



# ICS556-04

## LOW SKEW 1 TO 4 CLOCK BUFFER

### Description

The ICS556-04 is a low-skew, crystal input compatible clock buffer with oscillator. This device offers the lowest skew.

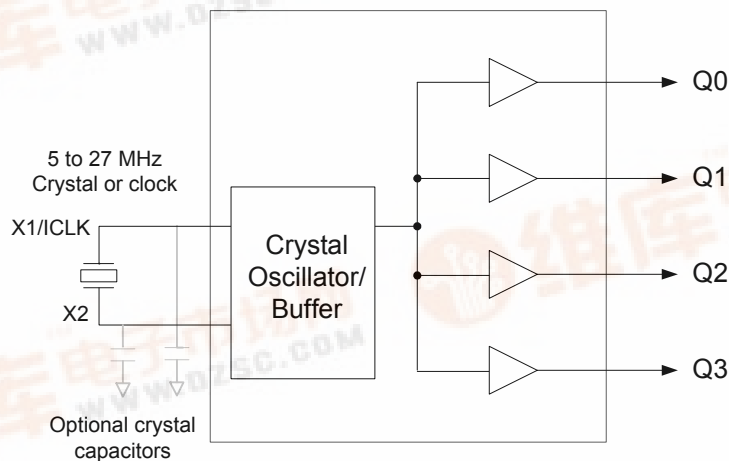
See the ICS552-02 for a 1-to-8 low skew buffer. For more than eight outputs see the MK74CBxxx Buffalo™ series of clock drivers.

ICS makes many non-PLL and PLL-based low-skew output devices. Contact ICS for all of your clocking needs.

### Features

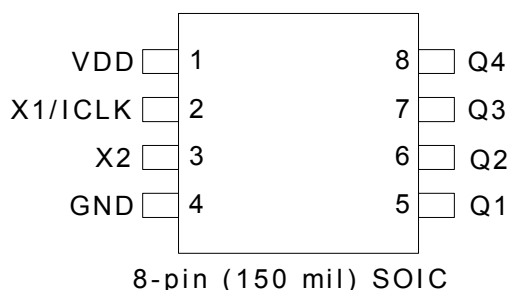
- Extremely low-skew outputs (50 ps maximum)
- Packaged in 8-pin SOIC
- Operating voltages of 2.5 to 5.0 V
- Low-power CMOS technology
- Industrial temperature range
- Available in Pb (lead) free package

### Block Diagram





## Pin Assignment



## Pin Descriptions

| Pin Number | Pin Name | Pin Type | Pin Description                                                            |
|------------|----------|----------|----------------------------------------------------------------------------|
| 1          | VDD      | Power    | Connect to +2.5 V, +3.3 V or +5.0 V.                                       |
| 2          | X1/ICLK  | Input    | Crystal or clock input (5 V tolerant input). Connect to 5 to 27 MHz input. |
| 3          | X2       | Input    | Connect to a fundamental mode crystal. Leave open for clock input.         |
| 4          | GND      | Power    | Connect to ground.                                                         |
| 5          | Q1       | Output   | Clock Output 1.                                                            |
| 6          | Q2       | Output   | Clock Output 2.                                                            |
| 7          | Q3       | Output   | Clock Output 3.                                                            |
| 8          | Q4       | Output   | Clock Output 3.                                                            |

## External Components

A minimum number of external components are required for proper operation. A decoupling capacitor of 0.01  $\mu$ F should be connected between VDD on pin 1 and GND on pin 4, 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 ICS556-04 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 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.

## Crystal Information

The crystal used should be a fundamental mode (do not use third overtone), parallel resonant. Crystal capacitors should be connected from pins X1 to ground and X2 to ground to optimize the initial accuracy. The value of these capacitors is given by the following equation:

$$\text{Crystal caps (pF)} = (\text{CL} - 6) \times 2$$

In the equation, CL is the crystal load capacitance. So, for a crystal with a 16 pF load capacitance, two 20 pF [(16-6) x 2] capacitors should be used.



## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS556-04. These ratings, which are standard values for ICS 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 5.5 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) | +2.375 |      | +5.25 | V     |

## DC Electrical Characteristics

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

| Parameter                | Symbol          | Conditions               | Min.  | Typ. | Max.  | Units |
|--------------------------|-----------------|--------------------------|-------|------|-------|-------|
| Operating Voltage        | VDD             |                          | 2.375 |      | 2.625 | V     |
| Input High Voltage       | V <sub>IH</sub> |                          | 2.0   |      |       | 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     |      |       | V     |
| Output Low Voltage       | V <sub>OL</sub> | I <sub>OL</sub> = 12 mA  |       |      | 0.4   | V     |
| Operating Supply Current | IDD             | No load, 27MHz           |       | 25   |       | mA    |
| Nominal Output Impedance | Z <sub>O</sub>  |                          |       | 20   |       | Ω     |
| Short Circuit Current    | I <sub>OS</sub> |                          |       | ±28  |       | mA    |

**DC Electrical Characteristics (continued)**

**VDD=3.3 V  $\pm$ 5%** , Ambient temperature -40 to +85 °C, unless stated otherwise

| Parameter                        | Symbol          | Conditions               | Min.    | Typ.     | Max. | Units    |
|----------------------------------|-----------------|--------------------------|---------|----------|------|----------|
| Operating Voltage                | VDD             |                          | 3.15    |          | 3.45 | V        |
| Input High Voltage               | V <sub>IH</sub> |                          | 2.0     |          |      | V        |
| Input Low Voltage                | V <sub>IL</sub> |                          |         |          | 0.8  | V        |
| Output High Voltage              | V <sub>OH</sub> | I <sub>OH</sub> = -25 mA | 2.4     |          |      | V        |
| Output Low Voltage               | V <sub>OL</sub> | I <sub>OL</sub> = 25 mA  |         |          | 0.4  | V        |
| Output High Voltage (CMOS Level) | V <sub>OH</sub> | I <sub>OH</sub> = -12 mA | VDD-0.4 |          |      | V        |
| Operating Supply Current         | IDD             | No load, 27 MHz          |         | 35       |      | mA       |
| Nominal Output Impedance         | Z <sub>O</sub>  |                          |         | 20       |      | $\Omega$ |
| Short Circuit Current            | I <sub>OS</sub> |                          |         | $\pm$ 50 |      | mA       |

**VDD=5 V  $\pm$ 5%** , Ambient temperature -40 to +85 °C, unless stated otherwise

| Parameter                        | Symbol          | Conditions               | Min.    | Typ.     | Max. | Units    |
|----------------------------------|-----------------|--------------------------|---------|----------|------|----------|
| Operating Voltage                | VDD             |                          | 4.75    |          | 5.25 | V        |
| Input High Voltage               | V <sub>IH</sub> |                          | 2.0     |          |      | V        |
| Input Low Voltage                | V <sub>IL</sub> |                          |         |          | 0.8  | V        |
| Output High Voltage              | V <sub>OH</sub> | I <sub>OH</sub> = -35 mA | 2.4     |          |      | V        |
| Output Low Voltage               | V <sub>OL</sub> | I <sub>OL</sub> = 35 mA  |         |          | 0.4  | V        |
| Output High Voltage (CMOS Level) | V <sub>OH</sub> | I <sub>OH</sub> = -12 mA | VDD-0.4 |          |      | V        |
| Operating Supply Current         | IDD             | No load, 27 MHz          |         | 45       |      | mA       |
| Nominal Output Impedance         | Z <sub>O</sub>  |                          |         | 20       |      | $\Omega$ |
| Short Circuit Current            | I <sub>OS</sub> |                          |         | $\pm$ 80 |      | mA       |

Notes:

1. Nominal switching threshold is VDD/2



## AC Electrical Characteristics

VDD = 2.5 V  $\pm$ 5%, Ambient Temperature -40 to +85 °C, unless stated otherwise

| Parameter             | Symbol          | Conditions                          | Min. | Typ. | Max. | Units |
|-----------------------|-----------------|-------------------------------------|------|------|------|-------|
| Input Frequency       |                 |                                     | 5    |      | 27   | MHz   |
| Output Rise Time      | t <sub>OR</sub> | 0.8 to 2.0 V, C <sub>L</sub> =15 pF |      | 1.8  | 2.5  | ns    |
| Output Fall Time      | t <sub>OF</sub> | 2.0 to 0.8 V, C <sub>L</sub> =15 pF |      | 1.8  | 2.5  | ns    |
| Output to output skew | Note 1          | Rising edges at VDD/2               |      | 0    | 50   | ps    |
| Duty Cycle            |                 | Measured at VDD/2                   | 45   | 50   | 55   | %     |

VDD = 3.3 V  $\pm$ 5%, Ambient Temperature -40 to +85 °C, unless stated otherwise

| Parameter                        | Symbol          | Conditions                          | Min. | Typ. | Max. | Units  |
|----------------------------------|-----------------|-------------------------------------|------|------|------|--------|
| Input Frequency                  |                 |                                     | 5    |      | 27   | MHz    |
| Output Rise Time                 | t <sub>OR</sub> | 0.8 to 2.0 V, C <sub>L</sub> =15 pF |      | 0.6  | 1.0  | ns     |
| Output Fall Time                 | t <sub>OF</sub> | 2.0 to 0.8 V, C <sub>L</sub> =15 pF |      | 0.6  | 1.0  | ns     |
| Output to output skew            | Note 1          | Rising edges at VDD/2               |      | 0    | 50   | ps     |
| Duty Cycle                       |                 | Measured at VDD/2                   | 45   | 50   | 55   | %      |
| Phase Noise at 1MHz from carrier |                 |                                     |      | -125 |      | dBc/Hz |
| Clock Jitter RMS 1KHz to 1MHz    |                 |                                     |      |      | 6    | ps     |

VDD = 5 V  $\pm$ 5%, Ambient Temperature -40 to +85 °C, unless stated otherwise

| Parameter             | Symbol          | Conditions                          | Min. | Typ. | Max. | Units |
|-----------------------|-----------------|-------------------------------------|------|------|------|-------|
| Input Frequency       |                 |                                     | 5    |      | 27   | MHz   |
| Output Rise Time      | t <sub>OR</sub> | 0.8 to 2.0 V, C <sub>L</sub> =15 pF |      | 0.3  | 0.7  | ns    |
| Output Fall Time      | t <sub>OF</sub> | 2.0 to 0.8 V, C <sub>L</sub> =15 pF |      | 0.3  | 0.7  | ns    |
| Output to output skew | Note 1          | Rising edges at VDD/2               |      | 0    | 50   | ps    |
| Duty Cycle            |                 | Measured at VDD/2                   | 45   | 50   | 55   | %     |

Notes: 1. Between any two outputs with equal loading.

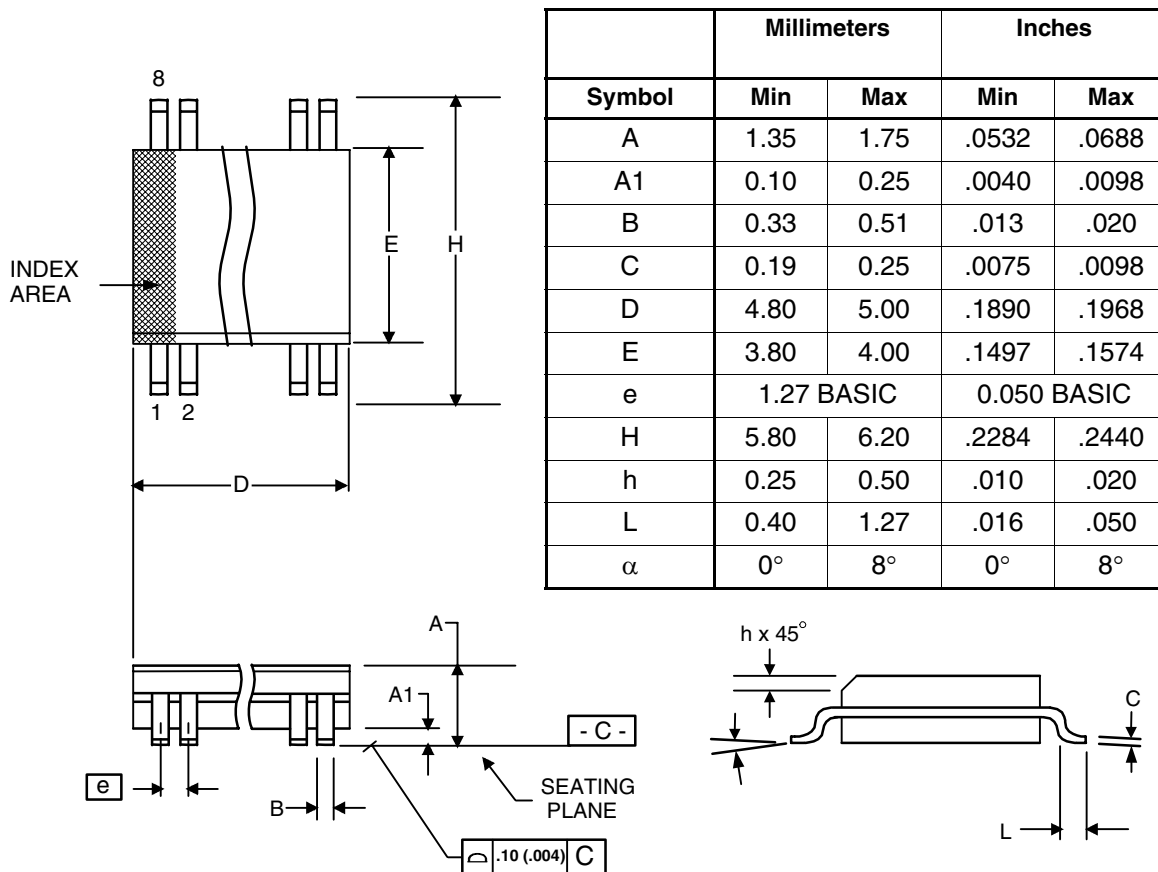
## Thermal Characteristics

| Parameter                              | Symbol        | Conditions     | Min. | Typ. | Max. | Units |
|----------------------------------------|---------------|----------------|------|------|------|-------|
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | Still air      |      | 150  |      | °C/W  |
|                                        | $\theta_{JA}$ | 1 m/s air flow |      | 140  |      | °C/W  |
|                                        | $\theta_{JA}$ | 3 m/s air flow |      | 120  |      | °C/W  |
| Thermal Resistance Junction to Case    | $\theta_{JC}$ |                |      | 40   |      | °C/W  |



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

Package dimensions are kept current with JEDEC Publication No. 95



## Ordering Information

| Part / Order Number | Marking  | Shipping Packaging | Package    | Temperature  |
|---------------------|----------|--------------------|------------|--------------|
| ICS556M-04I         | 556M-04I | Tubes              | 8-pin SOIC | -40 to +85°C |
| ICS556M-04IT        | 556M-04I | Tape and Reel      | 8-pin SOIC | -40 to +85°C |
| ICS556M-04ILF       | 556M04IL | Tubes              | 8-pin SOIC | -40 to +85°C |
| ICS556M-04ILFT      | 556M04IL | Tape and Reel      | 8-pin SOIC | -40 to +85°C |

“LF” denotes Pb free package.

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