TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7W53F,TC7W53FU,TC7W53FK

2-Channel Multiplexer/Demultiplexer

The TC7W53 is a high speed CMOS Analog Multiplexer/ Demultiplexer fabricated with silicon gate CMOS technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

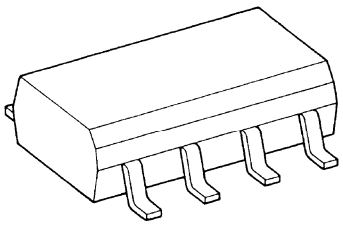
The TC7W53 has a 2 channel configuration.

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 V, GND = 0 V, V_{EE} = 5 V, signals between –5 V and +5 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.

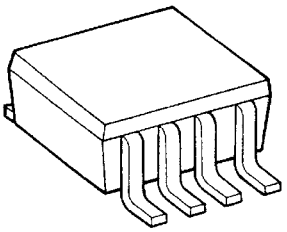
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

TC7W53F



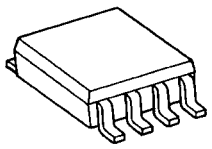
SOP8-P-1.27

TC7W53FU



SSOP8-P-0.65

TC7W53FK



SSOP8-P-0.50A

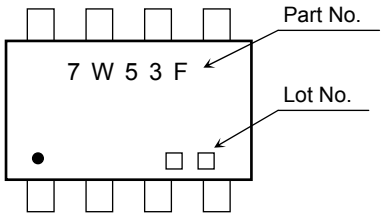
Weight
SOP8-P-1.27: 0.05 g (typ.)
SSOP8-P-0.65: 0.02 g (typ.)
SSOP8-P-0.50A: 0.01 g (typ.)

Features

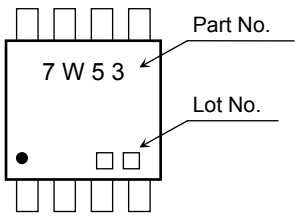
- High speed: t_{pd} = 15 ns (typ.) at V_{CC} = 5 V, V_{EE} = 0 V
- Low power dissipation: I_{CC} = 1 μA (max) at Ta = 25°C
- High noise immunity: V_{NIH} = V_{NIL} = 28% V_{CC} (min)
- Low ON resistance: R_{ON} = 50 Ω (typ.) at V_{CC} – V_{EE} = 9 V
- High degree of linearity: THD = 0.02 (typ.) at V_{CC} – V_{EE} = 9 V
- Pin and function compatible with TC4W53

Marking

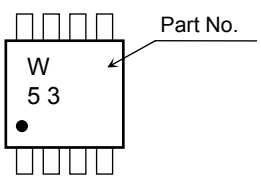
FM8



SM8



US8



Absolute Maximum Ratings (Ta = 25°C)

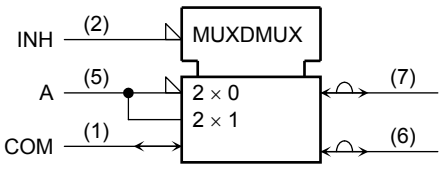
Characteristics	Symbol	Rating	Unit
Supply voltage range	V_{CC}	−0.5 to 7	V
	$V_{CC} - V_{EE}$	−0.5 to 13	
Control input voltage	V_{IN}	−0.5 to V_{CC} + 0.5	V
Switch I/O voltage	$V_{I/O}$	V_{EE} −0.5 to V_{CC} + 0.5	V
Control input diode current	I_{CK}	±20	mA
I/O diode current	I_{IOK}	±20	mA
Switch through current	I_T	±25	mA
DC V_{CC}/GND current	I_{CC}	±25	mA
Power dissipation	P_D	300 (FM8, SM8)	mW
		200 (US8)	
Storage temperature range	T_{stg}	−65 to 150	°C
Lead temperature (10 s)	T_L	260	°C

Truth Table

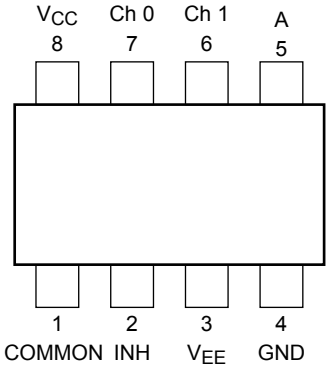
Control Input		On Channel
INH	A	
L	L	Ch 0
L	H	Ch 1
H	X	None

X: Don't care

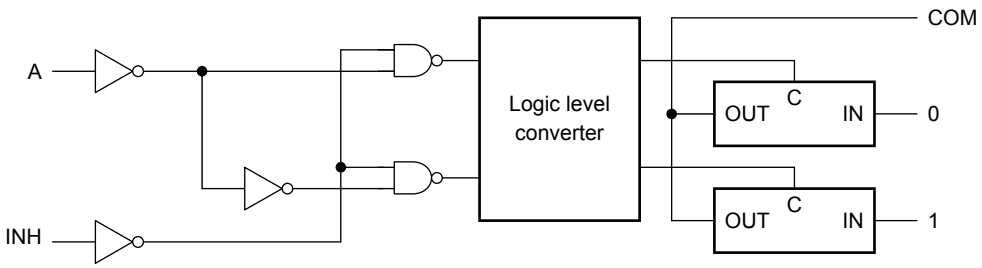
Logic Symbol



Pin Assignment (top view)



Logic Diagram



Operating Ranges

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	2 to 12	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 V)	ns
		0 to 500 (V_{CC} = 4.5 V)	
		0 to 400 (V_{CC} = 6.0 V)	

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 pF, input $t_r = t_f$ = 6 ns, GND = 0 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	ϕI/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)	GND	5.0	—	67	—	—	—	pF

Note: 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: $I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/2$

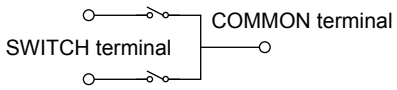
Analog Switch Characteristics (GND = 0 V, Ta = 25°C)

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 F_{IN} voltage to obtain 0dBm at V_{OS} Increase F_{IN} until dB Meter reads −3dB 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	
Feedthrough attenuation (switch OFF)	—	V_{IN} is centered at (V_{CC}–V_{EE})/2. Adjust input for 0dBm 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 0dBm 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.

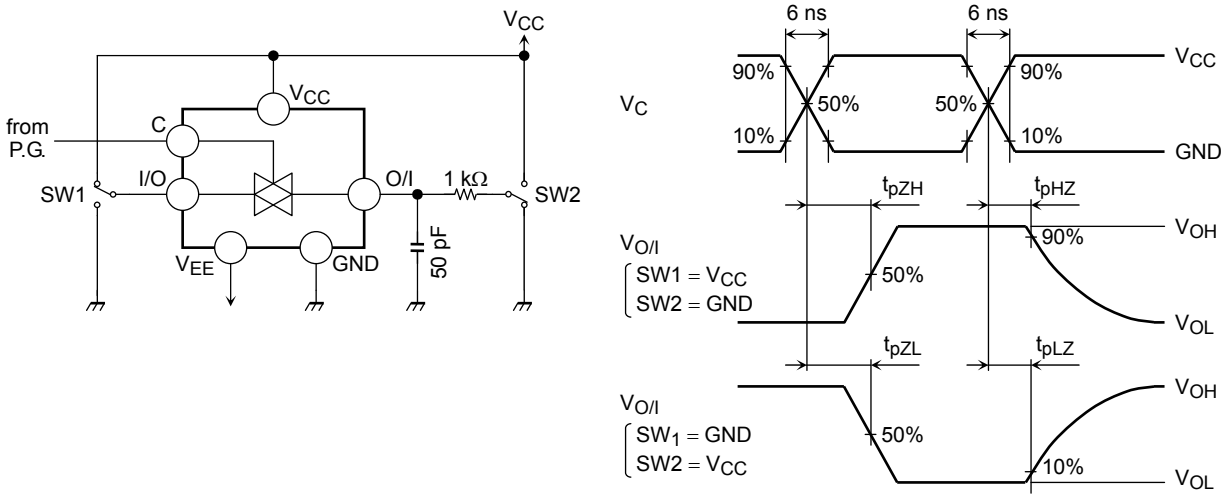
Note 1: Input COMMON terminal, and measure at SWITCH terminal.

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



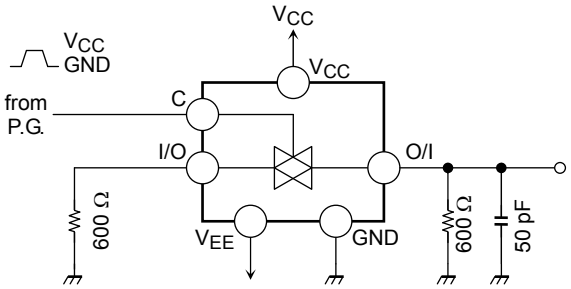
Switching Characteristics Test Circuits

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

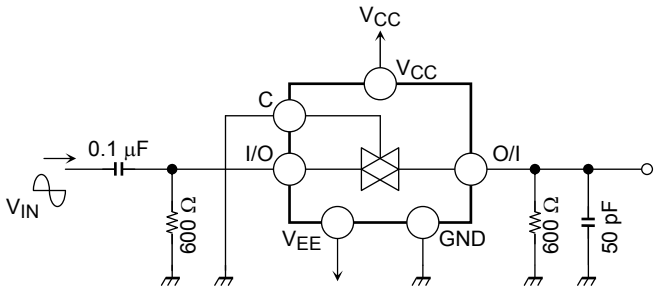


2. Cross Talk (control input-switch output)

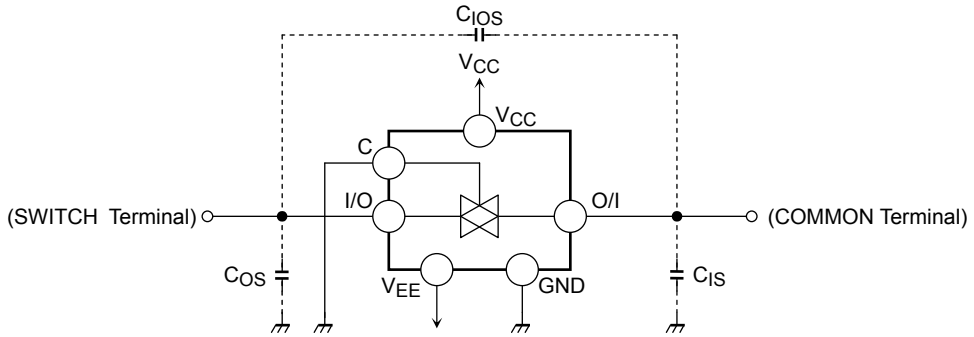
f_{in} = 1 MHz, duty = 50% and $t_r = t_f$ = 6 ns



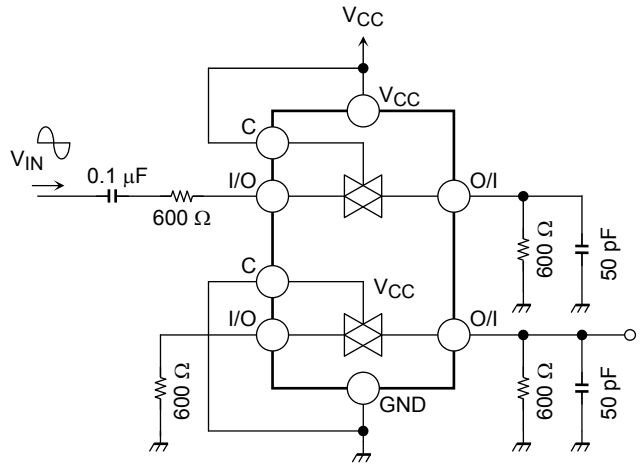
3. Feed Through Attenuation



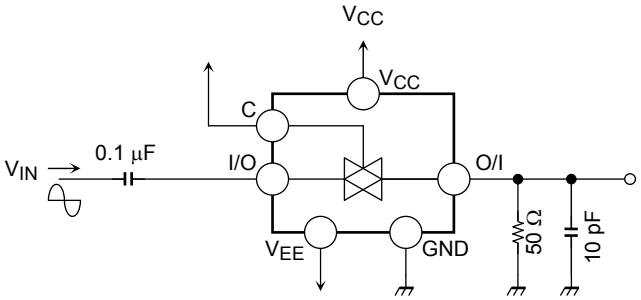
4. Clos, $C_{I/O}$



5. Cross Talk (between any two switches)

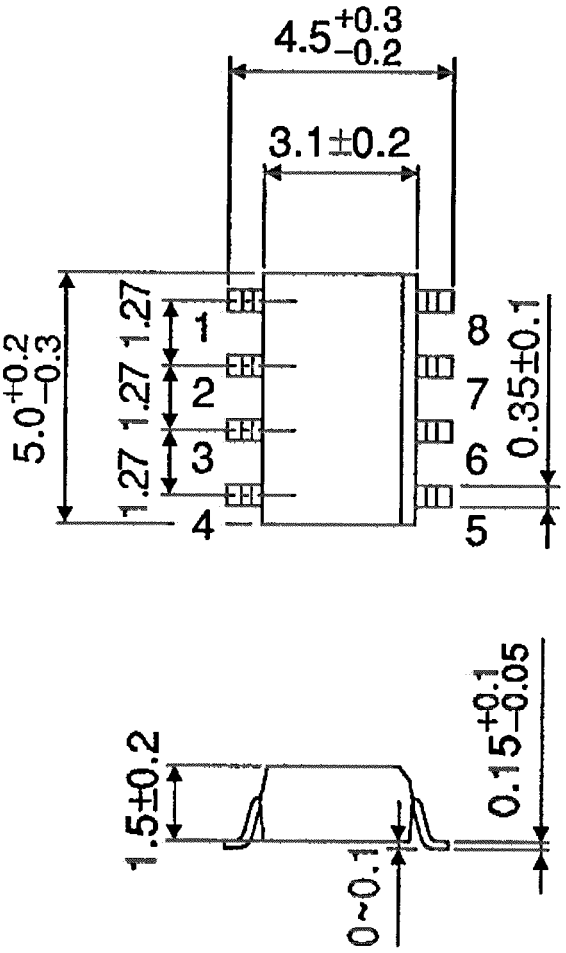


6. Frequency Response (switch ON)



Package Dimensions

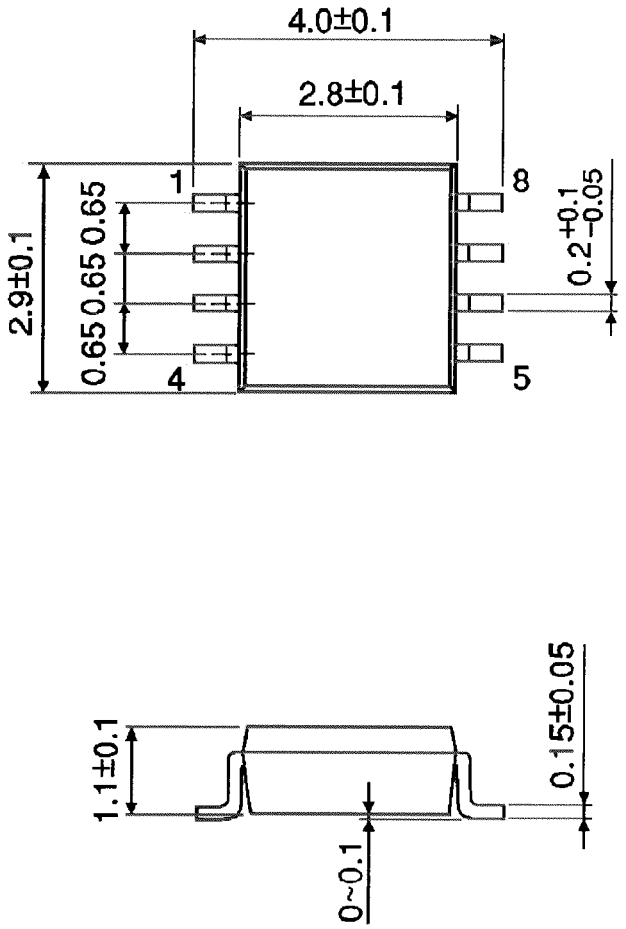
SOP8-P-1.27 Unit : mm



Weight: 0.05 g (typ.)

Package Dimensions

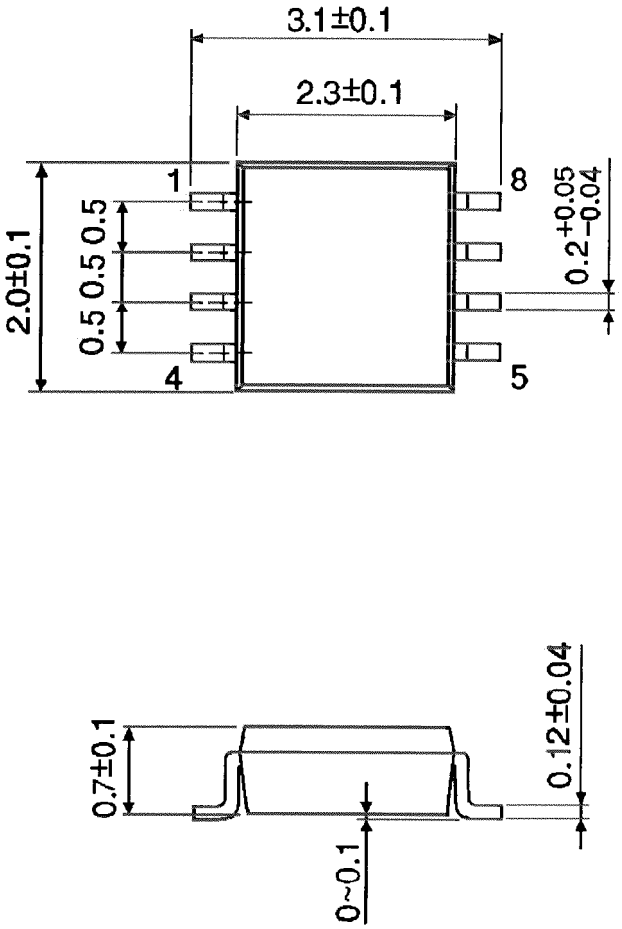
SSOP8-P-0.65 Unit : mm



Weight: 0.02 g (typ.)

Package Dimensions

SSOP8-P-0.50A Unit : mm



Weight: 0.01 g (typ.)

RESTRICTIONS ON PRODUCT USE

- Toshiba Corporation, and its subsidiaries and affiliates (collectively “TOSHIBA”), reserve the right to make changes to the information in this document, and related hardware, software and systems (collectively “Product”) without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA’s written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product’s quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the “TOSHIBA Semiconductor Reliability Handbook” and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. **TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS’ PRODUCT DESIGN OR APPLICATIONS.**
- Product is intended for use in general electronics applications (e.g., computers, personal equipment, office equipment, measuring equipment, industrial robots and home electronics appliances) or for specific applications as expressly stated in this document. Product is neither intended nor warranted for use in equipment or systems that require extraordinarily high levels of quality and/or reliability and/or a malfunction or failure of which may cause loss of human life, bodily injury, serious property damage or serious public impact (“Unintended Use”). Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. Do not use Product for Unintended Use unless specifically permitted in this document.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- **ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.**
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. TOSHIBA assumes no liability for damages or losses occurring as a result of noncompliance with applicable laws and regulations.