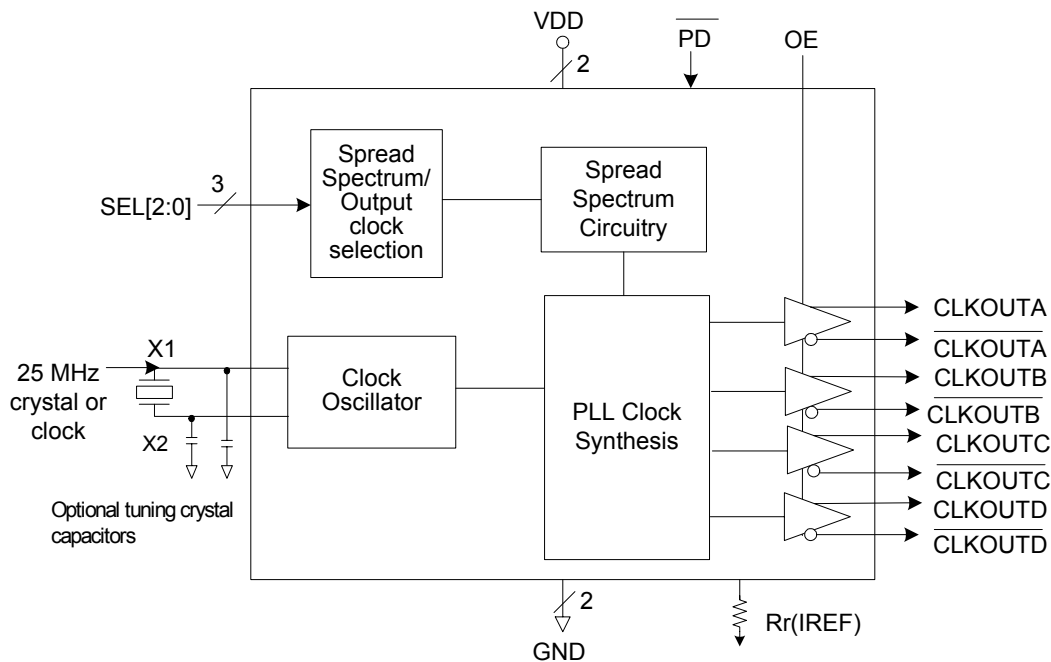


QUAD DIFFERENTIAL PCI-EXPRESS CLOCK SOURCE
ICS557-05A
Description

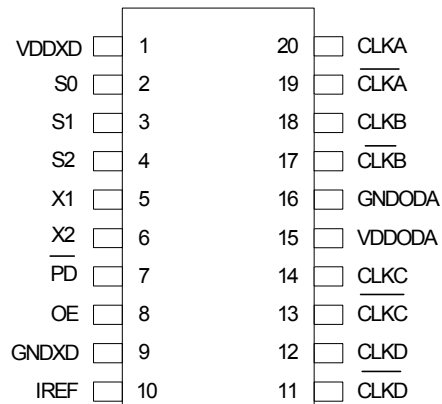
The ICS557-05A is a spread-spectrum clock generator that supports PCI-Express requirements. It is used in PC or embedded systems to substantially reduce electro-magnetic interference (EMI). The device provides four differential HCSL or LVDS high-frequency outputs with spread spectrum capability. The output frequency and spread type are selectable using external pins.

Features

- Packaged in 20-pin TSSOP
- Available in RoHS 5 (green) or RoHS 6 (green and lead free) complaint package
- Supports PCI-Express applications
- Four differential spread spectrum clock outputs
- Spread spectrum for EMI reduction
- Uses external 25 MHz clock or crystal input
- Power down pin turns off chip
- OE control tri-states outputs
- Spread and frequency selection via external pins
- Spread Bypass option available
- Industrial temperature range available

Block Diagram


Pin Assignment



20-pin (173 mil) TSSOP

Spread Spectrum Selection Table

| S2 | S1 | S0 | Spread% | Spread Type | Output Frequency |
|----|----|----|-----------|----------------|------------------|
| 0 | 0 | 0 | -0.5 | Down | 100 |
| 0 | 0 | 1 | -1.0 | Down | 100 |
| 0 | 1 | 0 | -1.5 | Down | 100 |
| 0 | 1 | 1 | No Spread | Not Applicable | 100 |
| 1 | 0 | 0 | -0.5 | Down | 200 |
| 1 | 0 | 1 | -1.0 | Down | 200 |
| 1 | 1 | 0 | -1.5 | Down | 200 |
| 1 | 1 | 1 | No Spread | Not Applicable | 200 |

Pin Descriptions

| Pin | Pin Name | Pin Type | Pin Description |
|-----|----------|----------|--|
| 1 | VDDXD | Power | Connect to +3.3 V digital supply. |
| 2 | S0 | Input | Spread spectrum select pin #0. See table above. Internal pull-up resistor. |
| 3 | S1 | Input | Spread spectrum select pin #1. See table above. Internal pull-up resistor. |
| 4 | S2 | Input | Spread spectrum select pin #2. See table above. Internal pull-up resistor. |
| 5 | X1 | Input | Crystal connection. Connect to a fundamental mode crystal or clock input. |
| 6 | X2 | Output | Crystal connection. Connect to a fundamental mode crystal or leave open. |
| 7 | PD | Input | Powers down all PLL's and tri-states outputs when low. Internal pull-up resistor. |
| 8 | OE | Input | Provides output on, tri-states output (High = enable outputs; Low = disable outputs). Internal pull-up resistor. |
| 9 | GND | Power | Connect to digital ground. |
| 10 | IREF | Output | Precision resistor attached to this pin is connected to the internal current reference. |
| 11 | CLKD | Output | Selectable 100/200 MHz spread spectrum differential Compliment output clock D. |
| 12 | CLKD | Output | Selectable 100/200 MHz spread spectrum differential True output clock D. |
| 13 | CLKC | Output | Selectable 100/200 MHz spread spectrum differential Compliment output clock C. |
| 14 | CLKC | Output | Selectable 100/200 MHz spread spectrum differential True output clock C. |
| 15 | VDDODA | Power | Connect to +3.3 V analog supply. |
| 16 | GND | Power | Connect to analog ground. |
| 17 | CLKB | Output | Selectable 100/200 MHz spread spectrum differential Compliment output clock B. |
| 18 | CLKB | Output | Selectable 100/200 MHz spread spectrum differential True output clock B. |
| 19 | CLKA | Output | Selectable 100/200 MHz spread spectrum differential Compliment output clock A. |
| 20 | CLKA | Output | Selectable 100/200 MHz spread spectrum differential True output clock A. |

Application Information

Decoupling Capacitors

As with any high-performance mixed-signal IC, the ICS557-05A must be isolated from system power supply noise to perform optimally.

Decoupling capacitors of 0.01 μ F must be connected between each VDD and the PCB ground plane.

PCB Layout Recommendations

For optimum device performance and lowest output phase noise, the following guidelines should be observed.

Each 0.01 μ F decoupling capacitor should be mounted on the component side of the board as close to the VDD pin as possible. No vias should be used between decoupling capacitor and VDD pin. The PCB trace to VDD pin should be kept as short as possible, as should the PCB trace to the ground via. Distance of the ferrite bead and bulk decoupling from the device is less critical.

2) An optimum layout is one with all components on the same side of the board, minimizing vias through other signal layers (the ferrite bead and bulk decoupling capacitor can be mounted on the back). Other signal traces should be routed away from the ICS557-05A.

This includes signal traces just underneath the device, or on layers adjacent to the ground plane layer used by the device.

External Components

A minimum number of external components are required for proper operation. Decoupling capacitors of 0.01 μ F should be connected between VDD and GND pairs (1,9 and 15,16) as close to the device as possible.

On chip capacitors- Crystal capacitors should be connected from pins X1 to ground and X2 to ground to optimize the initial accuracy. The value (in pf) of these crystal caps equal $(C_L - 12) * 2$ in this equation, C_L =crystal load capacitance in pf. For example, for a crystal with a 16 pF load cap, each external crystal cap would be 8 pF.
 $[(16-12) \times 2] = 8$.

Current Reference Source R_r (I_{ref})

If board target trace impedance (Z) is 50 Ω , then $R_r = 475\Omega$ (1%), providing IREF of 2.32 mA, output current (I_{OH}) is equal to 6*IREF.

Load Resistors R_L

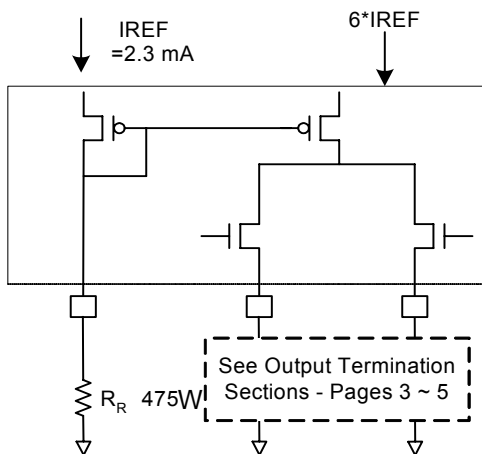
Since the clock outputs are open source outputs, 50 ohm external resistors to ground are to be connected at each clock output.

Output Termination

The PCI-Express differential clock outputs of the ICS557-05A are open source drivers and require an external series resistor and a resistor to ground. These resistor values and their allowable locations are shown in detail in the **PCI-Express Layout Guidelines** section.

The ICS557-05A can also be configured for LVDS compatible voltage levels. See the **LVDS Compatible Layout Guidelines** section.

Output Structures



General PCB Layout Recommendations

For optimum device performance and lowest output phase noise, the following guidelines should be observed.

1. Each 0.01μF decoupling capacitor should be mounted on the component side of the board as close to the VDD pin as possible.
2. No vias should be used between decoupling capacitor and VDD pin.
3. The PCB trace to VDD pin should be kept as short as possible, as should the PCB trace to the ground via. Distance of the ferrite bead and bulk decoupling from the device is less critical.
4. An optimum layout is one with all components on the same side of the board, minimizing vias through other signal layers (any ferrite beads and bulk decoupling capacitors can be mounted on the back). Other signal traces should be routed away from the ICS557-05A. This includes signal traces just underneath the device, or on layers adjacent to the ground plane layer used by the device.

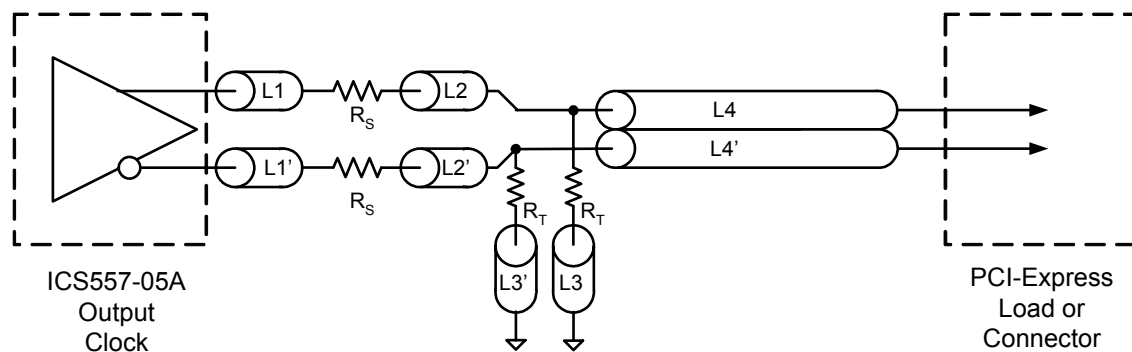
PCI-Express Layout Guidelines

| Common Recommendations for Differential Routing | Dimension or Value | Unit |
|---|--------------------|------|
| L1 length, Route as non-coupled 50 ohm trace. | 0.5 max | inch |
| L2 length, Route as non-coupled 50 ohm trace. | 0.2 max | inch |
| L3 length, Route as non-coupled 50 ohm trace. | 0.2 max | inch |
| R_S | 33 | ohm |
| R_T | 49.9 | ohm |

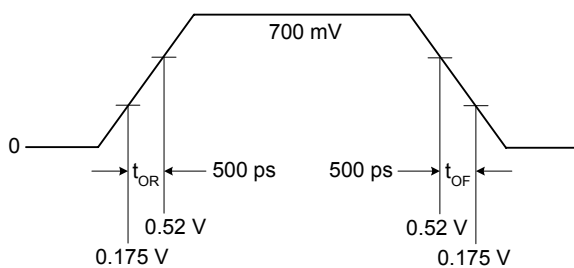
| Differential Routing on a Single PCB | Dimension or Value | Unit |
|---|---------------------|------|
| L4 length, Route as coupled microstrip 100 ohm differential trace. | 2 min to 16 max | inch |
| L4 length, Route as coupled stripline 100 ohm differential trace. | 1.8 min to 14.4 max | inch |

| Differential Routing to a PCI Express Connector | Dimension or Value | Unit |
|---|-----------------------|------|
| L4 length, Route as coupled microstrip 100 ohm differential trace. | 0.25 to 14 max | inch |
| L4 length, Route as coupled stripline 100 ohm differential trace. | 0.225 min to 12.6 max | inch |

PCI-Express Device Routing



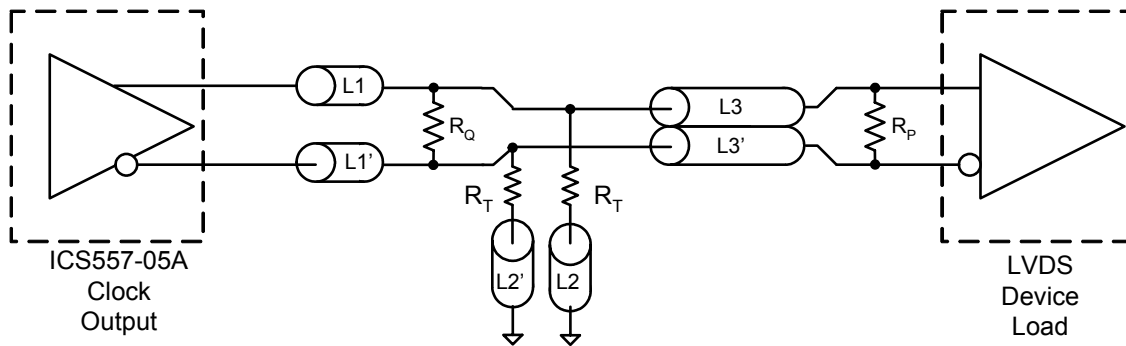
Typical PCI-Express (HCSL) Waveform



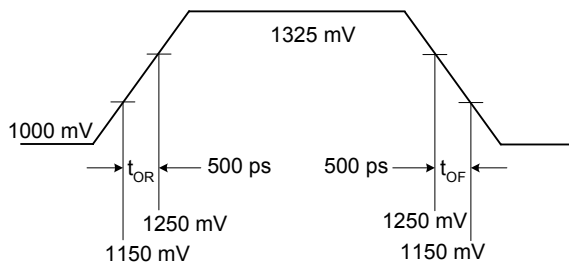
LVDS Compatible Layout Guidelines

| LVDS Recommendations for Differential Routing | Dimension or Value | Unit |
|--|--------------------|------|
| L1 length, Route as non-coupled 50 ohm trace. | 0.5 max | inch |
| L2 length, Route as non-coupled 50 ohm trace. | 0.2 max | inch |
| R_p | 100 | ohm |
| R_o | 100 | ohm |
| R_T | 150 | ohm |
| L3 length, Route as coupled 50 ohm differential trace. | | |
| L3 length, Route as coupled 50 ohm differential trace. | | |

LVDS Device Routing



Typical LVDS Waveform



Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS557-05A. These ratings are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

| Item | Rating |
|--|---------------------|
| Supply Voltage, VDD, VDDA | 5.5 V |
| All Inputs and Outputs | -0.5 V to VDD+0.5 V |
| Ambient Operating Temperature (commercial) | 0 to +70° C |
| Ambient Operating Temperature (industrial) | -40 to +85° C |
| Storage Temperature | -65 to +150° C |
| Junction Temperature | 125° C |
| Soldering Temperature | 260° C |
| ESD Protection (Input) | 2000 V min. (HBM) |

DC Electrical Characteristics

Unless stated otherwise, VDD = 3.3 V ±5%, Ambient Temperature -40 to +85° C

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|------------------------------------|-------------------|-------------------------------|---------|------|----------|-------|
| Supply Voltage | V | | 3.135 | | 3.465 | |
| Input High Voltage ¹ | V _{IH} | | 2.0 | | VDD +0.3 | V |
| Input Low Voltage ¹ | V _{IL} | | VSS-0.3 | | 0.8 | V |
| Input Leakage Current ² | I _{IL} | 0 < V _{in} < VDD | -5 | | 5 | μA |
| Operating Supply Current | I _{DD} | 50Ω, 2 pF load @100 MHz | | 105 | | mA |
| | I _{DDOE} | OE =Low | | 40 | | mA |
| | I _{DDPD} | No load, \overline{PD} =Low | | 500 | | μA |
| Input Capacitance | C _{IN} | Input pin capacitance | | | 7 | pF |
| Output Capacitance | C _{OUT} | Output pin capacitance | | | 6 | pF |
| Pin Inductance | L _{PIN} | | | | 5 | nH |
| Output Resistance | R _{out} | CLK outputs | 3.0 | | | kΩ |
| Pull-up Resistance | R _{PUP} | OE, SEL, \overline{PD} pins | | 110 | | kΩ |

1. Single edge is monotonic when transitioning through region.
2. Inputs with pull-ups/-downs are not included.

AC Electrical Characteristics - CLKOUTA/CLKOUTB

Unless stated otherwise, VDD=3.3 V ±5%, Ambient Temperature -40 to +85° C

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|---|---------------------|-------------------------------------|------|------|------|-------|
| Input Frequency | | | | 25 | | MHz |
| Output Frequency | | HCSL termination | | | 200 | MHz |
| | | LVDS termination | | | 100 | MHz |
| Output High Voltage ^{1,2} | V _{OH} | | 660 | 700 | 850 | mV |
| Output Low Voltage ^{1,2} | V _{OL} | | -150 | 0 | 27 | mV |
| Crossing Point Voltage ^{1,2} | | Absolute | 250 | 350 | 550 | mV |
| Crossing Point Voltage ^{1,2,4} | | Variation over all edges | | | 140 | mV |
| Jitter, Cycle-to-Cycle ^{1,3} | | | | | 80 | ps |
| Modulation Frequency | | Spread spectrum | 30 | 31.5 | 33 | kHz |
| Rise Time ^{1,2} | t _{OR} | From 0.175 V to 0.525 V | 175 | 332 | 700 | ps |
| Fall Time ^{1,2} | t _{OF} | From 0.525 V to 0.175 V | 175 | 344 | 700 | ps |
| Skew between outputs | | At crossing point Voltage | | | 50 | ps |
| Duty Cycle ^{1,3} | | | 45 | | 55 | % |
| Output Enable Time ⁵ | | All outputs | | | 10 | us |
| Output Disable Time ⁵ | | All outputs | | | 10 | us |
| Power-up Time | t _{STABLE} | From power-up VDD=3.3 V | | 3.0 | | ms |
| Spread Change Time | t _{SPREAD} | Settling period after spread change | | 3.0 | | ms |

¹ Test setup is R_L=50 ohms with 2 pF, R_r = 475Ω (1%).

² Measurement taken from a single-ended waveform.

³ Measurement taken from a differential waveform.

⁴ Measured at the crossing point where instantaneous voltages of both CLKOUT and $\overline{\text{CLKOUT}}$ are equal.

⁵ CLKOUT pins are tri-stated when OE is asserted low. CLKOUT is driven differential when OE is high unless its $\overline{\text{PD}}$ = low.

Thermal Characteristics

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|--|-----------------|----------------|------|------|------|-------|
| Thermal Resistance Junction to Ambient | θ _{JA} | Still air | | 93 | | °C/W |
| | θ _{JA} | 1 m/s air flow | | 78 | | °C/W |
| | θ _{JA} | 3 m/s air flow | | 65 | | °C/W |
| Thermal Resistance Junction to Case | θ _{JC} | | | 20 | | °C/W |

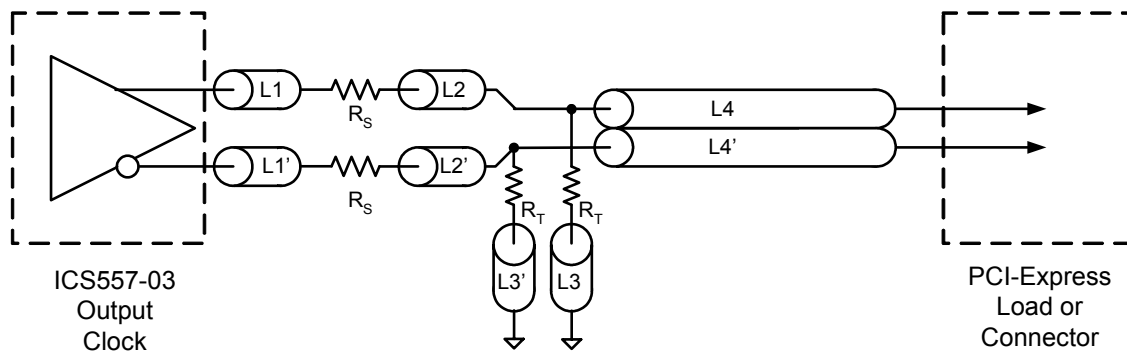
PCI-Express Layout Guidelines

| Common Recommendations for Differential Routing | Dimension or Value | Unit |
|---|--------------------|------|
| L1 length, Route as non-coupled 50 ohm trace. | 0.5 max | inch |
| L2 length, Route as non-coupled 50 ohm trace. | 0.2 max | inch |
| L3 length, Route as non-coupled 50 ohm trace. | 0.2 max | inch |
| R_S | 33 | ohm |
| R_T | 49.9 | ohm |

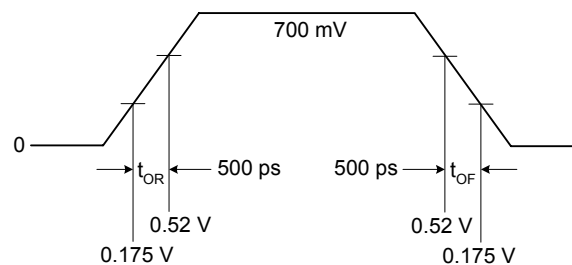
| Differential Routing on a Single PCB | Dimension or Value | Unit |
|---|---------------------|------|
| L4 length, Route as coupled microstrip 100 ohm differential trace. | 2 min to 16 max | inch |
| L4 length, Route as coupled stripline 100 ohm differential trace. | 1.8 min to 14.4 max | inch |

| Differential Routing to a PCI Express Connector | Dimension or Value | Unit |
|---|-----------------------|------|
| L4 length, Route as coupled microstrip 100 ohm differential trace. | 0.25 to 14 max | inch |
| L4 length, Route as coupled stripline 100 ohm differential trace. | 0.225 min to 12.6 max | inch |

PCI-Express Device Routing

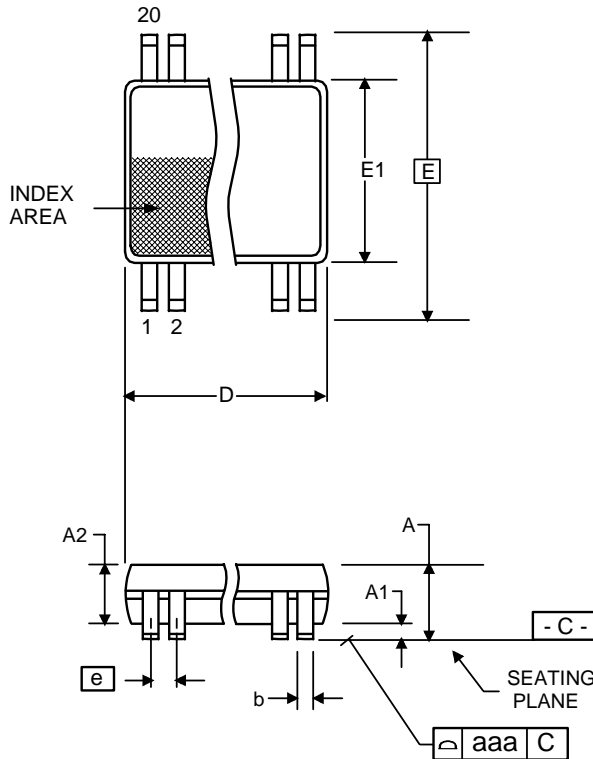


Typical PCI-Express (HCSL) Waveform

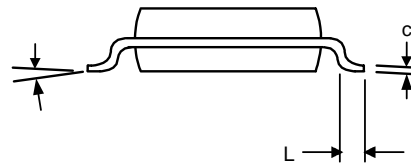


Package Outline and Package Dimensions (20-pin TSSOP, 173 mil Body)

Package dimensions are kept current with JEDEC Publication No. 95, MO-153



| Symbol | Millimeters | | Inches* | |
|--------|-------------|------|--------------|-------|
| | Min | Max | Min | Max |
| A | | 1.20 | | 0.047 |
| A1 | 0.05 | 0.15 | 0.002 | 0.006 |
| A2 | 0.80 | 1.05 | 0.032 | 0.041 |
| b | 0.19 | 0.30 | 0.007 | 0.012 |
| c | 0.09 | 0.20 | 0.0035 | 0.008 |
| D | 6.40 | 6.60 | 0.252 | 0.260 |
| E | 6.40 BASIC | | 0.252 BASIC | |
| E1 | 4.30 | 4.50 | 0.169 | 0.177 |
| e | 0.65 Basic | | 0.0256 Basic | |
| L | 0.45 | 0.75 | 0.018 | 0.030 |
| a | 0° | 8° | 0° | 8° |
| aaa | -- | 0.10 | -- | 0.004 |



Ordering Information

| Part / Order Number | Marking | Shipping Packaging | Package | Temperature |
|---------------------|-------------|--------------------|--------------|---------------|
| 557G-05A | ICS557G-05A | Tubes | 20-pin TSSOP | 0 to +70° C |
| 557G-05AT | ICS557G-05A | Tape and Reel | 20-pin TSSOP | 0 to +70° C |
| 557G-05ALF | 557G-05ALF | Tubes | 20-pin TSSOP | 0 to +70° C |
| 557G-05ALFT | 557G-05ALF | Tape and Reel | 20-pin TSSOP | 0 to +70° C |
| 557GI-05A | 557GI-05A | Tubes | 20-pin TSSOP | -40 to +85° C |
| 557GI-05AT | 557GI-05A | Tape and Reel | 20-pin TSSOP | -40 to +85° C |
| 557GI-05ALF | 557GI-05AL | Tubes | 20-pin TSSOP | -40 to +85° C |
| 557GI-05ALFT | 557GI-05AL | Tape and Reel | 20-pin TSSOP | -40 to +85° C |

Parts that are ordered with a "LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.

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