

# LOW SKEW 1 TO 4 CLOCK BUFFER

ICS651

## Description

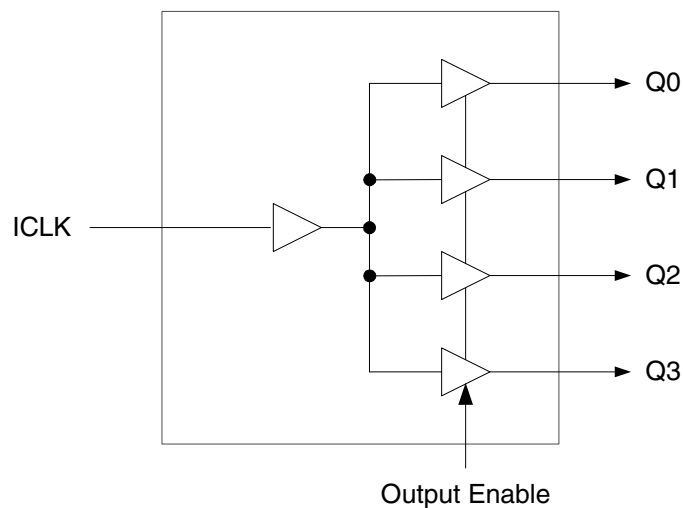
The ICS651 is a low skew, single input to four output, clock buffer. Part of IDT's ClockBlocks™ family, this is a low skew, small clock buffer.

IDT makes many non-PLL and PLL based low skew output devices as well as Zero Delay Buffers to synchronize clocks. Contact us for all of your clocking needs.

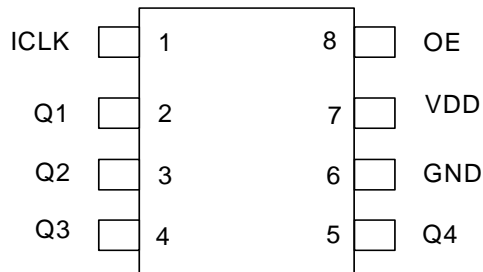
## Features

- Low skew outputs (250 ps)
- Packaged in 8-pin SOIC
- RoHS 6 compliant package
- Low power CMOS technology
- Operating Voltages of 1.5 V to 2.5 V
- Output Enable pin tri-states outputs
- 3.3 V tolerant input clock
- Industrial or commercial temperature ranges

## Block Diagram



## Pin Assignment



## Pin Descriptions

| Pin Number | Pin Name | Pin Type | Pin Description  |
|------------|----------|----------|--|
| 1          | ICLK     | Input    | Clock Input. 3.3 V tolerant input.   |
| 2          | Q1       | Output   | Clock Output 1.  |
| 3          | Q2       | Output   | Clock Output 2.  |
| 4          | Q3       | Output   | Clock Output 3.  |
| 5          | Q4       | Output   | Clock Output 4.  |
| 6          | GND      | Power    | Connect to ground.   |
| 7          | VDD      | Power    | Connect to +1.5 V or +2.5 V.   |
| 8          | OE       | Input    | Output Enable. Tri-states outputs when low. Connect to VDD for normal operation. |

## External Components

A minimum number of external components are required for proper operation. A decoupling capacitor of 0.01  $\mu\text{F}$  should be connected between VDD on pin 7 and GND on pin 6, as close to the device as possible. A 33  $\Omega$  series terminating resistor may be used on each clock output if the trace is longer than 1 inch.

To achieve the low output skew that the ICS651 is capable of, careful attention must be paid to board layout. Essentially, all four outputs must have identical terminations, identical loads and identical trace geometries. If they do not, the output skew will be degraded. For example, using a 30 $\Omega$  series termination on one output (with 33 $\Omega$  on the others) will cause at least 15 ps of skew.

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS651. These ratings, which are standard values for IDT commercially rated parts, 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                        | 7 V                        |
| Output Enable and All Outputs              | -0.5 V to VDD+0.5 V        |
| ICLK                                       | -0.5 V to 3.6 V (VDD > 0V) |
| Ambient Operating Temperature (industrial) | -40 to +85 °C              |
| Ambient Operating Temperature (commercial) | 0 to +70 °C                |
| Storage Temperature                        | -65 to +150° C             |
| Junction Temperature                       | 125° C                     |
| Soldering Temperature                      | 260° C                     |

## Recommended Operation Conditions

| Parameter   | Min.   | Typ. | Max.   | Units |
|---|--------|------|--------|-------|
| Ambient Operating Temperature (industrial)        | -40    |      | +85    | °C    |
| Ambient Operating Temperature (commercial)        | 0      |      | +70    | °C    |
| Power Supply Voltage (measured in respect to GND) | +1.425 |      | +2.625 | V     |

## DC Electrical Characteristics

VDD=1.5 V ±5%, Ambient temperature -40 to +85° C or 0 to +70° C, unless stated otherwise

| Parameter                | Symbol          | Conditions              | Min.  | Typ. | Max.  | Units |
|--------------------------|-----------------|-------------------------|-------|------|-------|-------|
| Operating Voltage        | VDD             |                         | 1.425 |      | 1.575 | V     |
| Input High Voltage       | V <sub>IH</sub> | Note 1, ICLK, OE        | 1.17  |      | 3.6   | V     |
| Input Low Voltage        | V <sub>IL</sub> | Note 1, ICLK, OE        |       |      | 0.63  | V     |
| Output High Voltage      | V <sub>OH</sub> | I <sub>OH</sub> = -6 mA | 1.35  |      |       | V     |
| Output Low Voltage       | V <sub>OL</sub> | I <sub>OL</sub> = 6 mA  |       |      | 0.45  | V     |
| Operating Supply Current | IDD             | No load, 133 MHz        |       | 25   |       | mA    |
| Nominal Output Impedance | Z <sub>O</sub>  |                         |       | 20   |       | Ω     |
| Input Capacitance        | C <sub>IN</sub> | ICLK, OE pin            |       | 5    |       | pF    |
| Short Circuit Current    | I <sub>OS</sub> |                         |       | ±28  |       | mA    |

Notes: 1. Nominal switching threshold is VDD/2

VDD=1.8 V ±5%, Ambient temperature -40 to +85° C or 0 to +70° C, unless stated otherwise

| Parameter                | Symbol          | Conditions              | Min. | Typ. | Max. | Units |
|--------------------------|-----------------|-------------------------|------|------|------|-------|
| Operating Voltage        | VDD             |                         | 1.71 | 1.8  | 1.89 | V     |
| Input High Voltage, ICLK | V <sub>IH</sub> | Note 1, ICLK, OE        | 1.17 |      | 3.6  | V     |
| Input Low Voltage, ICLK  | V <sub>IL</sub> | Note 1, ICLK, OE        |      |      | 0.63 | V     |
| Output High Voltage      | V <sub>OH</sub> | I <sub>OH</sub> = -8 mA | 1.35 |      |      | V     |
| Output Low Voltage       | V <sub>OL</sub> | I <sub>OL</sub> = 8mA   |      |      | 0.45 | V     |
| Operating Supply Current | IDD             | No load, 133 MHz        |      | 30   |      | mA    |
| Nominal Output Impedance | Z <sub>O</sub>  |                         |      | 20   |      | Ω     |
| Input Capacitance        | C <sub>IN</sub> | ICLK, OE pin            |      | 5    |      | pF    |
| Short Circuit Current    | I <sub>OS</sub> |                         |      | ±32  |      | mA    |

Notes: 1. Nominal switching threshold is VDD/2

VDD=2.5 V ±5%, Ambient temperature -40 to +85° C or 0 to +70° C, unless stated otherwise

| Parameter                | Symbol          | Conditions              | Min.  | Typ. | Max.  | Units |
|--------------------------|-----------------|-------------------------|-------|------|-------|-------|
| Operating Voltage        | VDD             |                         | 2.375 |      | 2.625 | V     |
| Input High Voltage, ICLK | V <sub>IH</sub> | Note 1, ICLK, OE        | 1.7   |      | 3.6   | V     |
| Input Low Voltage, ICLK  | V <sub>IL</sub> | Note 1, ICLK, OE        |       |      | 0.7   | V     |
| Output High Voltage      | V <sub>OH</sub> | I <sub>OH</sub> = -8 mA | 2     |      |       | V     |
| Output Low Voltage       | V <sub>OL</sub> | I <sub>OL</sub> = 8mA   |       |      | 0.4   | V     |
| Operating Supply Current | IDD             | No load, 133 MHz        |       | 50   |       | mA    |
| Nominal Output Impedance | Z <sub>O</sub>  |                         |       | 20   |       | Ω     |
| Input Capacitance        | C <sub>IN</sub> | ICLK, OE pin            |       | 5    |       | pF    |
| Short Circuit Current    | I <sub>OS</sub> |                         |       | ±50  |       | mA    |

Notes: 1. Nominal switching threshold is VDD/2

## AC Electrical Characteristics

VDD = 1.5 V ±5%, Ambient Temperature -40 to +85°C or 0 to +70°C, unless stated otherwise

| Parameter             | Symbol          | Conditions            | Min. | Typ. | Max. | Units |
|-----------------------|-----------------|-----------------------|------|------|------|-------|
| Input Frequency       |                 |                       | 0    |      | 166  | MHz   |
| Output Rise Time      | t <sub>OR</sub> | 0.63 V to 1.17 V      |      | 1.0  | 1.5  | ns    |
| Output Fall Time      | t <sub>OF</sub> | 1.17 V to 0.63 V      |      | 1.0  | 1.5  | ns    |
| Propagation Delay     | Note 1          |                       | 2.2  | 3    | 5    | ns    |
| Output to Output Skew | Note 2          | Rising edges at VDD/2 |      |      | ±250 | ps    |

VDD = 1.8 V ±5%, Ambient Temperature -40 to +85°C or 0 to +70°C, unless stated otherwise

| Parameter             | Symbol          | Conditions            | Min. | Typ. | Max. | Units |
|-----------------------|-----------------|-----------------------|------|------|------|-------|
| Input Frequency       |                 |                       | 0    |      | 200  | MHz   |
| Output Rise Time      | t <sub>OR</sub> | 0.63 V to 1.17 V      |      | 1.0  | 1.5  | ns    |
| Output Fall Time      | t <sub>OF</sub> | 1.17 V to 0.63 V      |      | 1.0  | 1.5  | ns    |
| Propagation Delay     | Note 1          |                       | 2.2  | 3    | 5    | ns    |
| Output to Output Skew | Note 2          | Rising edges at VDD/2 |      |      | ±250 | ps    |

VDD = 2.5 V ±5%, Ambient Temperature -40 to +85°C or 0 to +70°C, unless stated otherwise

| Parameter             | Symbol          | Conditions            | Min. | Typ. | Max. | Units |
|-----------------------|-----------------|-----------------------|------|------|------|-------|
| Input Frequency       |                 |                       | 0    |      | 200  | MHz   |
| Output Rise Time      | t <sub>OR</sub> | 0.7 V to 1.7 V        |      | 1.0  | 1.5  | ns    |
| Output Fall Time      | t <sub>OF</sub> | 1.7 V to 0.7 V        |      | 1.0  | 1.5  | ns    |
| Propagation Delay     | Note 1          |                       | 2.2  | 3    | 5    | ns    |
| Output to Output Skew | Note 2          | Rising edges at VDD/2 |      |      | ±250 | ps    |

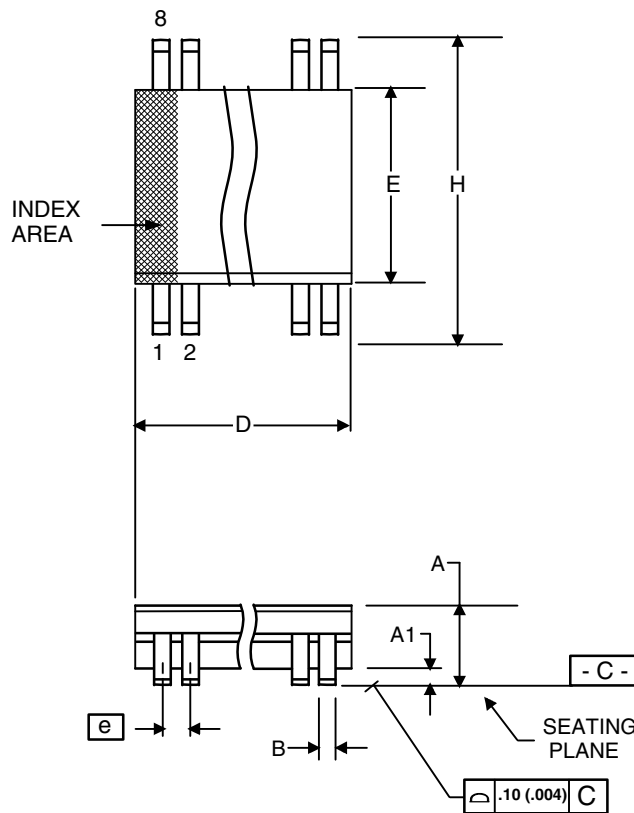
- Notes: 1. With rail to rail input clock  
2. Between any 2 outputs with equal loading.

## Thermal Characteristics

| Parameter                                  | Symbol          | Conditions     | Min. | Typ. | Max. | Units |
|--|-----------------|----------------|------|------|------|-------|
| Thermal Resistance Junction to Ambient     | θ <sub>JA</sub> | Still air      |      | 150  |      | °C/W  |
|  | θ <sub>JA</sub> | 1 m/s air flow |      | 140  |      | °C/W  |
|  | θ <sub>JA</sub> | 3 m/s air flow |      | 120  |      | °C/W  |
| Thermal Resistance Junction to Case        | θ <sub>JC</sub> |                |      | 40   |      | °C/W  |
| Case Temperature                           |                 |                |      |      | 120  | °C    |
| Thermal Resistance Junction to Top of Case | Ψ <sub>JT</sub> | Still air      |      | 20   |      | °C/W  |

## Package Outline and Package Dimensions (8-pin SOIC, 150 Mil. Narrow Body)

Package dimensions are kept current with JEDEC Publication No. 95



| Symbol   | Millimeters |      | Inches*     |       |
|----------|-------------|------|-------------|-------|
|          | Min         | Max  | Min         | Max   |
| A        | 1.35        | 1.75 | .0532       | .0688 |
| A1       | 0.10        | 0.25 | .0040       | .0098 |
| B        | 0.33        | 0.51 | .013        | .020  |
| C        | 0.19        | 0.25 | .0075       | .0098 |
| D        | 4.80        | 5.00 | .1890       | .1968 |
| E        | 3.80        | 4.00 | .1497       | .1574 |
| e        | 1.27 BASIC  |      | 0.050 BASIC |       |
| H        | 5.80        | 6.20 | .2284       | .2440 |
| h        | 0.25        | 0.50 | .010        | .020  |
| L        | 0.40        | 1.27 | .016        | .050  |
| $\alpha$ | 0°          | 8°   | 0°          | 8°    |

\*For reference only. Controlling dimensions in mm.

## Ordering Information

| Part / Order Number | Marking | Shipping Packaging | Package    | Temperature   |
|---------------------|---------|--------------------|------------|---------------|
| 651MILF             | 651MILF | Tubes              | 8-pin SOIC | -40 to +85° C |
| 651MILFT            | 651MILF | Tape and Reel      | 8-pin SOIC | -40 to +85° C |
| 651MLF              | 651MLF  | Tubes              | 8-pin SOIC | 0 to +70° C   |
| 651MLFT             | 651MLF  | Tape and Reel      | 8-pin SOIC | 0 to +70° C   |

“LF” suffix to the part number are the Pb-Free configuration and are RoHS compliant.

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**Revision History**

| <b>Rev.</b> | <b>Originator</b> | <b>Date</b> | <b>Description of Change</b>  |
|-------------|-------------------|-------------|---|
| A           | K. Beckmeyer      | 6/27/05     | Preliminary Datasheet   |
| B           | K. Beckmeyer      | 8/31/05     | Output high and low voltage current conditions changed to 6mA and 6mA respectively at 1.5V, and -8mA and 8mA respectively at 2.5V operation. Short circuit current spec changed to $\pm 50$ mA typical at 2.5V operation. Output-to-output skew max spec changed to $\pm 250$ ps at both 1.5V and 2.5V operation. |
| C           | K. Beckmeyer      | 12/08/05    | Added LF ordering info.   |
| D           | P. Griffith       | 03/23/06    | Added commercial temperature range and ordering info; added Psi JT spec to Thermals.  |
| F           |                   | 11/04/09    | Added EOL note for non-green parts.   |
| G           |                   | 05/13/10    | Removed EOL note and non-green parts.   |
| H           | K. Beckmeyer      | 10/11/11    | Added 1.8V AC and DC specification tables.  |

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