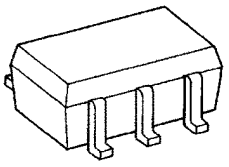
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7PA53FU

2-Channel Multiplexer/Demultiplexer

## Features

- Ultra-low on resistance: $R_{ON}$ = 21 Ω (max) at $V_{CC}$ = 3.6 V
- Operating voltage range: $V_{CC\ (opr.)}$ = 1.8 to 3.6 V
- 3.6 V Tolerant inputs.



SSOP6-P-0.65A

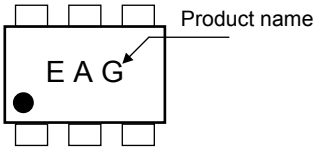
Weight: 0.0068 g (typ.)

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

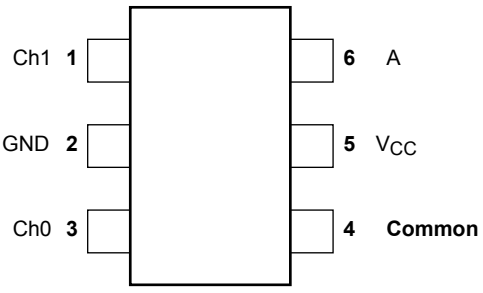
| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Supply voltage | | $V_{CC}$ | −0.5 to 4.6 | V |
| DC input voltage | | $V_{IN}$ | −0.5 to 4.6 | V |
| Switch I/O voltage | | $V_S$ | −0.5 to $V_{CC}$ + 0.5 | V |
| Clamp diode current | Control input block | $I_{IK}$ | −50 | mA |
| | Switch block | | ±50 | |
| Switch through current | | $I_T$ | 100 | mA |
| Power dissipation | | $P_D$ | 200 | mW |
| DC $V_{CC}$/ground current | | $I_{CC}$ | ±100 | mA |
| 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).

## Marking



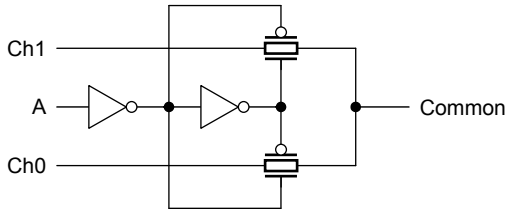

## Pin Assignment (top view)



## Truth Table

| Input A | On Channel |
|---|---|
| L | Ch0 |
| H | Ch1 |

## System Diagram




## Operating Ranges

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage | $V_{CC}$ | 1.8 to 3.6 | V |
| Control input voltage | $V_{IN}$ | 0 to 3.6 | V |
| Switch I/O voltage | $V_S$ | 0 to $V_{CC}$ | V |
| Operating temperature | $T_{opr}$ | −40 to 85 | °C |
| Control input rise and fall time | dt/dv | 0 to 10 | ns/V |

## Electrical Characteristics

### DC Electrical Characteristics (Ta = –40 to 85°C)

| Characteristics | | Symbol | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|
| Input voltage | High level | $V_{IH}$ | — | 1.8 | $V_{CC}$ × 0.75 | — | V |
| | | | | 2.3 to 3.6 | $V_{CC}$ × 0.75 | — | |
| | Low level | $V_{IL}$ | — | 1.8 | — | $V_{CC}$ × 0.25 | |
| | | | | 2.3 to 3.6 | — | $V_{CC}$ × 0.25 | |
| On resistance<br>$V_{I/O}$ = $V_{CC}$ or GND | | $R_{ON}$ | $V_{IN}$ = 0 V, $I_O$ = 24 mA | 3.6 | — | 19 | Ω |
| | | | $V_{IN}$ = 1.9 V, $I_O$ = –24 mA | 3.6 | — | 18 | |
| | | | $V_{IN}$ = 3.6 V, $I_O$ = –24 mA | 3.6 | — | 16 | |
| | | | $V_{IN}$ = 0 V, $I_O$ = 24 mA | 3.0 | — | 21 | |
| | | | $V_{IN}$ = 3 V, $I_O$ = –24 mA | 3.0 | — | 17 | |
| | | | $V_{IN}$ = 0 V, $I_O$ = 18 mA | 2.3 | — | 25 | |
| | | | $V_{IN}$ = 2.3 V, $I_O$ = –18 mA | 2.3 | — | 20 | |
| | | | $V_{IN}$ = 0 V, $I_O$ = 6 mA | 1.8 | — | 32 | |
| | | | $V_{IN}$ = 1.8 V, $I_O$ = –6 mA | 1.8 | — | 26 | |
| On resistance<br>$V_{I/O}$ = $V_{CC}$ to GND | | $R_{ON}$ | 0 < $V_{IN}$ < 3.6 V, $I_O$ = 24 mA | 3.6 | — | 21 | Ω |
| | | | 0 < $V_{IN}$ < 3 V, $I_O$ = 24 mA | 3.0 | — | 23 | |
| | | | 0 < $V_{IN}$ < 2.3 V, $I_O$ = 18 mA | 2.3 | — | 42 | |
| | | | 0 < $V_{IN}$ < 1.8 V, $I_O$ = 6 mA | 1.8 | — | 140 | |
| Control input leakage current | | $I_{IN}$ | $V_{IN}$ = 0 to 3.6 V | 3.6 | — | ±5.0 | μA |
| Switch I/O leakage current | | $I_{SZ}$ | $V_{IN}$ = 0 to 3.6 V | 3.6 | — | 10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | 3.6 | — | 20.0 | μA |
| Increase in $I_{CC}$ per Input | | $\Delta I_{CC}$ | $V_{IH}$ = 3 V | 3.6 | — | 750 | |

## AC Characteristics (Ta = –40 to 85°C, input $t_r = t_f = 2.0$ ns, $C_L = 30$ pF, $R_L = 500\ \Omega$)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Output enable time | $t_{pZL}$ $t_{pZH}$ | Figure 1,2 | 1.8 | — | 9 | ns |
| | | | 2.5 ± 0.2 | — | 7 | |
| | | | 3.3 ± 0.3 | — | 5 | |
| Output disable time | $t_{pLZ}$ $t_{pHZ}$ | Figure 1,2 | 1.8 | — | 9 | ns |
| | | | 2.5 ± 0.2 | — | 7 | |
| | | | 3.3 ± 0.3 | — | 5 | |

The propagation delay time is defined by test condition as follows: (calculating condition: see Figure 3)

Propagation delay time (reference) = $- ( C_{OS} + C_L ) \cdot (R_{DRIVE+} R_{ON}) \cdot \ln ( ( ( V_{OH} – V_{OL} ) – V_M) / ( V_{OH} – V_{OL} ) )$

$R_{DRIVE}$ = Output impedance of front circuit
$V_M$= Arbitrary output threshold voltage

Example of calculation:
Propagation delay time (reference) = $- ( 15 + 15 ) \cdot ( 0 + 21) \cdot \ln ( ( ( 3.6 - 0 ) – 3.6 \cdot 50\% ) / ( 3.6 – 0 ) )$
= approximately 0.4 ns

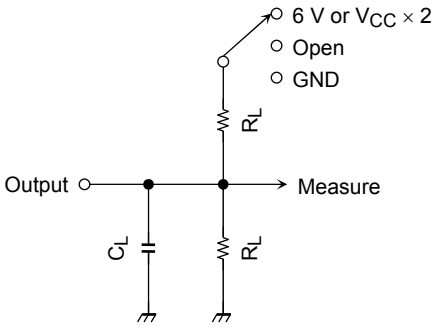
Calculating condition:
$V_{CC}$ = 3.6V , $C_L$ = 15pF , $R_{DRIVE}$ = 0 Ω (ideal signal source) , $V_M$ = 50%
Input signal to switch = Digital signal ( “H” revel voltage=3.6V , ”L” revel voltage = 0V )

## Capacitive Characteristics (Ta = 25°C)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|
| Input capacitance | $C_{IN}$ | — | 1.8, 2.5, 3.3 | 3 | pF |
| Common Terminal Capacitance | $C_{IS}$ | — | 1.8, 2.5, 3.3 | 6 | pF |
| Switch Terminal Capacitance | $C_{OS}$ | — | 1.8, 2.5, 3.3 | 15 | pF |
| Feed Through Capacitance | $C_{IOS}$ | — | 1.8, 2.5, 3.3 | 0.3 | pF |
| Power dissipation capacitance | $C_{PD}$ | $f_{IN}$ = 10 MHz (Note 1) | 1.8, 2.5, 3.3 | 5.5 | pF |

Note 1: $C_{PD}$ is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current is given as:
$I_{CC\ (opr.)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$

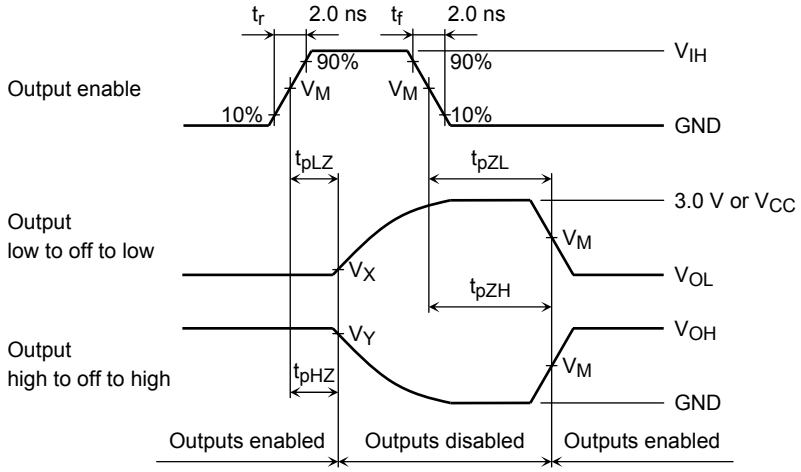
## AC Test Circuit




| Characteristics | Switch | |
|---|---|---|
| $t_{pLZ}$, $t_{pZL}$ | 6 V | at $V_{CC}$ = 3.3 ± 0.3 V |
| | $V_{CC}$ × 2 | at $V_{CC}$ = 2.5 ± 0.2 V<br>at $V_{CC}$ = 1.8 V |
| $t_{pHZ}$, $t_{pZH}$ | GND | |

**Figure 1**

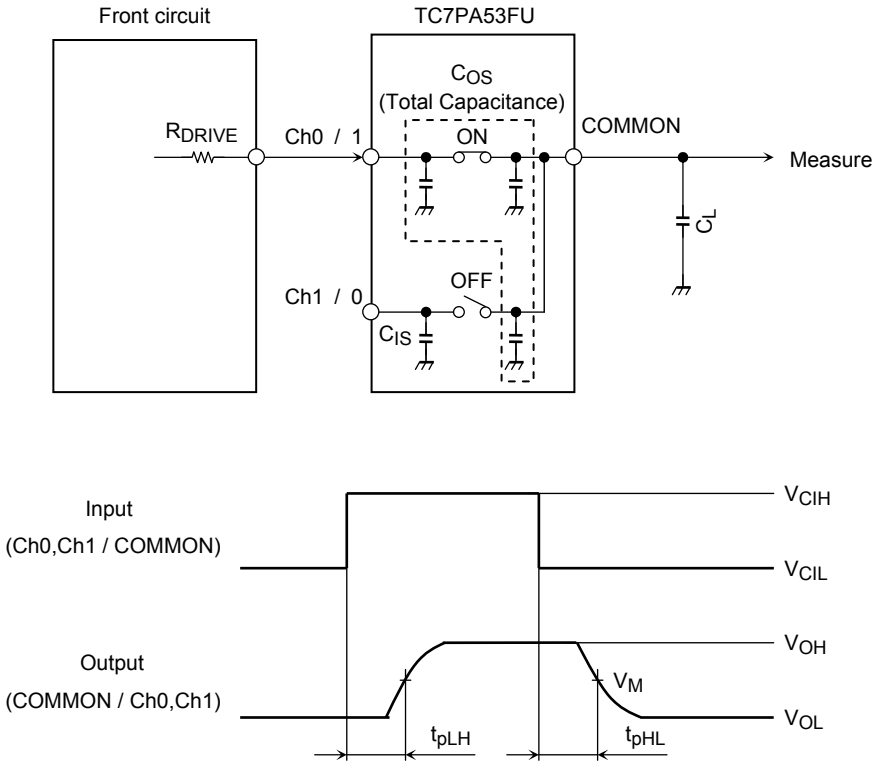
## AC Waveforms




| Symbol | $V_{CC}$ | | |
|---|---|---|---|
| | 3.3 ± 0.3 V | 2.5 ± 0.2 V | 1.8 V |
| $V_{IH}$ | 2.7 V | $V_{CC}$ | $V_{CC}$ |
| $V_M$ | 1.5 V | $V_{CC/2}$ | $V_{CC/2}$ |
| $V_X$ | $V_{OL}$ + 0.3 V | $V_{OL}$ + 0.15 V | $V_{OL}$ + 0.15 V |
| $V_Y$ | $V_{OH}$ − 0.3 V | $V_{OH}$ − 0.15 V | $V_{OH}$ − 0.15 V |

**Figure 2 $t_{pLZ}$, $t_{pHZ}$, $t_{pZL}$, $t_{pZH}$**

**Calculating condition for propagation delay time**




$R_{DRIVE}$ = Output impedance of front circuit
$V_M$ = Arbitrary output threshold voltage
$V_{CIH}$ = “H” revel input voltage to switch
$V_{CIL}$ = ”L” revel input voltage to switch

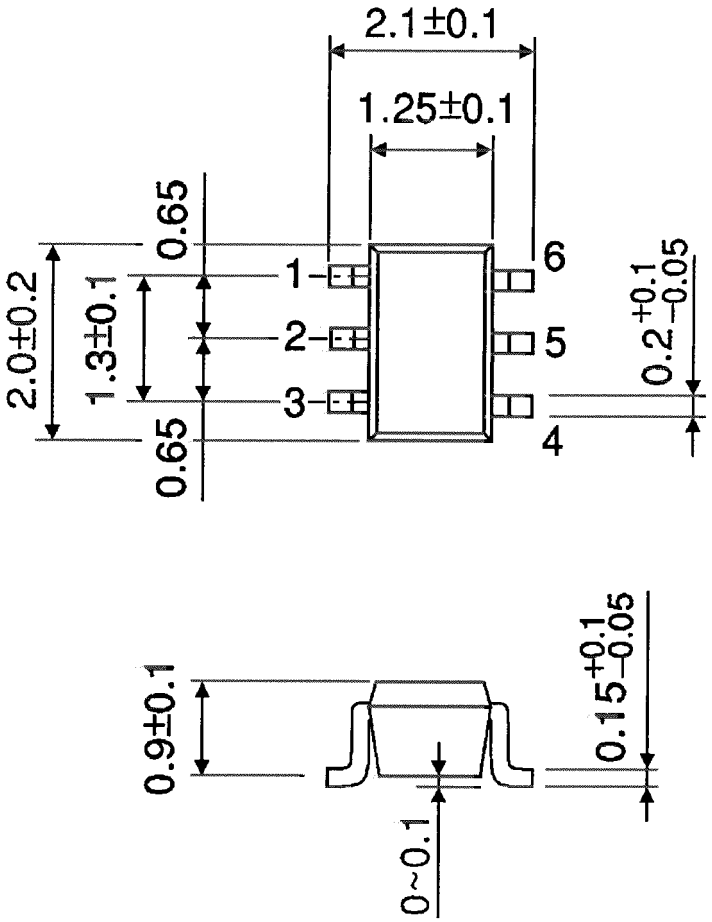
| Symbol | $V_{CC}$ | | |
|---|---|---|---|
| | 3.3 ± 0.3 V | 2.5 ± 0.2 V | 1.8 V |
| $V_M$ | arbitrary | arbitrary | arbitrary |

**Figure 3 $t_{pLH}$, $t_{pHL}$**

## Package Dimensions

SSOP6-P-0.65A

Unit: mm




Weight: 0.0068 g (typ.)

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