SY20704

150mA LDO Regulator

General Description

The SY20704 is a high input voltage, low-ground current, low-dropout voltage regulator capable of sourcing 150mA with only 300mV of dropout. The SY20704 wide input-voltage range supports operation as low as 2.3V and up to 30V. It provides a resistor programmable output voltage with ±2% accuracy over temperature.

The SY20704 provides protection features including logic enable control, thermal shutdown, current limit, and reverse leakage current protection for reliable operation. Its internal compensation enables stable operation using low ESR ceramic capacitors. The device also provides reverse input voltage protection up to -20V Abs. Max.

The device is suitable for use in multiple consumer and industrial applications.

The SY20704 is available in SOT23-5 or DFN 2mm×2mm-6pin packages.

Features

- Input Voltage Range: 2.3V to 30V
- Low Dropout Voltage (300mV @ 150mA)
- 150mA Output Current Capability
- Low Ground Current
- Ultra-Low Shutdown Current
- High Output Accuracy of ±2% Over Operating Temperature Range
- Stable with Small Ceramic Capacitors
- Excellent Load and Line Regulation
- Reverse Leakage Current Protection
- Reverse Input Voltage Protection
- TTL Logic Enable Input
- Thermal Shutdown
- Compact SOT23-5 or DFN2×2-6 Packages
- RoHS Compliant and Halogen Free

Applications

- Battery-Powered Applications
- Consumer and Portable Products
- Notebooks
- Smartphones
- SMPS Post-Regulator/ DC-DC Modules

Typical Applications

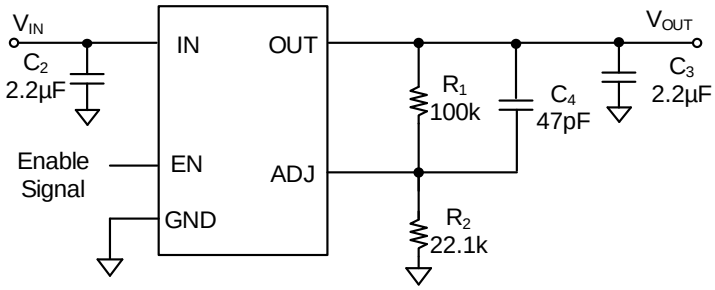


Figure 1. Schematic Diagram

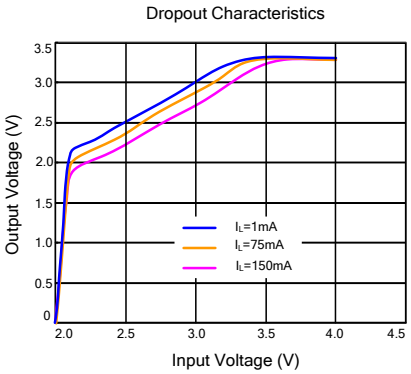


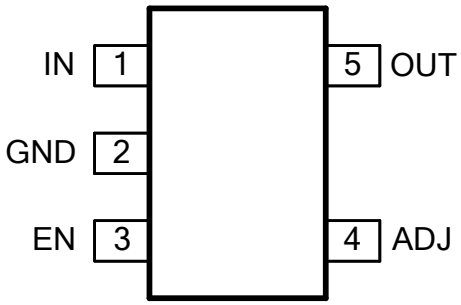
Figure 2. Dropout Characteristics

Ordering Information

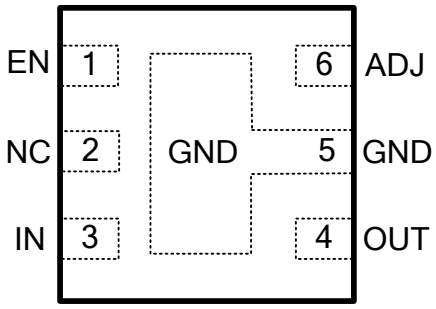
Ordering Part Number	Package Type	Top Mark
SY20704AAC	SOT23-5 RoHS Compliant and Halogen Free	**JN*xyz***
SY20704DEC	DFN2×2-6 RoHS Compliant and Halogen Free	**PE*xyz***

x=year code, y=week code, z= lot number code

Pinout (top view)



(SOT23-5)

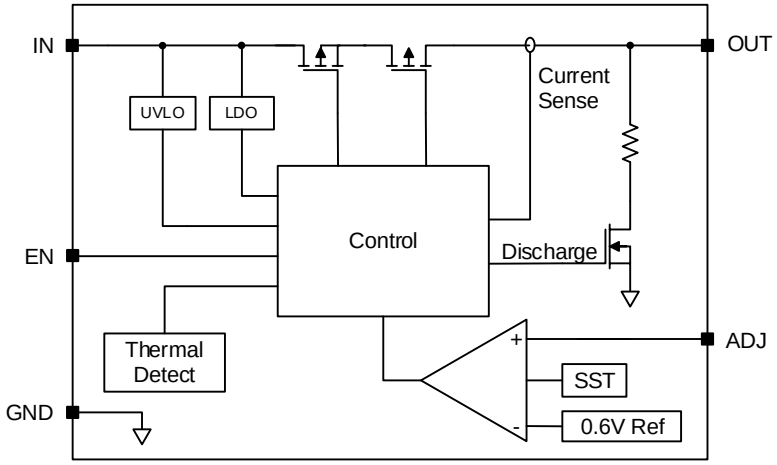


(DFN2×2-6)

Pin Description

Pin Name	SOT23-5	DFN2×2-6	Pin Description
IN	1	3	Supply input pin.
GND	2	5	Ground pin.
OUT	5	4	LDO output pin.
EN	3	1	Enable pin. A low level placed the part in shutdown. A high level enables operation. Do not leave floating.
ADJ	4	6	Output voltage configuration pin. The output voltage can be set using a resistor divider: $V_O = 0.6 \times (1 + \frac{R1}{R2})$

Block Diagram



Absolute Maximum Ratings

Parameter (Note1)	Min	Max	Unit
IN	-20	36	V
OUT		V_{IN}+0.3	
EN	-0.3	V_{IN}+0.3	
ADJ	0	3.6	
Lead Temperature (Soldering, 10 sec.)		260	°C
Junction Temperature, Operating	-40	150	
Storage Temperature	-65	150	

Thermal Information

Parameter (Note2)	Typ	Unit
θ_{JA} Junction-to-ambient Thermal Resistance (SOT23-5/ DFN2×2-6)	100/62	°C/W
θ_{JC} Junction-to-case Thermal Resistance (SOT23-5/ DFN2×2-6)	25/8.5	
P_D Power Dissipation T_A = 25°C (SOT23-5/ DFN2×2-6)	1/1.6	W

Recommended Operating Conditions

Parameter (Note 3)	Min	Max	Unit
IN	2.3	30	V
OUT		V_{IN}+0.3	
EN	0	V_{IN}+0.3	
Junction Temperature, Operating	-40	125	°C

Electrical Characteristics

(V_{IN} =V_{OUT}+1V, or V_{IN}=2.3V, V_{EN}=V_{IN}, T_A = 25°C unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Unit
Input Voltage	V_{IN}		2.3		30	V
Output Voltage Accuracy	V_{OUT}	I_O=100μA	-2		2	%
Line Regulation	ΔV_{LNR}	V_{IN}=(V_{OUT}+0.3) to 30V, I_O=100μA		0.04		%
Load Regulation	ΔV_{LDR}	I_O=0.1mA to 150mA		0.25	1	%
Dropout Voltage	V_{IN}-V_{OUT}	I_O=10mA		20		mV
		I_O=50mA		100		mV
		I_O=100mA		200		mV
		I_O=150mA		300		mV
Shutdown Current	I_{SHDN}	V_{EN}=0V, V_{IN}=24V		1		μA
Quiescent Current	I_Q	I_O=0.1mA		18	30	μA
		I_O=150mA		450		μA
Current Limit	I_{LIM}	V_{OUT}=0.9×V_{OUT}(normal)		350	500	mA
Reverse leakage current limit	I_{RLK}	V_{IN}= -15V, Load=500Ω		-0.1		uA
Power-supply Rejection Ratio	PSRR	f=1kHz, C_{OUT}=10μF		50		dB
Input UVLO Threshold	V_{UVLO}	V_{IN} rising			2.25	V
UVLO Hysteresis	V_{UVLO_TH}			100		mV
Shutdown Discharge Resistor				500		Ω
Enable Input Logic-High Voltage	V_{EN_H}	V_{IN}=2.8 to 5.5V	1.5			V
Enable Input Logic-Low Voltage	V_{EN_L}	V_{IN}=2.8 to 5.5V			0.6	V
Thermal Shutdown Temperature	T_{SD}			150		°C
Thermal Shutdown Hysteresis	T_{HYS}			20		°C

Note 1: Stresses beyond "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. 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.

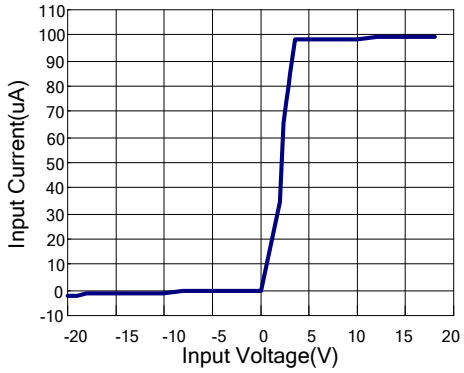
Note 2: θ_{JA} is measured in the natural convection at T_A = 25°C on a two-layer Silergy Evaluation Board.

Note 3: The device is not guaranteed to function outside its operating conditions.

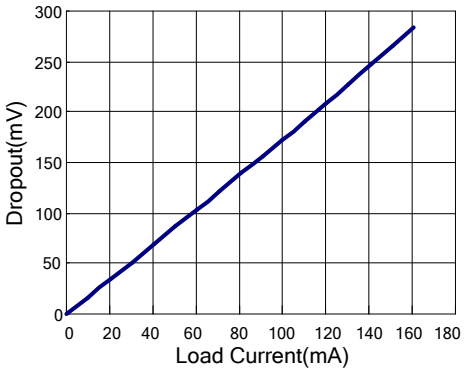
Typical Performance Characteristics

Input Current vs. Input Voltage

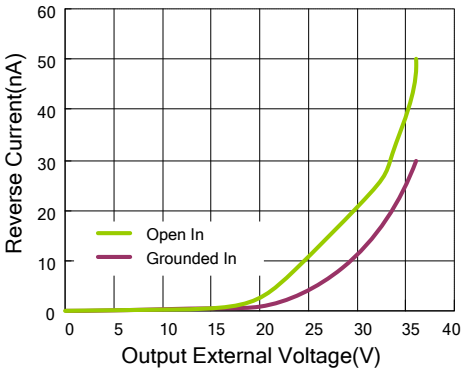
(V_{IN}=5V, V_{OUT}=3.3V, R_L=33ohm)



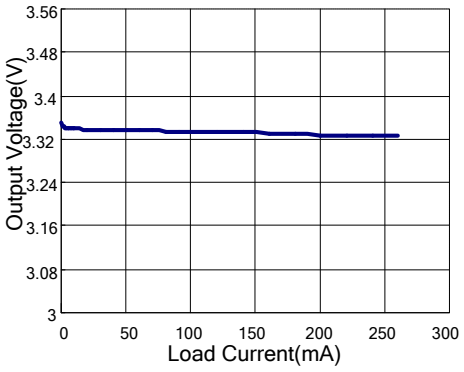
Dropout Voltage vs. Load Current



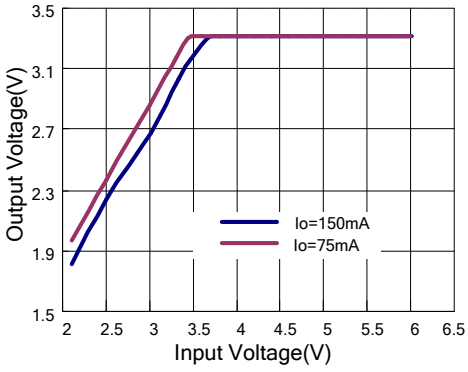
Reverse Current



Load Regulation

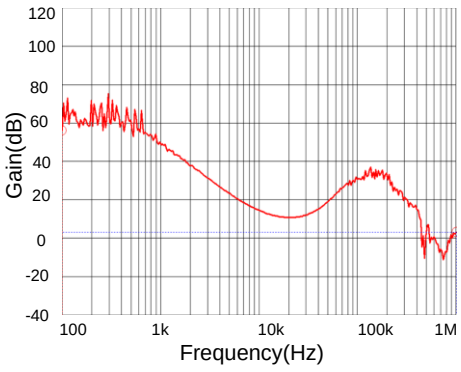


Line Regulation



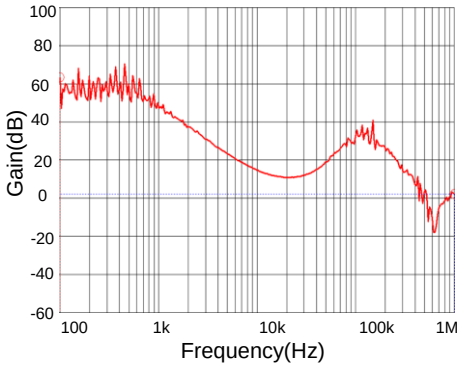
PSRR

(Vin=5,Vout=3.3,Iout=150mA)



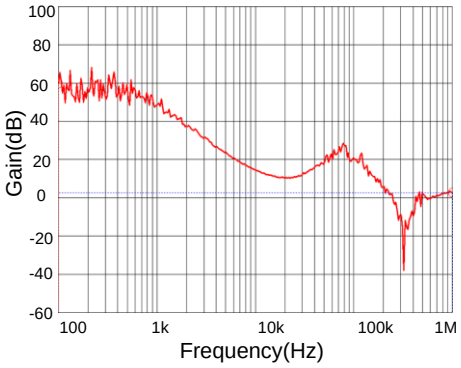
PSRR

(Vin=5,Vout=3.3,Iout=100mA)



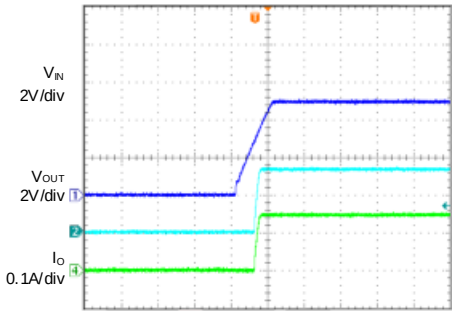
PSRR

(Vin=5,Vout=3.3,Iout=10mA)



Startup from V_{IN}

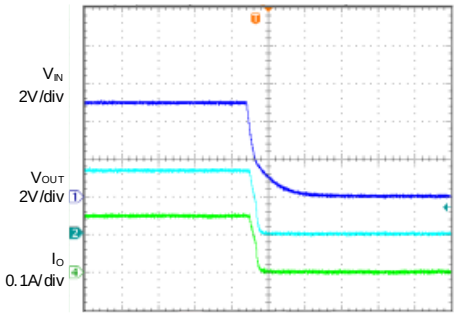
(V_{IN}=5.0V, V_{OUT}=3.3V, I_O=0.15A)



Time (1ms/div)

Shutdown from V_{IN}

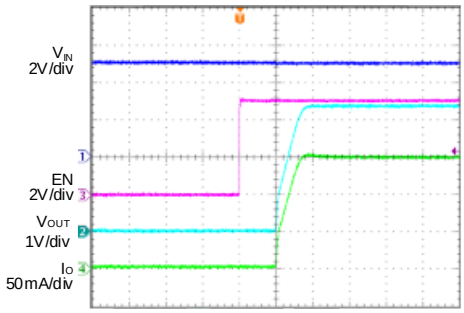
(V_{IN}=5.0V, V_{OUT}=3.3V, I_O=0.15A)



Time (1ms/div)

Startup from Enable

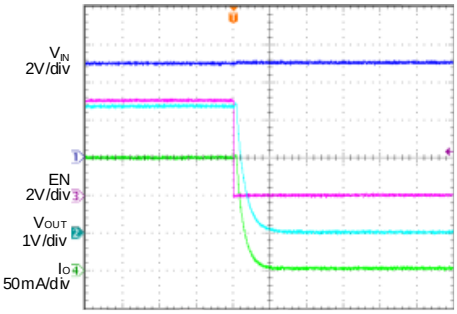
(V_{IN}=5.0V, V_{OUT}=3.3V, I_O=0.15A)



Time (200us/div)

Shutdown from Enable

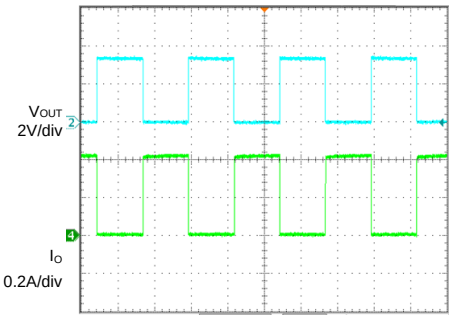
(V_{IN}=5.0V, V_{OUT}=3.3V, I_O=0.15A)



Time (200us/div)

Hard Short Protection

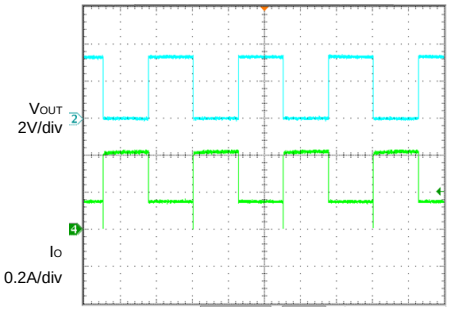
(V_{IN}=5.0V, V_{OUT}=3.3V, Null load to short)



Time (200ms/div)

Hard Short Protection

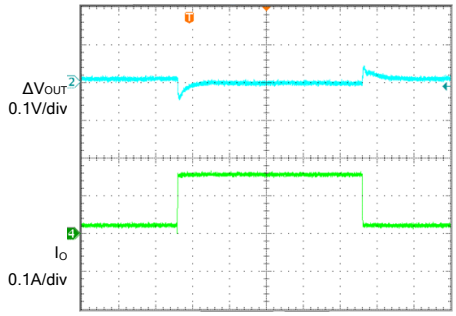
(V_{IN}=5.0V, V_{OUT}=3.3V, 0.15A to short)



Time (200ms/div)

Load Transient

(V_{IN}=5.0V, V_{OUT}=3.3V, I_O=15~150mA)



Time (40μs/div)

Application Information

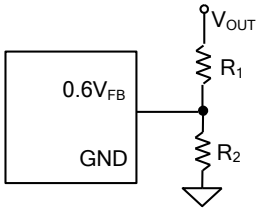
The SY20704 is a linear voltage regulator supporting an input voltage range between 2.3V and 30V. It regulates the voltage with a 2% accuracy and has a 150mA maximum output current. Low equivalent series resistance (ESR) ceramic capacitors are recommended at the input and output pins for stable operation.

Feedback Resistor Dividers R_1 and R_2:

The output voltage of the SY20704 can be adjusted using a resistor divider network, as shown below. To minimize power consumption under light loads, choosing large resistance values for both R1 and R2 is recommended. A value of between 10kΩ and 2MΩ is recommended for both resistors.

If the target V_{OUT} is 3.3V, and R_1=100k is selected, then using following equation, R_2 can be calculated to be 22.1k:

$$R_2 = \frac{0.6V}{V_{OUT} - 0.6V} R_1 .$$



Input Capacitor C_{IN}:

A 2.2μF decoupling capacitor is recommended between the IN terminal and GND. Locate the input and output capacitors as near as practical to the input and output pins to minimize the trace inductance from the capacitor to the device.

Output Capacitor C_{OUT}:

The SY20704 is designed to operate using low equivalent series resistance (ESR) ceramic capacitors. This forms a zero to provide phase lead which is required for loop stability. A 2.2μF or higher ceramic capacitor can be used in this application. Higher capacitance values help to improve transient response.

Dropout Voltage:

The SY20704 has a very low dropout voltage due to its extra low $R_{DS(ON)}$ of the main PMOS, which determines the lowest usable supply voltage.

$V_{DROPOUT}=V_{IN}-V_{OUT}=R_{DS(ON)}\times I_{OUT}$

Over-Current and Short-Circuit Protection:

The device includes over-current and short-circuit protection. The device regulates the output current to its threshold limit to protect the device from damage. During over-current or short circuit conditions, the output voltage drops while in the current limiting state, increasing power dissipation of the internal FET. In cases where often over-current or short-circuits are expected, the input voltage it recommended to be below 9V.

Thermal Considerations:

The SY20704 can source a current of up to 150mA over the full operating junction temperature range. However, the maximum output current must be derated at a higher ambient temperature to limit junction temperature to a maximum of 125℃. The junction temperature must be within the operating range specified under all operating conditions. The LDO power dissipation depends on the input-to-output voltage difference and load current.

The dissipated power, P_D, can be calculated using the following equation:

$P_D=(V_{IN}-V_{OUT})\times I_{OUT}+V_{IN}\times I_{GND}$

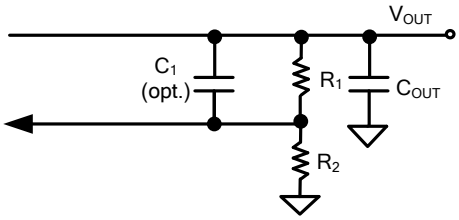
The operating junction temperature can be estimated by using the following formula:

$P_{D(MAX)}=(T_{J(MAX)}-T_A)/\theta_{JA}$

Where $T_{J(MAX)}$ is the maximum junction temperature of die (125℃), and T_A is the maximum ambient temperature. The junction to ambient thermal resistance (θ_{JA}) footprint is 100℃/W for the SOT23-5 package and 62℃/W for the DFN2×2-6 package.

Load Transient Considerations:

The SY20704 integrates the compensation components to achieve good stability and fast transient response.
In some applications, adding a small ceramic capacitor in parallel with R_1 may optimize the load transient performance and is thus recommended for applications with large load transient step requirements.

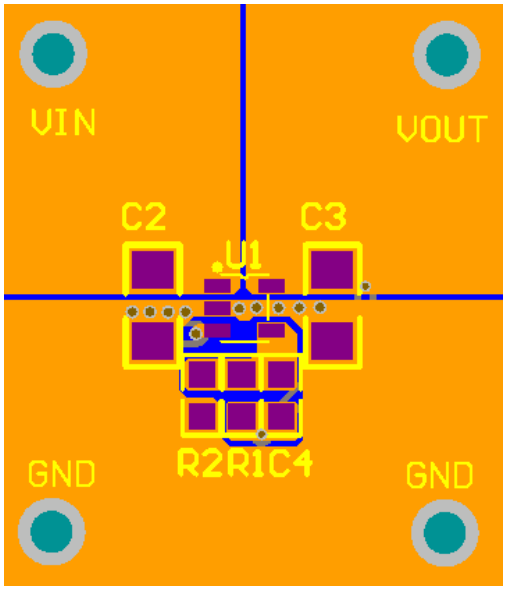


PCB Layout Guide

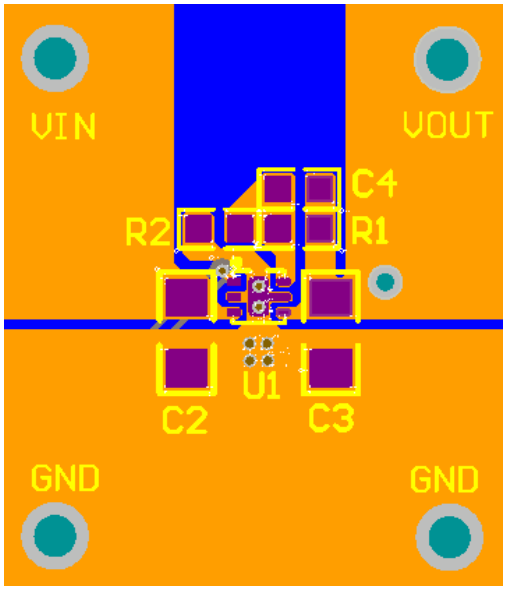
Good board layout practices must be used for stable operation, and a large PCB copper area can improve thermal performance. The input and output capacitors must be directly connected to the input, output, and ground pins of the device using traces which have no other currents flowing through them.

Place C_{IN} and C_{OUT} near the device with short traces to the V_{IN}, V_{OUT}, and ground pins. The regulator ground pin should be connected to the external circuit ground so that the regulator and its capacitors have a “single point ground”.

Below are the recommended PCB layout diagrams:

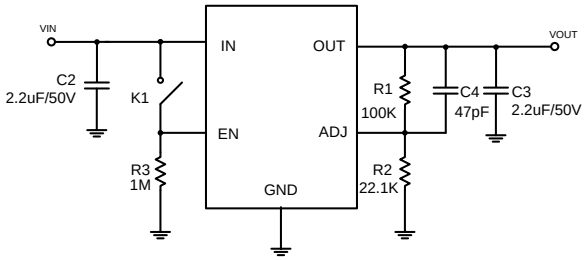


SOT23-5



DNF2×2-6

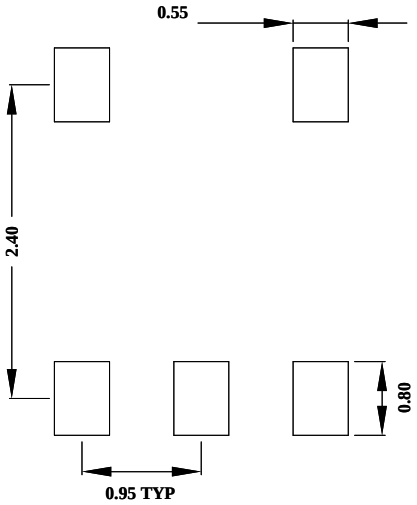
Application Schematic (V_{OUT} = 3.3V)



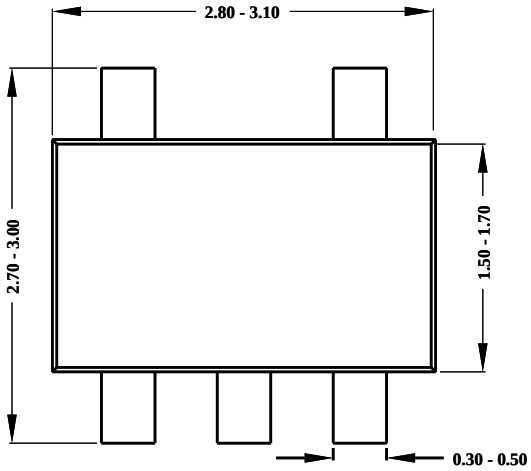
BOM List

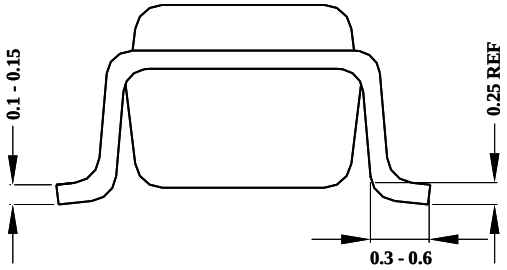
Reference Designator	Description	Part Number	Manufacturer
U1	24V, 150mA	SY20704	Silergy
C2, C5	CHIP CAP X7R 2.2μF ±10% 50V 1206	C3216X7R1H225K	TDK
C6	CHIP CAP C0G 47pF ±5% 50V 0603	C1608C0G1H680J	TDK
R1	100KΩ ±1% 0.1W 0603		
R2	22.1KΩ ±1% 0.1W 0603		
R3	1MΩ ±1% 0.1W 0603		

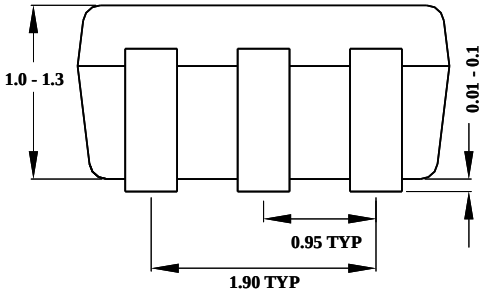
SOT23-5 Package Outline & PCB Layout



Recommended Pad Layout

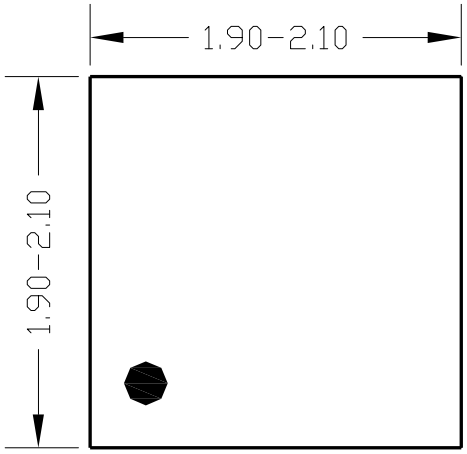




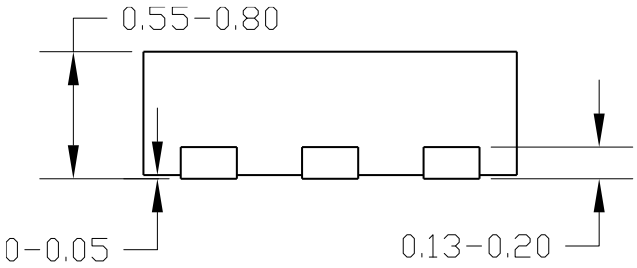


Note: All dimensions are in millimeters and exclude mold flash and metal burr.

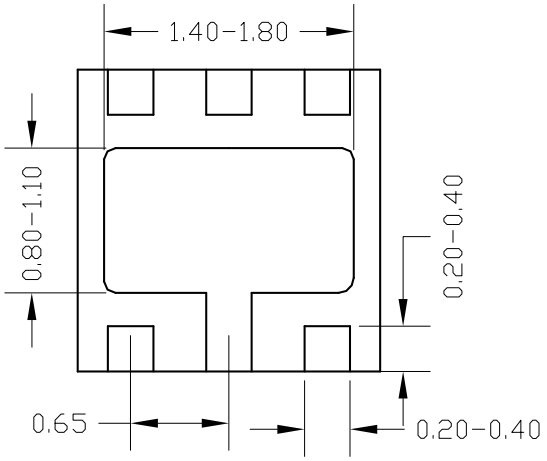
DFN2×2-6 Package Outline



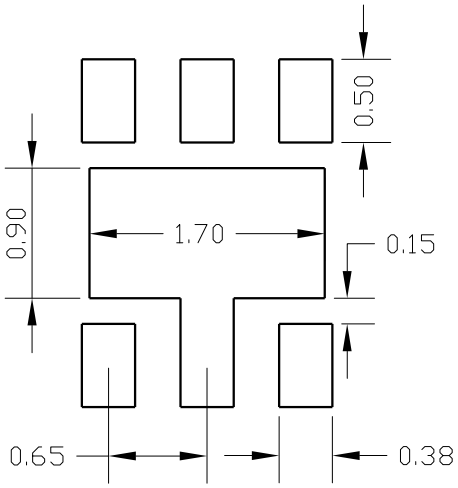
Top View



Side View



Bottom View

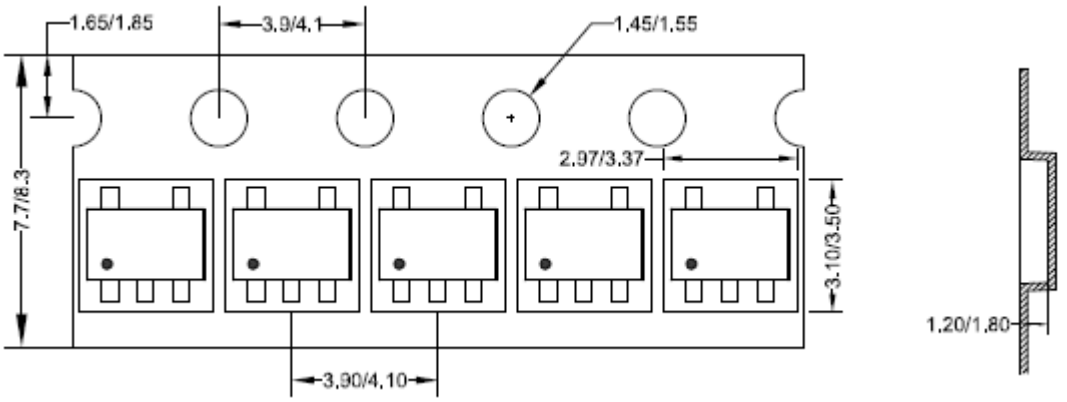


Recommended PCB Layout

Note: All dimensions are in millimeters and exclude mold flash and metal burr.

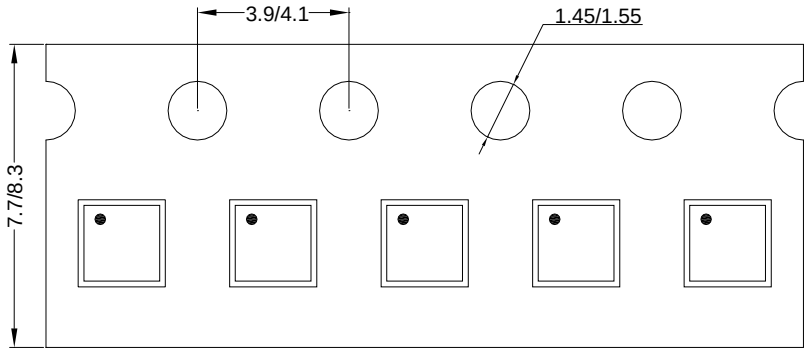
Taping & Reel Specification

1. SOT23-5 Taping Orientation



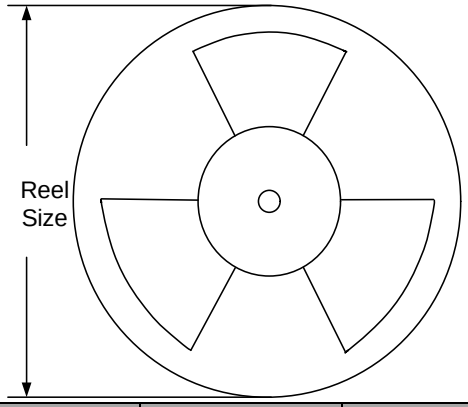
Feeding direction ⟶

2. DFN2×2 Taping Orientation



Feeding direction ⟶

3. Carrier Tape & Reel Specification for Packages



Package types	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
DFN2×2	8	4	7"	400	160	3000

4. Others: NA

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/stdterms, 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