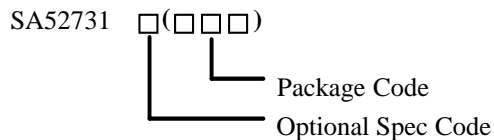


General Description

The SA52731 is a 500mA, 3.3V~5V, push-pull transformer driver, designed to provide a simple solution for isolated power supplies. The IC contains the carefully designed oscillating and driving circuit to provide precise complementary signals for two N-channel MOSFETs. The IC includes a soft-start feature that prevents high inrush current during power up. Its internal protection features include current limiting, under-voltage lockout and thermal shutdown. The SA52731 is available in a small 5-pin SOT-23 package and qualified with AEC-Q100.

Ordering Information



Ordering Number	Package Type	Note
SA52731AAT	SOT23-5	--

Features

- Single 3.3V or 5V Supply
- Push-Pull Driver for Small Transformers
- High Primary-side Current Drive: 500mA
- Spread Spectrum Clocking
- Thermal Shutdown
- Soft Start
- Small SOT23-5 Package
- AEC-Q100 Qualified

Applications

- Isolated Interface Power Supply for CAN, RS-485, RS-422, RS-232, SPI, I²C, Low-Power LAN
- Industrial Equipment
- Automobile
- Medical Equipment

Typical Application

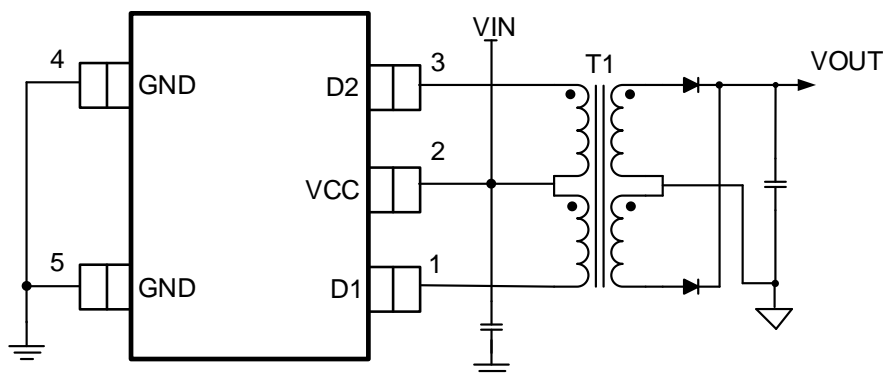
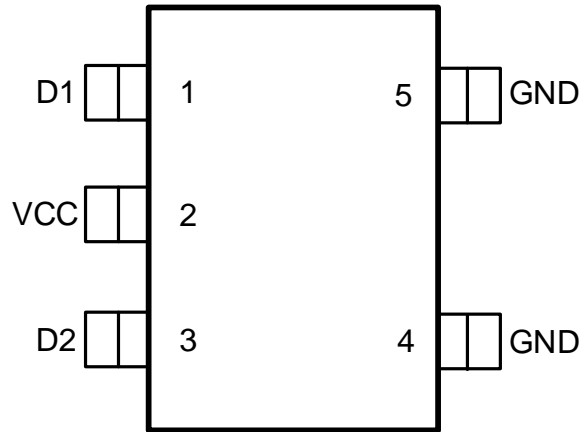


Figure 1. Typical Application Circuit



Pinout (Top View)



(SOT23-5)

Top Mark: 2qxyz (device code: 2q, x=year code, y=week code, z=lot number code)

Pin No.	Pin Name	Description
1	D1	Open drain output 1. Connect this pin to one end of the transformer primary side.
2	VCC	Supply voltage input. Connect this pin to the center-tap of the transformer primary side. Buffer this voltage with a 1μF to 10μF ceramic capacitor.
3	D2	Open drain output 2. Connect this pin to another end of the transformer primary side.
4, 5	GND	Ground.

Block Diagram

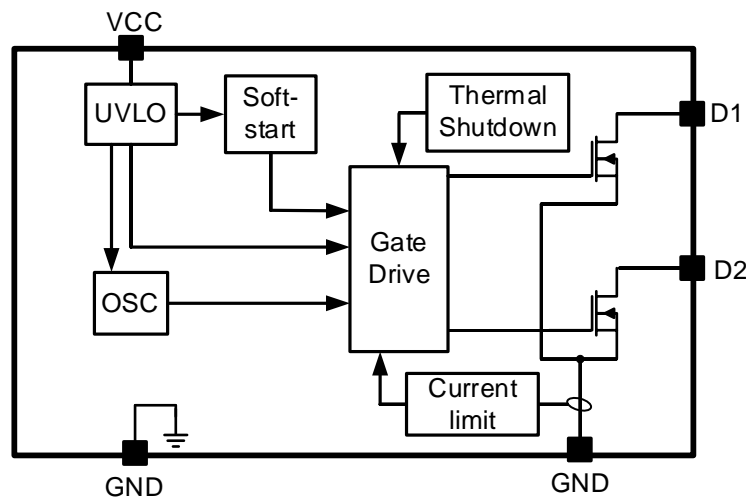


Figure 2. Block Diagram



Absolute Maximum Ratings (Note 1)

Supply Voltage (VCC) -----	-0.3V to 6V
Output Switching Voltage (D _x) -----	-0.3V to 14V
Peak Output Switching Current (I _{D1} , I _{D2}) -----	2.3A
Electrostatic Discharge	
HBM (Human Body Model) -----	2.5kV
CDM (Charge Device Model) -----	1kV
Package Thermal Resistance (Note 2)	
θ_{JA} -----	240°C/W
θ_{JC} -----	45°C/W
Junction Temperature (T _J) -----	-40°C to +150°C
Storage Temperature -----	-65°C to +150°C

Recommended Operating Conditions

VCC -----	3V to 5.5V
D _x (VCC=5V±10%) -----	-0.3V to 11V
D _x (VCC=3.3V±10%) -----	-0.3V to 7.2V
I _{Dx} -----	less than 500mA
Ambient Temperature Range (T _A) -----	-40°C to 125°C

Electrical Characteristics

(-40°C < T_A < 125°C, 3V < VCC < 5.5V unless otherwise specified. All typical values are at T_A=25°C, VCC=5V)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Voltage Supply						
Supply Current	I _{VCC}	R _L =50Ω; 3V<VCC<5.5V		1	1.4	mA
Leakage Current on D1, D2	I _{lk}	Voltage of D1, D2=14V		0.1		uA
Output Status						
Average on Time Mismatch between D1 and D2	t _{DMM}	VCC=5V, R _L =50Ω		0	50	ns
Highest spread Spectrum Oscillator Frequency	f _{C_H}	R _L =50Ω; Refer to Figure 3	314	394	467	kHz
Lowest Spread Spectrum Oscillator Frequency	f _{C_L}	R _L =50Ω; Refer to Figure 3	286	358	427	kHz
Switch on Resistance	R _{DSON}	VCC=5V, I _{D1} =I _{D2} =100mA		0.6	1.1	Ω
D1, D2 Output Rise Time	t _r	VCC=5V, R _L =50Ω; Refer to Figure 3		75		ns
D1, D2 Output Fall Time	t _f	VCC=5V, R _L =50Ω; Refer to Figure 3		140		ns
Break-before-make Time	t _{BBM}	Refer to Figure 3		120		ns
Protection						
VCC UVLO Rising Threshold	V _{CC_uvlo_r}	VCC rising		2.7	2.9	V
VCC UVLO Failing Threshold	V _{CC_uvlo_f}	VCC falling	2.2	2.4		V
VCC UVLO Threshold Hysteresis	V _{CC_uvlo_hys}			300		mV
Thermal Shutdown Temperature	T _{SD}		150	165		°C
Thermal Shutdown Hysteresis	T _{SD_HYS}			17		°C
Current Limit	I _{limit}	3V<VCC<5.5V(Note 3)	0.8		2.3	A
Soft-start Time	t _{ss}	Refer to Figure 4	0.5		10	ms

Note 1: Stresses listed as the above “Absolute Maximum Ratings” may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied.

Note 2: θ_{JA} and θ_{JC} are measured in the natural convection at T_A = 25°C, mounted on low effective single layer PCB in accordance with JESD51-3.

Note 3: Guaranteed by design.

Note 4: Power dissipation and thermal limits must be observed.

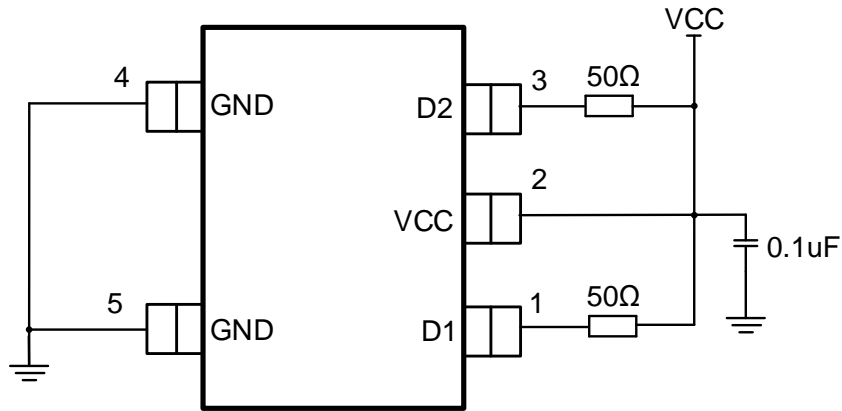


Figure 3. Test Circuit for t_{BBM} , t_r , t_f , f_{C_H} , f_{C_L}

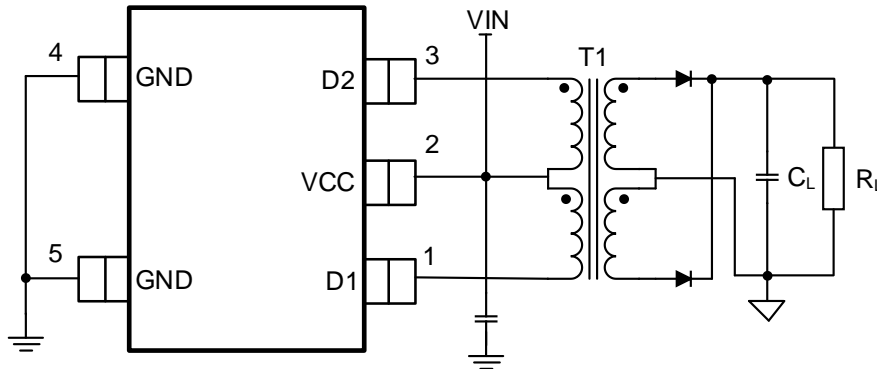


Figure 4. Test Circuit for t_{ss}

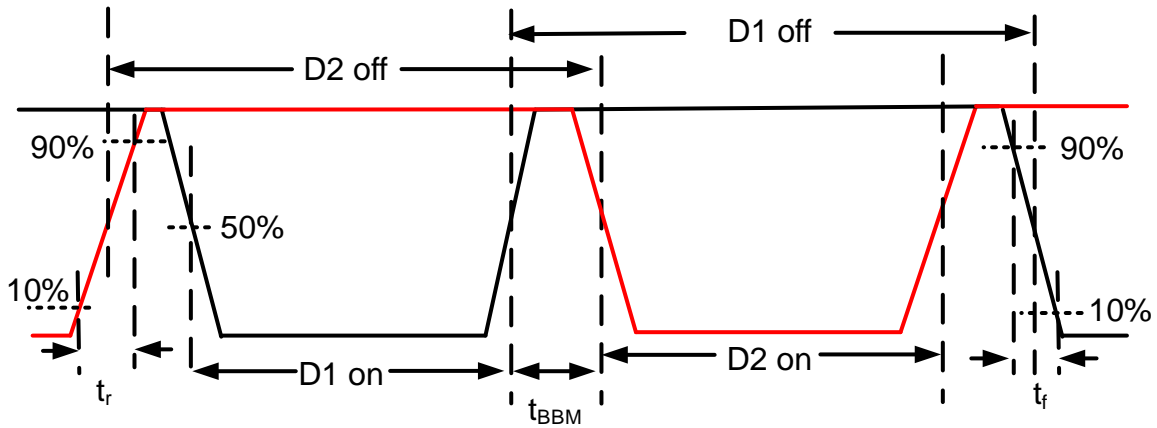
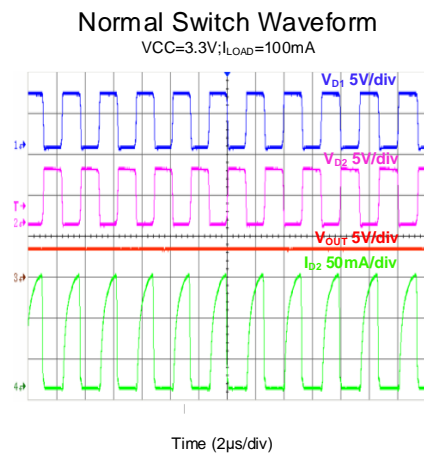
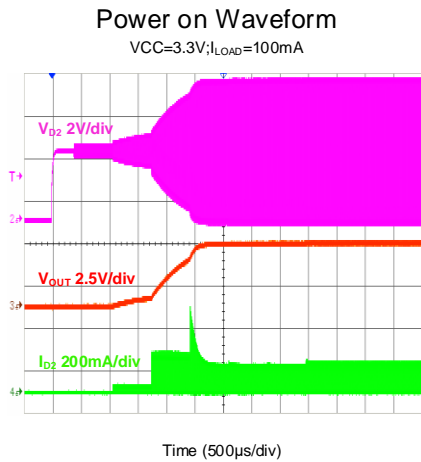
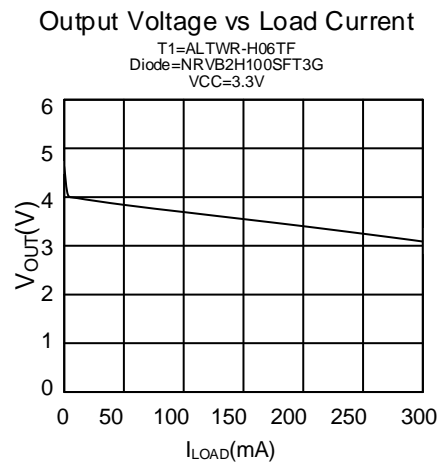
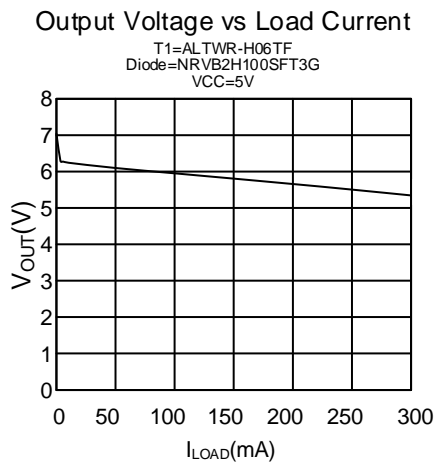
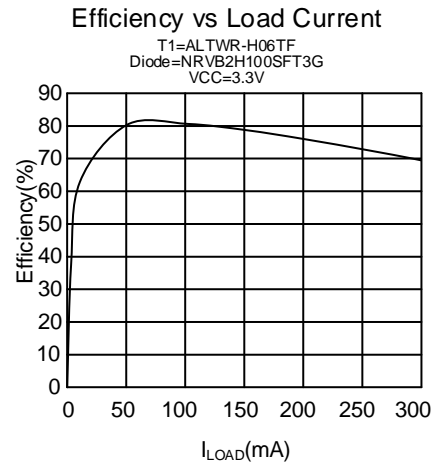
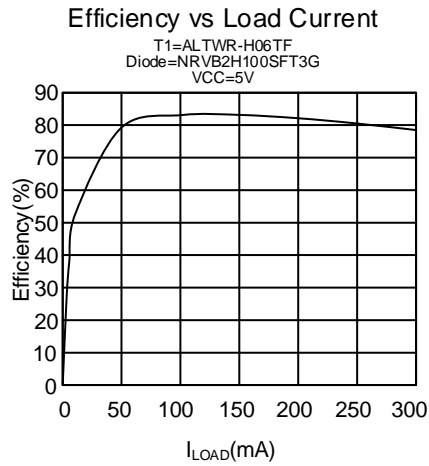


Figure 5. Timing Diagram

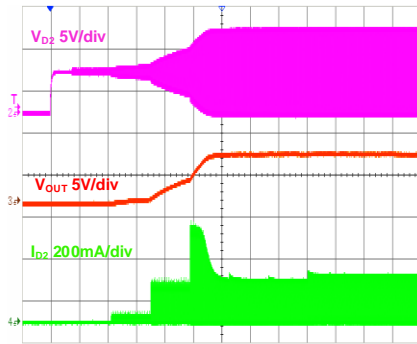
Typical Performance Characteristics

Curves are measured with the circuit in Figure 4.



Power on Waveform

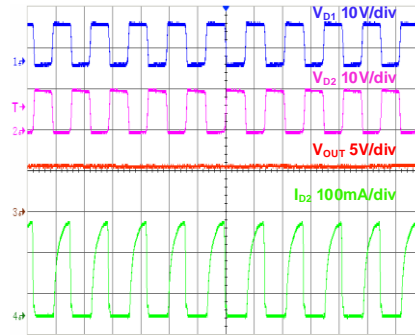
VCC=5V; I_{LOAD}=100mA



Time (500μs/div)

Normal Switch Waveform

VCC=5V; I_{LOAD}=100mA



Time (2μs/div)

Functional Description

The SA52731 is a low noise, small form-factor, push-pull transformer driver, designed to provide an isolated power supply for communications, industrial automation, process control, etc.

Push-pull Converter

Push-pull converter is composed of primary switching circuit Q1 and Q2, center-tap transformer and secondary rectifier circuit CR1, CR2.

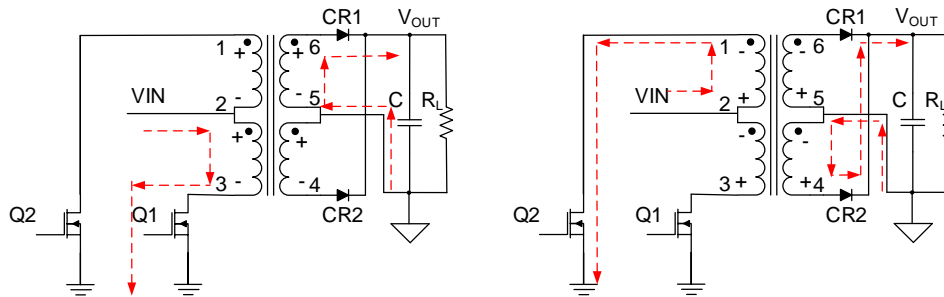


Figure 6. Switching Cycles of a Push-Pull Converter

From Figure 6, when Q1 conducts, the input voltage V_{IN} will apply to the positive electrode of primary winding (2-3) of transformer, and thus the positive voltage V_{IN} and $N_S \cdot V_{IN} / N_P$ are induced in both primary and secondary windings, where N_S , N_P represent the winding turns in primary and secondary side. And then, the rectifier diode CR1 in secondary side conducts, charging the load capacitor C. Moreover, it can be observed from Figure 6 that the voltage stress of Q2 is $2 \cdot V_{IN}$ and the voltage stress of CR2 is $2 \cdot V_{OUT}$ when Q1, CR1 conduct.

Similarly, when Q2 conducts, the input voltage V_{IN} will apply to the negative electrode of primary winding (1-2). As a result, the negative voltage is sensed in winding (2-3), winding (4-5) and winding (5-6). The rectifier diode CR2 in secondary side conducts and charge the load capacitor C. In this commutating mode, the voltage stress of Q1 is $2 \cdot V_{IN}$ and the voltage stress of CR1 is $2 \cdot V_{OUT}$.

Start-Up Mode

The SA52731 has a built-in soft-start circuit to prevent high inrush current from VCC during power-up. Upon power up or VCC rises again and reaches the switch on voltage $V_{CC_uvlo_r}$ threshold, or when recovering from temperature shutdown protection, the gate drive voltage of the output power-MOSFET is gradually increased over a period of time.

The specification of V_{GS} during start up is defined as Figure.7

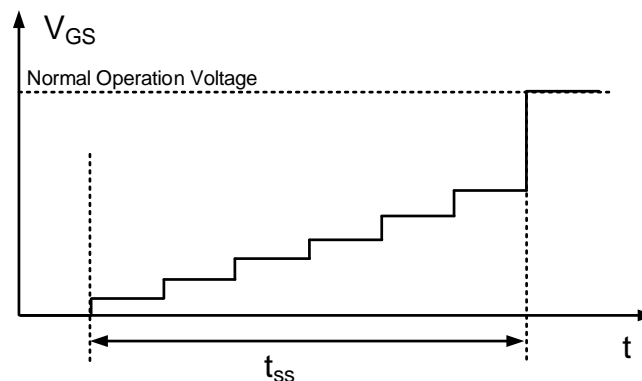


Figure 7. Start-up Waveform



Spread Spectrum Clocking

The SA52731 addresses EMI by modulating its internal clock in such a way that the emitting energy is spread over multiple frequency bins. This Spread Spectrum clocking feature greatly improves the EMI performance of the entire power supply block and hence relieves the system designer from one major concern in isolated power supply design.

As shown in the figure 8, triangular type spread spectrum is illustrated, where the switching frequency is plotted as a function of time.

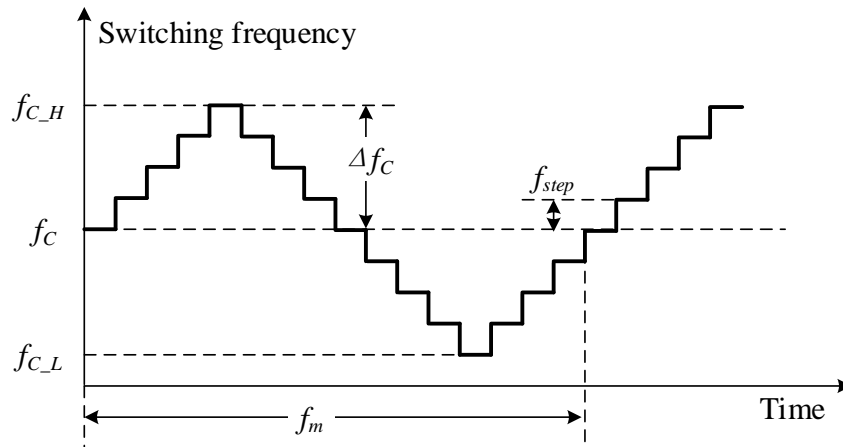


Figure 8. Spread Spectrum Clocking Feature

Protection

Current Limit (CL)

The device offers current limit protection, once the current limit threshold is reached, the MOS current will be clamped at I_{limit} until the fault disappears.

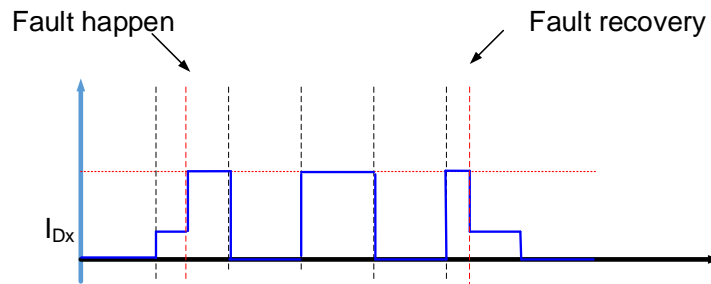


Figure 9. The Waveform of Current Limit Protection (Dx)

Thermal Shutdown (TSD)

The device offers temperature shutdown protection. If one or more temperature sensors reach the shut-down temperature threshold, the output will be latched off. The output will be reactivated when the temperature is lower than $(T_{SD} - T_{SD,HYS})$. $V_{D1/2_normal}$ represents normal voltage waveform of D1 or D2, $V_{D1/2_TSD}$ represents the voltage waveform of D1 or D2 when thermal shutdown occurs.

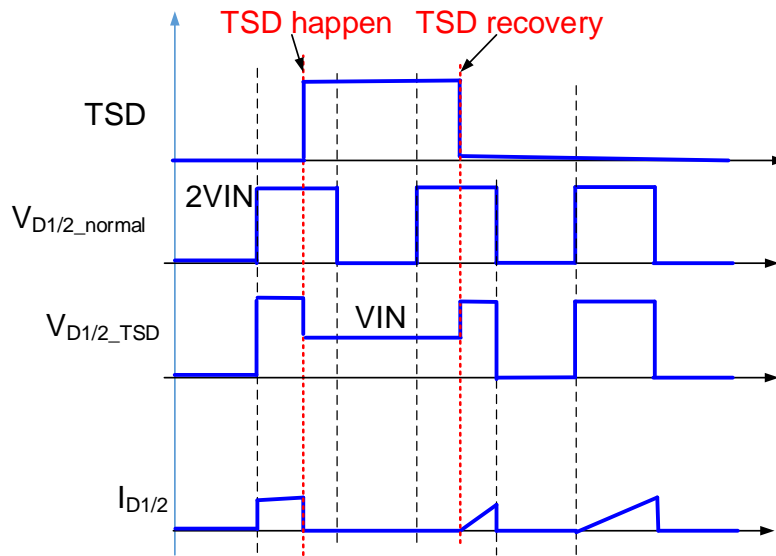
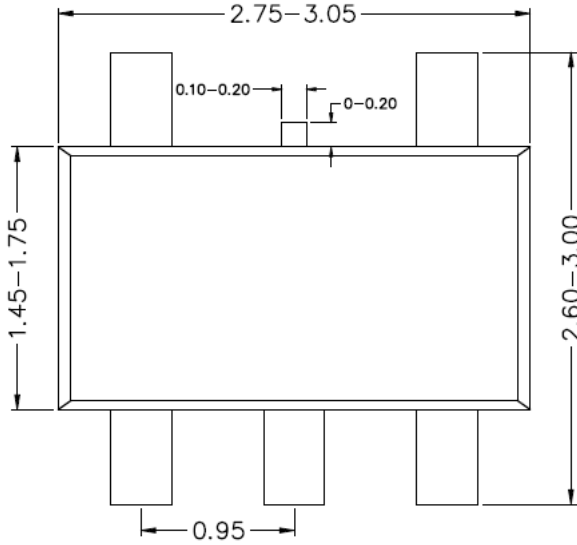
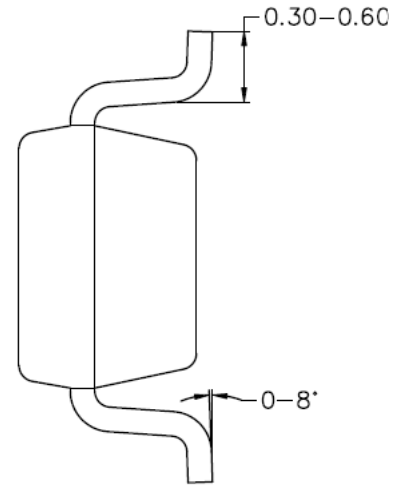


Figure 10. The Waveform of TSD (D1 or D2)

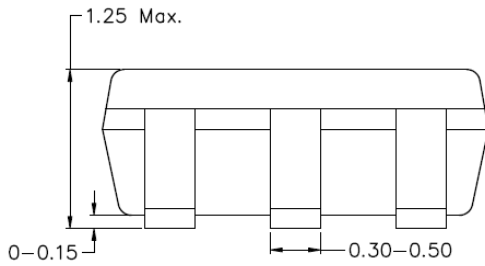
SOT23-5 Package Outline & PCB Layout



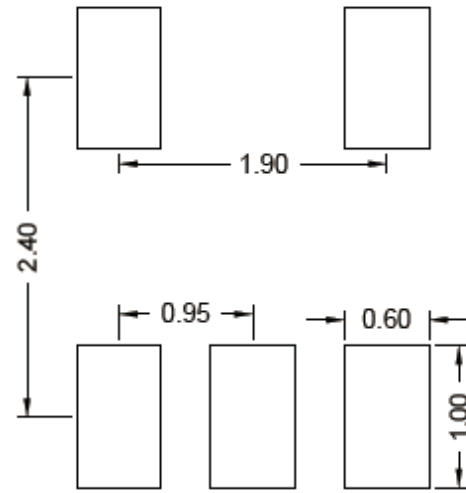
Top view



Side view



Front view



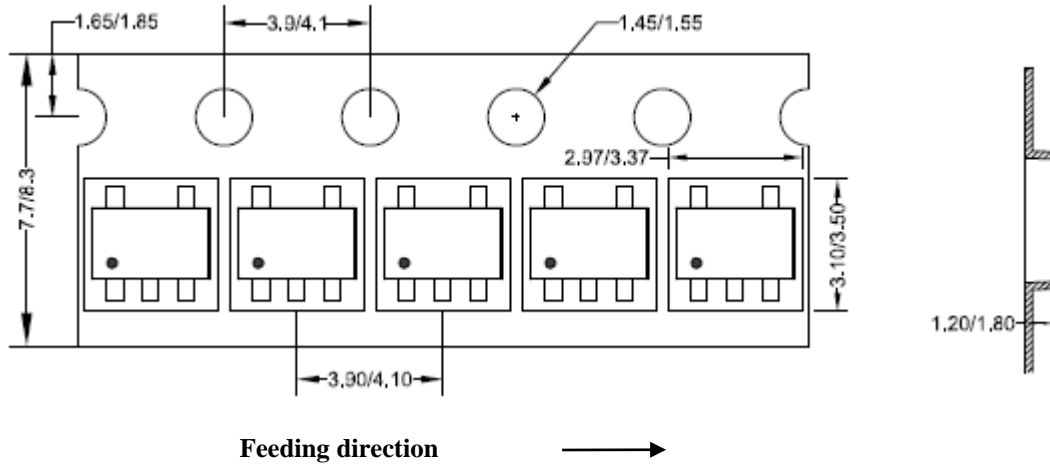
**Recommended PCB pad Layout
(Reference only)**

Notes: All dimension in millimeter and exclude mold flash & metal burr.

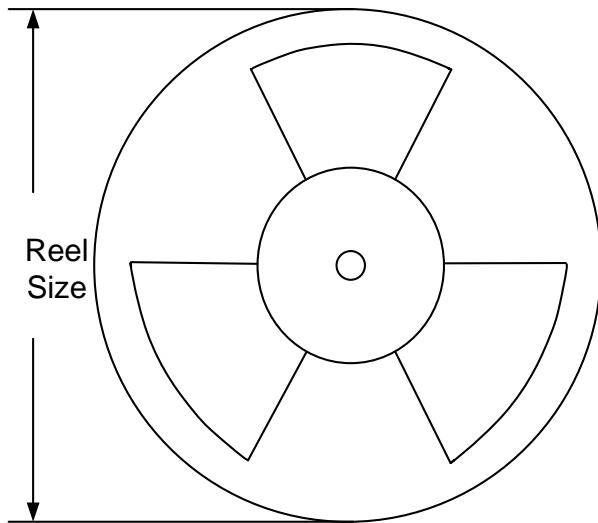
Taping & Reel Specification

1. Taping Orientation

SOT23-5



2. Carrier Tape & Reel Specification for Packages



Package type	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Trailer length(mm)	Leader length (mm)	Qty per reel
SOT23-5	8	4	7"	280	160	3000

3. Others: NA

Revision History

The revision history provided is for informational purposes only and is believed to be accurate; however, not warranted. Please make sure that you have the latest revision.

Revision Number	Revision Date	Description
Rev 0.9	July 26, 2023	Initial Release
Rev 1.0	July 26, 2024	Production Release
Rev 1.0A	March 3, 2025	<ol style="list-style-type: none"> 1. Page 3: Peak Output Switching Current (ID1, ID2) was changed from 0.8A to 2.3A; 2. Page 4: Current limit maximum spec (2.3A) was added; 3. Page 8: Figure 7 was added to illustrate the tss parameter. 4. Page 4: Soft-start time maximum spec (10 ms) was added



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