

Slew Rate Controlled High Side Load Switch With Output Short Circuit Protection

General Information

The LTS7604 is a high side load switch with controlled slew rate. This load switch provides power domain isolation for extended battery life. The LTS7604 integrates a P-Channel MOSFET with typical $55\text{m}\Omega$ $R_{\text{DS(ON)}}$ delivering up to 2.0A continuous output current. Three slew rate options, 1us, 100us, and 1ms are available.

The LTS7604 operates with 1.2V to 5.5V input voltage. It also features an under voltage lockout that turns off the switch when an input UVLO exits. The LTS7604 features an output short circuit protection that prevents the device from damage when output short circuit occurs.

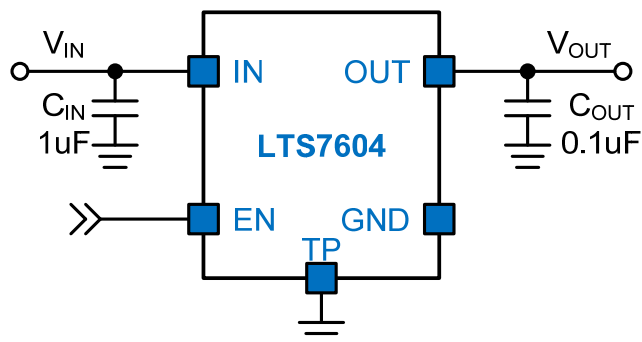
The LTS7604 features a TTL and CMOS compatible logic input to turn on/off the switch. In shutdown mode, the output is be controlled by an external loading when device is in UVLO or disabled. The quiescent current is as low as 1.6uA in operation mode and is less than 1uA in shutdown mode.

The LTS7604 is available in WDFN1.6x1.6-6L and TSOT23-5 packages.

Applications

- Cellular Telephones, PDAs, MP3 Players
- Digital Cameras and Audio Devices
- Portable and Battery-Powered Equipments
- Notebook Computers
- Hot-Swap Applications

Typical Applications Circuit



Features

- 1.2V to 5.5V Input Voltage Range
 - Input Under Voltage Lockout
 - Low $R_{\text{DS(ON)}}$ (Typical $65\text{m}\Omega$ at 5V)
 - 2.0A Continuous Output Current
- Controlled Turn-On Slew Rate
 - 1ms (LTS7604A)
 - 100us (LTS7604B)
 - 1us (LTS7604C)
- Output Short Circuit Protection
- Reverse current Blocking
- Typical 1.6uA Quiescent Current
- TTL/CMOS Input Logic Level
- Less Than 1uA Shutdown Current
- 2kV ESD Rating
- WDFN1.6x1.6-6L and TSOT23-5 Packages
- RoHS Compliant and Halogen Free

Pin Configuration & Top Marking

Pin Configuration	Top Marking
<p>WDFN1.6x1.6-6L</p>	<p>PPPP: Product Code YMDS: Week Code</p>
<p>TSOT23-5</p>	<p>PPPP: Product Code YMDS: Week Code</p>

Ordering Information

LTS7604 □□□□

Slew Rate

A: 1ms

B: 100us

C: 1us

Package Type

ST5: TSOT23-5

DA6: WDFN1.6x1.6-6L

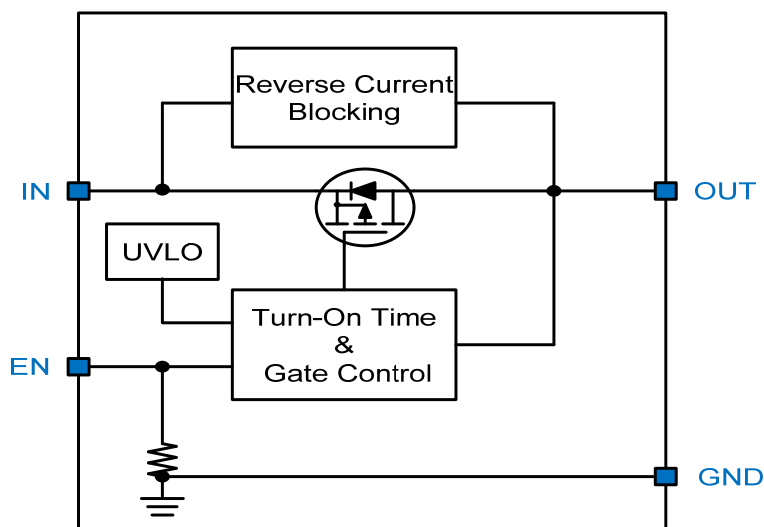
Ordering Number	Package	Top Marking (Product Code)	Note
LTS7604AST5	TSOT23-5	A116	1mS Turn-on Slew Rate
LTS7604ADA6	WDFN1.6x1.6-6L	A117	1mS Turn-on Slew Rate
LTS7604BST5	TSOT23-5	A118	100uS Turn-on Slew Rate
LTS7604BDA6	WDFN1.6x1.6-6L	A119	100uS Turn-on Slew Rate
LTS7604CST5	TSOT23-5	A120	1uS Turn-on Slew Rate
LTS7604CDA6	WDFN1.6x1.6-6L	A121	1uS Turn-on Slew Rate

Note 1. Leading TECH products are RoHs compliant and compatible with the current requirement of IPC/JDEC J-STD-020 and are suitable for use in SnPb or Pb-Free soldering processes.

Functional Pin Descriptions

Pin No.		Pin Name	Pin Function
ST5	DA6		
5	1, 2	IN	Input Voltage. This pin is the P-channel MOSFET source connection. Bypass to ground through a 1.0uF capacitor.
1	5, 6	OUT	Output Voltage. This pin is the P-channel MOSFET drain connection. Bypass to ground through a 0.1uF capacitor.
3	3	EN	Active High Enable Input. The EN pin is internally pulled to ground through a 13MΩ resistor.
2	4	GND	Ground. Connect to the thermal pad and to the ground rail of the circuit.
4	NA	NC	Not Internally Connected.
NA	Thermal Pad	TP	Thermal Pad. Must tie this pad to the ground island/plane through the lowest impedance connection available. This pin is also used as heat-sink of the IC and should be well-soldered to the PCB for optimal thermal performance.

Functional Block Diagram



Operation Principles

The LTS7604 is a high side load switch with controlled slew rate. This load switch provides power domain isolation for extended battery life. Three slew rate options, 1 μ s, 100 μ s, and 1ms are available. The LTS7604 integrates a P-Channel MOSFET with typical 55m Ω $R_{DS(ON)}$ delivering up to 2.0A continuous output current.

Input Under Voltage Lockout (UVLO)

The LTS7604 operates with 1.2V to 5.5V input voltage. It also features an under voltage lockout that turns off the switch when an input UVLO exits. The UVLO threshold level is typical 1.1V with about 100mV hysteresis.

ON/OFF Control

The LTS7604 features a TTL/CMOS compatible EN pin for enabling/disabling the device. The EN pin is internally pulled to ground by a 13M Ω resistor. EN = High enables the device and EN = Low disables the device. The threshold hold voltage is about 0.9V.

The quiescent current is as low as 2.0 μ A in operation mode (including EN pull-low current) and is less than 1 μ A in shutdown mode.

Slew Rate Control

The LTS7604 controls the output voltage slew rate to limit input inrush current when enabled. Once the enable delay time expires, the gate driver and slew-rate control circuitry

immediately raises the source-to-gate voltage of the P-channel MOSFET to its threshold level, and then gradually turns on the MOSFET by linearly increases the source-to-gate voltage. After the MOSFET is fully enhanced, the LTS7604 quickly increases the source-to-gate voltage to the full input voltage to minimize on resistance and reduce power dissipation. Three slew-rate options are available. The LTS7604A has a slew rate of 1ms, the LTS7604B 100 μ s and the LTS7604C 1 μ s.

Output Short Circuit Protection

After output-slewing completes, the LTS7604 continuously monitors the output voltage for output short circuit protection (SCP). SCP is asserted and shuts down the device if the output voltage is lower than the SCP threshold level. This protects the devices from damage when SCP occurs. SCP turns off the device and latches off. It can only be reset by toggling EN pin or cycling the input voltage.

Reverse Current Protection

The reverse current protection feature prevents the current to flow from OUT to IN when LTS7704 is disabled. This feature is particularly useful when the output of LTS7704 needs to be driven by another voltage source after LTS7704 is disabled (for example in a power multiplexer application).

Absolute Maximum Ratings (Note 1)

Input Supply Voltage (V_{IN})	-0.3V to 6.0V
OUT	-0.3V to ($V_{IN} + 0.3V$)
EN	-0.3V to 6.0V
Maximum Continuous Switch Current	2.0A
ESD <small>(Note 2)</small>	
Human Body Mode	2kV
Machine Mode	200V

Thermal Information

Continuous Junction Temperature Range	-40°C to 150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 second)	260°C
Package Thermal Resistance <small>(Note 3)</small>	
TSOT23-5, θ_{JA}	250°C/W
TSOT23-5, θ_{JC}	25°C/W
WDFN1.6x1.6-6L, θ_{JA}	150°C/W
WDFN1.6x1.6-6L, θ_{JC}	30°C/W
Maximum Power Dissipation, P_D @ $T_A = 25^\circ\text{C}$ <small>(Note 4)</small>	
TSOT23-5	0.4W
WDFN1.6x1.6-6L	0.67W

Recommended Operation Conditions

Continuous Junction Temperature Range	-40°C to 125°C
Ambient Temperature Range	-40°C to 85°C
Input Voltage Range	1.2V to 5.5V

Note 1: Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability and lifetime.

Note 2: This device is sensitive to electrostatic discharge. Follow proper handling procedures.

Note 3: The Thermal Resistance specifications are based on a JEDEC standard JESD51-3 single-layer PCB. θ_{JA} will vary with board size and copper area.

Note 4: The maximum allowable power dissipation is a function of the maximum junction temperature, T_{J-MAX} , the junction-to-ambient thermal resistance, θ_{JA} , and the ambient temperature, T_A . The maximum allowable power dissipation at any ambient temperature is calculated using: $P_{D(MAX)} = (T_{D(MAX)} - T_A)/\theta_{JA}$. The maximum power dissipation is determined using $T_A = 25^\circ\text{C}$, and $T_{J(MAX)} = 125^\circ\text{C}$.

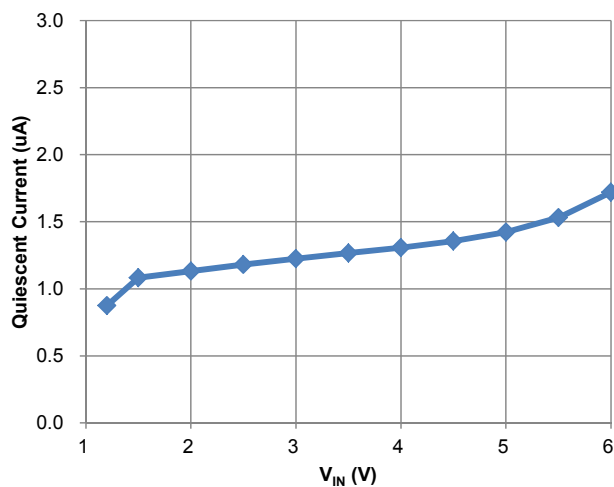
Electrical Characteristics

$V_{IN} = V_{EN} = 3.3V$ and $T_A = 25^\circ C$ unless otherwise specified.

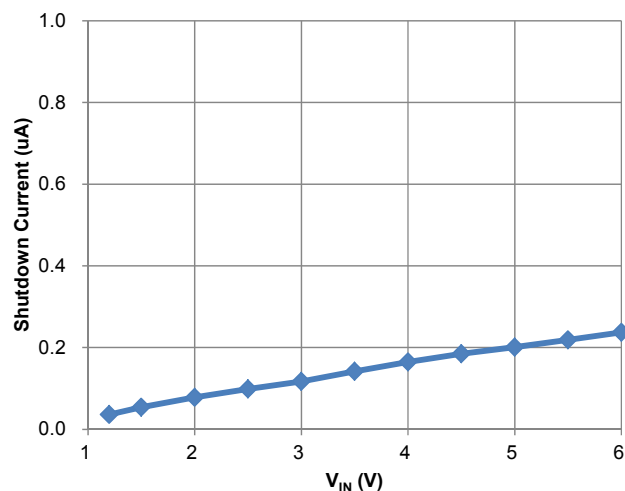
Parameters	Symbol	Condition	Min	Typ	Max	Unit
Input Supply Voltage	V_{IN}		1.2	--	5.5	V
Under Voltage Lockout	V_{UVLO}	V_{IN} rising	--	1.1	1.2	V
		V_{IN} falling	--	1.0	--	
Quiescent Current from V_{IN}	I_Q	$EN = 3.3V$	--	1.6	3	μA
		$EN = 0V$	--	--	1	
Revere Current from V_{OUT}	I_{REV1}	$V_{IN} = \text{floating}, V_{OUT} = 5V$	--	0.3	0.8	μA
	I_{REV2}	$V_{IN} = 0V, V_{OUT} = 5V$	--	1	2	μA
Switch On Resistance	$R_{DS(ON)}$	$V_{IN} = 5.0V$	--	65	85	m Ω
		$V_{IN} = 4.2V$	--	70	90	
		$V_{IN} = 3.0V$	--	75	105	
		$V_{IN} = 1.8V$	--	100	135	
Enable Input Low Voltage	V_{IL}	$V_{IN} = 1.2V \sim 5.5V$	--	--	0.4	V
Enable Input High Voltage	V_{IH}	$V_{IN} = 1.2V \sim 2.0V$	1.2	--	V_{IN}	V
		$V_{IN} = 2.2V \sim 4.2V$	2	--	V_{IN}	V
		$V_{IN} = 4.2V \sim 5.5V$	2.4	--	V_{IN}	V
Enable Pull Low Resistance	R_{EN}		--	13	--	M Ω
Turn On Delay Time	$t_{D(ON)}$	$V_{IN} = 3.3V, R_L = 6\Omega$	--	10	--	μs
Turn Off Delay Time	$t_{D(OFF)}$	$V_{IN} = 3.3V, R_L = 6\Omega$	--	10	--	μs
Output Rise Time	t_R	LTS7604A, $V_{IN} = 3.3V, R_L = 6\Omega$	--	1000	--	μs
		LTS7604B, $V_{IN} = 3.3V, R_L = 6\Omega$	--	100	--	
		LTS7604C, $V_{IN} = 3.3V, R_L = 6\Omega$	--	1	-	

Typical Characteristics

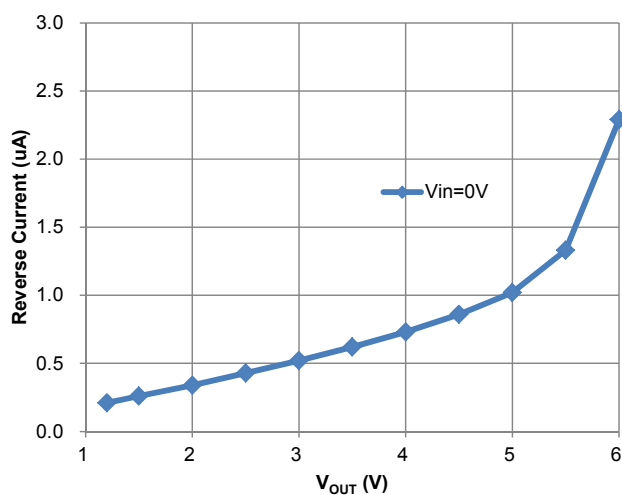
Input Quiescent Current vs Input Voltage



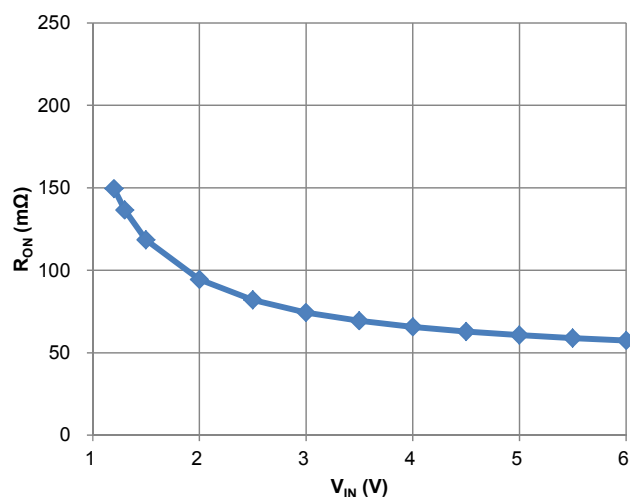
Input Shutdown Current vs Input Voltage



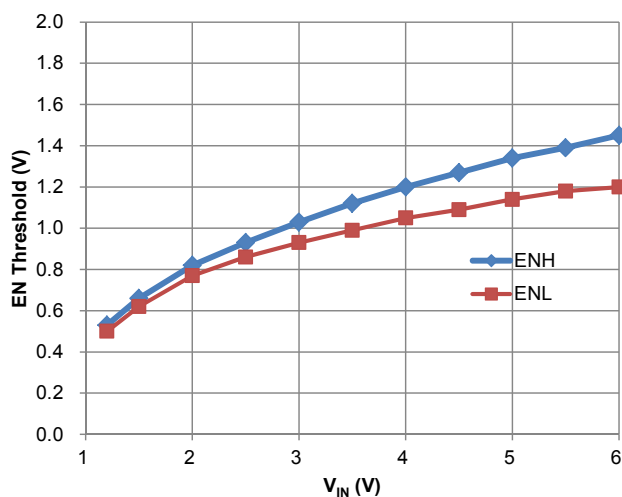
Reverse Current vs Output Voltage



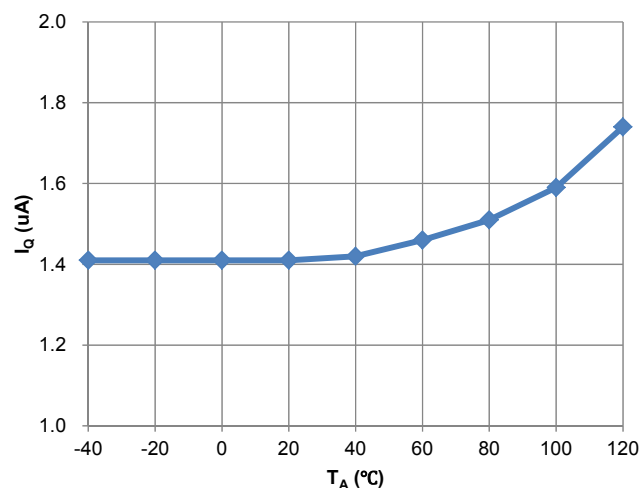
R_{ON} vs Input Voltage



EN Threshold vs Input Voltage



Input Quiescent Current vs Temperature



Application Information

Input Capacitor

A 1 μ F or larger capacitor is typically recommended for C_{IN} in most applications. A C_{IN} capacitor is not required for basic operation. However, C_{IN} is useful in preventing load transients from affecting upstream circuits. C_{IN} should be located as close to the device V_{IN} pin as practically possible. Ceramic, tantalum, or aluminum electrolytic capacitors may be selected for C_{IN} . There is no specific capacitor ESR requirement for C_{IN} . However, for higher current operation, ceramic capacitors are recommended for C_{IN} due to their inherent capability over tantalum capacitors to withstand input current surges from low impedance sources, such as batteries in portable devices.

Output Capacitor

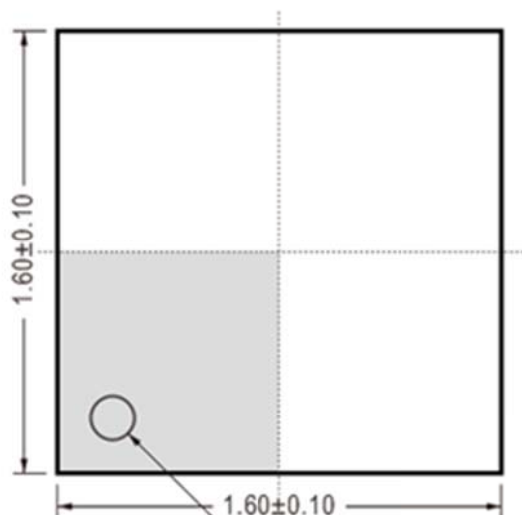
For proper slew operation, a 0.1 μ F capacitor or greater between V_{OUT} and GND is recommended. The output capacitor has no specific capacitor type or ESR requirement. If desired, C_{OUT} may be increased without limit to accommodate any load transient condition without adversely affecting the device turn-on slew rate time.

Enable Function

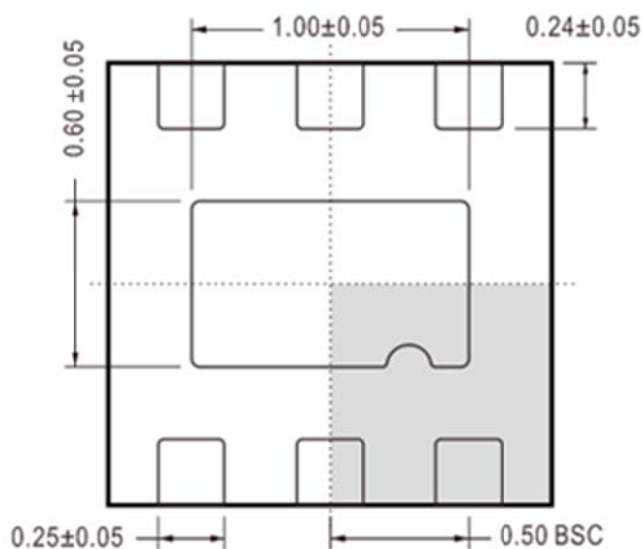
The LTS7604 features an enable / disable function. This pin (ON/OFF) is compatible with both TTL and CMOS logic.

Package Information – WDFN1.6x1.6-6L

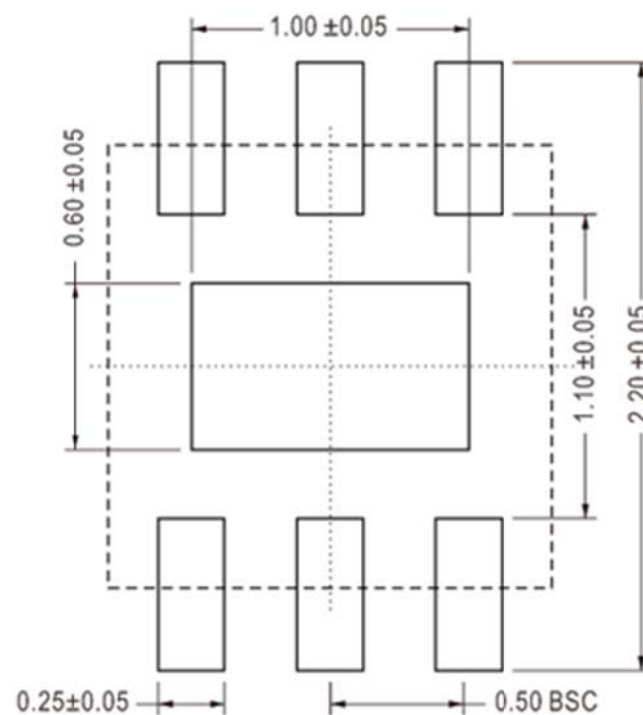
Unit: mm.



Pin 1 mark



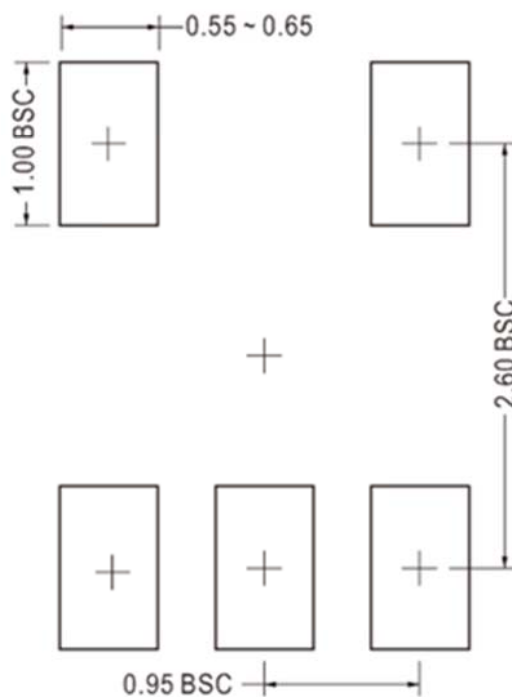
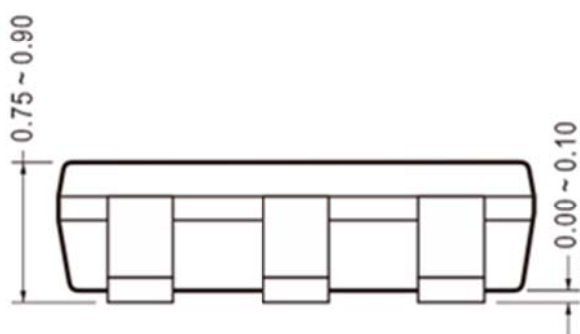
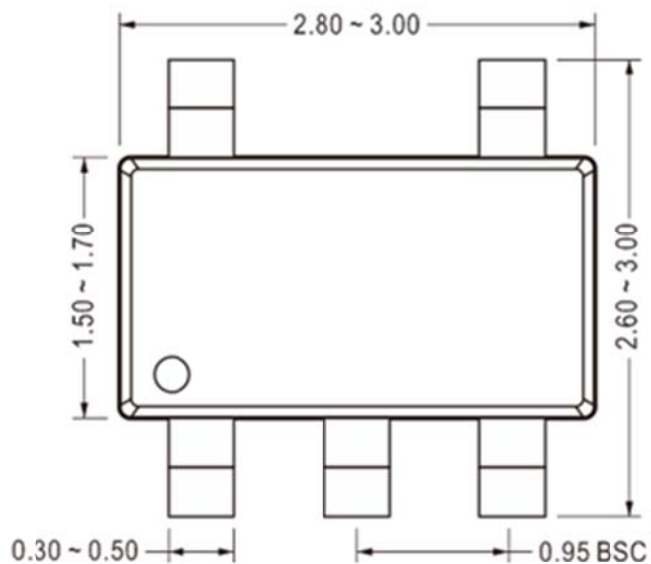
Bottom View - Exposed Pad



Recommended Solder Pad Pitch and Dimensions

Package Information – TSOT23-5

Unit: mm.



Layout Recommendation

