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# LOW PHASE NOISE ZERO DELAY BUFFER AND MULTIPLIER

**ICS670-03**

## Description

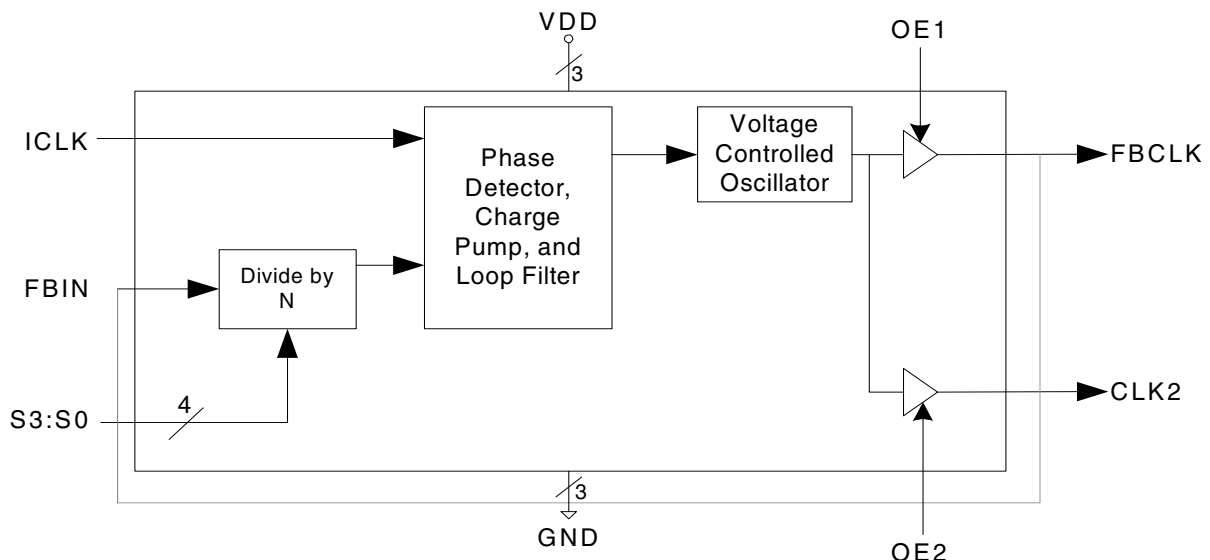
The ICS670-03 is a high speed, low phase noise, Zero Delay Buffer (ZDB) which integrates IDT's proprietary analog/digital Phase Locked Loop (PLL) techniques. It is identical to the ICS670-01, but with an increased maximum output frequency of 210 MHz. Part of IDT's ClockBlocks™ family, the part's zero delay feature means that the rising edge of the input clock aligns with the rising edges of the outputs giving the appearance of no delay through the device. There are two identical outputs on the chip. The FBCLK should be used to connect to the FBIN. Each output has its own output enable pin.

The ICS670-03 is ideal for synchronizing outputs in a large variety of systems, from personal computers to data communications to video. By allowing off-chip feedback paths, the ICS670-03 can eliminate the delay through other devices. The 15 different on-chip multipliers work in a variety of applications. For other multipliers, including functional multipliers, see the ICS527.

## Features

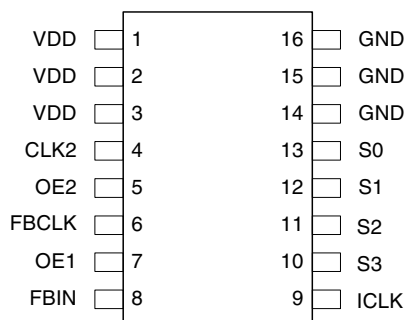
- Packaged in 16-pin SOIC
- Pb (lead) free package, RoHS compliant
- Clock inputs from 5 to 210 MHz (see page 2)
- Patented PLL with low phase noise
- Output clocks up to 210 MHz at 3.3V
- 15 selectable on-chip multipliers
- Power down mode available
- Low phase noise: -124 dBc/Hz at 10 kHz
- Output enable function tri-states outputs
- Low jitter 15 ps one sigma
- Advanced, low power, sub-micron CMOS process
- Industrial temperature rated
- Operating voltage of 3.3 V or 5 V

## Block Diagram



External Feedback from FBCLK is recommended.

## Pin Assignment



## Multiplier Select Table

| S3 | S2 | S1 | S0 | CLK2 (and FBCLK)             | Input Range (MHz) |
|----|----|----|----|------------------------------|-------------------|
| 0  | 0  | 0  | 0  | Low (Power down entire chip) | -                 |
| 0  | 0  | 0  | 1  | Input x1.333                 | 18 - 157.5        |
| 0  | 0  | 1  | 0  | Input x6                     | 5 - 35            |
| 0  | 0  | 1  | 1  | Input x1.5                   | 16.67 - 140       |
| 0  | 1  | 0  | 0  | Input x3.333                 | 7.5 - 63          |
| 0  | 1  | 0  | 1  | Input x2.50                  | 10 - 84           |
| 0  | 1  | 1  | 0  | Input x4                     | 6 - 52.5          |
| 0  | 1  | 1  | 1  | Input x1                     | 25 - 210          |
| 1  | 0  | 0  | 0  | Input x2.333                 | 11 - 90           |
| 1  | 0  | 0  | 1  | Input x2.666                 | 10 - 78.75        |
| 1  | 0  | 1  | 0  | Input x12                    | 5 - 17.5          |
| 1  | 0  | 1  | 1  | Input x3                     | 8 - 70            |
| 1  | 1  | 0  | 0  | Input x10                    | 5 - 21            |
| 1  | 1  | 0  | 1  | Input x5                     | 6 - 42            |
| 1  | 1  | 1  | 0  | Input x8                     | 5 - 26.25         |
| 1  | 1  | 1  | 1  | Input x2                     | 12 - 105          |

## Pin Descriptions

| Pin Number | Pin Name | Pin Type | Pin Description  |
|------------|----------|----------|--|
| 1 - 3      | VDD      | Input    | Power supply. Connect both pins to the same voltage (either 3.3 V or 5 V).           |
| 4          | CLK2     | Output   | Clock output from VCO. Output frequency equals the input frequency times multiplier. |
| 5          | OE2      | Input    | Output clock enable 2. Tri-states the clock 2 output when low.                       |
| 6          | FBCLK    | Output   | Clock output from VCO. Output frequency equals the input frequency times multiplier. |
| 7          | OE1      | Input    | Output clock enable 1. Tri-states the feedback clock output when low.                |
| 8          | FBIN     | Input    | Feedback clock input.  |
| 9          | ICLK     | Input    | Clock input. Connect to a 5 - 210 MHz clock.   |
| 10         | S3       | Input    | Multiplier select pin 3. Determines outputs per table above. Internal pull-up.       |
| 11         | S2       | Input    | Multiplier select pin 2. Determines outputs per table above. Internal pull-up.       |
| 12         | S1       | Input    | Multiplier select pin 1. Determines outputs per table above. Internal pull-up.       |
| 13         | S0       | Input    | Multiplier select pin 0. Determines outputs per table above. Internal pull-up.       |
| 14 - 16    | GND      | Power    | Connect to ground.   |

## External Components

The ICS670-03 requires a minimum number of external components for proper operation. Decoupling capacitors of 0.01mF should be connected between VDD (pins 1, 2, and 3) and GND (pins 14, 15, and 16), as close to the device as possible. A series termination resistor of 33Ω may be used to each clock output pin to reduce reflections.

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS670-03. 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                 |
| All Inputs and Outputs        | -0.5 V to VDD+0.5 V |
| Ambient Operating Temperature | -40 to +85° 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                     | -40  |      | +85  | °C    |
| Power Supply Voltage (measured in respect to GND) | +3.0 |      | +5.5 | V     |

## DC Electrical Characteristics

VDD=3.3V ±10%, Ambient temperature -40 to +85° C, unless stated otherwise

| Parameter                       | Symbol          | Conditions               | Min.    | Typ. | Max. | Units |
|---------------------------------|-----------------|--------------------------|---------|------|------|-------|
| Operating Voltage               | VDD             |                          | 3.0     |      | 5.5  | V     |
| Input High Voltage              | V <sub>IH</sub> |                          | 2       |      |      | V     |
| Input Low Voltage               | V <sub>IL</sub> |                          |         |      | 0.8  | V     |
| Output High Voltage             | V <sub>OH</sub> | I <sub>OH</sub> = -12 mA | 2.4     |      |      | V     |
| Output Low Voltage              | V <sub>OL</sub> | I <sub>OL</sub> = 12 mA  |         |      | 0.4  | V     |
| Output High Voltage, CMOS level | V <sub>OH</sub> | I <sub>OH</sub> = -4 mA  | VDD-0.4 |      |      | V     |
| Operating Supply Current        | IDD             | No Load                  |         | 35   |      | mA    |

| Parameter                 | Symbol   | Conditions      | Min. | Typ. | Max. | Units |
|---------------------------|----------|-----------------|------|------|------|-------|
| Short Circuit Current     | $I_{OS}$ | Each output     |      | ±50  |      | mA    |
| Internal Pull-up Resistor | $R_{PU}$ | OE, select pins |      | 200  |      | kΩ    |
| Input Capacitance         | $C_{IN}$ | OE, select pins |      | 5    |      | pF    |

## AC Electrical Characteristics

VDD = 3.3V ±10%, Ambient Temperature -40 to +85° C, unless stated otherwise

| Parameter                                      | Symbol   | Conditions            | Min. | Typ. | Max. | Units  |
|--|----------|-----------------------|------|------|------|--------|
| Input Clock Frequency                          | $f_{IN}$ | See table on page 2   | 5    |      | 210  | MHz    |
| Output Clock Frequency                         |          |                       |      |      | 210  | MHz    |
| Output Rise Time                               | $t_{OR}$ | 0.8 to 2.0 V, no load |      |      | 1.5  | ns     |
| Output Fall Time                               | $t_{OF}$ | 2.0 to 0.8 V, no load |      |      | 1.5  | ns     |
| Output Clock Duty Cycle                        | $t_{DC}$ | measured at VDD/2     | 40   | 50   | 60   | %      |
| Input to Output Skew                           |          | Note 1                |      | ±100 |      | ps     |
| Maximum Absolute Jitter                        |          | short term            |      | ±45  |      | ps     |
| Maximum Jitter                                 |          | one sigma             |      | 15   |      | ps     |
| Phase Noise, relative to carrier, 125 MHz (x5) |          | 100 Hz offset         |      | -110 |      | dBc/Hz |
|  |          | 1 kHz offset          |      | -122 |      | dBc/Hz |
|  |          | 10 kHz                |      | -124 |      | dBc/Hz |
|  |          | 200 kHz               |      | -117 |      | dBc/Hz |

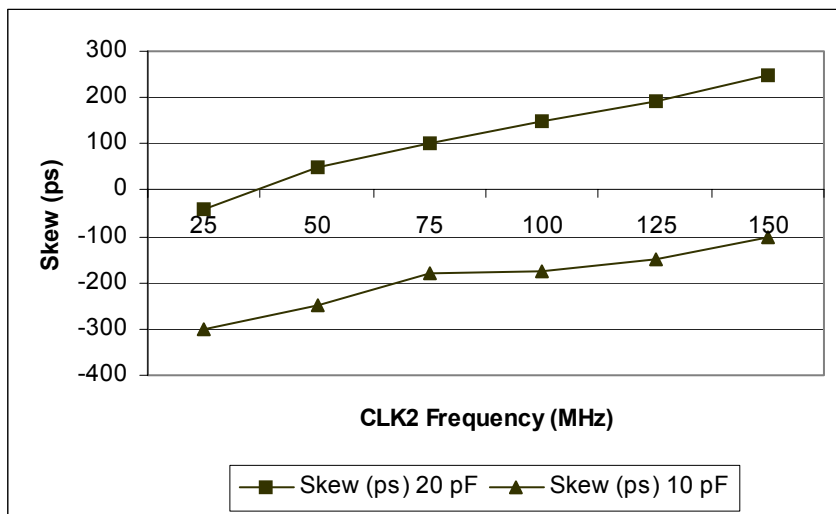
Note 1: Rising edge of ICLK compared with rising edge of CLK2, with FBCLK connected to FBIN, and 15 pF load on CLK2. See graph on page 5 for skew vs. frequency and loading.

## Thermal Characteristics

| Parameter                              | Symbol        | Conditions     | Min. | Typ. | Max. | Units |
|--|---------------|----------------|------|------|------|-------|
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | Still air      |      | 120  |      | °C/W  |
|  | $\theta_{JA}$ | 1 m/s air flow |      | 115  |      | °C/W  |
|  | $\theta_{JA}$ | 3 m/s air flow |      | 105  |      | °C/W  |
| Thermal Resistance Junction to Case    | $\theta_{JC}$ |                |      | 58   |      | °C/W  |



**Figure 1. Skew from ICLK to CLK2, with change in load capacitance (VDD = 3.3V)**

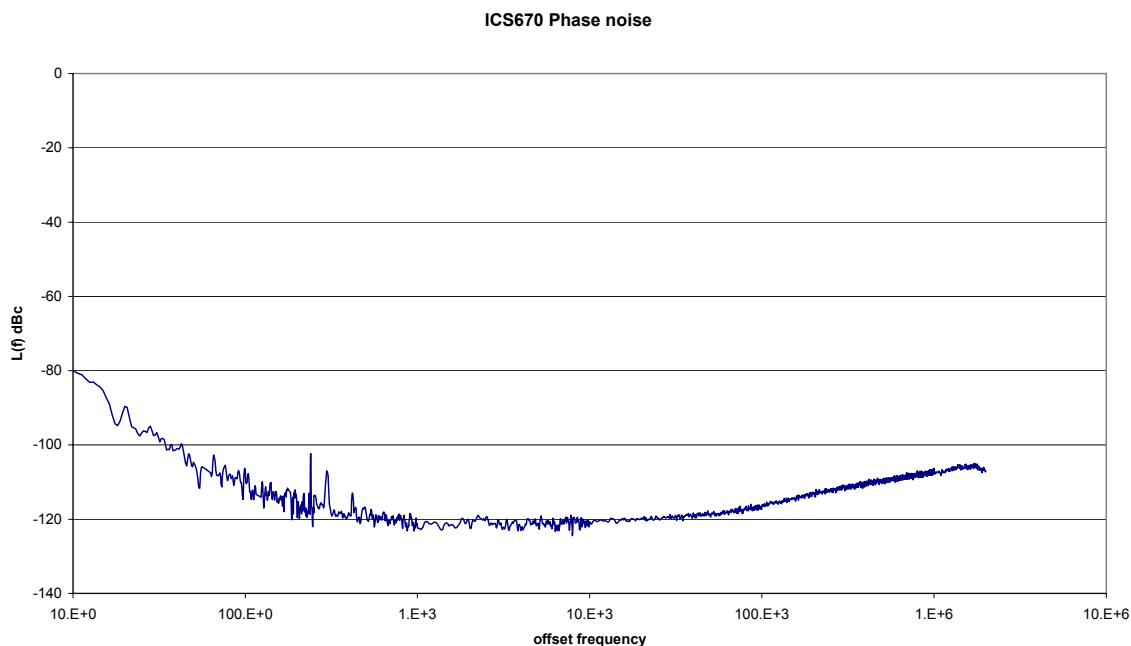


### Adjusting Input/Output Skew

The data in Figure 1 can be used to adjust individual circuit characteristics and achieve the minimum possible skew between ICLK and CLK2. With a 125 MHz output, for example, having a total load capacitance of 15 pF will result in nearly zero skew between ICLK and CLK2. Note that the load

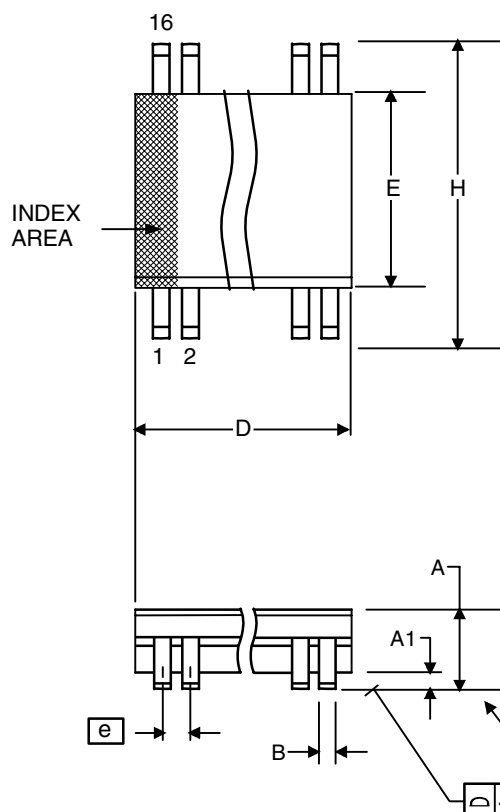
capacitance includes board trace capacitance, input capacitance of the load being driven by the ICS670-03, and any additional capacitors connected to CLK2.

**Figure 2. Phase Noise at 125 MHz out, 25 MHz clock input (VDD = 3.3V)**



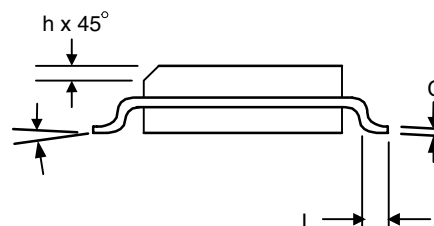
## Package Outline and Package Dimensions (16-pin SOIC, 150 Mil. Narrow Body)

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        | 9.80        | 10.00 | .3859       | .3937 |
| 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   |
|---------------------|------------|--------------------|-------------|---------------|
| 670M-03ILF          | 670M-03ILF | Tubes              | 16-pin SOIC | -40 to +85° C |
| 670M-03ILFT         | 670M-03ILF | Tape and Reel      | 16-pin SOIC | -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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