

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7W53FU, TC7W53FK

1. Functional Description

2-Channel Multiplexer/Demultiplexer

2. General

The TC7W53 is a high speed C²MOS Analog Multiplexer/Demultiplexer fabricated with silicon gate C²MOS technology. It achieves the high speed operation similar to equivalent LSTTL while maintaining the C²MOS low power dissipation.

The TC7W53 has a 2 channel configuration.

The digital signal to the control terminal turns "ON" the corresponding switch of each channel a large amplitude signal ($V_{CC} - V_{EE}$) can then be switched by the small logical amplitude ($V_{CC} - GND$) control signal.

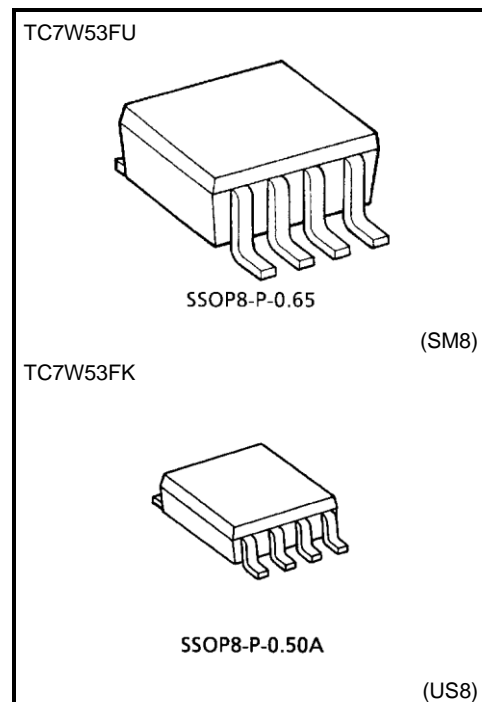
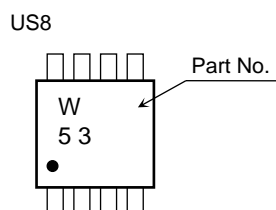
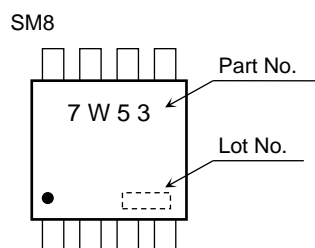
For example, in the case of $V_{CC} = 5\text{ V}$, $GND = 0\text{ V}$, $V_{EE} = -5\text{ V}$, signals between -5 V and $+5\text{ V}$ can be switched from the logical circuit with a signal power supply of 5 V . As the ON-resistance of each switch is low, they can be connected to circuit with low input impedance.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.

3. Features

- High speed: $t_{pd} = 15\text{ ns}$ (typ.) at $V_{CC} = 5\text{ V}$, $V_{EE} = 0\text{ V}$
- Low power dissipation: $I_{CC} = 4\text{ }\mu\text{A}$ (max) at $T_a = 25^\circ\text{C}$
- High noise immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (min)
- Low ON resistance: $R_{ON} = 50\text{ }\Omega$ (typ.) at $V_{CC} - V_{EE} = 9\text{ V}$
- High degree of linearity: $THD = 0.02\%$ (typ.) at $V_{CC} - V_{EE} = 9\text{ V}$
- Pin and function compatible with TC4W53

4. Marking



Weight
SSOP8-P-0.65: 0.02 g (typ.)
SSOP8-P-0.50A: 0.01 g (typ.)

Start of commercial production
1997-12

5. Absolute Maximum Ratings (Ta = 25°C) (Note)

| Characteristics | Symbol | Rating | Unit |
|-----------------------------|-----------|-----------------------|------|
| Supply voltage range | VCC | −0.5 to 7 | V |
| | VCC − VEE | −0.5 to 13 | |
| Control input voltage | VIN | −0.5 to VCC + 0.5 | V |
| Switch I/O voltage | VI/O | VEE −0.5 to VCC + 0.5 | V |
| Control input diode current | ICK | ±20 | mA |
| I/O diode current | IIOK | ±20 | mA |
| Switch through current | IT | ±25 | mA |
| DC VCC/GND current | ICC | ±25 | mA |
| Power dissipation | PD | 300 (SM8) | mW |
| | | 200 (US8) | |
| Storage temperature range | Tstg | −65 to 150 | °C |
| Lead temperature (10 s) | TL | 260 | °C |

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

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.

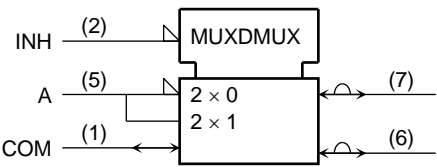
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook (“Handling Precautions”/“Derating Concept and Methods”) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

6. Truth Table

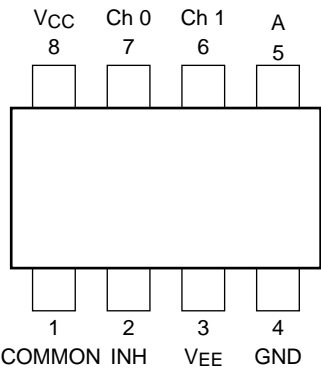
| Control Input | | On Channel |
|---------------|---|------------|
| INH | A | |
| L | L | Ch 0 |
| L | H | Ch 1 |
| H | X | None |

X: Don't care

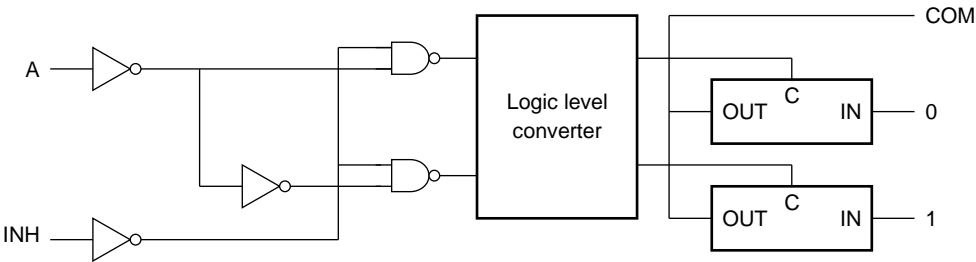
7. Logic Symbol



8. Pin Assignment (top view)



9. Logic Diagram



10. Operating Ranges

| Characteristics | Symbol | Rating | Unit |
|-----------------------------|-------------------|---------------------------------------|------|
| Supply voltage | V_{CC} | 2 to 6 | V |
| | V_{EE} | -6 to 0 | |
| | $V_{CC} - V_{EE}$ | 2 to 12 | |
| Control input voltage | V_{IN} | 0 to V_{CC} | V |
| Switch I/O voltage | $V_{I/O}$ | V_{EE} to V_{CC} | V |
| Operating temperature range | T_{opr} | -40 to 85 | °C |
| Input rise and fall time | t_r, t_f | 0 to 1000 ($V_{CC} = 2.0\text{ V}$) | ns |
| | | 0 to 500 ($V_{CC} = 4.5\text{ V}$) | |
| | | 0 to 400 ($V_{CC} = 6.0\text{ V}$) | |

11. Electrical Characteristics

DC Electrical Characteristics

| Characteristics | | Symbol | Test Condition | Ta = 25°C | | | | | Ta = -40 to 85°C | | Unit |
|--|------------------|------------------|--|---------------------|---------------------|------|------|------|------------------|-------|------|
| | | | | V _{EE} (V) | V _{CC} (V) | Min | Typ. | Max | Min | Max | |
| Control input voltage | High level | V _{IHC} | — | — | 2.0 | 1.5 | — | — | 1.5 | — | V |
| | | | | — | 4.5 | 3.15 | — | — | 3.15 | — | |
| | | | | — | 6.0 | 4.2 | — | — | 4.2 | — | |
| | Low level | V _{ILC} | — | — | 2.0 | — | — | 0.5 | — | 0.5 | |
| | | | | — | 4.5 | — | — | 1.35 | — | 1.35 | |
| | | | | — | 6.0 | — | — | 1.8 | — | 1.8 | |
| ON resistance | | R _{ON} | V _{IN} = V _{ILC} or V _{IHC} V _{I/O} = V _{CC} to V _{EE} I _{I/O} ≤ 2 mA | GND | 4.5 | — | 85 | 180 | — | 225 | Ω |
| | | | | -4.5 | 4.5 | — | 55 | 120 | — | 150 | |
| | | | | -6.0 | 6.0 | — | 50 | 100 | — | 125 | |
| | | | V _{IN} = V _{ILC} or V _{IHC} V _{I/O} = V _{CC} or V _{EE} I _{I/O} ≤ 2 mA | GND | 2.0 | — | 150 | — | — | — | |
| | | | | GND | 4.5 | — | 70 | 150 | — | 190 | |
| | | | | -4.5 | 4.5 | — | 50 | 100 | — | 125 | |
| | | | | -6.0 | 6.0 | — | 45 | 80 | — | 100 | |
| | | | | | | | | | | | |
| Difference of ON resistance between switches | ΔR _{ON} | | V _{IN} = V _{ILC} or V _{IHC} V _{I/O} = V _{CC} to V _{EE} I _{I/O} ≤ 2 mA | GND | 4.5 | — | 10 | 30 | — | 35 | Ω |
| | | | | -4.5 | 4.5 | — | 5 | 12 | — | 15 | |
| | | | | -6.0 | 6.0 | — | 5 | 10 | — | 12 | |
| Input/output leakage current (switch off) | I _{OFF} | | V _{OS} = V _{CC} or GND V _{IS} = GND to V _{CC} V _{IN} = V _{ILC} or V _{IHC} | GND | 6.0 | — | — | ±60 | — | ±600 | nA |
| | | | | -6.0 | 6.0 | — | — | ±100 | — | ±1000 | |
| Switch input leakage current (switch on output open) | I _{IZ} | | V _{OS} = V _{CC} or GND V _{IN} = V _{ILC} or V _{IHC} | GND | 6.0 | — | — | ±60 | — | ±600 | nA |
| | | | | -6.0 | 6.0 | — | — | ±100 | — | ±1000 | |
| Control input current | I _{IN} | | V _{IN} = V _{CC} or GND | GND | 6.0 | — | — | ±0.1 | — | ±1.0 | μA |
| Quiescent supply current | I _{CC} | | V _{IN} = V _{CC} or GND | GND | 6.0 | — | — | 4 | — | 40 | μA |
| | | | | -6.0 | 6.0 | — | — | 8 | — | 80 | |

AC Electrical Characteristics ($C_L = 50 \text{ pF}$, input $t_r = t_f = 6 \text{ ns}$, $GND = 0 \text{ V}$)

| Characteristics | Symbol | Test Condition | | | Ta = 25°C | | | Ta = -40 to 85°C | | Unit |
|---|--------------------------------------|-----------------------|---------------------|---------------------|-----------|------|-----|------------------|-----|------|
| | | | V _{EE} (V) | V _{CC} (V) | Min | Typ. | Max | Min | Max | |
| Phase difference between input and output | φ _{I/O} | — | GND | 2.0 | — | 25 | 60 | — | 75 | ns |
| | | | GND | 4.5 | — | 6 | 12 | — | 15 | |
| | | | GND | 6.0 | — | 5 | 10 | — | 13 | |
| | | | -4.5 | 4.5 | — | 4 | — | — | — | |
| Output enable time | t _{pZL} t _{pZH} | R _L = 1 kΩ | GND | 2.0 | — | 50 | 225 | — | 280 | ns |
| | | | GND | 4.5 | — | 14 | 45 | — | 56 | |
| | | | GND | 6.0 | — | 12 | 38 | — | 48 | |
| | | | -4.5 | 4.5 | — | 14 | — | — | — | |
| Output disable time | t _{pLZ} t _{pHZ} | R _L = 1 kΩ | GND | 2.0 | — | 95 | 225 | — | 280 | ns |
| | | | GND | 4.5 | — | 30 | 45 | — | 56 | |
| | | | GND | 6.0 | — | 26 | 38 | — | 48 | |
| | | | -4.5 | 4.5 | — | 26 | — | — | — | |
| Control input capacitance | C _{IN} | — | — | — | — | 5 | 10 | — | 10 | pF |
| Common terminal capacitance | C _{IS} | — | -5.0 | 5.0 | — | 11 | 20 | — | 20 | pF |
| Switch terminal capacitance | C _{OS} | — | -5.0 | 5.0 | — | 7 | 15 | — | 15 | pF |
| Feed through capacitance | C _{IOS} | — | -5.0 | 5.0 | — | 0.75 | 2 | — | 2 | pF |
| Power dissipation capacitance | C _{PD} | (Note 1) | GND | 5.0 | — | 67 | — | — | — | pF |

Note 1: CPD 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: $ICC(\text{opr}) = CPD \cdot V_{CC} \cdot f_{IN} + ICC/2$

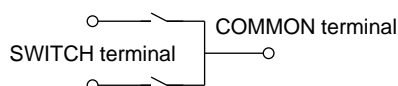
Analog Switch Characteristics (Note) (GND = 0 V, Ta = 25°C)

| Characteristics | Symbol | Test Condition | | V _{EE} (V) | V _{CC} (V) | Typ. | Unit |
|--|------------------|---|----------------------------|---------------------|---------------------|-------|------|
| | | | | | | | |
| Sine wave distortion (T.H.D) | — | R _L = 10 kΩ, C _L = 50 pF f _{IN} = 1 kHz | V _{IN} = 4.0 Vp-p | −2.25 | 2.25 | 0.025 | % |
| | | | V _{IN} = 8.0 Vp-p | −4.5 | 4.5 | 0.02 | |
| | | | V _{IN} = 11 Vp-p | −6.0 | 6.0 | 0.018 | |
| Frequency response (switch ON) | t _{MAX} | Adjust V _{IN} voltage to obtain 0 dBm at V _{OS} Increase F _{IN} until dB Meter reads −3 dB R _L = 50 Ω, C _L = 10 pF f _{IN} = 1 MHz, sine wave | (Note1) | −2.25 | 2.5 | 120 | MHz |
| | | | (Note2) | | | 95 | |
| | | | (Note1) | −4.5 | 4.5 | 190 | |
| | | | (Note2) | | | 150 | |
| | | | (Note1) | −6.0 | 6.0 | 200 | |
| | | | (Note2) | | | 190 | |
| Feed Through attenuation (switch OFF) | — | V _{IN} is centered at (V _{CC} −V _{EE})/2. Adjust input for 0 dBm R _L = 600 Ω, C _L = 50 pF f _{IN} = 1 MHz, sine wave | | −2.25 | 2.25 | −50 | dB |
| | | | | −4.5 | 4.5 | −50 | |
| | | | | −6.0 | 6.0 | −50 | |
| Crosstalk (control input to signal output) | — | R _L = 600 Ω, C _L = 50 pF f _{IN} = 1 MHz, square wave (t _r = t _f = 6 ns) | | −2.25 | 2.25 | 60 | mV |
| | | | | −4.5 | 4.5 | 140 | |
| | | | | −6.0 | 6.0 | 200 | |
| Crosstalk (between any switches) | — | Adjust V _{IN} to obtain 0 dBm at input R _L = 600 Ω, C _L = 50 pF f _{IN} = 1 MHz, sine wave | | −2.25 | 2.25 | −50 | dB |
| | | | | −4.5 | 4.5 | −50 | |
| | | | | −6.0 | 6.0 | −50 | |

Note: These characteristics are determined by design of device.

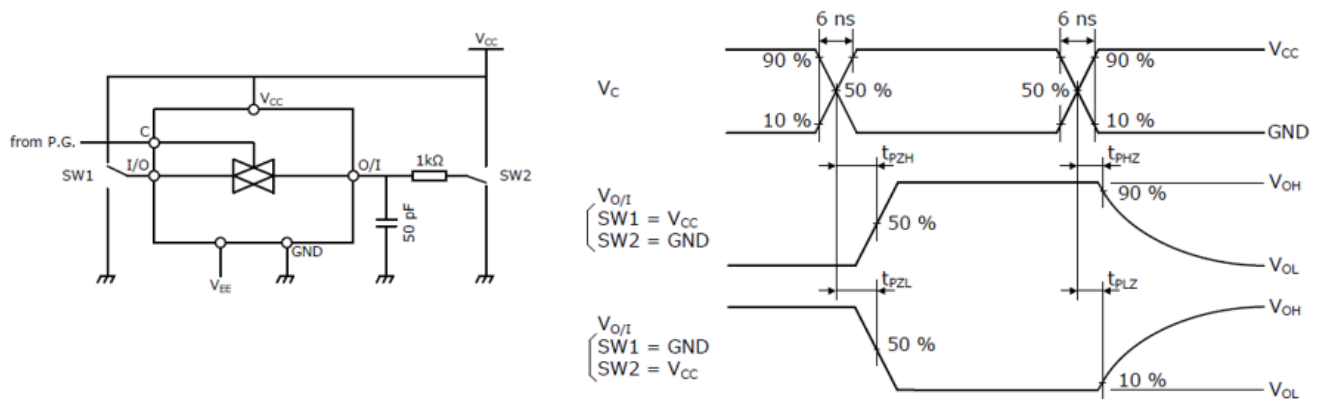
Note 1: Input COMMON terminal, and measure at SWITCH terminal.

Note 2: Input SWITCH terminal, and measure at COMMON terminal.

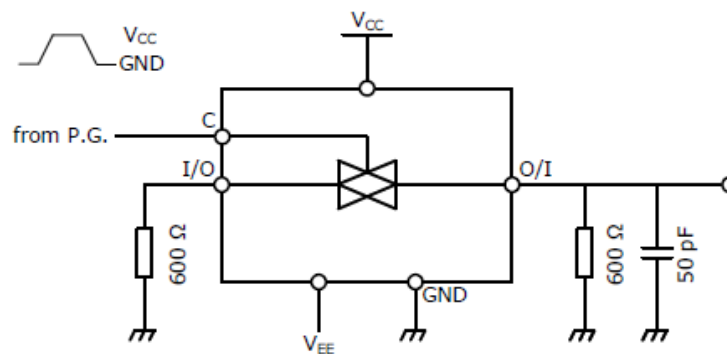


12. Switching Characteristics Test Circuits

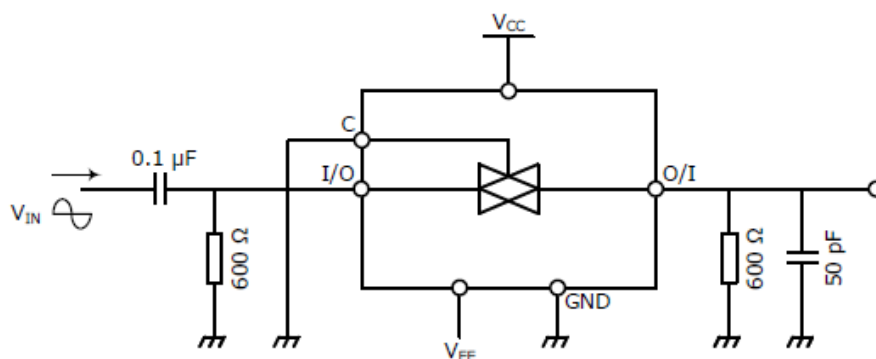
1. t_{pLZ} , t_{pHZ} , t_{pZL} and t_{pZH}



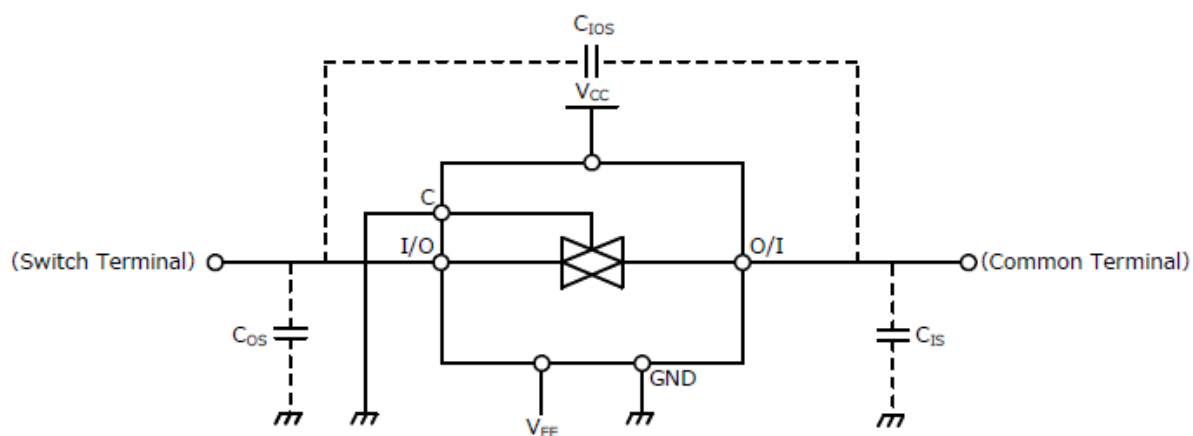
2. Cross Talk (control input-switch output) $f_{IN} = 1$ MHz, duty = 50% and $t_r = t_f = 6$ ns



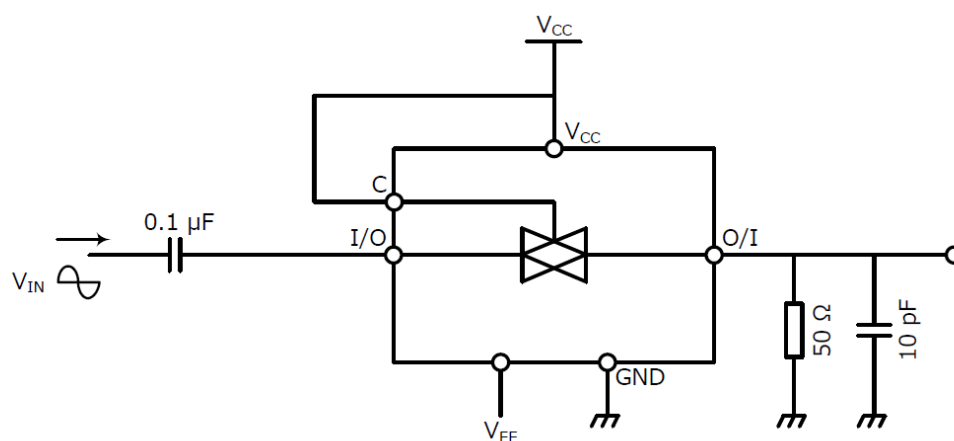
3. Feed Through Attenuation



4. Cios, Cis, Cos



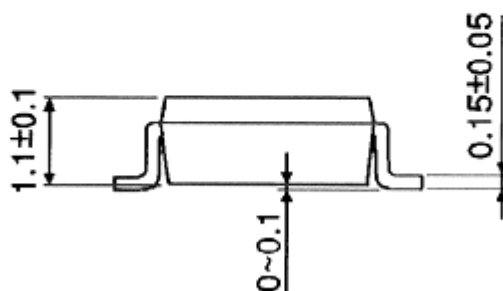
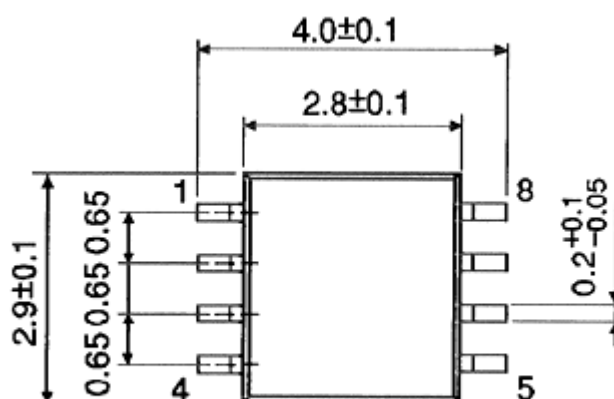
5. Frequency Response (switch ON)



Package Dimensions

SSOP8-P-0.65

Unit : mm



Weight: 0.02 g (typ.)

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