|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | | | 1.60 | | | 63.0 |
| A1 | 0.05 | 0.10 | 0.15 | 2.0 | 3.9 | 5.9 |
| A2 | 1.35 | 1.40 | 1.45 | 53.1 | 55.1 | 57.1 |
| b | 0.30 | 0.37 | 0.45 | 11.8 | 14.6 | 17.7 |
| b1 | 0.30 | 0.35 | 0.40 | 11.8 | 13.8 | 15.7 |
| c | 0.09 | | 0.20 | 3.5 | | 7.9 |
| c1 | 0.09 | | 0.16 | 3.5 | | 6.3 |
| D | 8.85 | 9.00 | 9.15 | 348.4 | 354.3 | 360.2 |
| D1 | 6.90 | 7.00 | 7.10 | 271.7 | 275.6 | 279.5 |
| D2 | 4.51 | 4.71 | 4.91 | 177.6 | 185.4 | 193.3 |
| E | 8.85 | 9.00 | 9.15 | 348.4 | 354.3 | 360.2 |
| E1 | 6.90 | 7.00 | 7.10 | 271.7 | 275.6 | 279.5 |
| E2 | 4.51 | 4.71 | 4.91 | 177.6 | 185.4 | 193.3 |
| e | 0.75 | 0.80 | 0.85 | 29.5 | 31.5 | 33.5 |
| L | 0.45 | 0.60 | 0.75 | 17.7 | 23.6 | 29.5 |
| L1 | 0.85 | 1.00 | 1.15 | 33.5 | 39.4 | 45.3 |
| R1 | 0.08 | | | 3.1 | | |
| R2 | 0.08 | | 0.20 | 3.1 | | 7.9 |
| Y | | | 0.10 | | | 3.9 |
| θ | 0° | 3.5° | 7° | 0° | 3.5° | 7° |
| $\theta 1$ | 0° | | | 0° | | |
| $\theta 2$ | 11° | 12° | 13° | 11° | 12° | 13° |
| $\theta 3$ | 11° | 12° | 13° | 11° | 12° | 13° |

2.5V-3.3V Low-Skew 1:10 Differential PECL Fanout Buffer

ORDERING INFORMATION (GREEN PACKAGE)

For part ordering, please contact our Sales Department:

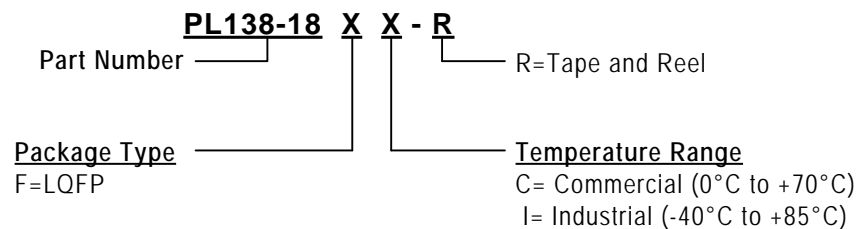
2180 Fortune Drive, San Jose, CA 95131, USA

Tel: (408) 944-0800 Fax: (408) 474-1000

PART NUMBER

The order number for this device is a combination of the following:

Part number, Package type and Operating temperature range



| Part/Order Number | Marking | Package Option |
|-------------------|------------------------|--------------------|
| PL138-18FC | P138-18 FC LLLLL | 32-Pin LQFP (Tray) |

*Note: LLLLL designates lot number

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