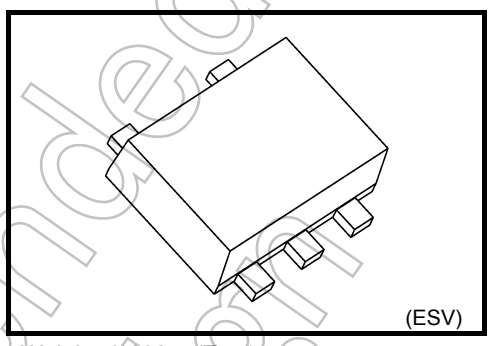
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7SX04BFE

Digital Clock-Buffer with High-pass-filter, linear-amplifier and Digital-output-buffer

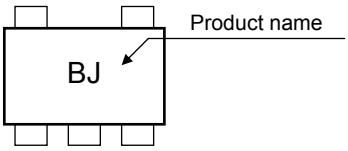
## Features

- High speed operation : $f_{IN}$= 0.032 to 80 MHz
  at square-wave,
  input rise and fall time = 0 to 10 ns/V
  : Slew rate = 0.53 V/ns (min)
  at $V_{CC}$ = 1.65 to 1.95 V, $C_L$=25 pF
- Operating voltage range : $V_{CC}$ = 1.65 to 3.6 V
- Output drive capability :Fan-out (Load capacitance) = 25 pF
- 3.6-V tolerant inputs.

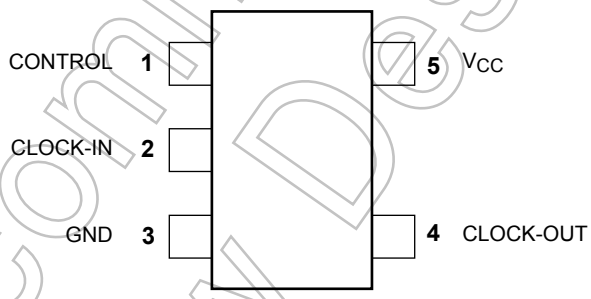



Weight: 0.003 g (Typ.)

## Marking




## Pin Assignment (top view)




## Absolute Maximum Ratings (Ta = 25°C)

| Characteristic | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage | $V_{CC}$ | −0.5 to 4.6 | V |
| Input voltage | $V_{IN}$ | −0.5 to 4.6 | V |
| Output voltage | $V_{OUT}$ | −0.5 to $V_{CC}$ + 0.5 | V |
| Input diode current | $I_{IK}$ | −20 | mA |
| Output diode current | $I_{OK}$ | ±20 (Note 1) | mA |
| Output current | $I_{OUT}$ | ±50 | mA |
| $V_{CC}$/GND current | $I_{CC}$ | ±50 | mA |
| Power dissipation | $P_D$ | 150 | mW |
| Storage temperature | $T_{stg}$ | −65 to 150 | °C |

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook (“Handling Precautions”/“Derating Concept and Methods”) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: $V_{OUT}$ < GND, $V_{OUT}$ > $V_{CC}$

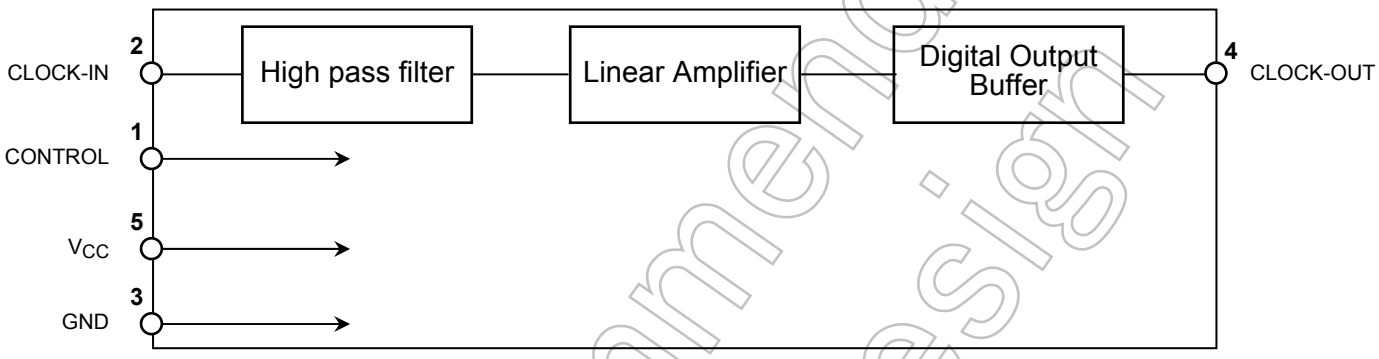
Start of commercial production
2011-05

## Truth Table

| INPUT | | OUTPUT | Function |
|---|---|---|---|
| CONTROL | CLOCK-IN | CLOCK-OUT | |
| L | X | L | Disable |
| H | ↓ | H | Enable |
| H | ↑ | L | Enable |

X: Don't care

## System Diagram




## Operating Ranges

| Characteristic | Symbol | Rating | | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | 1.65 to 3.6 | | V |
| CONTROL Input voltage | $V_{IN}$ | 0 to 3.6 | | V |
| CLOCK-IN Input voltage (peak to peak) | $V_{ICpp}$ | 0.7 to 3.6 | (Note 2) | V |
| | | 0 to 3.6 | (Note 3) | |
| Output voltage | $V_{OUT}$ | 0 to $V_{CC}$ | | V |
| Operating temperature | $T_{opr}$ | −40 to 85 | | °C |
| Clock input frequency (Square-wave) | $f_{IN}$ | 0.032 to 80 | (Note 4) | MHz |
| Clock input frequency (Sine-wave) | $f_{IN}$ | 12 to 80 | | MHz |

Note 2: CONTROL = H level state

Note 3: CONTROL = L level state

Note 4: Input rise and fall time = 0 to 10 ns/V

## Electrical Characteristics

### DC Characteristics

| Characteristic | | Symbol | Test Condition | | $V_{CC}$ (V) | Ta = 25°C | | | Ta = −40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Min | Typ. | Max | Min | Max | |
| CONTROL Input voltage | High Level | $V_{IH}$ | — | | 1.65 to 1.95 | $V_{CC}$ × 0.75 | — | — | $V_{CC}$ × 0.75 | — | V |
| | | | | | 2.3 to 3.6 | $V_{CC}$ × 0.7 | — | — | $V_{CC}$ × 0.7 | — | |
| | Low Level | $V_{IL}$ | — | | 1.65 to 1.95 | — | — | $V_{CC}$ × 0.25 | — | $V_{CC}$ × 0.25 | |
| | | | | | 2.3 to 3.6 | — | — | $V_{CC}$ × 0.3 | — | $V_{CC}$ × 0.3 | |
| Output voltage | High Level | $V_{OH}$ | — | $I_{OH}$ = −100 μA | 1.65 | 1.55 | 1.65 | — | 1.55 | — | V |
| | | | | | 2.3 | 2.2 | 2.3 | — | 2.2 | — | |
| | | | | | 3.0 | 2.9 | 3.0 | — | 2.9 | — | |
| | | | | $I_{OH}$ = −4 mA | 1.65 | 1.29 | 1.52 | — | 1.29 | — | |
| | | | | $I_{OH}$ = −8 mA | 2.3 | 1.9 | 2.15 | — | 1.9 | — | |
| | | | | $I_{OH}$ = −24 mA | 3.0 | 2.3 | 2.68 | — | 2.3 | — | |
| | Low Level | $V_{OL}$ | — | $I_{OL}$ = 100 μA | 1.65 | — | 0 | 0.1 | — | 0.1 | |
| | | | | | 2.3 | — | 0 | 0.1 | — | 0.1 | |
| | | | | | 3.0 | — | 0 | 0.1 | — | 0.1 | |
| | | | | $I_{OL}$ = 4 mA | 1.65 | — | 0.08 | 0.24 | — | 0.24 | |
| | | | | $I_{OL}$ = 8 mA | 2.3 | — | 0.1 | 0.3 | — | 0.3 | |
| | | | | $I_{OL}$ = 24 mA | 3.0 | — | 0.22 | 0.55 | — | 0.55 | |
| Input leakage current | | $I_{IN}$ | $V_{IN(CONTROL)}$ = 0 to 3.6V | | 0 to 3.6 | — | — | ±1 | — | ±10 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN(CONTROL)}$ = $V_{IL}$<br>$V_{IC(CLOCK-IN)}$ = OPEN | | 3.6 | — | — | ±1 | — | ±10 | μA |

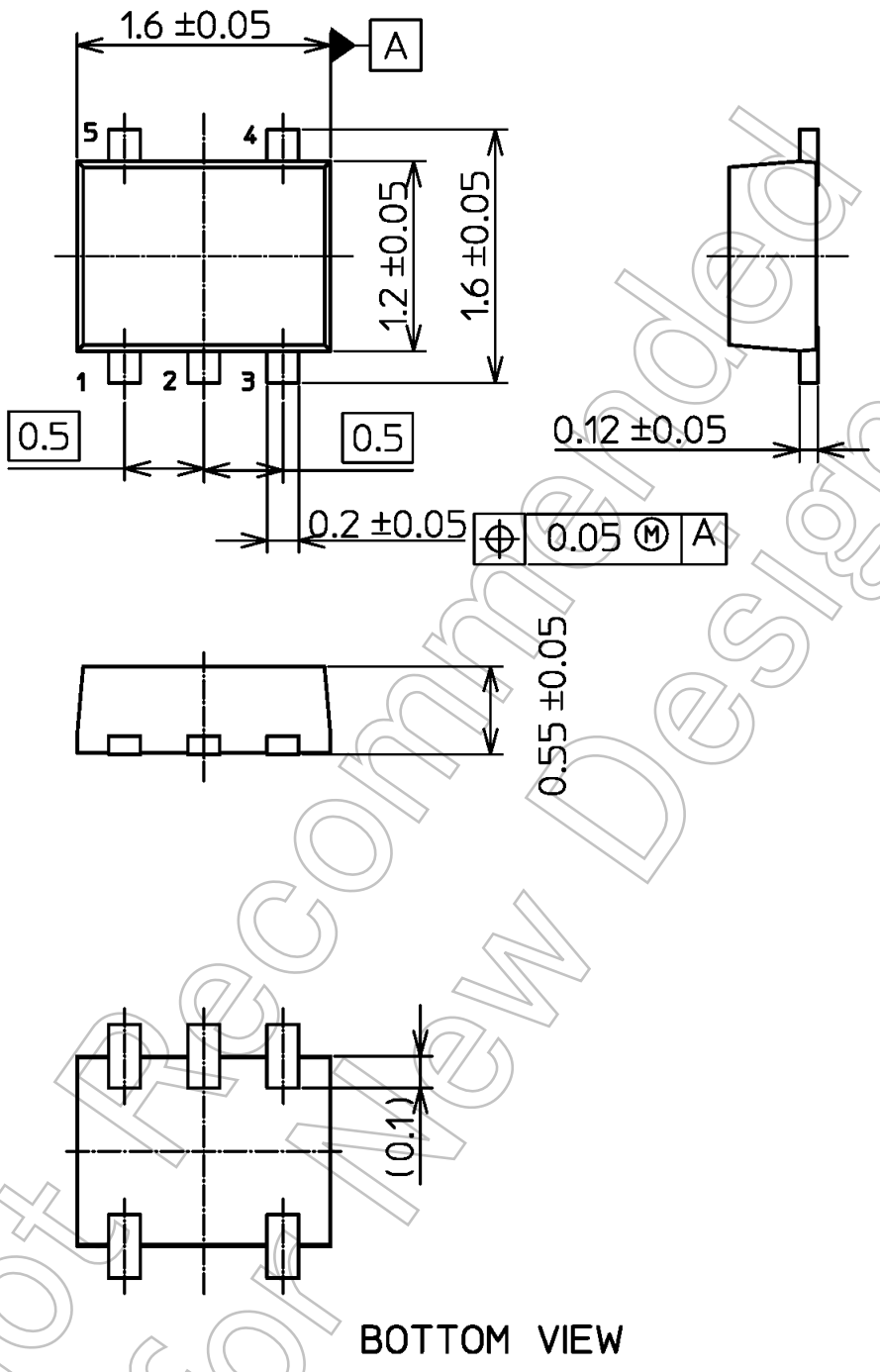
## AC Characteristics (unless otherwise specified, Input: square-wave, $t_r = t_f = 3$ns)

| Characteristic | Symbol | Test Condition | | Ta = 25°C | | | Ta = −40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | Min | Typ. | Max | Min | Max | |
| Propagation delay time | $t_{pLH}$ $t_{pHL}$ | $C_L$ = 5 pF, $R_L$ = 1 MΩ | 1.65 to 1.95 | — | 5.2 | — | — | 7.4 | ns |
| | | | 2.3 to 2.7 | — | 3.0 | — | — | 4.8 | |
| | | | 3.0 to 3.6 | — | 2.3 | — | — | 4.1 | |
| | | $C_L$ = 25 pF, $R_L$ = 1 MΩ | 1.65 to 1.95 | — | 5.4 | — | — | 8.7 | |
| | | | 2.3 to 2.7 | — | 3.3 | — | — | 5.3 | |
| | | | 3.0 to 3.6 | — | 2.6 | — | — | 4.6 | |
| Slew rate | SR | $C_L$ = 5 pF, $R_L$ = 1 MΩ | 1.65 to 1.95 | — | — | — | 1.02 | — | V/ns |
| | | | 2.3 to 2.7 | — | — | — | 1.42 | — | |
| | | | 3.0 to 3.6 | — | — | — | 1.85 | — | |
| | | $C_L$ = 25 pF, $R_L$ = 1 MΩ | 1.65 to 1.95 | — | — | — | 0.53 | — | |
| | | | 2.3 to 2.7 | — | — | — | 0.74 | — | |
| | | | 3.0 to 3.6 | — | — | — | 0.96 | — | |
| Input capacitance (CONTROL) | $C_{IN-CNT}$ | — | 3.3 | — | 2.1 | — | — | — | pF |
| Input capacitance (CLOCK-IN) | $C_{IN-CKI}$ | — | 3.3 | — | 3.3 | — | — | — | pF |
| Power dissipation capacitance | $C_{PD}$ | (Note 5) | 1.8 | — | 24 | — | — | — | pF |
| | | | 3.3 | — | 29 | — | — | — | |

Note 5: $C_{PD}$ is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.
Average operating current can be obtained by the equation:
$I_{CC\ (opr.)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$

**Package Dimensions**

Unit: mm




Weight: 0.003 g (Typ.)

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