

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

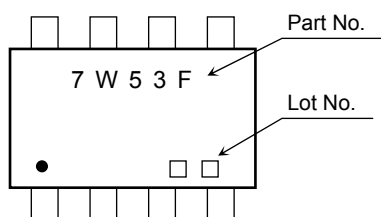
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

### Features

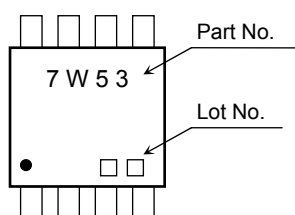
- High speed:  $t_{pd} = 15\text{ ns}$  (typ.) at  $V_{CC} = 5\text{ V}$ ,  $V_{EE} = 0\text{ V}$
- Low power dissipation:  $I_{CC} = 1\text{ }\mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- Low ON resistance:  $R_{ON} = 50\text{ }\Omega$  (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

### Marking

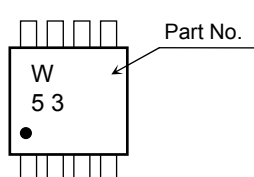
FM8



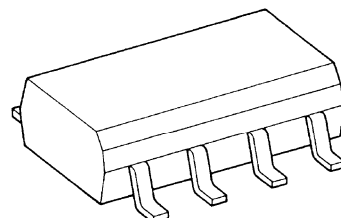
SM8



US8

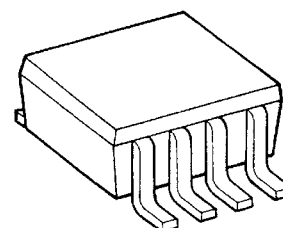


TC7W53F



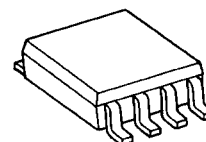
SOP8-P-1.27

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.)

Absolute Maximum Ratings (Ta = 25°C)

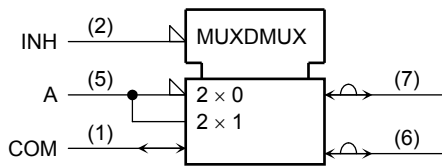
Characteristics	Symbol	Rating	Unit
Supply voltage range	V <sub>CC</sub>	−0.5 to 7	V
	V <sub>CC</sub> − V <sub>EE</sub>	−0.5 to 13	
Control input voltage	V <sub>IN</sub>	−0.5 to V <sub>CC</sub> + 0.5	V
Switch I/O voltage	V <sub>I/O</sub>	V <sub>EE</sub> − 0.5 to V <sub>CC</sub> + 0.5	V
Control input diode current	I <sub>CK</sub>	±20	mA
I/O diode current	I <sub>I/O</sub>	±20	mA
Switch through current	I <sub>T</sub>	±25	mA
DC V <sub>CC</sub> /GND current	I <sub>CC</sub>	±25	mA
Power dissipation	P <sub>D</sub>	300 (FM8, SM8)	mW
		200 (US8)	
Storage temperature range	T <sub>stg</sub>	−65 to 150	°C
Lead temperature (10 s)	T <sub>L</sub>	260	°C

Truth Table

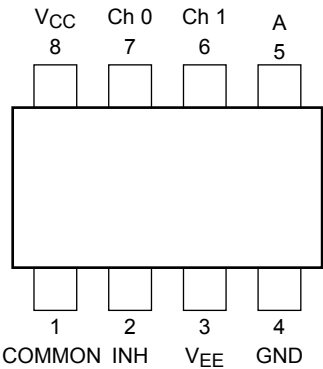
Control Input		On Channel
INH	A	
L	L	Ch 0
L	H	Ch 1
H	X	None

X: Don't care

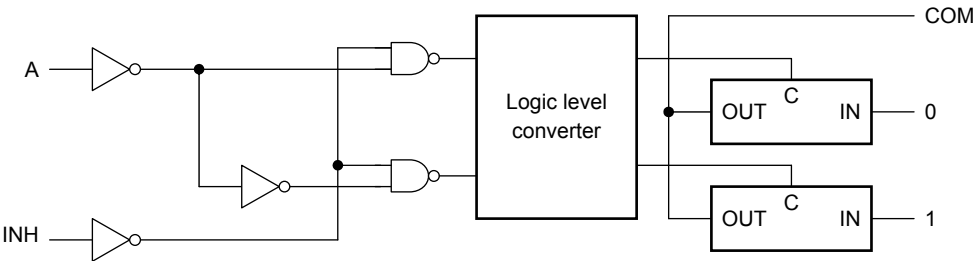
Logic Symbol



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	V <sub>EE</sub> (V)		V <sub>CC</sub> (V)		Ta = 25°C			Ta = -40 to 85°C		Unit
								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 $V_{EE}$ $I_{I/O} \leq 2$ mA	GND	4.5	—	85	180	—	—	—	225	$\Omega$
				-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 $V_{EE}$ $I_{I/O} \leq 2$ 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		$\Delta R_{ON}$	$V_{IN} = V_{ILC}$ or $V_{IHC}$ $V_{I/O} = V_{CC}$ to $V_{EE}$ $I_{I/O} \leq 2$ mA	GND	4.5	—	10	30	—	—	—	35	$\Omega$
				-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 <sub>EE</sub> (V)	V <sub>CC</sub> (V)	Min	Typ.	Max	Min	Max	
Phase difference between input and output	ϕ <sub>I/O</sub>	—	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 <sub>pZL</sub> t <sub>pZH</sub>	R <sub>L</sub> = 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 <sub>pLZ</sub> t <sub>pHZ</sub>	R <sub>L</sub> = 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 <sub>IN</sub>	—	—	—	—	5	10	—	10	pF
Common terminal capacitance	C <sub>IS</sub>	—	−5.0	5.0	—	11	20	—	20	pF
Switch terminal capacitance	C <sub>OS</sub>	—	−5.0	5.0	—	7	15	—	15	pF
Feed through capacitance	C <sub>IOS</sub>	—	−5.0	5.0	—	0.75	2	—	2	pF
Power dissipation capacitance	C <sub>PD</sub>	(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:  $I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/2$

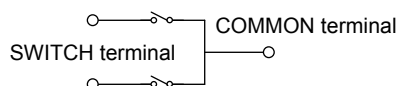
## Analog Switch Characteristics (GND = 0 V, Ta = 25°C)

Characteristics	Symbol	Test Condition		V <sub>EE</sub> (V)	V <sub>CC</sub> (V)	Typ.	Unit
Sine wave distortion (T.H.D)	—	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 50 pF f <sub>IN</sub> = 1 kHz	V <sub>IN</sub> = 4.0 Vp-p	−2.25	−2.25	0.025	%
			V <sub>IN</sub> = 8.0 Vp-p	−4.5	4.5	0.02	
			V <sub>IN</sub> = 11 Vp-p	−6.0	6.0	0.018	
Frequency response (switch ON)	t <sub>MAX</sub>	Adjust F <sub>IN</sub> voltage to obtain 0dBm at V <sub>OS</sub> Increase F <sub>IN</sub> until dB Meter reads −3dB R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF f <sub>IN</sub> = 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 <sub>IN</sub> is centered at (V <sub>CC</sub> −V <sub>EE</sub> )/2. Adjust input for 0dBm R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF f <sub>IN</sub> = 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 <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF f <sub>IN</sub> = 1 MHz, square wave (t <sub>r</sub> = t <sub>f</sub> = 6 ns)		−2.25	2.25	60	mV
				−4.5	−4.5	140	
				−6.0	6.0	200	
Crosstalk (between any switches)	—	Adjust V <sub>IN</sub> to obtain 0dBm at input R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF f <sub>IN</sub> = 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.

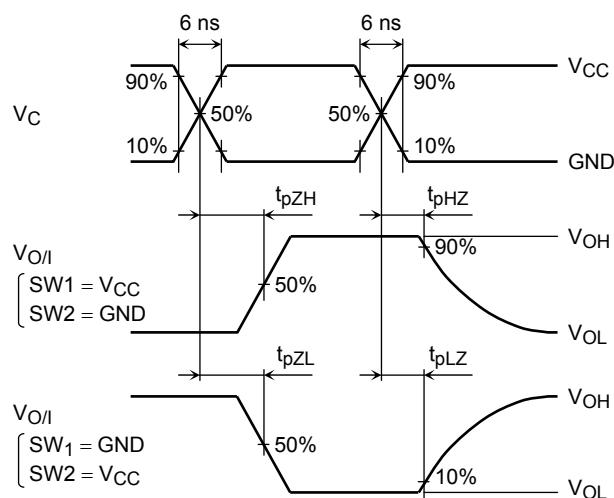
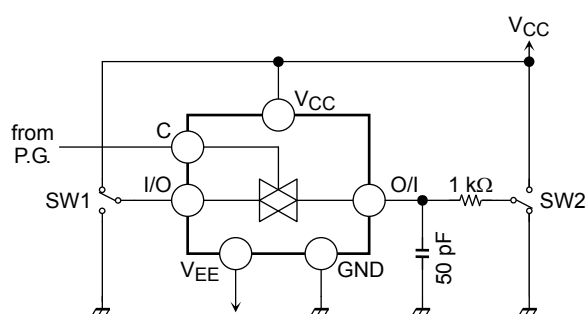
Note 1: Input COMMON terminal, and measure at SWITCH terminal.

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



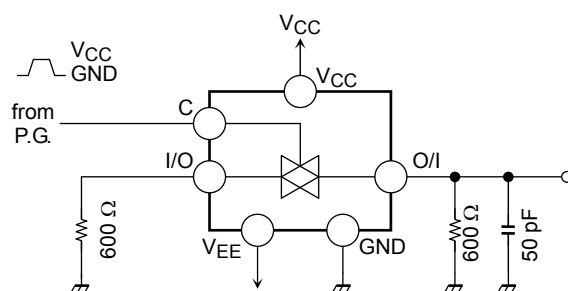
## Switching Characteristics Test Circuits

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

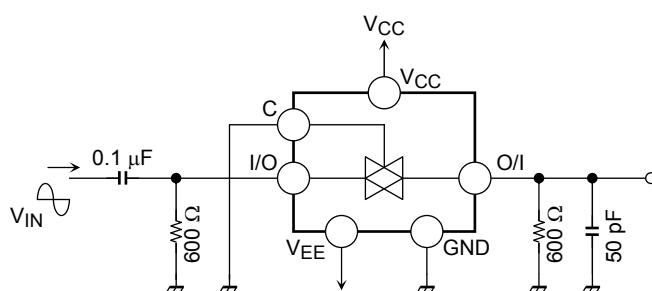


### 2. Cross Talk (control input-switch output)

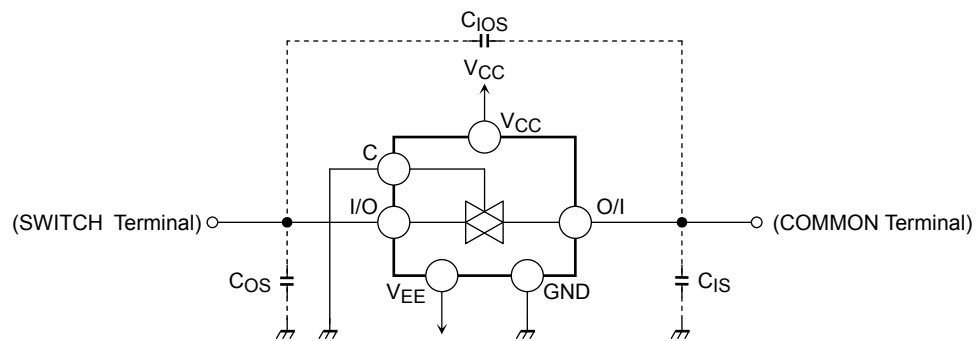
$f_{in} = 1 \text{ MHz}$ , duty = 50% and  $t_r = t_f = 6 \text{ ns}$



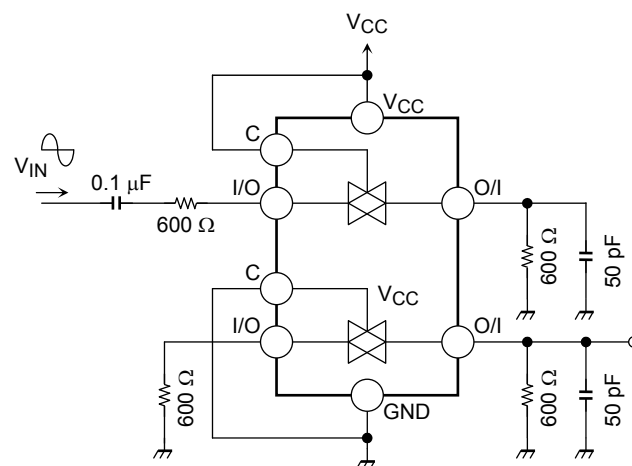
### 3. Feed Through Attenuation



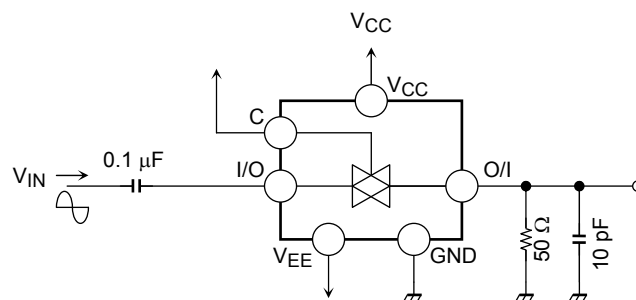
## 4. Clos, $C_{I/O}$



## 5. Cross Talk (between any two switches)

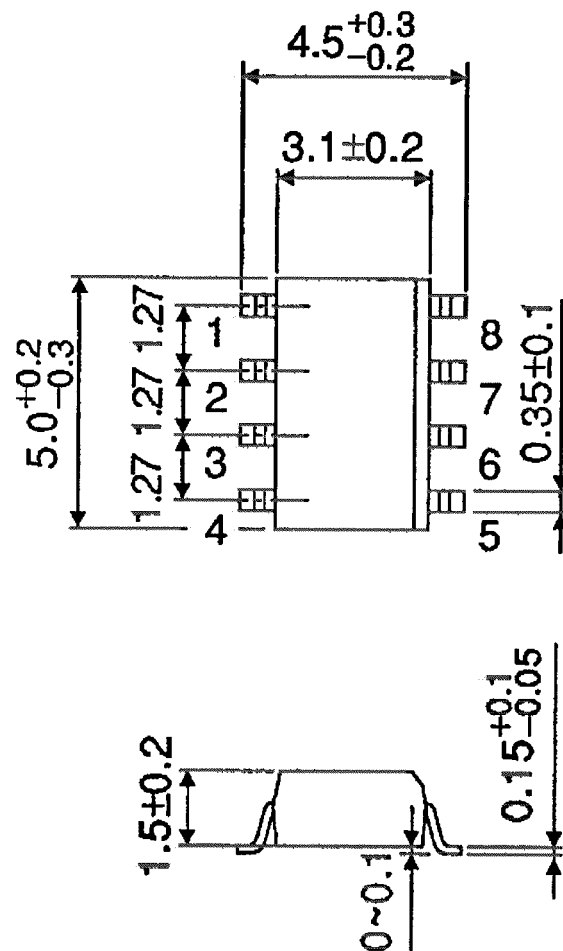


## 6. Frequency Response (switch ON)



**SOP8-P-1.27**

Unit : mm



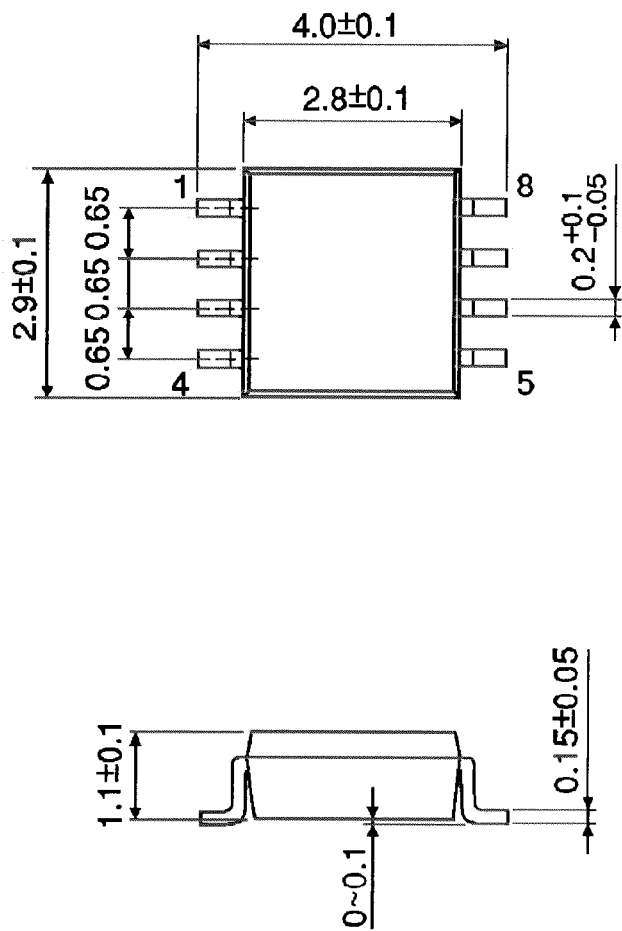
Weight: 0.05 g (typ.)



Package Dimensions

SSOP8-P-0.65

Unit : mm

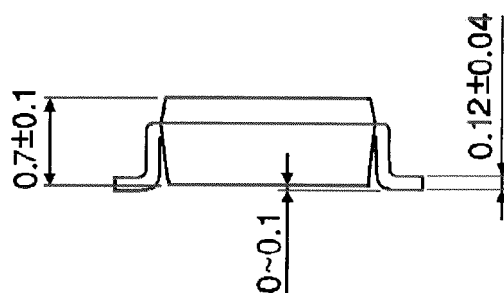
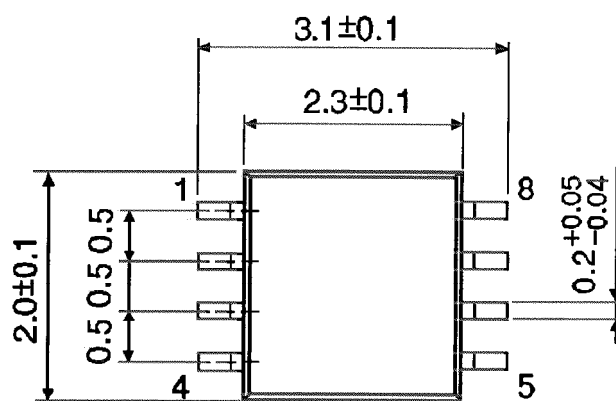


Weight: 0.02 g (typ.)

## Package Dimensions

SSOP8-P-0.50A

Unit : mm



Weight: 0.01 g (typ.)

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