SY2A58720

Transformer Driver for Isolated Power Supplies

General Description

The SY2A58720 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 SY2A58720 is available in a small 5-pin SOT-23 package and qualified with AEC-Q100.

Ordering Information

SY2A58720 □(□□□)

Package Code

Optional Spec Code

Ordering Number	Package Type	Note
SY2A58720AAT	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, I^2C, Low-Power LAN
- Industrial Equipment
- Automobile
- Medical Equipment

Typical Application

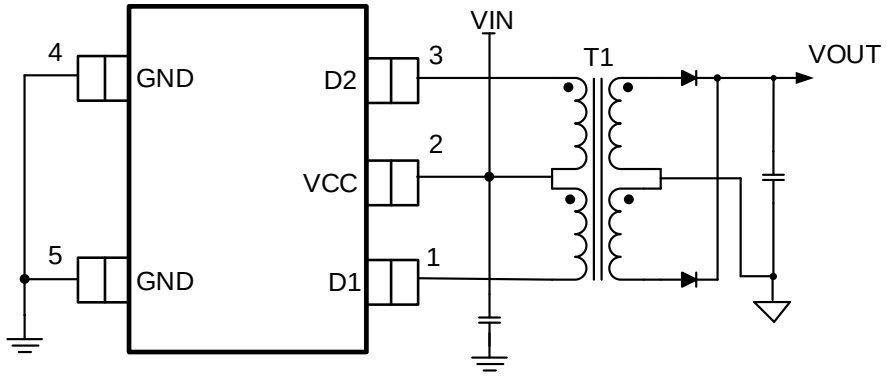
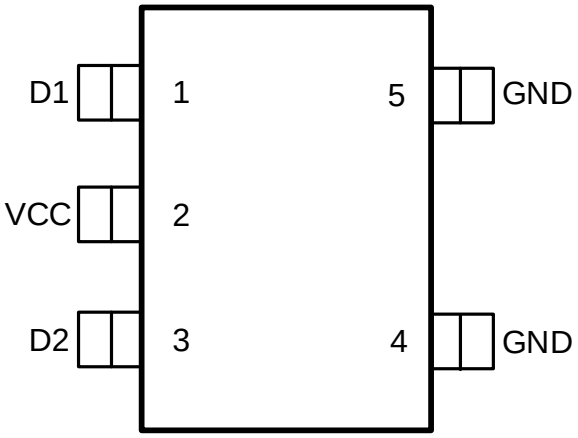


Figure 1. Typical Application Circuit

Pinout (Top View)



(SOT23-5)

Top Mark: 2q*xyz* **(**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

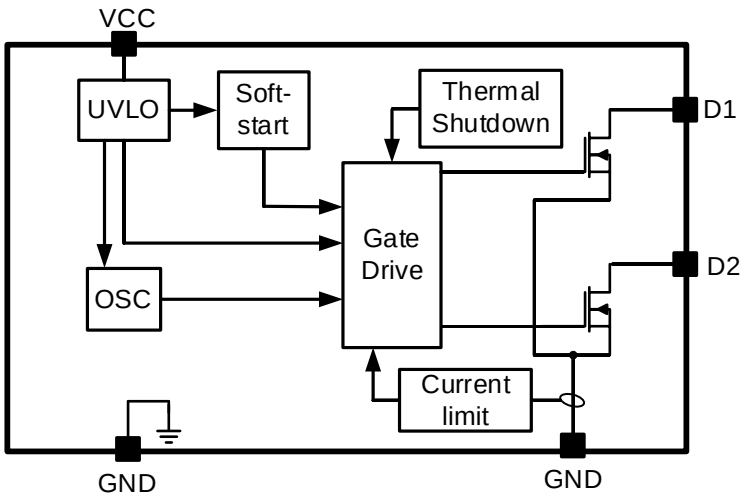


Figure 2. Block Diagram

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		℃
Thermal Shutdown Hysteresis	T_{SD_HYS}			17		℃
Current Limit	I_{limit}	3V<VCC<5.5V(Note 3)	0.8		2.3	A
Soft-start Time	t_{ss}	Refer to Figure 7	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.

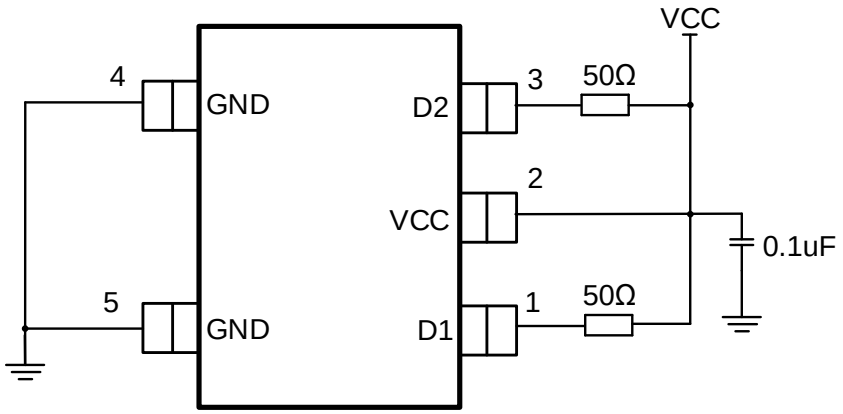


Figure 3. Test Circuit for t_{BBM}, t_r, t_f, f_{C_H}, f_{C_L}

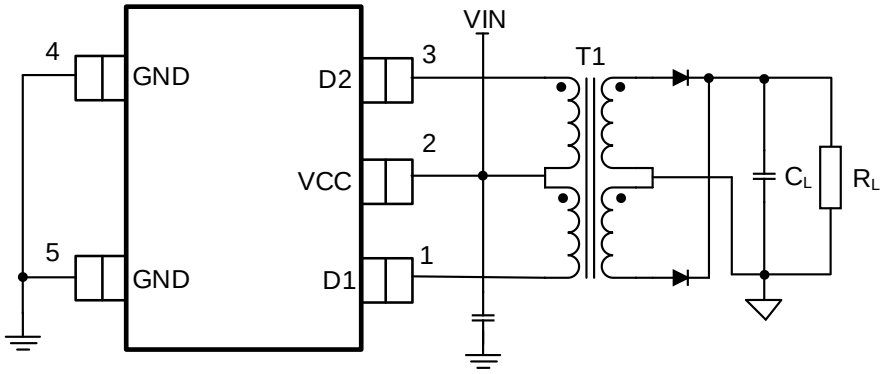


Figure 4. Test Circuit for t_{ss}

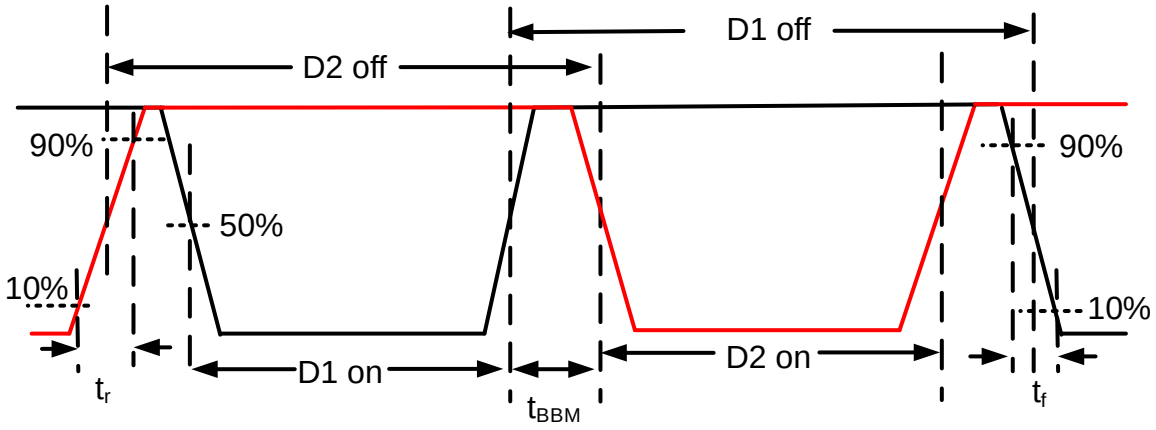
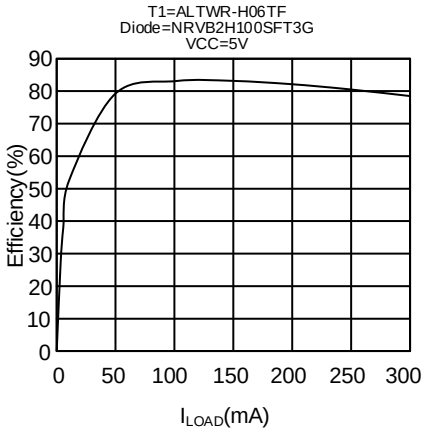


Figure 5. Timing Diagram

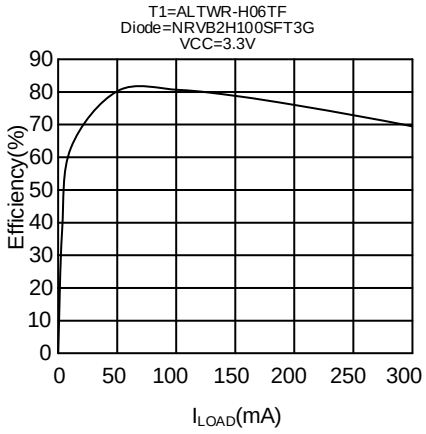
Typical Performance Characteristics

Curves are measured with the circuit in Figure 4.

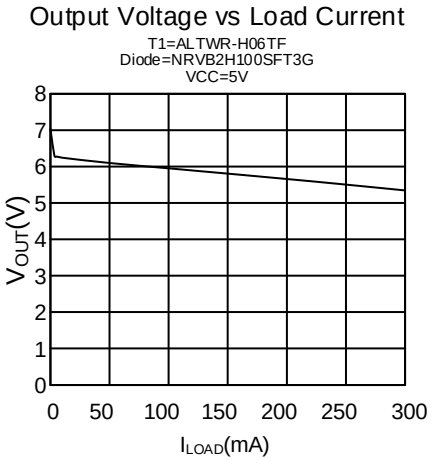
Efficiency vs Load Current



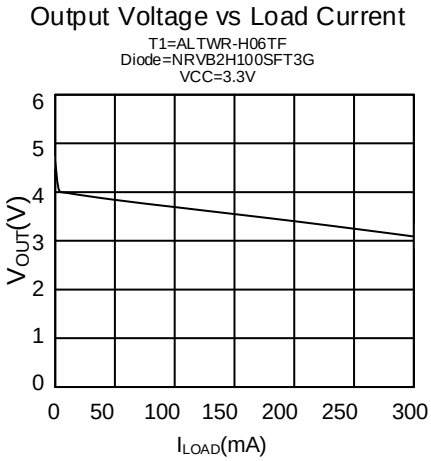
Efficiency vs Load Current



Output Voltage vs Load Current

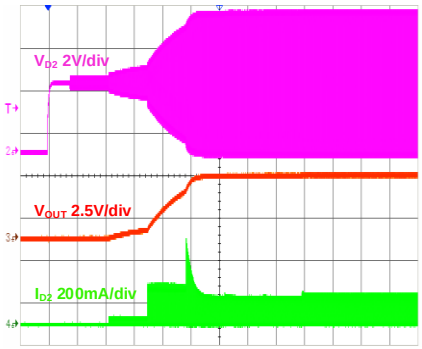


Output Voltage vs Load Current



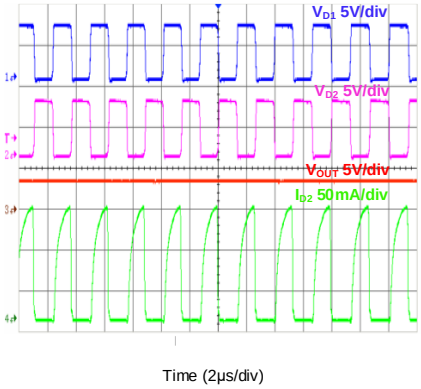
Power on Waveform

VCC=3.3V;I_{LOAD}=100mA



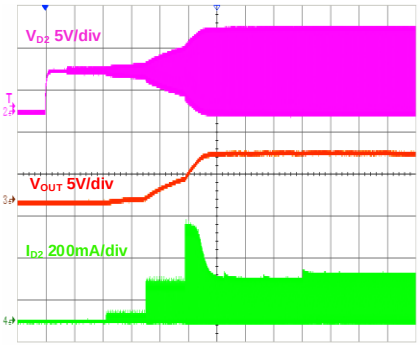
Normal Switch Waveform

VCC=3.3V;I_{LOAD}=100mA



Power on Waveform

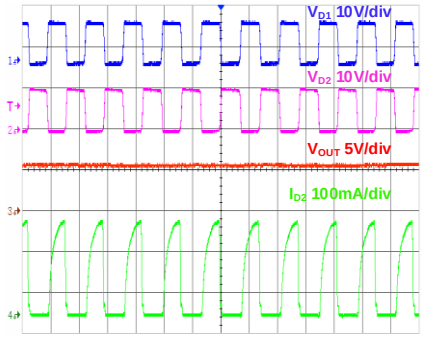
VCC=5V;I_{LOAD}=100mA



Time (500μs/div)

Normal Switch Waveform

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



Time (2μs/div)

Functional Description

The SY2A58720 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.

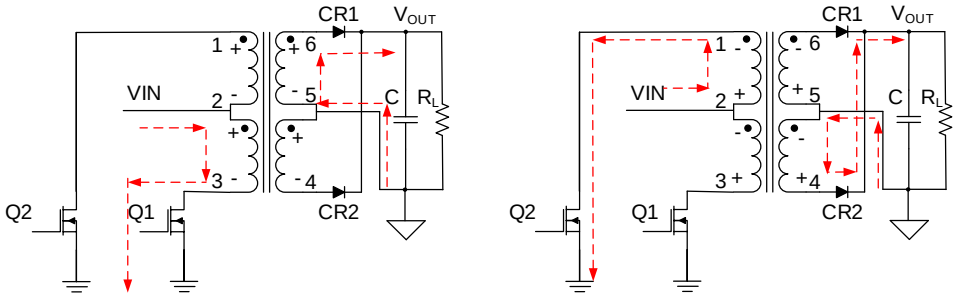


Figure 6. Switching Cycles of a Push-Pull Converter

From Figure 6, when Q1 conducts, the input voltage VIN will apply to the positive electrode of primary winding (2-3) of transformer, and thus the positive voltage VIN and $N_S \cdot VIN / N_P$ 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*VIN and the voltage stress of CR2 is $2*V_{OUT}$ when Q1, CR1 conduct.

Similarly, when Q2 conducts, the input voltage VIN 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* VIN and the voltage stress of CR1 is $2*V_{OUT}$.

Start-Up Mode

The SY2A58720 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

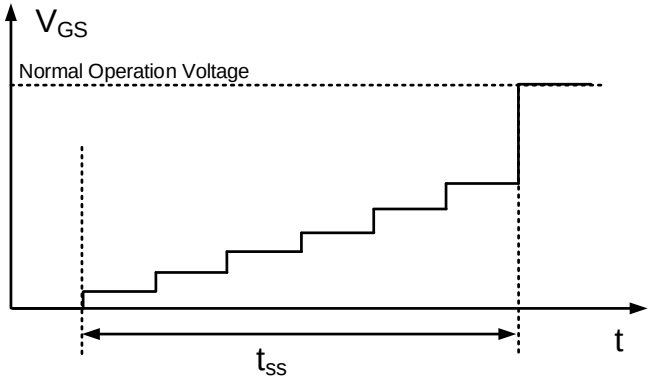


Figure 7. Start-up Waveform

Spread Spectrum Clocking

The SY2A58720 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.

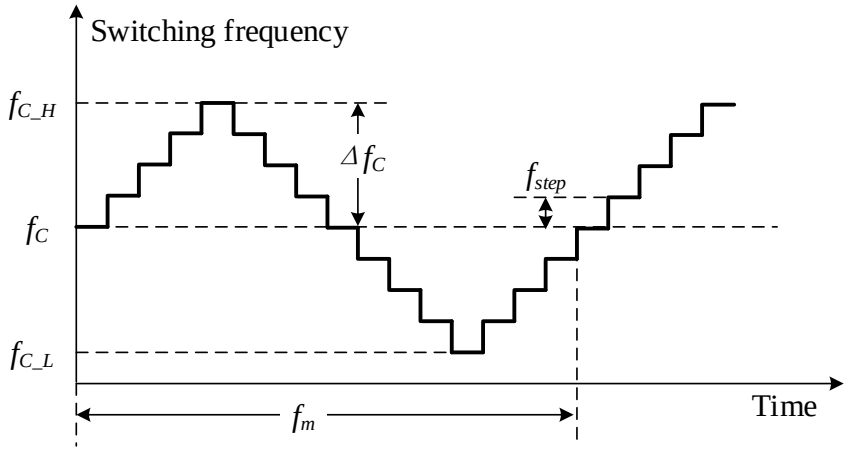


Figure 8. Spread Spectrum Clocking Feature

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.

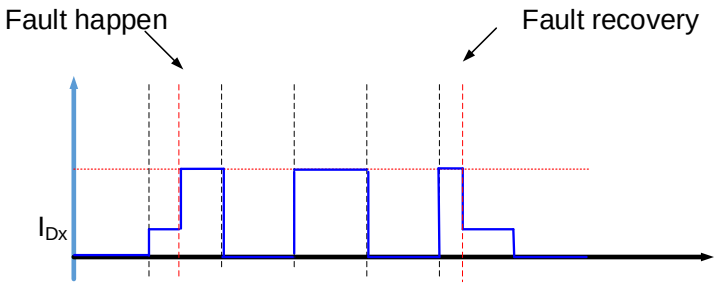


Figure 9. The Waveform of Current Limit Protection (D_X)

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.

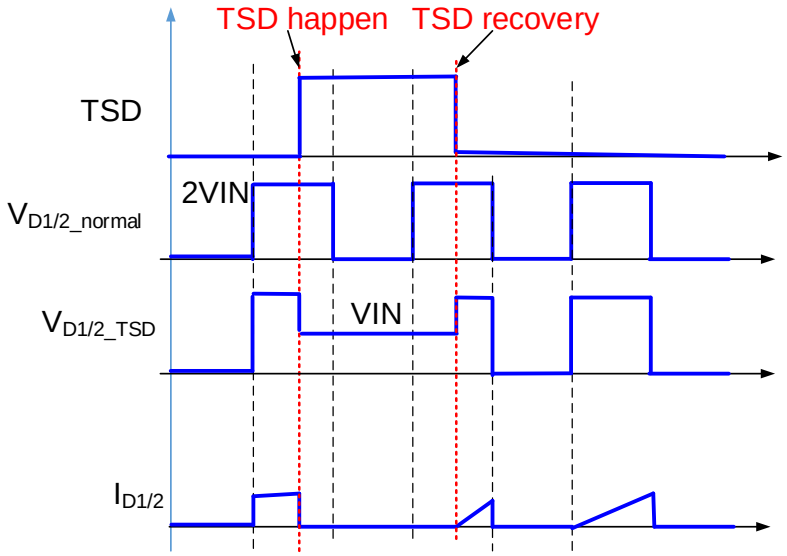
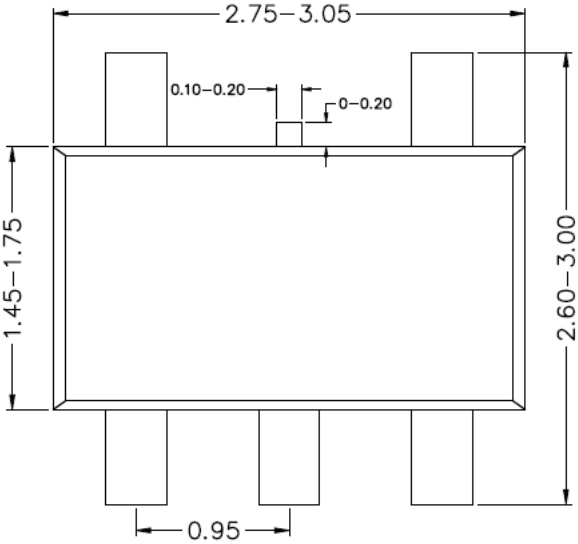
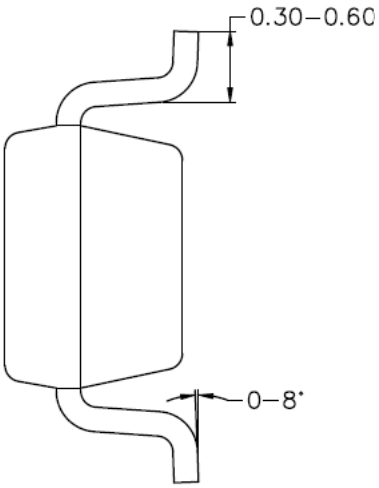


Figure 10. The Waveform of TSD (D1 or D2)

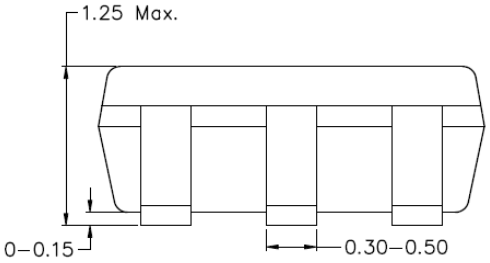
SOT23-5 Package Outline & PCB Layout



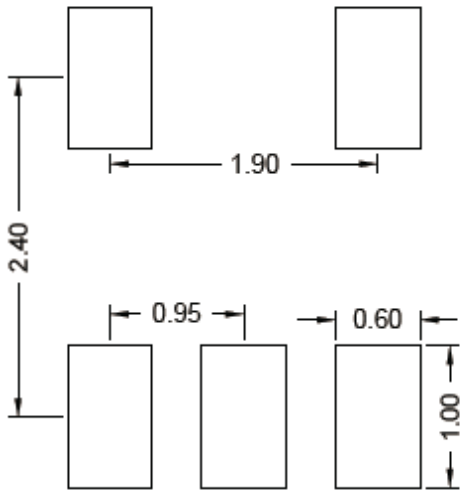
Top view



Side view



Front view



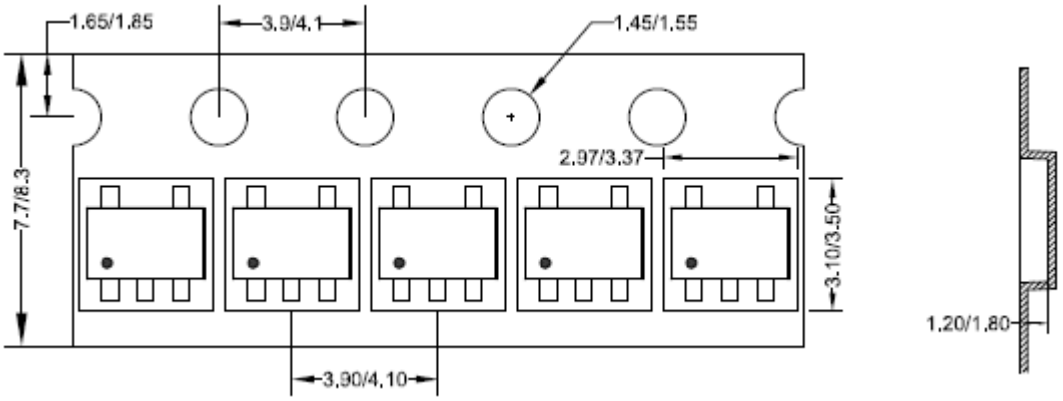
Recommended PCB pad Layout (Reference only)

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

Taping & Reel Specification

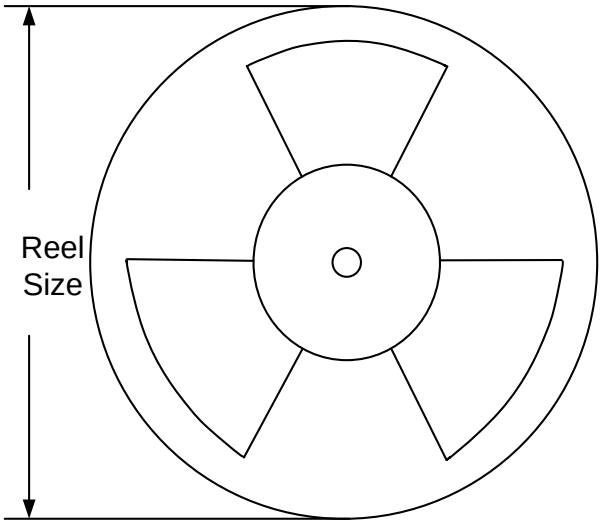
1. Taping Orientation

SOT23-5



Feeding direction

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 warrantied. 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	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

IMPORTANT NOTICE

1. **Right to make changes.** Silergy and its subsidiaries (hereafter Silergy) reserve the right to change any information published in this document, including but not limited to circuitry, specification and/or product design, manufacturing or descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products are sold subject to Silergy's standard terms and conditions of sale.

2. Applications. Application examples that are described herein for any of these products are for illustrative purposes only. Silergy makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification. Buyers are responsible for the design and operation of their applications and products using Silergy products. Silergy or its subsidiaries assume no liability for any application assistance or designs of customer products. It is customer's sole responsibility to determine whether the Silergy product is suitable and fit for the customer's applications and products planned. To minimize the risks associated with customer's products and applications, customer should provide adequate design and operating safeguards. Customer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Silergy assumes no liability related to any default, damage, costs or problem in the customer's applications or products, or the application or use by customer's third-party buyers. Customer will fully indemnify Silergy, its subsidiaries, and their representatives against any damages arising out of the use of any Silergy components in safety-critical applications. It is also buyers' sole responsibility to warrant and guarantee that any intellectual property rights of a third party are not infringed upon when integrating Silergy products into any application. Silergy assumes no responsibility for any said applications or for any use of any circuitry other than circuitry entirely embodied in a Silergy product.

3. **Limited warranty and liability.** Information furnished by Silergy in this document is believed to be accurate and reliable. However, Silergy makes no representation or warranty, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. In no event shall Silergy be liable for any indirect, incidental, punitive, special or consequential damages, including but not limited to lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges, whether or not such damages are based on tort or negligence, warranty, breach of contract or any other legal theory. Notwithstanding any damages that customer might incur for any reason whatsoever, Silergy' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Standard Terms and Conditions of Sale of Silergy.

4. **Suitability for use.** Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of Silergy components in its applications, notwithstanding any applications-related information or support that may be provided by Silergy. Silergy products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of a Silergy product can reasonably be expected to result in personal injury, death or severe property or environmental damage. Silergy assumes no liability for inclusion and/or use of Silergy products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

5. **Terms and conditions of commercial sale**. Silergy products are sold subject to the standard terms and conditions of commercial sale, as published at http://www.silergy.com, unless otherwise agreed in a valid written individual agreement specifically agreed to in writing by an authorized officer of Silergy. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. Silergy hereby expressly objects to and denies the application of any customer's general terms and conditions with regard to the purchase of Silergy products by the customer.

6. **No offer to sell or license**. Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights. Silergy makes no representation or warranty that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right. Information published by Silergy regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from Silergy under the patents or other intellectual property of Silergy.

For more information, please visit: www.silergy.com