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## USB 2.0 Peak EMI reduction IC

### General Features

- 1x Peak EMI Reduction IC
- Input frequency:
  - 10MHz - 60MHz @ 2.5V
  - 10MHz - 70MHz @ 3.3V
- Output frequency:
  - 10MHz - 60MHz @ 2.5V
  - 10MHz - 70MHz @ 3.3V
- Supply Voltage: 2.5V±0.2V  
3.3V ±0.3V
- Analog Spread Selection up to ±0.5%
- ModRate selection option
- Commercial temperature range
- 8-pin TSSOP, SOIC and TDFN (2mmX2mm) Package
- Conforms to USB2.0 compliance standards
- The First True Drop-in Solution

### Product Description

PCS3P73U00A is a versatile, 3.3V / 2.5V Peak EMI reduction IC. PCS3P73U00A accepts an input clock either from a Crystal or from an external reference (AC or DC

coupled to XIN / CLKIN) and locks on to it delivering a 1x modulated clock output. PCS3P73U00A has a Frequency Selection (FS) control that facilitates selecting one of the two frequency ranges within the operating frequency range. Refer to the *Frequency Selection Table* for details.

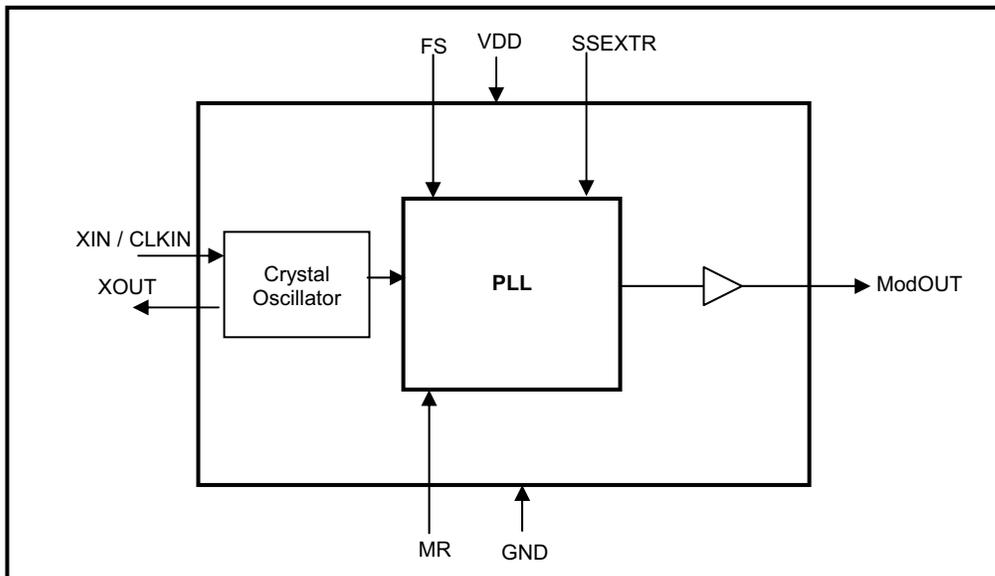
PCS3P73U00A has an SSEXTR pin to select different deviations depending upon the value of an external resistor connected between SSEXTR and GND. Modulation Rate (MR) control selects two different Modulation Rates.

PCS3P73U00A operates from a 3.3V / 2.5V supply and is available in an 8-pin TSSOP, SOIC, and TDFN (2mmX2mm) packages, over commercial temperature range.

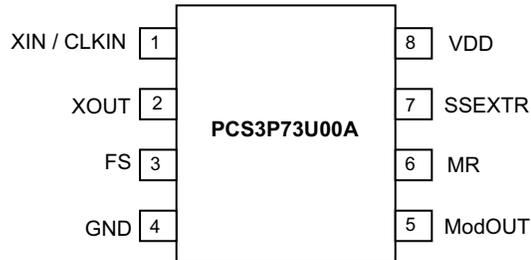
### Application

PCS3P73U00A is targeted for USB applications. Refer to *SSEXTR Resistance Table for USB2.0 Compliance* for commonly used frequencies.

### Block Diagram



## Pin Configuration



## Pin Description

| Pin # | Pin Name    | Pin Type | Description   |
|-------|-------------|----------|---|
| 1     | XIN / CLKIN | I        | Crystal connection or external reference clock input.   |
| 2     | XOUT        | O        | Crystal connection. If using an external reference, this pin should be left open.   |
| 3     | FS          | I        | Frequency Select. Pull LOW to select Low Frequency range. Selects High Frequency range when pulled HIGH. Has an internal pull-up resistor (see <i>Frequency Selection Table</i> for details). |
| 4     | GND         | P        | Ground.   |
| 5     | ModOUT      | O        | Buffered Modulated clock output.  |
| 6     | MR          | I        | Modulation Rate Select. When LOW selects Low Modulation Rate. Selects High Modulation Rate when pulled HIGH. Has an internal pull-down resistor.  |
| 7     | SSEXTR      | I        | Analog Spread Selection through external resistor to GND.   |
| 8     | VDD         | P        | 3.3V / 2.5V supply Voltage  |

## Frequency Selection table

| VDD(V) | FS | Frequency (MHz) |
|--------|----|-----------------|
| 2.5V   | 0  | 10-20           |
|        | 1  | 20-60           |
| 3.3V   | 0  | 10-27           |
|        | 1  | 20-70           |

## Absolute Maximum Rating

| Symbol    | Parameter   | Rating       | Unit |
|-----------|---|--------------|------|
| $V_{DD}$  | Voltage on any pin with respect to Ground             | -0.5 to +4.6 | V    |
| $T_{STG}$ | Storage temperature                                   | -65 to +125  | °C   |
| $T_s$     | Max. Soldering Temperature (10 sec)                   | 260          | °C   |
| $T_J$     | Junction Temperature                                  | 150          | °C   |
| $T_{DV}$  | Static Discharge Voltage (As per JEDEC STD22- A114-B) | 2            | KV   |

Note: 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.

## Operating Conditions

| Parameter      | Description                                 | Min | Max | Unit |
|----------------|---|-----|-----|------|
| $V_{DD(3.3V)}$ | Supply Voltage                              | 3.0 | 3.6 | V    |
| $V_{DD(2.5V)}$ | Supply Voltage                              | 2.3 | 2.7 | V    |
| $T_A$          | Operating Temperature (Ambient Temperature) | 0   | +70 | °C   |
| $C_L$          | Load Capacitance                            |     | 10  | pF   |
| $C_{IN}$       | Input Capacitance                           |     | 7   | pF   |

## Electrical Characteristics for 3.3V Supply voltage

| Parameter | Description            | Test Conditions           | Min           | Typ | Max | Unit |
|-----------|------------------------|---------------------------|---------------|-----|-----|------|
| $V_{DD}$  | Supply Voltage         |                           | 3.0           | 3.3 | 3.6 | V    |
| $V_{IL}$  | Input LOW Voltage      |                           |               |     | 0.8 | V    |
| $V_{IH}$  | Input HIGH Voltage     |                           | 2.0           |     |     | V    |
| $I_{IL}$  | Input LOW Current      | $V_{IN} = 0V$             |               |     | -50 | μA   |
| $I_{IH}$  | Input HIGH Current     | $V_{IN} = V_{DD}$         |               |     | 50  | μA   |
| $V_{OL}$  | Output LOW Voltage     | $I_{OL} = 8mA$            |               |     | 0.4 | V    |
| $V_{OH}$  | Output HIGH Voltage    | $I_{OH} = -8mA$           | 2.4           |     |     | V    |
| $I_{CC}$  | Static Supply Current  | XIN / CLKIN pulled to GND |               |     | 750 | μA   |
| $I_{DD}$  | Dynamic Supply Current | Unloaded outputs          | FS=0; @ 12MHz | 8   |     | mA   |
|           |                        |                           | FS=1; @ 48MHz | 12  |     |      |
| $Z_o$     | Output Impedance       |                           |               | 30  |     | Ω    |

## Switching Characteristics for 3.3 Supply Voltage

| Parameter                            | Test Conditions   | Min | Typ  | Max | Unit |
|--------------------------------------|---|-----|------|-----|------|
| Input Frequency                      | FS=0  | 10  | 12   | 27  | MHz  |
|                                      | FS=1  | 20  | 48   | 70  |      |
| ModOUT                               | FS=0  | 10  | 12   | 27  |      |
|                                      | FS=1  | 20  | 48   | 70  |      |
| Duty Cycle <sup>1,2</sup>            | Measured at $V_{DD}/2$  | 45  | 50   | 55  | %    |
| Rise Time <sup>1,2</sup>             | Measured between 20% to 80%                                   |     | 1.1  |     | nS   |
| Fall Time <sup>1,2</sup>             | Measured between 80% to 20%                                   |     | 0.7  |     | nS   |
| Cycle-to-Cycle Jitter <sup>1,2</sup> | Loaded outputs  |     | ±150 |     | pS   |
| PLL Lock Time <sup>2</sup>           | Stable power supply, valid clock presented on XIN / CLKIN pin |     |      | 3   | mS   |

Notes: 1. All parameters are specified with 10pF loaded outputs.  
2. Parameter is guaranteed by design and characterization. Not 100% tested in production.

## Electrical Characteristics for 2.5V Supply voltage

| Parameter | Description            | Test Conditions           | Min           | Typ | Max | Unit |
|-----------|------------------------|---------------------------|---------------|-----|-----|------|
| $V_{DD}$  | Supply Voltage         |                           | 2.3           | 2.5 | 2.7 | V    |
| $V_{IL}$  | Input LOW Voltage      |                           |               |     | 0.7 | V    |
| $V_{IH}$  | Input HIGH Voltage     |                           | 1.7           |     |     | V    |
| $I_{IL}$  | Input LOW Current      | $V_{IN} = 0V$             |               |     | -50 | μA   |
| $I_{IH}$  | Input HIGH Current     | $V_{IN} = V_{DD}$         |               |     | 50  | μA   |
| $V_{OL}$  | Output LOW Voltage     | $I_{OL} = 8mA$            |               |     | 0.6 | V    |
| $V_{OH}$  | Output HIGH Voltage    | $I_{OH} = -8mA$           | 1.8           |     |     | V    |
| $I_{CC}$  | Static Supply Current  | XIN / CLKIN pulled to GND |               |     | 500 | μA   |
| $I_{DD}$  | Dynamic Supply Current | Unloaded outputs          | FS=0; @ 12MHz | 5   |     | mA   |
|           |                        |                           | FS=1; @ 48MHz | 8   |     |      |
| $Z_o$     | Output Impedance       |                           |               | 40  |     | Ω    |

## Switching Characteristics for 2.5V Supply Voltage

| Parameter                         | Test Conditions   | Min | Typ  | Max | Unit |
|-----------------------------------|---|-----|------|-----|------|
| Input Frequency                   | FS=0  | 10  | 12   | 20  | MHz  |
|                                   | FS=1  | 20  | 48   | 60  |      |
| ModOUT                            | FS=0  | 10  | 12   | 20  |      |
|                                   | FS=1  | 20  | 48   | 60  |      |
| Duty Cycle <sup>1,2</sup>         | Measured at $V_{DD}/2$  | 45  | 50   | 55  | %    |
| Rise Time <sup>1,2</sup>          | Measured between 20% to 80%                                   |     | 1.6  |     | nS   |
| Fall Time <sup>1,2</sup>          | Measured between 80% to 20%                                   |     | 0.8  |     | nS   |
| Cycle-Cycle Jitter <sup>1,2</sup> | Loaded outputs  |     | ±200 |     | pS   |
| PLL Lock Time <sup>2</sup>        | Stable power supply, valid clock presented on XIN / CLKIN pin |     |      | 3   | mS   |

Notes: 1. All parameters are specified with 10pF loaded outputs.  
2. Parameter is guaranteed by design and characterization. Not 100% tested in production.

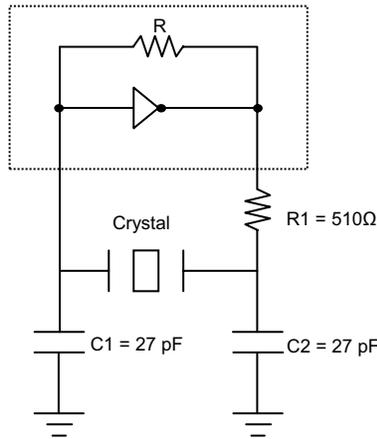


Fig. 1: Typical Crystal Interface Circuit

Note: For AC Coupled Interface refer to Application Brief: CT100801.

Typical Crystal Specifications

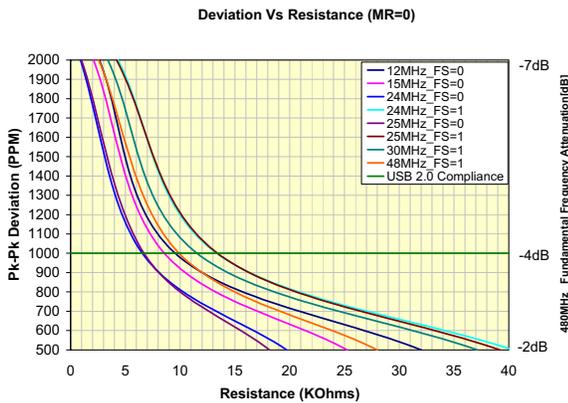
| Fundamental AT cut parallel resonant crystal |                          |
|--|--------------------------|
| Nominal frequency                            | 48MHz                    |
| Frequency tolerance                          | ±50ppm or better at 25°C |
| Operating temperature range                  | -25°C to +85°C           |
| Storage temperature                          | -40°C to +85°C           |
| Load capacitance                             | 18pF                     |
| Shunt capacitance                            | 7pF maximum              |
| ESR  | 25 Ω                     |

**R<sub>Compliance</sub>**

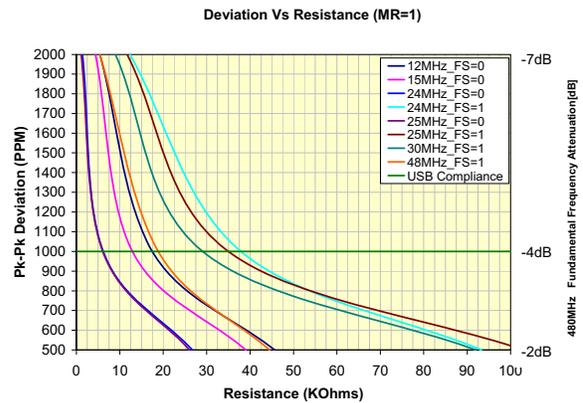
The value of the compliance resistor, R<sub>Compliance</sub> sets the USB2.0 signaling rate (frequency) deviation to 1000ppm peak-to-peak (+/-500ppm). It causes a -4dB peak power EMI reduction at the 480MHz fundamental USB2.0 frequency. Higher harmonics are reduced more.

If the R<sub>Compliance</sub> is set to a lower value than its compliance limit, it will set the USB2.0 signaling rate (frequency) deviation to above 1000ppm peak-to-peak. For settings above 1000ppm the USB2.0 compliance pass/fail

becomes gradually intermittent. USB2.0 functionality is maintained upto 3000ppm peak-to-peak signaling rate (frequency) deviation. The EMI tradeoff in the system is attenuation/compliance. While fully functional (and compliant intermittent) the 2000ppm frequency deviation can provide -7dB of EMI attenuation at the 480MHz fundamental.



**Fig. 2: Deviation Vs Resistance for USB 2.0 Compliance (MR=0)**



**Fig. 3: Deviation Vs Resistance for USB 2.0 Compliance (MR=1)**

### SSEXTR Resistance Table for USB2.0 compliance ( $R_{Compliance}$ )

VDD = 3.3V; MR = 0

| Frequency (MHz) | FS (MHz) | SSEXTR <sup>1</sup> Resistance (K $\Omega$ ) |
|-----------------|----------|--|
| 12              | 0        | 10   |
| 15              | 0        | 8.87   |
| 24              | 0        | 6.81   |
|                 | 1        | 13.7   |
| 25              | 0        | 6.98   |
|                 | 1        | 13.7   |
| 30              | 1        | 12.1   |
| 48              | 1        | 10   |

VDD = 3.3V; MR = 1

| Frequency (MHz) | FS (MHz) | SSEXTR <sup>1</sup> Resistance (K $\Omega$ ) |
|-----------------|----------|--|
| 12              | 0        | 17.8   |
| 15              | 0        | 13   |
| 24              | 0        | 6.49   |
|                 | 1        | 39.2   |
| 25              | 0        | 6.49   |
|                 | 1        | 35.7   |
| 30              | 1        | 29.4   |
| 48              | 1        | 19.1   |

VDD = 2.5V; MR = 0

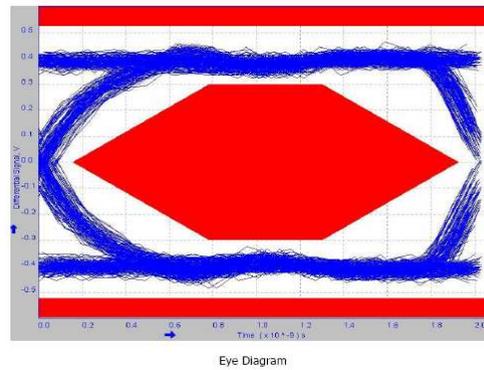
| Frequency (MHz) | FS (MHz) | SSEXTR <sup>1</sup> Resistance (K $\Omega$ ) |
|-----------------|----------|--|
| 12              | 0        | 10   |
| 15              | 0        | 8.87   |
| 24              | 1        | 13.7   |
| 25              | 1        | 13.7   |
| 30              | 1        | 12.1   |
| 48              | 1        | 10   |

VDD = 2.5V; MR = 1

| Frequency (MHz) | FS (MHz) | SSEXTR <sup>1</sup> Resistance (K $\Omega$ ) |
|-----------------|----------|--|
| 12              | 0        | 17.8   |
| 15              | 0        | 13   |
| 24              | 1        | 39.2   |
| 25              | 1        | 35.7   |
| 30              | 1        | 29.4   |
| 48              | 1        | 19.1   |

**Note:** 1. Standard 1% tolerance Resistors.  
Device to Device variation of Deviation is  $\pm 10\%$ .

**Fig. 4:Eye Diagram example (480MHz)** computed from the USB-IF test pattern during USB2.0 compliance verification of an existing HOST PHY ASIC clocked at 48MHz by PCS3P73U00A.



Results based on USB-IF / Waiver Limits:

| Measurement Name   | Minimum      | Maximum      | Mean         | pk-pk      | Standard Deviation | RMS          | Population | Status |
|--------------------|--------------|--------------|--------------|------------|--------------------|--------------|------------|--------|
| Monotonic Property | -            | -            | -            | -          | -                  | -            | 0          | Pass   |
| Eye Diagram Test   | -            | -            | -            | -          | -                  | -            | -          | Pass   |
| Signal Rate        | 471.8836Mbps | 488.7984Mbps | 479.8467Mbps | 0.0000bps  | 2.881103Mbps       | 480.0828Mbps | 512        | Pass   |
| EOP Width          | -            | -            | 15.74583ns   | -          | -                  | -            | 1          | Pass   |
| EOP Width (Bits)   | -            | -            | 7.555586     | -          | -                  | -            | 1          | Pass   |
| Rise Time          | 568.8889ps   | 854.1667ps   | 692.4406ps   | 285.2778ps | 58.62538ps         | 694.8948ps   | 107        | Pass   |
| Fall Time          | 554.5263ps   | 825.0000ps   | 691.5909ps   | 270.4737ps | 55.33780ps         | 693.7807ps   | 107        | Pass   |

Monotonicity test is performed on the test limits of 25.0% and 75.0%.

Additional Information:

Consecutive Jitter range: -79.57ps to 88.44ps      RMS Jitter    37.01ps  
 KJ Paired Jitter range: -61.95ps to 75.99ps      RMS Jitter    17.61ps  
 JK Paired Jitter range: -37.71ps to 49.32ps      RMS Jitter    15.43ps

\*The Overall Result for this test is **Pass**, because one or more individual status of the measurements is **Pass**.  
 For this test, the recommended configuration for USB2 testing (as per USB-IF) is on Tier 1.

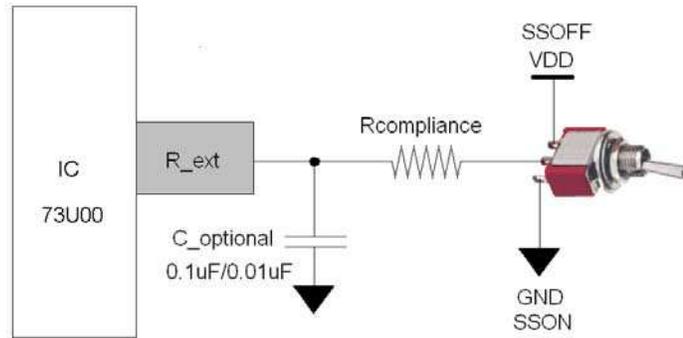


Fig. 5: EMI Radiated Emission Test Circuit (requires USB PHY ASIC, not shown here)

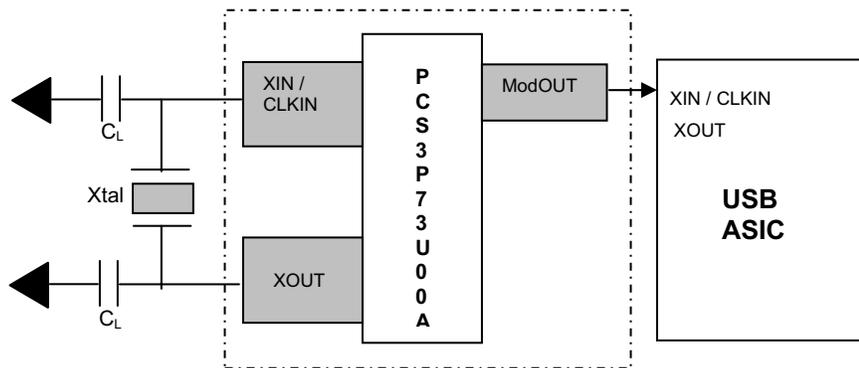
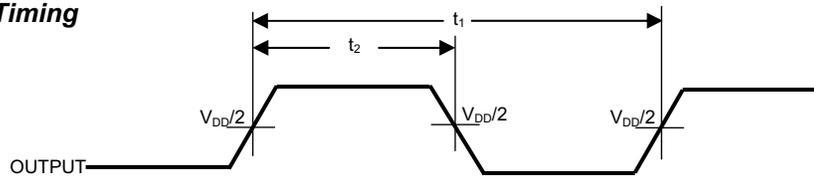


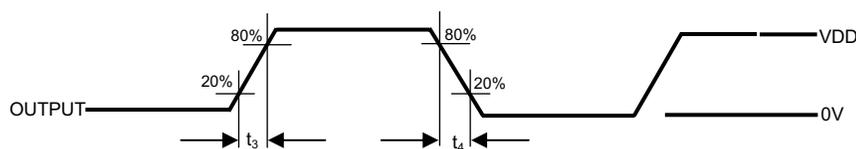
Fig. 6: Typical Application Circuit

**Switching Waveforms**

**Duty Cycle Timing**

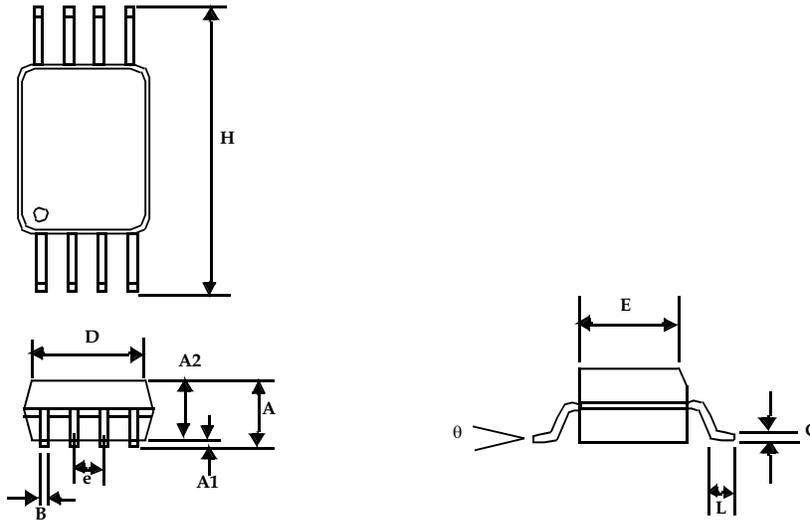


**Output Rise/Fall Time**



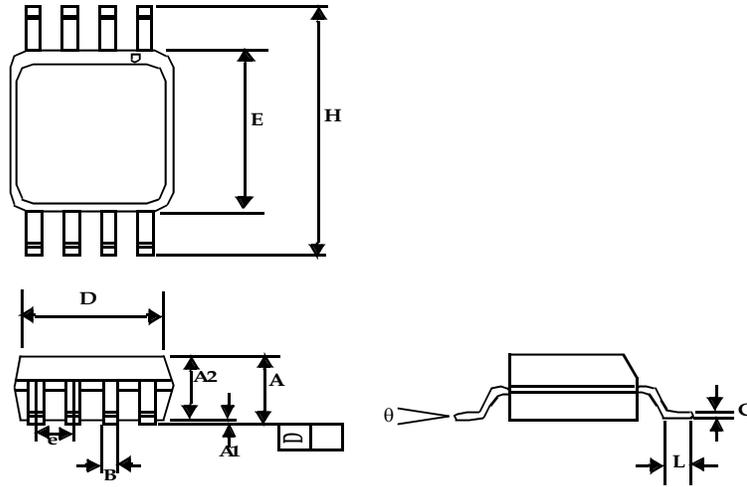
Package Information

8-lead TSSOP (4.40-MM Body)



| Symbol | Dimensions |       |             |      |
|--------|------------|-------|-------------|------|
|        | Inches     |       | Millimeters |      |
|        | Min        | Max   | Min         | Max  |
| A      |            | 0.043 |             | 1.10 |
| A1     | 0.002      | 0.006 | 0.05        | 0.15 |
| A2     | 0.033      | 0.037 | 0.85        | 0.95 |
| B      | 0.008      | 0.012 | 0.19        | 0.30 |
| C      | 0.004      | 0.008 | 0.09        | 0.20 |
| D      | 0.114      | 0.122 | 2.90        | 3.10 |
| E      | 0.169      | 0.177 | 4.30        | 4.50 |
| e      | 0.026 BSC  |       | 0.65 BSC    |      |
| H      | 0.252 BSC  |       | 6.40 BSC    |      |
| L      | 0.020      | 0.028 | 0.50        | 0.70 |
| theta  | 0°         | 8°    | 0°          | 8°   |

8-Pin SOIC

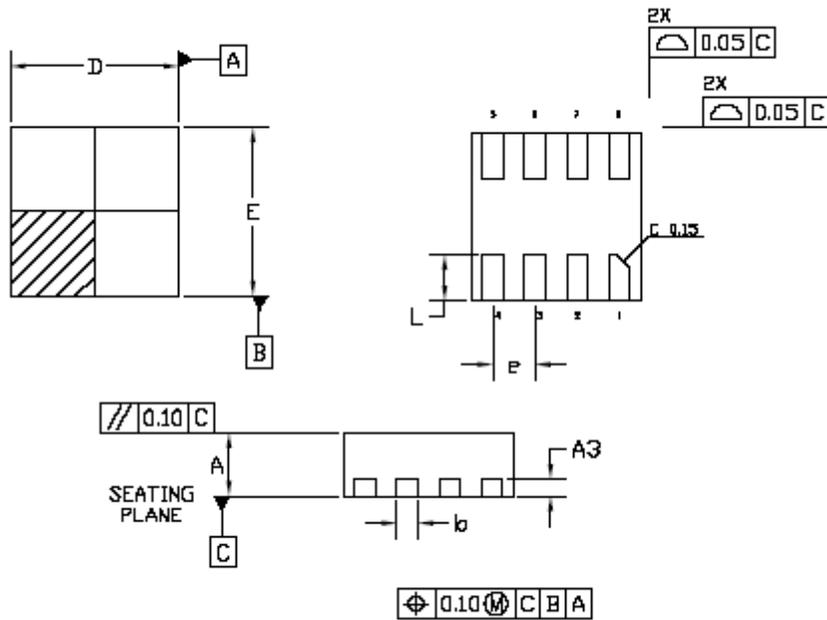


| Symbol   | Dimensions |       |             |      |
|----------|------------|-------|-------------|------|
|          | Inches     |       | Millimeters |      |
|          | Min        | Max   | Min         | Max  |
| A1       | 0.004      | 0.010 | 0.10        | 0.25 |
| A        | 0.053      | 0.069 | 1.35        | 1.75 |
| A2       | 0.049      | 0.059 | 1.25        | 1.50 |
| B        | 0.012      | 0.020 | 0.31        | 0.51 |
| C        | 0.007      | 0.010 | 0.18        | 0.25 |
| D        | 0.193 BSC  |       | 4.90 BSC    |      |
| E        | 0.154 BSC  |       | 3.91 BSC    |      |
| e        | 0.050 BSC  |       | 1.27 BSC    |      |
| H        | 0.236 BSC  |       | 6.00 BSC    |      |
| L        | 0.016      | 0.050 | 0.41        | 1.27 |
| $\theta$ | 0°         | 8°    | 0°          | 8°   |

TDFN (2mmX2mm) 8L package Outline drawing

TOP VIEW

BOTTOM VIEW



SIDE VIEW

| Symbol | Dimensions |        |             |      |
|--------|------------|--------|-------------|------|
|        | Inches     |        | Millimeters |      |
|        | Min        | Max    | Min         | Max  |
| A      | 0.027      | 0.0315 | 0.70        | 0.80 |
| A3     | 0.008 BSC  |        | 0.203 BSC   |      |
| b      | 0.008      | 0.012  | 0.20        | 0.30 |
| D      | 0.079 BSC  |        | 2.00 BSC    |      |
| E      | 0.078 BSC  |        | 2.00 BSC    |      |
| e      | 0.020 BSC  |        | 0.50 BSC    |      |
| L      | 0.020      | 0.024  | 0.50        | 0.60 |
| e      | 0.020 BSC  |        | 0.50 BSC    |      |
| L      | 0.020      | 0.024  | 0.50        | 0.60 |

**Ordering Code**

| Part Number     | Marking | Package                                 | Temperature  |
|-----------------|---------|---|--------------|
| P3P73U00AG-08SR | BML     | 8-Pin SOIC, Tape & Reel, Green          | 0°C to +70°C |
| P3P73U00AG-08ST | BML     | 8-Pin SOIC, Tube, Green                 | 0°C to +70°C |
| PCP73U00AG-08TR | BML     | 8-Pin TSSOP, Tape & Reel, Green         | 0°C to +70°C |
| P3P73U00AG-08TT | BML     | 8-Pin TSSOP, Tube, Green                | 0°C to +70°C |
| P3P73U00AG-08CR | BM      | 8-Pin TDFN (2mmX2mm),Tape & Reel, Green | 0°C to +70°C |

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