

## 2 TO 4 DIFFERENTIAL CLOCK MUX

## ICS557-06

### Description

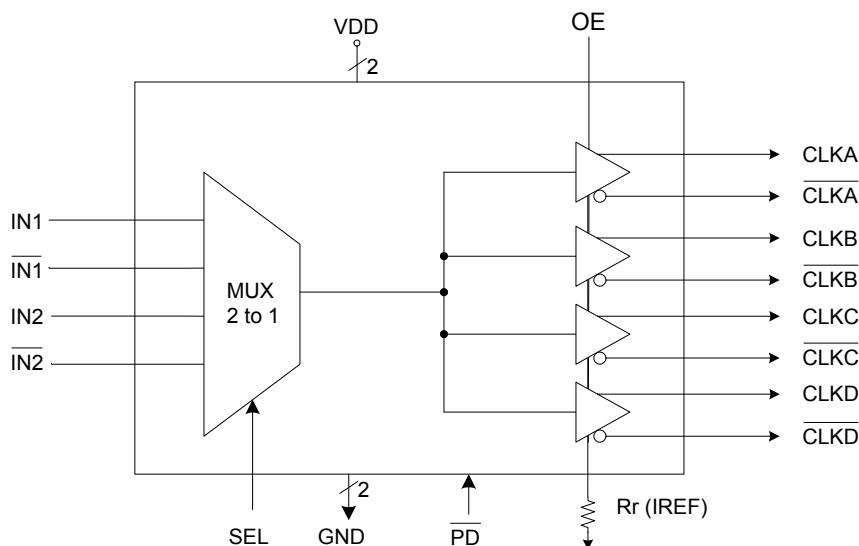
The ICS557-06 is a two to four differential clock mux designed for use in PCI-Express applications. The device selects one of the two differential HCSL or LVDS input pairs and fans out to four pairs of differential HCSL or LVDS outputs.

### Features

- Packaged in 20-pin TSSOP
- Available in Pb (lead) free package
- Operating voltage of 3.3 V
- Low power consumption
- Input differential clock of up to 200 MHz for HCSL and up to 100 MHz for LVDS
- Jitter 60 ps (cycle-to-cycle)
- Output-to-output skew of 50 ps
- Available in industrial temperature range (-40 to +85°C)

**NOTE: EOL for non-green parts to occur on 5/13/10 per PDN U-09-01**

### Block Diagram



## Pin Assignment

|                         |                          |    |    |                          |                          |
|-------------------------|--------------------------|----|----|--------------------------|--------------------------|
| SEL                     | <input type="checkbox"/> | 1  | 20 | <input type="checkbox"/> | CLKA                     |
| VDDIN                   | <input type="checkbox"/> | 2  | 19 | <input type="checkbox"/> | $\overline{\text{CLKA}}$ |
| IN1                     | <input type="checkbox"/> | 3  | 18 | <input type="checkbox"/> | CLKB                     |
| $\overline{\text{IN1}}$ | <input type="checkbox"/> | 4  | 17 | <input type="checkbox"/> | $\overline{\text{CLKB}}$ |
| $\overline{\text{PD}}$  | <input type="checkbox"/> | 5  | 16 | <input type="checkbox"/> | GND                      |
| IN2                     | <input type="checkbox"/> | 6  | 15 | <input type="checkbox"/> | VDD                      |
| $\overline{\text{IN2}}$ | <input type="checkbox"/> | 7  | 14 | <input type="checkbox"/> | CLKC                     |
| OE                      | <input type="checkbox"/> | 8  | 13 | <input type="checkbox"/> | $\overline{\text{CLKC}}$ |
| GND                     | <input type="checkbox"/> | 9  | 12 | <input type="checkbox"/> | CLKD                     |
| IREF                    | <input type="checkbox"/> | 10 | 11 | <input type="checkbox"/> | $\overline{\text{CLKD}}$ |

20-pin (173 mil) TSSOP

## Select Table

| SEL | Input Pair selected          |
|-----|------------------------------|
| 0   | IN2/ $\overline{\text{IN2}}$ |
| 1   | IN1/ $\overline{\text{IN1}}$ |

## Pin Descriptions

| Pin | Pin Name                 | Pin Type | Pin Description                                                                                                       |
|-----|--------------------------|----------|-----------------------------------------------------------------------------------------------------------------------|
| 1   | SEL                      | Input    | SEL=1 selects IN1/ $\overline{\text{IN1}}$ . SEL =0 selects IN2/ $\overline{\text{IN2}}$ . Internal pull-up resistor. |
| 2   | VDDIN                    | Power    | Connect to +3.3 V. Supply voltage for Input clocks.                                                                   |
| 3   | IN1                      | Input    | HCSL/LVDS true input signal 1.                                                                                        |
| 4   | $\overline{\text{IN1}}$  | Input    | HCSL/LVDS complimentary input signal 1.                                                                               |
| 5   | $\overline{\text{PD}}$   | Input    | Powers down the chip and tri-states outputs when low. Internal pull-up                                                |
| 6   | IN2                      | Input    | HCSL/LVDS true input signal 2.                                                                                        |
| 7   | $\overline{\text{IN2}}$  | Input    | HCSL/LVDS complimentary input signal 2.                                                                               |
| 8   | OE                       | Input    | Provides fast output on, tri-states output (High = enable outputs; Low = disable). Internal pull-up resistor outputs. |
| 9   | GND                      | Power    | Connect to ground.                                                                                                    |
| 10  | Rr(IREF)                 | Output   | Precision resistor attached to this pin is connected to the internal current                                          |
| 11  | CLKD                     | Output   | Differential Complimentary output clock D.                                                                            |
| 12  | $\overline{\text{CLKD}}$ | Output   | Differential True output clock D.                                                                                     |
| 13  | CLKC                     | Output   | Differential Complimentary output clock C.                                                                            |
| 14  | $\overline{\text{CLKC}}$ | Output   | Differential True output clock C.                                                                                     |
| 15  | VDDOUT                   | Power    | Connect to +3.3 V. Supply Voltage for Output Clocks.                                                                  |
| 16  | GND                      | Power    | Connect to ground.                                                                                                    |
| 17  | CLKB                     | Output   | Differential Complimentary output clock B.                                                                            |
| 18  | $\overline{\text{CLKB}}$ | Output   | Differential True output clock B.                                                                                     |
| 19  | CLKA                     | Output   | Differential Complimentary output clock A.                                                                            |
| 20  | $\overline{\text{CLKA}}$ | Output   | Differential True output clock A.                                                                                     |

## Application Information

### Decoupling Capacitors

As with any high-performance mixed-signal IC, the ICS557-06 must be isolated from system power supply noise to perform optimally.

Decoupling capacitors of 0.01 $\mu$ 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 $\mu$ 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 ICS557-06.

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  $\mu$ F should be connected between VDD and GND pairs (2,9 and 15,16) as close to the device as possible.

### Current Reference Source $R_r$ ( $I_{ref}$ )

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

### Load Resistors $R_L$

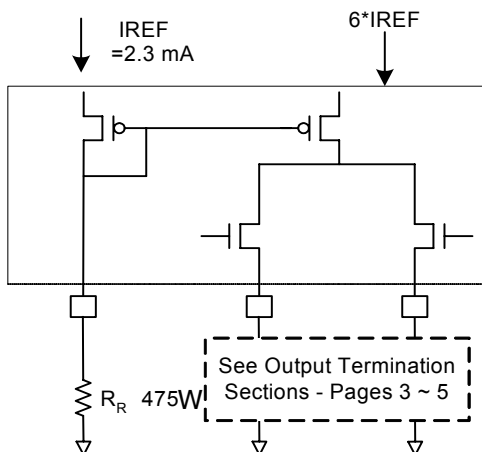
Since the clock outputs are open source outputs, 50 ohm external resistors to ground are to be connected at each clock output.

### Output Termination

The PCI-Express differential clock outputs of the ICS557-06 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 ICS557-06 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  $0.01\mu\text{F}$  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 ICS557-06. This includes signal traces just underneath the device, or on layers adjacent to the ground plane layer used by the device.

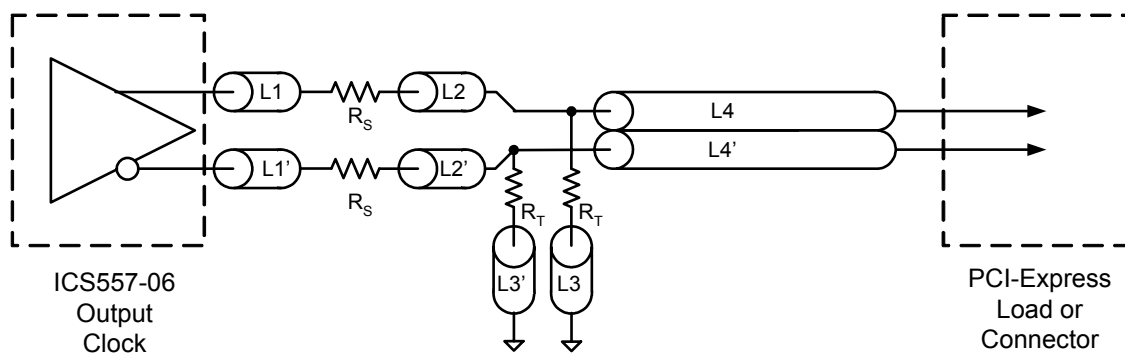
## PCI-Express Layout Guidelines

| 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  |

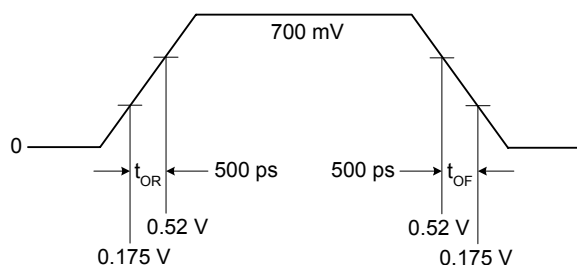
| Differential Routing on a Single PCB                                      | Dimension or Value  | Unit |
|---------------------------------------------------------------------------|---------------------|------|
| L4 length, Route as coupled <b>microstrip</b> 100 ohm differential trace. | 2 min to 16 max     | inch |
| L4 length, Route as coupled <b>stripline</b> 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 <b>microstrip</b> 100 ohm differential trace. | 0.25 to 14 max        | inch |
| L4 length, Route as coupled <b>stripline</b> 100 ohm differential trace.  | 0.225 min to 12.6 max | inch |

## PCI-Express Device Routing



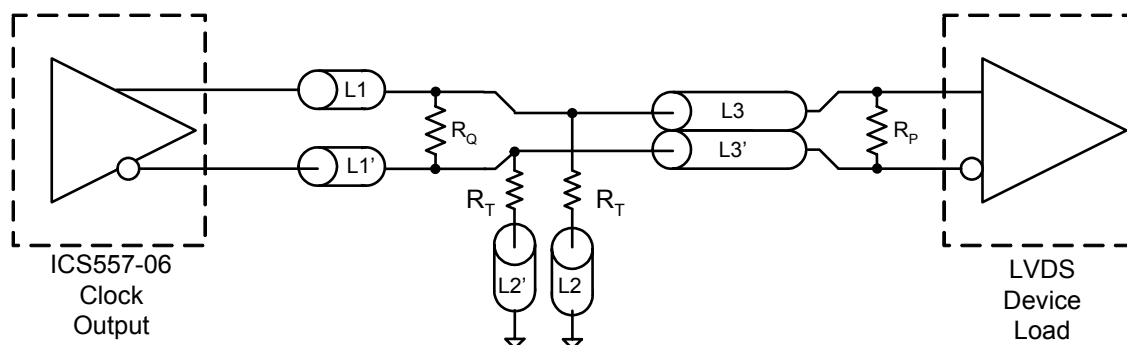
## Typical PCI-Express (HCSL) Waveform



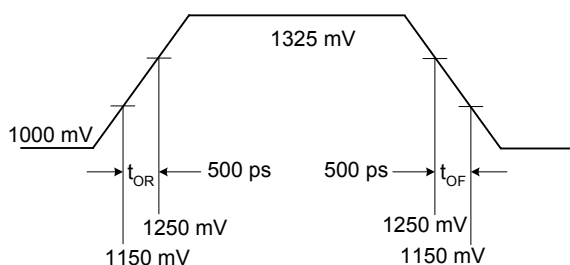
## LVDS Compatible Layout Guidelines

| 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 ICS557-06. 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 <sup>1</sup>    | V <sub>IH</sub>   | OE, SEL, $\overline{\text{PD}}$      | 2.0     |      | VDD +0.3 | V     |
| Input Low Voltage <sup>1</sup>     | V <sub>IL</sub>   | OE, SEL, $\overline{\text{PD}}$      | VSS-0.3 |      | 0.8      | V     |
| Input Leakage Current <sup>2</sup> | I <sub>IL</sub>   | 0 < V <sub>in</sub> < VDD            | -5      |      | 5        | μA    |
| Operating Supply Current           | I <sub>DD</sub>   | 50Ω, 2pF                             |         |      | 55       | mA    |
|                                    | I <sub>DDOE</sub> | OE =Low                              |         |      | 20       | mA    |
|                                    | I <sub>DDPD</sub> | No load, $\overline{\text{PD}}$ =Low |         |      | 400      | μA    |
| Input Capacitance                  | C <sub>IN</sub>   | Input pin capacitance                |         |      | 7        | pF    |
| Output Capacitance                 | C <sub>OUT</sub>  | Output pin capacitance               |         |      | 6        | pF    |
| Pin Inductance                     | L <sub>PIN</sub>  |                                      |         |      | 5        | nH    |
| Output Resistance                  | R <sub>OUT</sub>  | CLK outputs                          | 3.0     |      |          | kΩ    |
| Pull-up Resistor                   | R <sub>PUP</sub>  | SEL, OE, $\overline{\text{PD}}$      |         | 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                         |                    |                                                                                                                                |       |      | 200   | MHz   |
| Output Frequency                        |                    | HCSL termination                                                                                                               |       |      | 200   | MHz   |
|                                         |                    | LVDS termination                                                                                                               |       |      | 100   |       |
| Input High Voltage <sup>1,2</sup>       | V <sub>IH</sub>    | HCSL                                                                                                                           | 660   | 700  | 850   | mV    |
| Input Low Voltage <sup>1,2</sup>        | V <sub>IL</sub>    | HCSL                                                                                                                           | -150  | 0    |       | mV    |
| Differential Input Voltages             | (V <sub>ID</sub> ) | LVDS                                                                                                                           | 250   | 350  | 450   | mV    |
| Input Offset Voltage                    | (V <sub>IS</sub> ) | LVDS                                                                                                                           | 1.125 | 1.25 | 1.375 | V     |
| Output High Voltage <sup>1,2</sup>      | V <sub>OH</sub>    | HCSL                                                                                                                           | 660   | 700  | 850   | mV    |
| Output Low Voltage <sup>1,2</sup>       | V <sub>OL</sub>    | HCSL                                                                                                                           | -150  | 0    | 27    | mV    |
| Crossing Point Voltage <sup>1,2</sup>   |                    | Absolute                                                                                                                       | 250   | 350  | 550   | mV    |
| Crossing Point Voltage <sup>1,2,4</sup> |                    | Variation over all edges                                                                                                       |       |      | 140   | mV    |
| Jitter, Cycle-to-Cycle <sup>1,3</sup>   |                    |                                                                                                                                |       | 60   |       | ps    |
| Rise Time <sup>1,2</sup>                | t <sub>OR</sub>    | From 0.175 V to 0.525 V                                                                                                        | 175   | 332  | 700   | ps    |
| Fall Time <sup>1,2</sup>                | t <sub>OF</sub>    | From 0.525 V to 0.175 V                                                                                                        | 175   | 344  | 700   | ps    |
| Rise/Fall Time Variation <sup>1,2</sup> |                    |                                                                                                                                |       |      | 125   | ps    |
| Skew between Outputs                    |                    | Measured at crossing point                                                                                                     |       |      | 50    | ps    |
| Duty Cycle <sup>1,3</sup>               |                    |                                                                                                                                | 45    |      | 55    | %     |
| Output Enable Time <sup>5</sup>         |                    | All outputs                                                                                                                    |       | 10   |       | us    |
| Output Disable Time <sup>5</sup>        |                    | All outputs                                                                                                                    |       | 10   |       | us    |
| Input to Output Delay                   |                    | Input differential clock to output differential clock delay measured at mid point of input levels to mid pint of output levels |       | 3    |       | ns    |

<sup>1</sup> Test setup is R<sub>L</sub>=50 ohms with 2 pF, R<sub>r</sub> = 475Ω (1%).

<sup>2</sup> Measurement taken from a single-ended waveform.

<sup>3</sup> Measurement taken from a differential waveform.

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

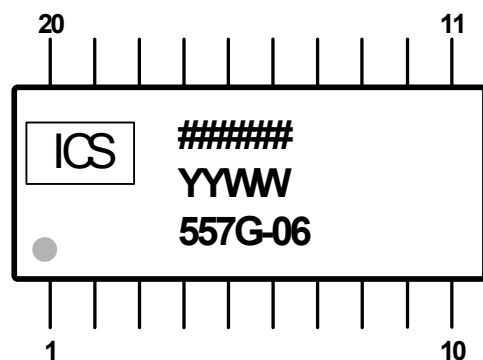
<sup>5</sup> CLKOUT pins are tri-stated when OE is Low asserted. CLKOUT is driven differential when OE is High unless its  $\overline{\text{PD}}$  = low.

## Thermal Characteristics

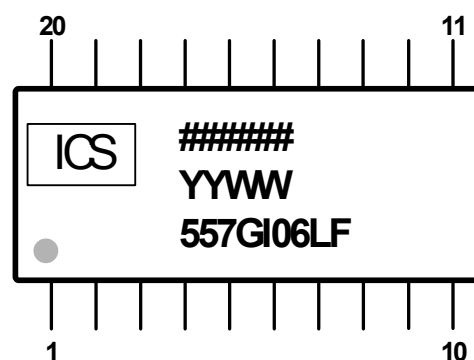
| Parameter                              | Symbol        | Conditions     | Min. | Typ. | Max. | Units |
|----------------------------------------|---------------|----------------|------|------|------|-------|
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | Still air      |      | 93   | 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

## Marking Diagrams

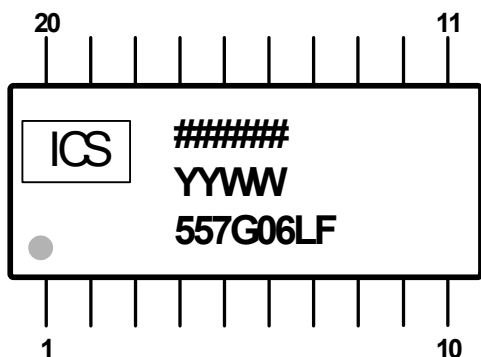
(ICS557G-06)



(ICS557GI-06LF)



(ICS557G-06LF)

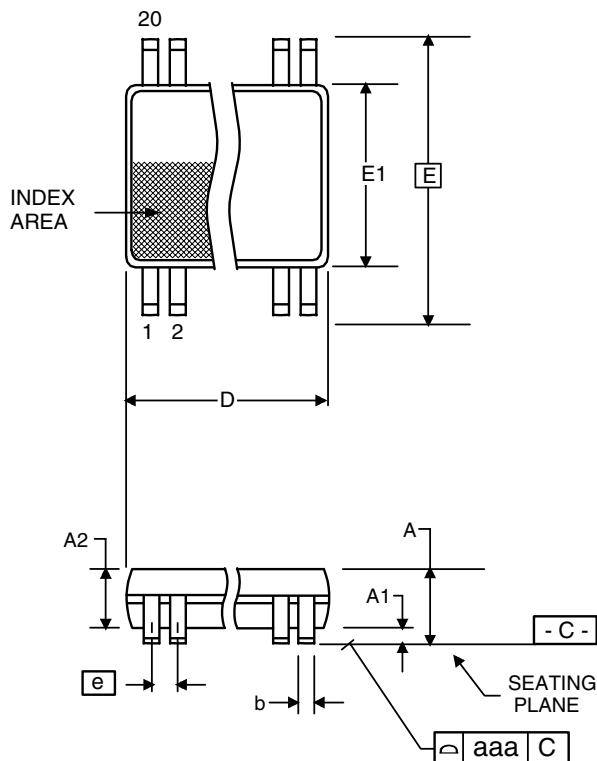


### Notes:

1. ##### is the lot code.
2. YYWW is the last two digits of the year, and the week number that the part was assembled.
3. "LF" denotes Pb free package.
4. Bottom marking: (origin). Origin = country of origin if not USA.

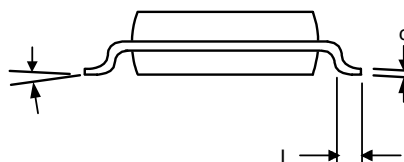
## Package Outline and Package Dimensions (20-pin TSSOP, 173 Mil. Narrow Body)

Package dimensions are kept current with JEDEC Publication No. 95



|        | Millimeters |      | Inches*      |       |
|--------|-------------|------|--------------|-------|
| Symbol | 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 |

\*For reference only. Controlling dimensions in mm.



## Ordering Information

| Part / Order Number | Marking    | Shipping Packaging | Package      | Temperature   |
|---------------------|------------|--------------------|--------------|---------------|
| 557G-06*            | See Page 9 | Tubes              | 20-pin TSSOP | 0 to +70° C   |
| 557G-06T*           |            | Tape and Reel      | 20-pin TSSOP | 0 to +70° C   |
| 557G-06LF           |            | Tubes              | 20-pin TSSOP | 0 to +70° C   |
| 557G-06LFT          |            | Tape and Reel      | 20-pin TSSOP | 0 to +70° C   |
| 557GI-06LF          |            | Tubes              | 20-pin TSSOP | -40 to +85° C |
| 557GI-06LFT         |            | Tape and Reel      | 20-pin TSSOP | -40 to +85° C |

**\*NOTE:** EOL for non-green parts to occur on 5/13/10 per PDN U-09-01

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

While the information presented herein has been checked for both accuracy and reliability, Integrated Device Technology (IDT) assumes no responsibility for either its use or for the infringement of any patents or other rights of third parties, which would result from its use. No other circuits, patents, or licenses are implied. This product is intended for use in normal commercial applications. Any other applications such as those requiring extended temperature range, high reliability, or other extraordinary environmental requirements are not recommended without additional processing by IDT. IDT reserves the right to change any circuitry or specifications without notice. IDT does not authorize or warrant any IDT product for use in life support devices or critical medical instruments.

**Innovate with IDT and accelerate your future networks. Contact:**

**www.IDT.com**

**For Sales**

800-345-7015  
408-284-8200  
Fax: 408-284-2775

**For Tech Support**

[www.idt/go/clockhelp](http://www.idt/go/clockhelp)

---

**Corporate Headquarters**

Integrated Device Technology, Inc.  
[www.idt.com](http://www.idt.com)



[www.IDT.com](http://www.IDT.com)