

## Low Voltage 1:18 Clock Distribution Chip

### Features

- LVPECL Clock Input
- 2.5V LVCMOS Outputs for PentiumII™ Microprocessor Support
- 200pS Maximum Targeted Output-to-Output Skew
- Maximum Output Frequency of 250MHz @3.3 V<sub>CC</sub>
- 32-Lead LQFP and TQFP Packaging
- Single 3.3V or 2.5V Supply
- Pin and Function compatible with MPC942P

### Functional Description

The PCS2I9942P is a 1:18 low voltage clock distribution chip with 2.5V or 3.3V LVCMOS output capabilities. The device is offered in two versions; the PCS2I9942C has an LVCMOS input clock while the PCS2I9942P has a LVPECL input clock. The 18 outputs are 2.5V or 3.3V LVCMOS compatible and feature the drive strength to drive 50Ω series or parallel terminated transmission lines. With output-to-output skews of 200pS, the PCS2I9942P is ideal as a clock distribution chip for the most demanding of synchronous systems. The 2.5V outputs also make the device ideal for supplying clocks for a high performance Pentium II™ microprocessor based design.

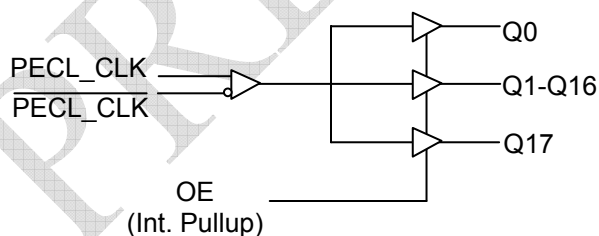
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With low output impedance ( $\approx 12\Omega$ ), in both the HIGH and LOW logic states, the output buffers of the PCS2I9942P are ideal for driving series terminated transmission lines. With an output impedance of  $12\Omega$ , the PCS2I9942P can drive two series terminated transmission lines from each output. This capability gives the PCS2I9942P an effective fanout of 1:36. The PCS2I9942P provides enough copies of low skew clocks for most high performance synchronous systems.

The differential LVPECL inputs of the PCS2I9942P allow the device to interface directly with a LVPECL fanout buffer to build very wide clock fanout trees or to couple to a high frequency clock source. The OE pins will place the outputs into a high impedance state. The OE pin has an internal pullup resistor.

The PCS2I9942P is a single supply device. The V<sub>CC</sub> power pins require either 2.5V or 3.3V. The 32 lead LQFP and TQFP package is chosen to optimize performance, board space and cost of the device. The 32-lead LQFP and TQFP have a 7x7mm<sup>2</sup> body size with conservative 0.8mm pin spacing.

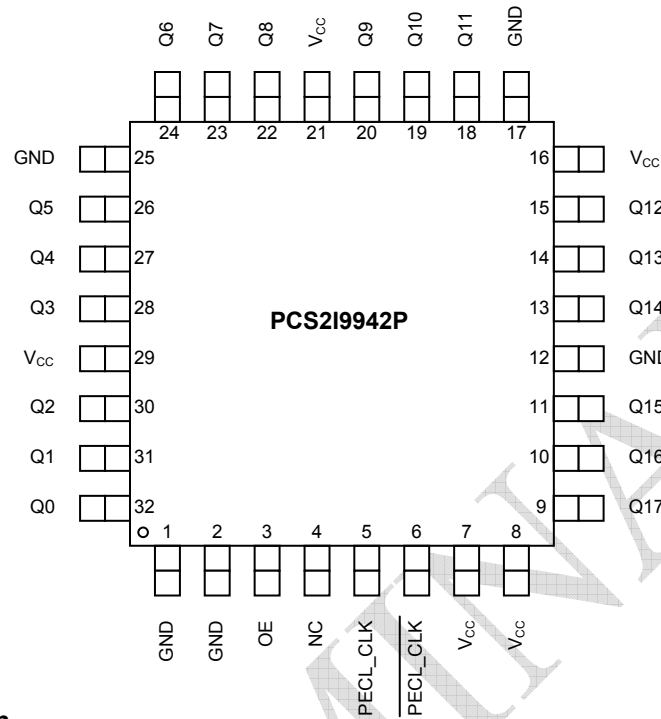
### Block Diagram



**Table 1. Function Table**

| OE | Output                            |
|----|-----------------------------------|
| 0  | HIGH IMPEDANCE<br>OUTPUTS ENABLED |
| 1  |                                   |

**Pin Diagram**



**Table 2. Pin Description**

| Pin #                                                    | Pin Name              | I/O    | Type            | Function                                                                                                                                       |
|----------------------------------------------------------|-----------------------|--------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 5<br>6                                                   | PECL_CLK,<br>PECL_CLK | Input  | LVPECL          | LVPECL Clock Inputs                                                                                                                            |
| 3                                                        | OE                    | Input  | LVC MOS         | Output enable/disable<br>(high-impedance tristate)                                                                                             |
| 4                                                        | NC                    |        |                 | No connect                                                                                                                                     |
| 32,31,30,28,27,26,24,23,22,20,19,18,15,<br>14,13,11,10,9 | Q0 – Q17              | Output | LVC MOS         | Clock outputs                                                                                                                                  |
| 1,2,12,17,25                                             | GND                   | Supply | Ground          | Negative power supply (GND)<br>for I/O and core.                                                                                               |
| 7,8,16,21,29                                             | V <sub>CC</sub>       | Supply | V <sub>CC</sub> | Positive power supply for I/O and<br>core. All V <sub>CC</sub> pins must be<br>connected to the positive power<br>supply for correct operation |

**Table 3. Absolute Maximum Rating<sup>1</sup>**

| Symbol            | Parameter                 | Min  | Max                   | Unit |
|-------------------|---------------------------|------|-----------------------|------|
| V <sub>CC</sub>   | Supply Voltage            | -0.3 | 3.6                   | V    |
| V <sub>I</sub>    | Input Voltage             | -0.3 | V <sub>CC</sub> + 0.3 | V    |
| I <sub>IN</sub>   | Input Current             |      | ±20                   | mA   |
| T <sub>Stor</sub> | Storage Temperature Range | -40  | 125                   | °C   |

Note: 1. These are stress ratings only and are not implied for functional use. Exposure to absolute maximum ratings for prolonged periods of time may affect device reliability.

**Table 4. DC Characteristics** ( $T_A = -40^\circ$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 2.5\text{V} \pm 5\%$ )

| Symbol    | Characteristic                   | Min          | Typ | Max          | Unit          | Condition                |
|-----------|----------------------------------|--------------|-----|--------------|---------------|--------------------------|
| $V_{IH}$  | Input HIGH Voltage               | 2.0          |     | $V_{CC}$     | V             |                          |
| $V_{IL}$  | Input LOW Voltage                |              |     | 0.8          | V             |                          |
| $V_{PP}$  | Input Swing PECL_CLK             | 0.6          |     | 1.0          | V             |                          |
| $V_X$     | Input Crosspoint PECL_CLK        | $V_{CC}-1.0$ |     | $V_{CC}-0.6$ | V             |                          |
| $V_{OH}$  | Output HIGH Voltage              | 2.0          |     |              | V             | $I_{OH} = -16\text{ mA}$ |
| $V_{OL}$  | Output LOW Voltage               |              |     | 0.5          | V             | $I_{OL} = 16\text{ mA}$  |
| $I_{IN}$  | Input Current                    |              |     | $\pm 200$    | $\mu\text{A}$ |                          |
| $C_{IN}$  | Input Capacitance                |              | 4.0 |              | pF            |                          |
| $C_{PD}$  | Power Dissipation Capacitance    |              | 14  |              | pF            | Per Output               |
| $Z_{OUT}$ | Output Impedance                 |              | 12  |              | $\Omega$      |                          |
| $I_{CC}$  | Maximum Quiescent Supply Current |              | 0.5 | 5.0          | mA            |                          |

**Table 5. AC Characteristics** ( $T_A = -40^\circ$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 2.5\text{V} \pm 5\%$ )

| Symbol       | Characteristic                        | Min | Typ | Max | Unit | Condition |
|--------------|---------------------------------------|-----|-----|-----|------|-----------|
| $F_{max}$    | Maximum Frequency                     |     |     | 200 | MHz  |           |
| $t_{PLH}$    | Propagation Delay                     | 1.8 |     | 4.0 | nS   |           |
| $t_{PHL}$    | Propagation Delay                     | 2.0 |     | 4.3 | nS   |           |
| $t_{sk(o)}$  | Output-to-Output Skew within one bank |     |     | 150 | pS   |           |
| $t_{sk(pr)}$ | Part-to-Part Skew <sup>1</sup>        |     |     | 2.2 | nS   |           |
| $t_{sk(pr)}$ | Part-to-Part Skew <sup>2</sup>        |     |     | 1.3 | pS   |           |
| $t_r, t_f$   | Output Rise/Fall Time                 | 0.1 |     | 1.0 | nS   |           |

Note: 1. Across temperature and voltage ranges, includes output skew.

2. For a specific temperature and voltage, includes output skew.

**Table 6. DC Characteristics** ( $T_A = -40^\circ$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 3.3\text{V} \pm 5\%$ )

| Symbol    | Characteristic                   | Min          | Typ | Max          | Unit          | Condition                |
|-----------|----------------------------------|--------------|-----|--------------|---------------|--------------------------|
| $V_{IH}$  | Input HIGH Voltage               | 2.4          |     | $V_{CC}$     | V             |                          |
| $V_{IL}$  | Input LOW Voltage                |              |     | 0.8          | V             |                          |
| $V_{PP}$  | Input Swing PECL_CLK             | 0.6          |     | 1.0          | V             |                          |
| $V_X$     | Input Crosspoint PECL_CLK        | $V_{CC}-1.0$ |     | $V_{CC}-0.6$ | V             |                          |
| $V_{OH}$  | Output HIGH Voltage              | 2.4          |     |              | V             | $I_{OH} = -20\text{ mA}$ |
| $V_{OL}$  | Output LOW Voltage               |              |     | 0.6          | V             | $I_{OL} = 20\text{ mA}$  |
| $I_{IN}$  | Input Current                    |              |     | $\pm 200$    | $\mu\text{A}$ |                          |
| $C_{IN}$  | Input Capacitance                |              | 4.0 |              | pF            |                          |
| $C_{PD}$  | Power Dissipation Capacitance    |              | 14  |              | pF            | Per Output               |
| $Z_{OUT}$ | Output Impedance                 |              | 12  |              | $\Omega$      |                          |
| $I_{CC}$  | Maximum Quiescent Supply Current |              | 0.5 | 5.0          | mA            |                          |

**Table 7. AC Characteristics** ( $T_A = -40^\circ$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 3.3\text{V} \pm 5\%$ )

| Symbol       | Characteristic                        | Min | Typ | Max | Unit | Condition |
|--------------|---------------------------------------|-----|-----|-----|------|-----------|
| $F_{\max}$   | Maximum Frequency                     |     |     | 250 | MHz  |           |
| $t_{PLH}$    | Propagation Delay                     | 1.5 |     | 3.2 | nS   |           |
| $t_{PHL}$    | Propagation Delay                     | 1.5 |     | 3.6 | nS   |           |
| $t_{sk(o)}$  | Output-to-output Skew within one bank |     |     | 150 | pS   |           |
| $t_{sk(pr)}$ | Part-to-Part Skew <sup>1</sup>        |     |     | 1.7 | nS   |           |
| $t_{sk(pr)}$ | Part-to-Part Skew <sup>2</sup>        |     |     | 1.0 | pS   |           |
| $t_r, t_f$   | Output Rise/Fall Time                 | 0.1 |     | 1.0 | nS   |           |

Note: 1. Across temperature and voltage ranges, includes output skew.

2. For a specific temperature and voltage, includes output skew.

## Power Consumption of the PCS2I9942P and Thermal Management

The PCS2I9942P AC specification is guaranteed for the entire operating frequency range up to 250MHz. The PCS2I9942P power consumption and the associated long-term reliability may decrease the maximum frequency limit, depending on operating conditions such as clock frequency, supply voltage, output loading, ambient temperature, vertical convection and thermal conductivity of package and board. This section describes the impact of these parameters on the junction temperature and gives a guideline to estimate the PCS2I9942P die junction temperature and the associated device reliability.

**Table 8. Die junction temperature and MTBF**

| Junction temperature (°C) | MTBF (Years) |
|---------------------------|--------------|
| 100                       | 20.4         |
| 110                       | 9.1          |
| 120                       | 4.2          |
| 130                       | 2.0          |

Increased power consumption will increase the die junction temperature and impact the device reliability (MTBF). According to the system-defined tolerable MTBF, the die junction temperature of the PCS2I9942P needs to be controlled and the thermal impedance of the board/package should be optimized. The power dissipated in the PCS2I9942P is represented in equation 1.

$$P_{TOT} = \left[ I_{CCQ} + V_{CC} \cdot f_{CLOCK} \cdot \left( N \cdot C_{PD} + \sum_M C_L \right) \right] \cdot V_{CC} \quad \text{Equation 1}$$

$$P_{TOT} = V_{CC} \cdot \left[ I_{CCQ} + V_{CC} \cdot f_{CLOCK} \cdot \left( N \cdot C_{PD} + \sum_M C_L \right) \right] + \sum_P \left[ DC_Q \cdot I_{OH} (V_{CC} - V_{OH}) + (1 - DC_Q) \cdot I_{OL} \cdot V_{OL} \right] \quad \text{Equation 2}$$

$$T_J = T_A + P_{TOT} \cdot R_{thja} \quad \text{Equation 3}$$

$$f_{CLOCKMAX} = \frac{1}{C_{PD} \cdot N \cdot V_{CC}^2} \cdot \left[ \frac{T_{JMAX} - T_A}{R_{thja}} - (I_{CCQ} \cdot V_{CC}) \right] \quad \text{Equation 4}$$

Where  $I_{CCQ}$  is the static current consumption of the PCS2I9942P,  $C_{PD}$  is the power dissipation capacitance per output,  $(M)\Sigma C_L$  represents the external capacitive output load,  $N$  is the number of active outputs ( $N$  is always 12 in case of the PCS2I9942P). The PCS2I9942P supports driving transmission lines to maintain high signal integrity and tight timing parameters. Any transmission line will hide the lumped capacitive load at the end of the board trace, therefore,  $\Sigma C_L$  is zero for controlled transmission line systems and can be eliminated from equation 1. Using parallel termination output termination results in equation 2 for power dissipation.

In equation 2,  $P$  stands for the number of outputs with a parallel or thevenin termination,  $V_{OL}$ ,  $I_{OL}$ ,  $V_{OH}$  and  $I_{OH}$  are a function of the output termination technique and  $DC_Q$  is the clock signal duty cycle. If transmission lines are used  $\Sigma C_L$  is zero in equation 2 and can be eliminated. In general, the use of controlled transmission line techniques eliminates the impact of the lumped capacitive loads at the end lines and greatly reduces the power dissipation of the device. Equation 3 describes the die junction temperature  $T_J$  as a function of the power consumption.

Where  $R_{thja}$  is the thermal impedance of the package (junction to ambient) and  $T_A$  is the ambient temperature. According to Table 8, the junction temperature can be used to estimate the long-term device reliability. Further, combining equation 1 and equation 2 results in a maximum operating frequency for the PCS2I9942P in a series terminated transmission line system, equation 4.

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$T_{j,MAX}$  should be selected according to the MTBF system requirements and Table 8.  $R_{thja}$  can be derived from Table 9. The  $R_{thja}$  represent data based on 1S2P boards, using 2S2P boards will result in lower thermal impedance than indicated below.

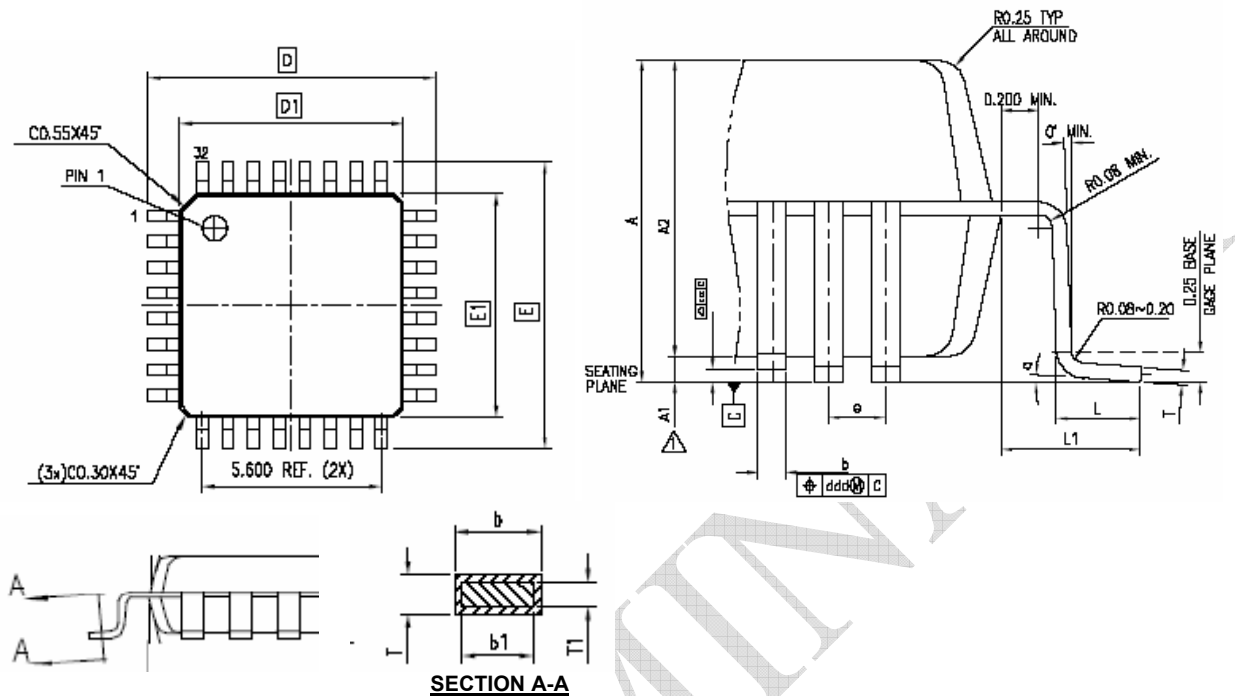
**Table 9. Thermal package impedance of the 32LQFP**

| Convection,<br>LFPM | $R_{thja}$ (1P2S<br>board), °C/W | $R_{thja}$ (2P2S<br>board), °C/W |
|---------------------|----------------------------------|----------------------------------|
| Still air           | 86                               | 61                               |
| 100 lfpm            | 76                               | 56                               |
| 200 lfpm            | 71                               | 54                               |
| 300 lfpm            | 68                               | 53                               |
| 400 lfpm            | 66                               | 52                               |
| 500 lfpm            | 60                               | 49                               |

If the calculated maximum frequency is below 350 MHz, it becomes the upper clock speed limit for the given application conditions. The following eight derating charts describe the safe frequency operation range for the PCS2I9942P. The charts were calculated for a maximum tolerable die junction temperature of 110°C (120°C), corresponding to an estimated MTBF of 9.1 years (4 years), a supply voltage of 3.3V and series terminated transmission line or capacitive loading. Depending on a given set of these operating conditions and the available device convection a decision on the maximum operating frequency can be made.

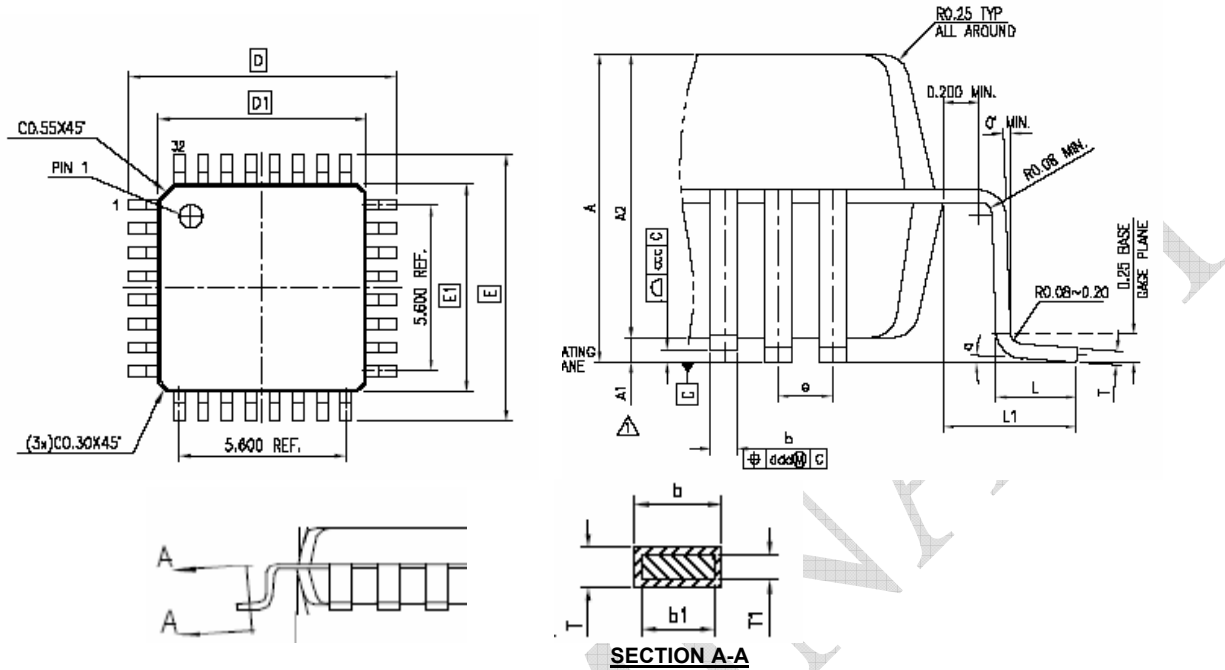
Package Information

32-lead TQFP



| Symbol | Dimensions  |        |             |       |
|--------|-------------|--------|-------------|-------|
|        | Inches      |        | Millimeters |       |
|        | Min         | Max    | Min         | Max   |
| A      | ....        | 0.0472 | ...         | 1.2   |
| A1     | 0.0020      | 0.0059 | 0.05        | 0.15  |
| A2     | 0.0374      | 0.0413 | 0.95        | 1.05  |
| D      | 0.3465      | 0.3622 | 8.8         | 9.2   |
| D1     | 0.2717      | 0.2795 | 6.9         | 7.1   |
| E      | 0.3465      | 0.3622 | 8.8         | 9.2   |
| E1     | 0.2717      | 0.2795 | 6.9         | 7.1   |
| L      | 0.0177      | 0.0295 | 0.45        | 0.75  |
| L1     | 0.03937 REF |        | 1.00 REF    |       |
| T      | 0.0035      | 0.0079 | 0.09        | 0.2   |
| T1     | 0.0038      | 0.0062 | 0.097       | 0.157 |
| b      | 0.0118      | 0.0177 | 0.30        | 0.45  |
| b1     | 0.0118      | 0.0157 | 0.30        | 0.40  |
| R0     | 0.0031      | 0.0079 | 0.08        | 0.2   |
| a      | 0°          | 7°     | 0°          | 7°    |
| e      | 0.031 BASE  |        | 0.8 BASE    |       |

32-lead LQFP



| Symbol | Dimensions  |        |             |       |
|--------|-------------|--------|-------------|-------|
|        | Inches      |        | Millimeters |       |
|        | Min         | Max    | Min         | Max   |
| A      | ....        | 0.0630 | ...         | 1.6   |
| A1     | 0.0020      | 0.0059 | 0.05        | 0.15  |
| A2     | 0.0531      | 0.0571 | 1.35        | 1.45  |
| D      | 0.3465      | 0.3622 | 8.8         | 9.2   |
| D1     | 0.2717      | 0.2795 | 6.9         | 7.1   |
| E      | 0.3465      | 0.3622 | 8.8         | 9.2   |
| E1     | 0.2717      | 0.2795 | 6.9         | 7.1   |
| L      | 0.0177      | 0.0295 | 0.45        | 0.75  |
| L1     | 0.03937 REF |        | 1.00 REF    |       |
| T      | 0.0035      | 0.0079 | 0.09        | 0.2   |
| T1     | 0.0038      | 0.0062 | 0.097       | 0.157 |
| b      | 0.0118      | 0.0177 | 0.30        | 0.45  |
| b1     | 0.0118      | 0.0157 | 0.30        | 0.40  |
| R0     | 0.0031      | 0.0079 | 0.08        | 0.20  |
| e      | 0.031 BASE  |        | 0.8 BASE    |       |
| a      | 0°          | 7°     | 0°          | 7°    |

## Ordering Information

| Ordering Code     | Marking      | Package Type                      | Operating Range |
|-------------------|--------------|-----------------------------------|-----------------|
| PCS2P9942PG-32-LT | PCS2P9942PGL | 32-pin LQFP, Tray, Green          | Commercial      |
| PCS2P9942PG-32-LR | PCS2P9942PGL | 32-pin LQFP, Tape and Reel, Green | Commercial      |
| PCS2P9942PG-32-ET | PCS2P9942PGE | 32-pin TQFP, Green                | Commercial      |
| PCS2P9942PG-32-ER | PCS2P9942PGE | 32-pin TQFP, Tape and Reel, Green | Commercial      |
| PCS2I9942PG-32-LT | PCS2I9942PGL | 32-pin LQFP, Tray, Green          | Industrial      |
| PCS2I9942PG-32-LR | PCS2I9942PGL | 32-pin LQFP, Tape and Reel, Green | Industrial      |
| PCS2I9942PG-32-ET | PCS2I9942PGE | 32-pin TQFP, Green                | Industrial      |
| PCS2I9942PG-32-ER | PCS2I9942PGE | 32-pin TQFP, Tape and Reel, Green | Industrial      |

## Device Ordering Information

PCS2I9942PG-32-LR

R = Tape & Reel, T = Tube or Tray

O = SOT  
S = SOIC  
T = TSSOP  
A = SSOP  
V = TVSOP  
B = BGA  
Q = QFN

U = MSOP  
E = TQFP  
L = LQFP  
U = MSOP  
P = PDIP  
D = QSOP  
X = SC-70

DEVICE PIN COUNT

G = GREEN PACKAGE, LEAD FREE, and RoHS

PART NUMBER

X = Automotive (-40C to +125C) I = Industrial (-40C to +85C) P or n/c = Commercial (0C to +70C)

1 = Reserved  
2 = Non PLL based  
3 = EMI Reduction  
4 = DDR support products  
5 = STD Zero Delay Buffer

6 = Power Management  
7 = Power Management  
8 = Power Management  
9 = Hi Performance  
0 = Reserved

PulseCore Semiconductor Mixed Signal Product



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Preliminary Information  
Part Number: PCS2I9942P  
Document Version: 0.4

Note: This product utilizes US Patent # 6,646,463 Impedance Emulator Patent issued to PulseCore Semiconductor, dated 11-11-2003

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