TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

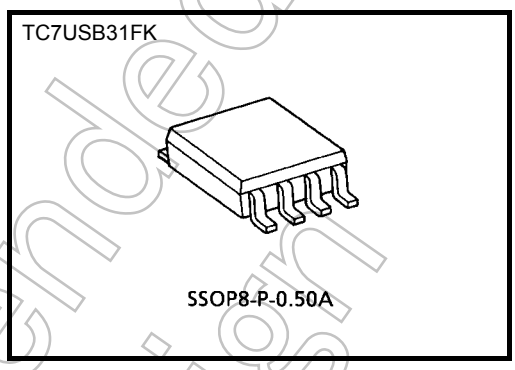
TC7USB31FK

Dual SPST USB Switch

TC7USB31 is high-speed CMOS dual SPST USB Switch. The low ON- resistance and the low capacitance of the switch allow connections to USB application.

The TC7USB31 requires the output enable ($\overline{OE}$) input to be set high to place the output into the high impedance.

All inputs are equipped with protection circuits against static discharge.



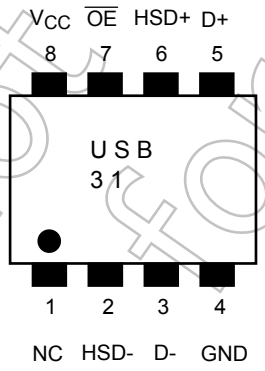
Weight
SSOP8-P-0.50A : 0.01 g (typ)

Features

- Operating voltage: V_{CC} = 2.3 to 3.6 V
- ON-capacitance: $C_{I/O}$ = 4 pF Switch ON (typ.)@V_{CC} = 3.3 V
- ON-resistance: R_{ON} = 4.5 Ω (typ.) @V_{CC} = 3 V, $V_{I/O}$ = 0 V
- R_{ON} Flatness: $R_{ON(flat)}$ = 1.2 Ω (typ.) @V_{CC} = 3 V
- Delta R_{ON}: ΔR_{ON} = 0.5 Ω (typ.) @V_{CC} = 3 V
- ESD performance: Machine model ≥ ± 200V
  Human body model ≥ ± 2000V
- Power-down protection for inputs ($\overline{OE}$ and I/O)
- Package : US8

Pin Assignment (top view)

FK (SSOP8-P-0.50A)

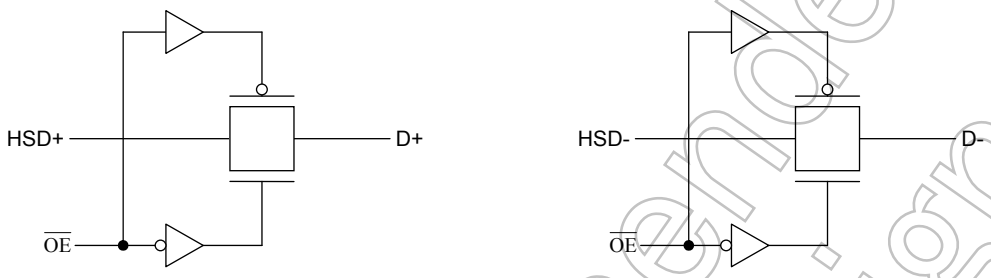


Start of commercial production
2009-09

Truth Table

Inputs $\overline{OE}$	Function
L	A port = B port
H	Disconnect

System Diagram



Absolute Maximum Ratings (Note)

Characteristic		Symbol	Rating	Unit
Power supply range		V_{CC}	−0.5 to 4.6	V
Control pin input voltage ($\overline{OE}$)		V_{IN}	−0.5 to 4.6	V
Switch terminal I/O voltage	V_{CC}=0V or Switch=Off	V_S	−0.5 to 4.6	V
	Switch=On		−0.5 to V_{CC}+0.5	
Clump diode current	Control input	I_{IK}	−50	mA
	Switch		±50	
Switch I/O current		I_S	50	mA
Power dissipation		P_D	200	mW
DC V_{CC}/GND current		I_{CC}/I_{GND}	±100	mA
Storage temperature		T_{stg}	−65 to 150	°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).

Operating Ranges (Note)

Characteristic		Symbol	Rating	Unit
Power supply voltage		V_{CC}	2.3 to 3.6	V
Control pin input voltage ($\overline{OE}$)		V_{IN}	0 to 3.6	V
Switch I/O voltage	V_{CC}=0V or Switch=Off	V_S	0 to 3.6	V
	Switch=On		0 to V_{CC}	
Operating temperature		T_{opr}	−40 to 85	°C
Input rise and fall time		dt/dv	0 to 10	ns/V

Note: The operating ranges must be maintained to ensure the normal operation of the device.Unused inputs must be tied to either V_{CC} or GND.

Electrical Characteristics

DC Characteristics (Ta = −40 to 85°C)

Characteristics		Symbol	Test Condition	V_{CC} (V)	Min	Typ.	Max	Unit
Input voltage ($\overline{OE}$)	"H" level	V_{IH}	—	2.3 to 3.6	0.46 × V_{CC}	—	—	V
	"L" level	V_{IL}	—	2.3 to 3.6	—	—	0.25 × V_{CC}	
Input leakage current ($\overline{OE}$)		I_{IN}	V_{IN} = 0 to 3.6 V	2.3 to 3.6	—	—	±1.0	μA
Power-off leakage current		I_{OFF}	V_{IN} = 0 to 3.6 V	0	—	—	±5.0	μA
Off-state leakage current (switch off)		I_{SZ}	V_{IS} = 0 to V_{CC}, $\overline{OE}$ = V_{CC}	2.3 to 3.6	—	—	±5.0	μA
ON resistance (Note 2)		R_{ON}	V_{IS} = 0 V, I_{IS} = 30 mA (Note 1)	3.0	—	4.5	9	Ω
			V_{IS} = 0.4 V, I_{IS} = 30 mA (Note 1)	3.0	—	5	9.5	
			V_{IS} = 3.0 V, I_{IS} = 30 mA (Note 1)	3.0	—	11	18	
Delta R_{ON}		ΔR_{ON}	V_{IS} = 0.4 V, 1.0 V, I_{IS} = 30 mA	3.0	—	0.5	—	Ω
On-Resistance Flatness		$R_{ON(flat)}$	V_{IN} = 0 V to 1.0 V, I_{IS} = 30 mA	3.0	—	1.2	—	Ω
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND, I_{OUT} = 0	3.6	—	—	2.0	μA
Increase in I_{CC} per input		ΔI_{CC}	V_{IN} = 1.8 V	3.6	—	—	10.0	μA

Note 1: All typical values are at Ta = 25°C.

Note 2: Measured by the voltage drop between D+/D- and HSD+/HSD- pins at the indicated current through the switch. ON resistance is determined by the lower of the voltages on the two pins.

AC Characteristics V_{CC} = 3.3V ± 10% (Ta = −40 to 85°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Typ.	Max	Unit
Propagation Delay Time (Note)	tpd	C_L=5pF	3.3 ± 0.3	—	0.25	—	ns
Turn ON Time ($\overline{OE}$ to Output)	t_{ON}	R_L=50Ω, C_L=5pF	3.3 ± 0.3	—	4	10	ns
Turn OFF Time ($\overline{OE}$ to Output)	t_{OFF}	R_L=50Ω, C_L=5pF	3.3 ± 0.3	—	3.2	9	ns
Output skew between center port to any other port (Note)	$t_{SK(O)}$	C_L=5pF	3.3 ± 0.3	—	0.1	—	ns
Skew of Opposite Transitions of the same output (t_{pHL}- t_{pLH}) (Note)	$t_{SK(P)}$	C_L=5pF	3.3 ± 0.3	—	0.1	—	ns
Off Isolation (Non-Adjacent)	OIRR	R_T=50Ω, f=240MHz	3.3 ± 0.3	—	-27	—	dB
Crosstalk(Non-Adjacent)	XTalk	R_T=50Ω, f=240MHz	3.3 ± 0.3	—	-60	—	dB
-3dB Bandwidth	BW	R_T=50Ω, C_L=0pF	3.3 ± 0.3	—	1100	—	MHz

Note: This parameter is guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Control pin input capacitance ($\overline{OE}$)	C_{IN}	V_{IN} = 0 V (Note)	3.3	4	pF
Switch terminal Off capacitance	$C_{I/O}$	V_{IS} = 0 V, $\overline{OE}$ = V_{CC} (Note)	3.3	2	pF
Switch terminal On capacitance	$C_{I/O}$	V_{IS} = 0 V, $\overline{OE}$ = GND (Note)	3.3	4	pF

Note: This parameter is guaranteed by design.

AC Test Circuit Load / Waveform

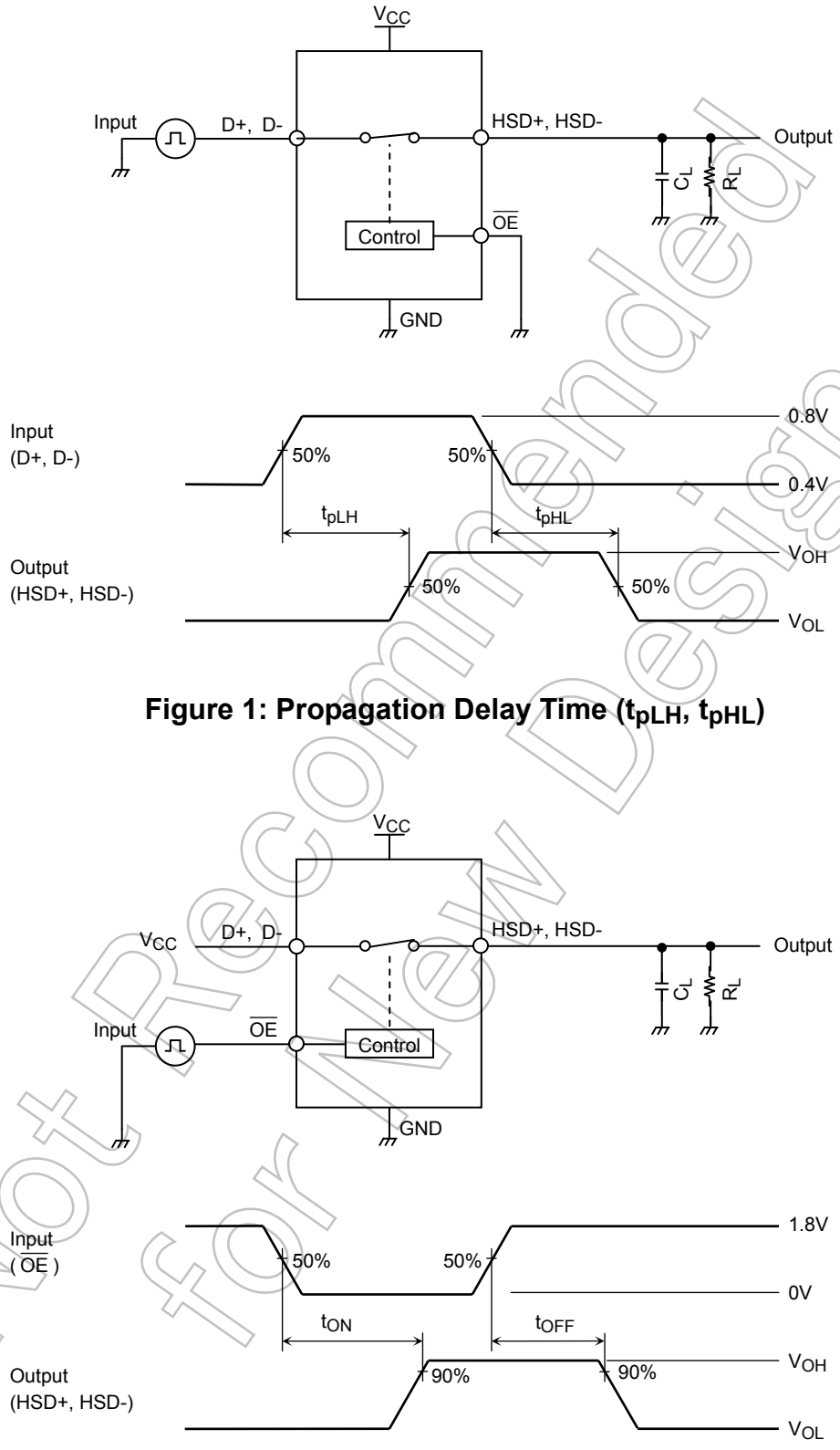
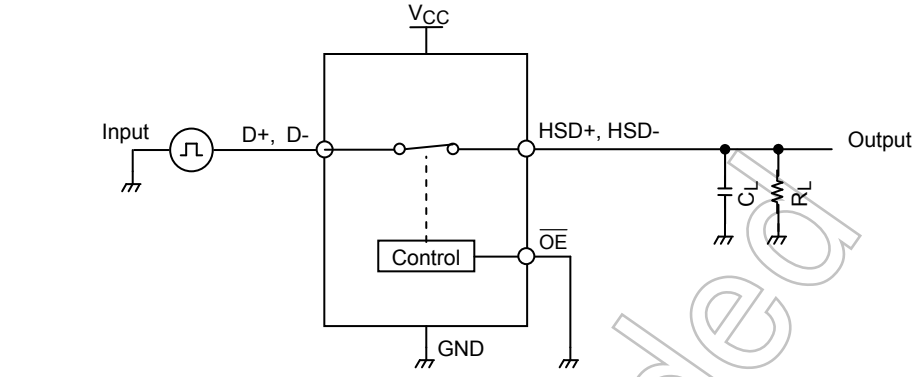
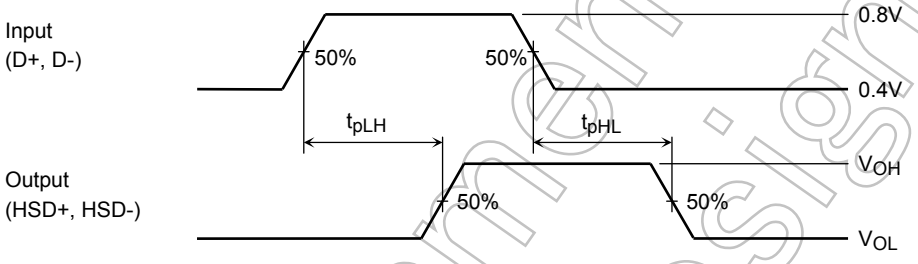


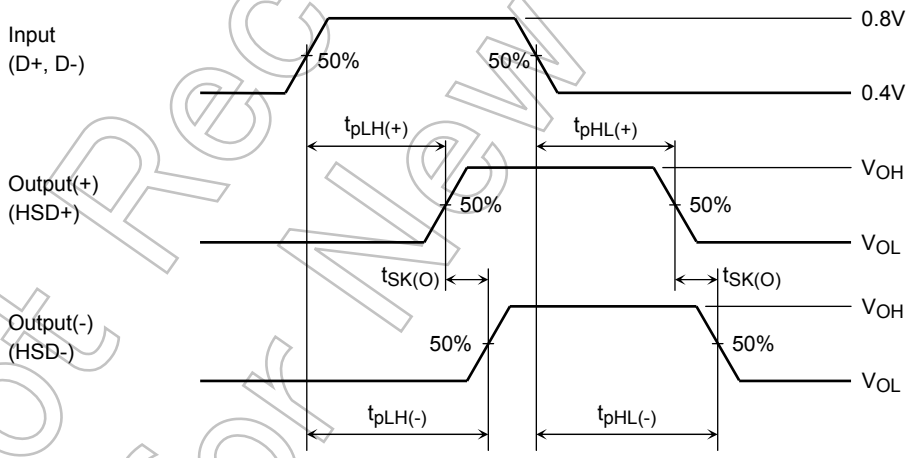
Figure 1: Propagation Delay Time (t_{pLH}, t_{pHL})

Figure 2: Turn ON/Turn OFF (t_{ON}, t_{OFF})





PULSE SKEW $t_{SK(P)} = |t_{pLH} - t_{pHL}|$



OUTPUT SKEW $t_{SK(O)} = |t_{pLH(+)} - t_{pLH(-)}|$ or $|t_{pHL(+)} - t_{pHL(-)}|$

Figure 3: Skew of Opposite Transitions of the same output, Output skew

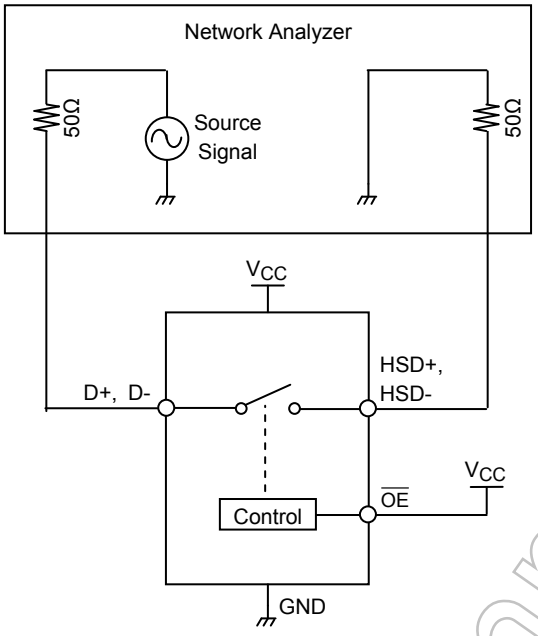


Figure 4: Channel OFF Isolation

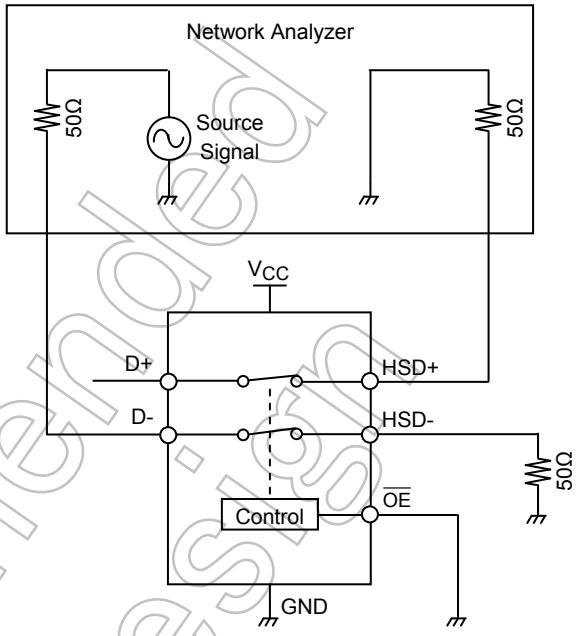


Figure 5: Crosstalk

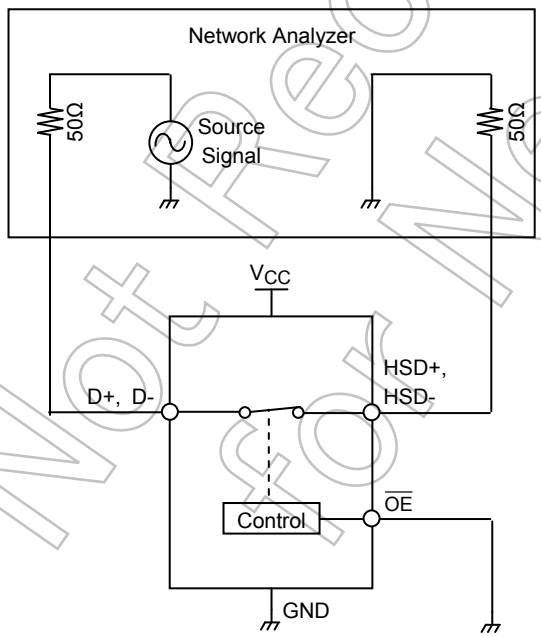


Figure 6: -3dB Bandwidth

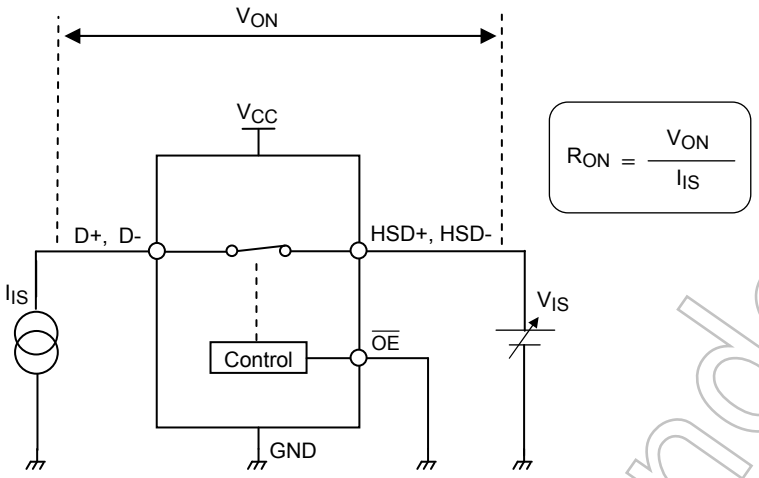


Figure 7: ON Resistance

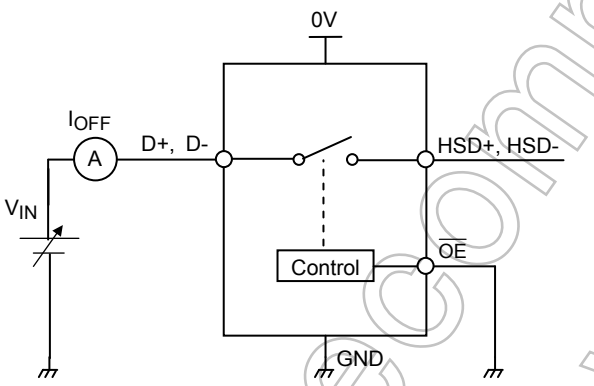


Figure 8: Power off Leakage Current

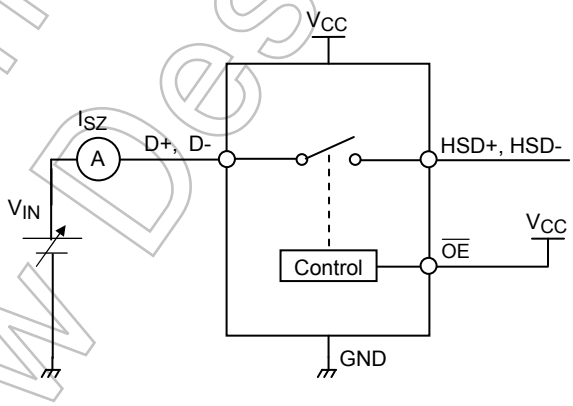
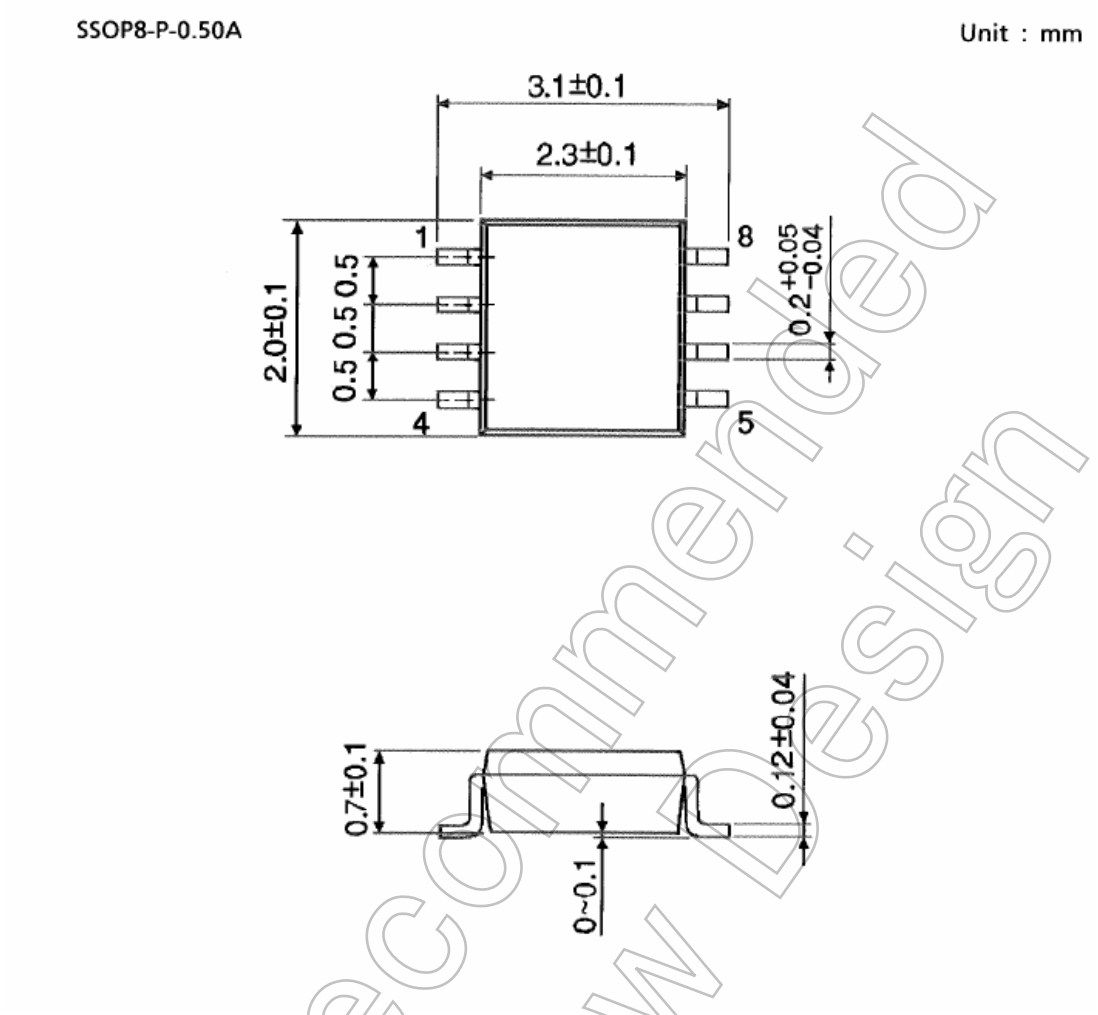


Figure 9: Off-State Leakage Current

Package Dimension



Weight: 0.01 g (Typ.)

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