SY20728

18V, 3A Fast-Response LDO Regulator

General Description

The SY20728 is a high-voltage, low-dropout LDO regulator with a 3A current capacity. It features fast recovery from input voltage surges and output load current changes.

The SY20728 provides protection features, including over-current limit, output short protection, and over-temperature protection, enabling the part to be used in demanding applications.

The SY20728 is available in either TO263-5 or TO252-5 packages.

Features

- 3V to 18V Input Voltage Range
- Low Dropout Voltage: 480mV at Full Load 3A
- High Current Capability: 3A Over Full Temperature Range
- Fast Transient Response
- Zero-Current Shutdown Mode
- Adjustable Output Voltage
- Low Ground Current
- Over Current Limit
- Output Short Circuit Protection
- Over Temperature Protection
- Package: TO263-5/TO252-5
- RoHS Compliant and Halogen Free

Typical Applications

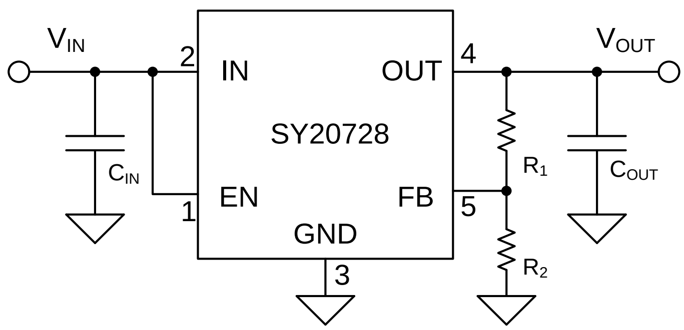


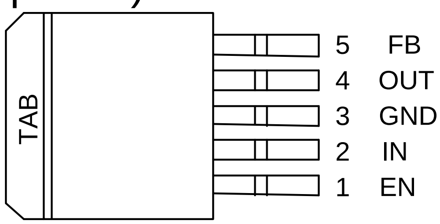
Figure 1. Adjustable Output Regulator

Ordering Information

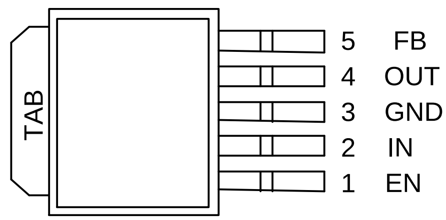
Ordering Part Number	Package Type	Top Mark
SY20728MAC	TO263-5 RoHS Compliant and Halogen Free	**BIJxyz**
SY20728JBC	TO252-5 RoHS Compliant and Halogen Free	**BRYxyz**

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

Pinout (top view)



TO263-5 (D2-Pak)



TO252-5 (D-Pak)

Pin Name	Pin Number	Pin Description
1	EN	Enable (Input): Active-high CMOS compatible control input. Do not leave it floating.
2	IN	INPUT: Unregulated input, +3V to +18V maximum.
3, TAB	GND	GND: TAB is also connected internally to the device's ground.
4	OUT	OUTPUT: The regulator output voltage.
5	FB	Feedback Voltage: 1.24V feedback from external resistor divider. $V_{OUT} = 1.24 \times (\frac{R_1 + R_2}{R_2})$

Block Diagram

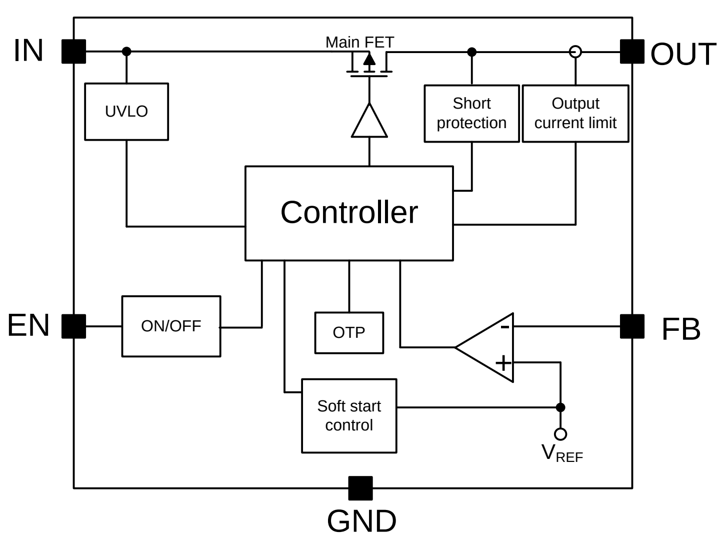


Figure 2. Block Diagram

Absolute Maximum Ratings

Parameter (Note1)	Min	Max	Unit
IN, EN, OUT, FB		19	V
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 (TO263/TO252)	24.5 /26	°C/W
θ_{JC} Junction-to-case Thermal Resistance (TO263/TO252)	1.4 /1.2	

Recommended Operating Conditions

Parameter (Note 3)	Min	Max	Unit
IN	3	18	V
EN, OUT, FB	0	18	
Junction Temperature, Operating	-40	125	°C
Ambient Temperature	-40	85	

Electrical Characteristics

(V_{IN} = 5V, V_{OUT}=3.3V, I_{OUT} = 100mA, T_A = -40°C ~85°C unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Unit
General						
Input Voltage	V_{IN}		3		18	V
Input voltage UVLO Threshold	V_{UVLO}	V_{IN} rising	2.4	2.5	2.7	V
UVLO Hysteresis	V_{UVLO_th}			200		mV
Soft Start Time	t_{SS}			2	4	ms
Enable Input Logic-High Voltage	$V_{EN,H}$	V_{IN}= V_{OUT}+1V	2.4			V
Enable Input Logic-Low Voltage	$V_{EN,L}$				0.8	V
Current Limit	I_{limit}		4	4.5	5	A
Thermal Shutdown Temperature	T_{SD}		130	150	170	°C
Thermal Shutdown Hysteresis	T_{HYS}			20		°C
Output short protection threshold	$V_{FB,SHORT}$		40	50	60	%V_{REF}
Output Short Off Time	t_{short_off}			38		ms
IN Pin to OUT pin Leakage Current	$I_{Leakage}$	EN=0,V_{IN-OUT}=18V		10	600	nA
Line Regulation	ΔV_{LNR}	I_{OUT} = 100mA, (V_{OUT} + 1V) $\leqq V_{IN} \leqq$ 16V		0.1	0.5	%
Load Regulation	ΔV_{LDR}	V_{IN} = V_{OUT} + 1V, 100mA $\leqq I_{OUT} \leqq$ 3A		0.2	1	%

Parameter	Symbol	Test Conditions	Min	Typical	Max	Unit
Dropout Voltage	ΔV_{DROP}	V_{FB}=1V, I_{OUT} = 100mA, TO263		16	24	mV
		V_{FB}=1V, I_{OUT} = 750mA, TO263		120	175	
		V_{FB}=1V, I_{OUT} = 1.5A, TO263		240	350	
		V_{FB}=1V, I_{OUT} = 3A, TO263		480	700	
		V_{FB}=1V, I_{OUT} = 100mA, TO252		11		
		V_{FB}=1V, I_{OUT} = 750mA, TO252		80		
		V_{FB}=1V, I_{OUT} = 1.5A, TO252		170		
		V_{FB}=1V, I_{OUT} = 3A, TO252		380		
Power Supply Rejection	PSRR	Frequency=100Hz, C_{OUT}=10µF (**Note 4**)		70		dB
		Frequency=100kHz, C_{OUT}=10µF (**Note 4**)		30		
Ground Current						
Ground Current	I_{GND}	IC shutdown		1	5	µA
		I_{OUT} = 0, V_{IN}=V_{OUT}+1V		120	150	µA
		I_{OUT} = 1.5A, V_{IN}=V_{OUT}+1V (**Note 4**)		2	4	mA
		I_{OUT} = 3A, V_{IN}=V_{OUT}+1V (**Note 4**)		4	8	mA
Reference Voltage						
Reference Voltage	V_{REF}		1.215	1.24	1.265	V
FB Pin Bias Current	I_{FB_Bias}	EN=0, FB pin floating			50	nA

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.

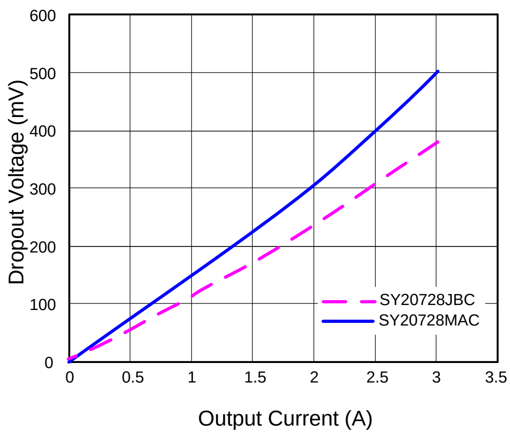
Note 2: θ_{JA} was measured according to JESD51-2 and chip mounted on Silergy PCB. The exposed paddle of TO263-5/TO252-5 is the case position for θ_{JC} measurement.

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

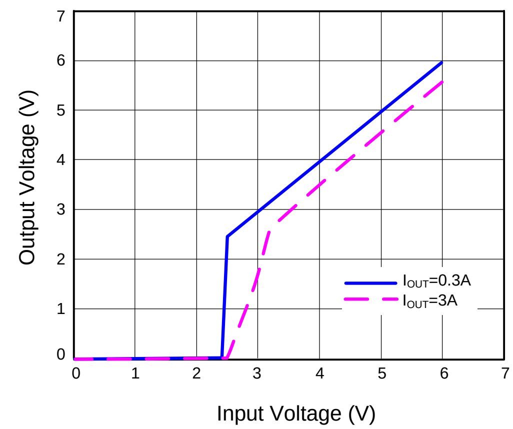
Note 4: Guaranteed by design.

Typical Performance Characteristics

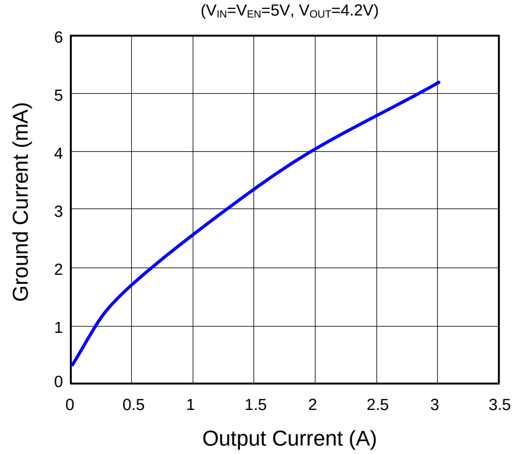
Dropout Voltage vs. Output Current
($V_{IN}=V_{EN}=5V$, $V_{FB}=1.1V$)



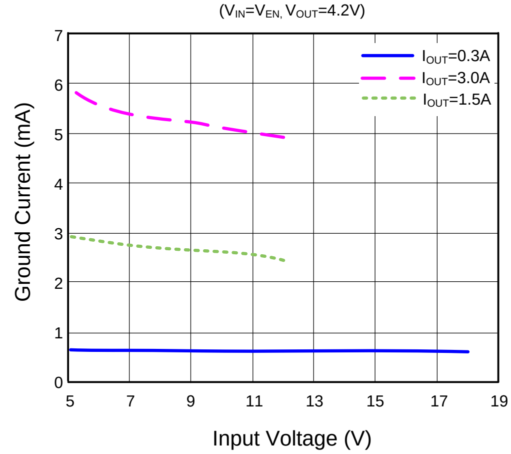
Output Voltage vs. Input Voltage
($V_{IN}=V_{EN}$, $V_{FB}=1.1V$)



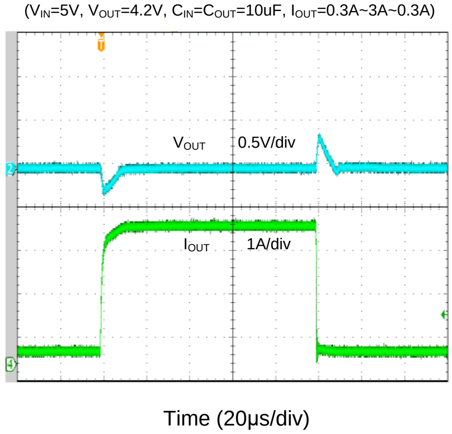
Ground Current vs. Output Current
($V_{IN}=V_{EN}=5V$, $V_{OUT}=4.2V$)



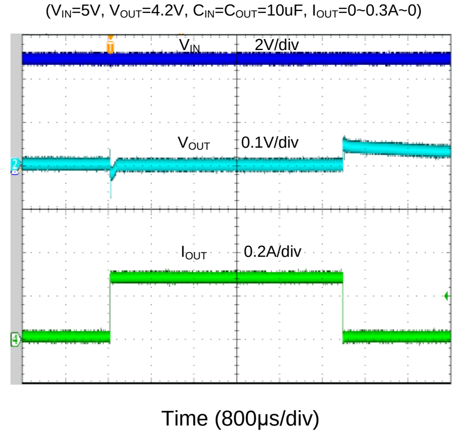
Ground Current vs. Input Voltage
($V_{IN}=V_{EN}$, $V_{OUT}=4.2V$)



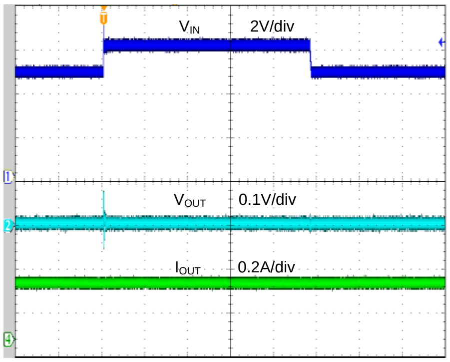
Load Transient
($V_{IN}=5V$, $V_{OUT}=4.2V$, $C_{IN}=C_{OUT}=10uF$, $I_{OUT}=0.3A\sim3A\sim0.3A$)



Load Transient
($V_{IN}=5V$, $V_{OUT}=4.2V$, $C_{IN}=C_{OUT}=10uF$, $I_{OUT}=0\sim0.3A\sim0$)

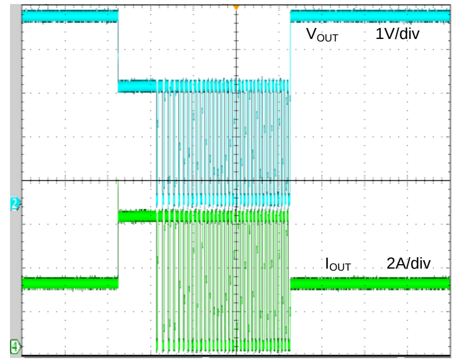


Line Transient
(V_{IN}=5V~6V~5V, C_{IN}=C_{OUT}=10uF, I_{OUT}=0.3A)



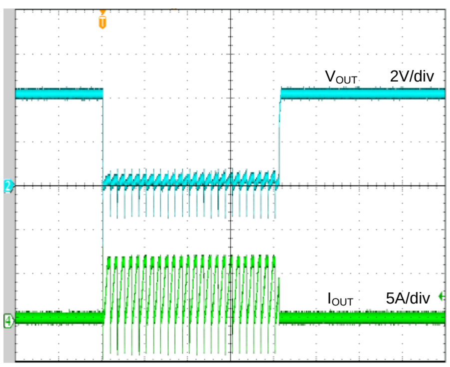
Time (800μs/div)

Over Current
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, OUT=1.4Ω to 0.42Ω to1.4Ω)



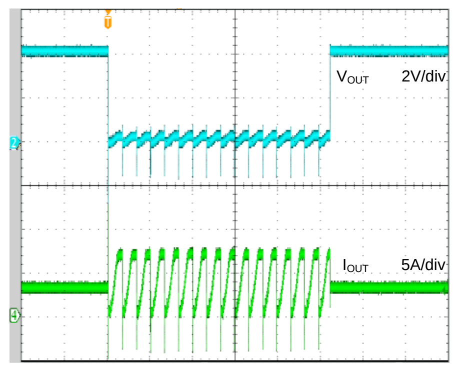
Time (100ms/div)

Short Current
(V_{IN}=5V, C_{IN}=C_{OUT}=10uF, I_{OUT}=0A to short to 0A)



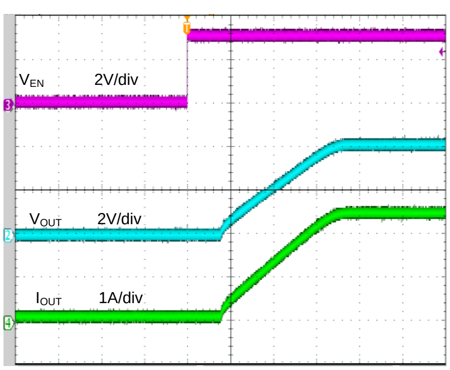
Time (20ms/div)

Short Current
(V_{IN}=5V, C_{IN}=C_{OUT}=10uF, I_{OUT}=3A to short to 3A)



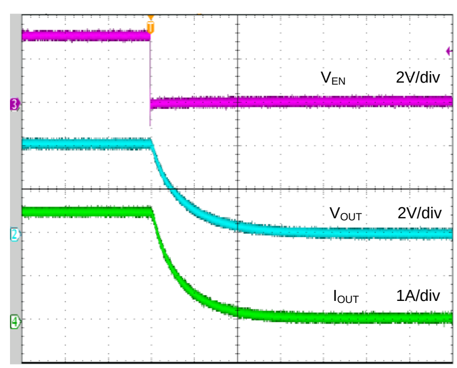
Time (10ms/div)

Startup from EN
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=3A)



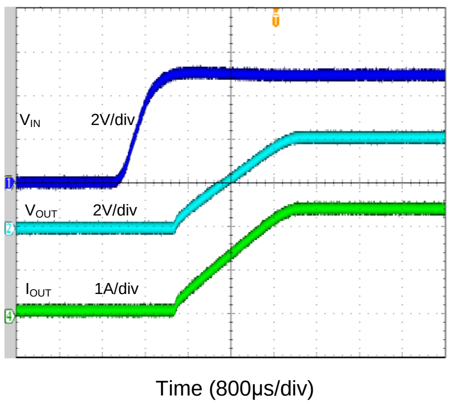
Time (800μs/div)

Shutdown from EN
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=3A)

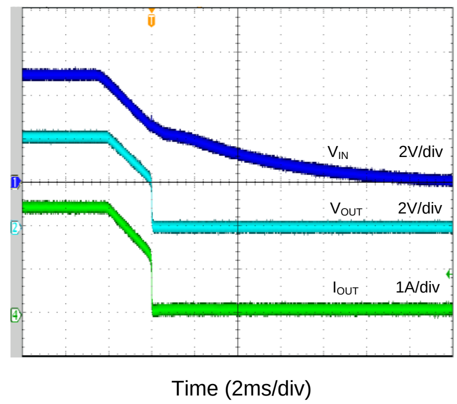


Time (20μs/div)

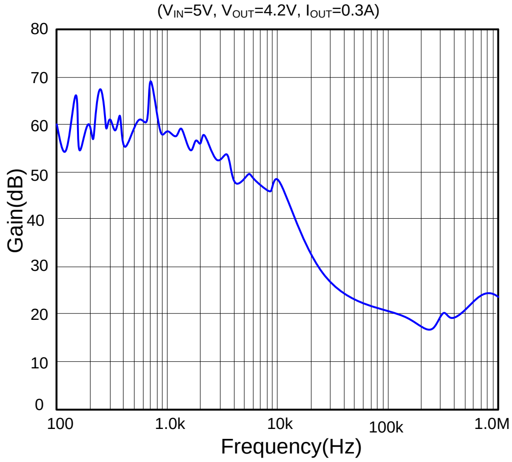
Startup from V_{IN}
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=3A)



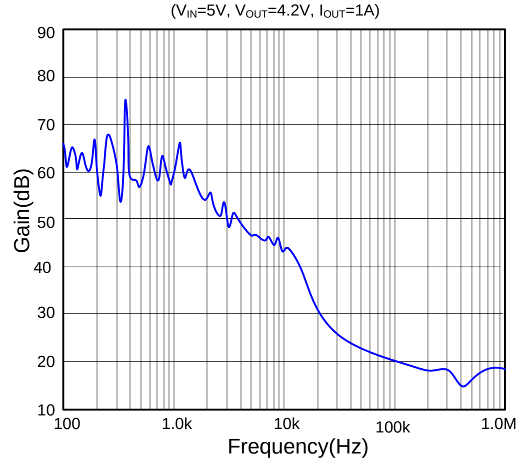
Shutdown from V_{IN}
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=3A)



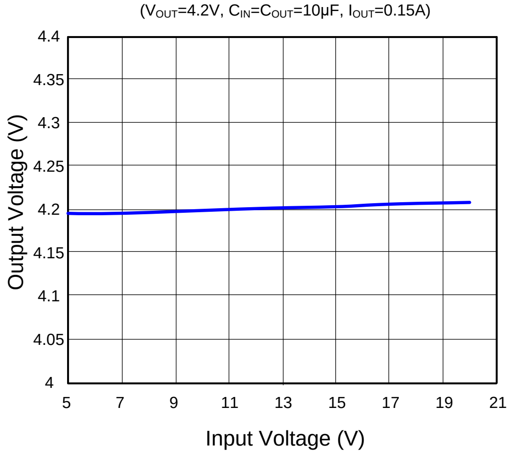
Power Supply Rejection Ratio
(V_{IN}=5V, V_{OUT}=4.2V, I_{OUT}=0.3A)



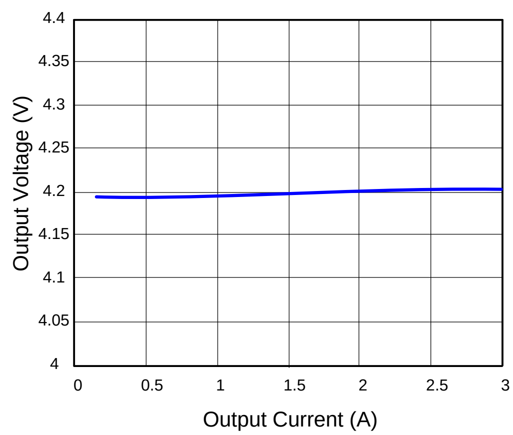
Power Supply Rejection Ratio
(V_{IN}=5V, V_{OUT}=4.2V, I_{OUT}=1A)

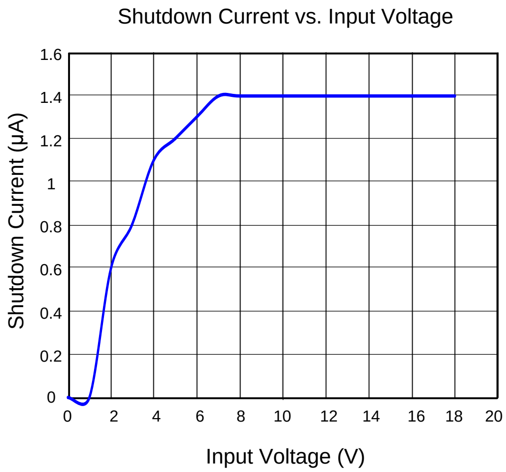


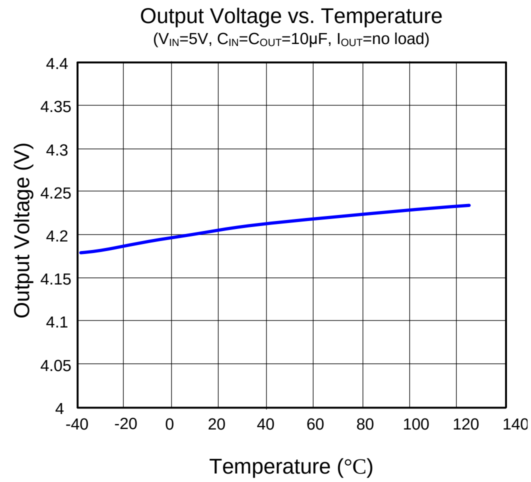
Line Regulation
(V_{OUT}=4.2V, C_{IN}=C_{OUT}=10μF, I_{OUT}=0.15A)

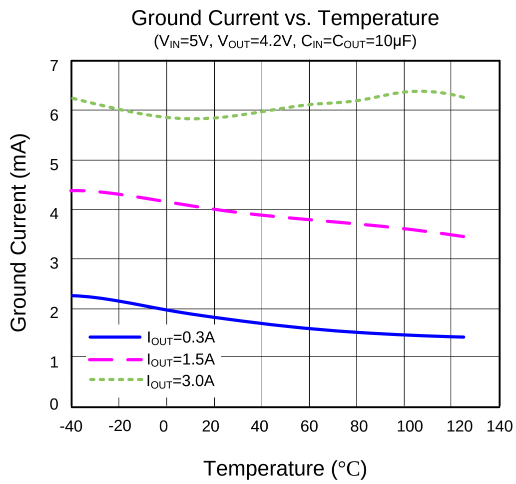


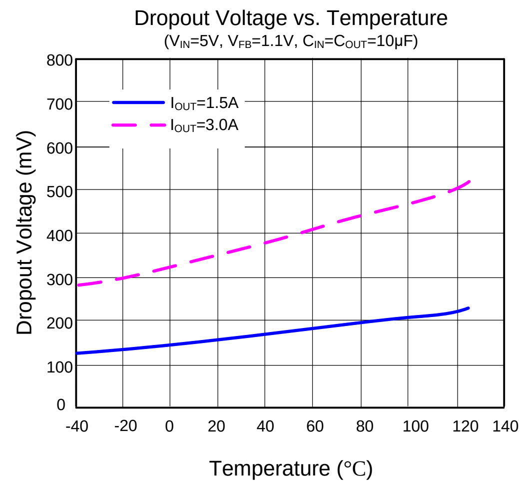
Load Regulation
(V_{IN}=5V, V_{OUT}=4.2V, C_{IN}=C_{OUT}=10μF)




Shutdown Current vs. Input Voltage
Shutdown Current (μA)
Input Voltage (V)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0 2 4 6 8 10 12 14 16 18 20


Output Voltage vs. Temperature
(VIN=5V, CIN=COUT=10μF, IOUT=no load)
Output Voltage (V)
Temperature (°C)
4
4.05
4.1
4.15
4.2
4.25
4.3
4.35
4.4
-40 -20 0 20 40 60 80 100 120 140


Ground Current vs. Temperature
(VIN=5V, VOUT=4.2V, CIN=COUT=10μF)
Ground Current (mA)
Temperature (°C)
IOUT=0.3A
IOUT=1.5A
IOUT=3.0A
0
1
2
3
4
5
6
7
-40 -20 0 20 40 60 80 100 120 140


Dropout Voltage vs. Temperature
(VIN=5V, VFB=1.1V, CIN=COUT=10μF)
Dropout Voltage (mV)
Temperature (°C)
IOUT=1.5A
IOUT=3.0A
0
100
200
300
400
500
600
700
800
-40 -20 0 20 40 60 80 100 120 140

Application Information

The SY20728 is a high-voltage, 3A current capability and low dropout LDO regulator, which features fast transient recovery from input voltage surges and output load current changes. The SY20728 has protection features, including over-current limit, output short protection, over-input voltage protection, and over-temperature protection.

The following paragraphs provide guidance on selecting the external components required for operation.

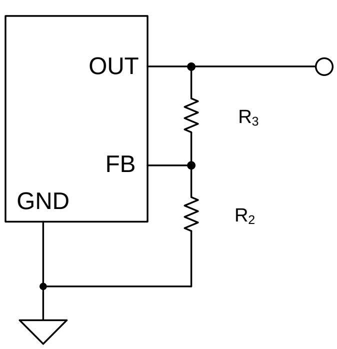
Input Capacitor C_{IN}:

An input capacitor with voltage rating of 20% higher than the highest input voltage and a capacitance higher than 10μF is required between the device input and ground pins. A typical X5R or better grade ceramic capacitor ng is recommended for most applications. Place the input capacitor as close to the device as practical to ensure stable operation.

Output Capacitor C_{OUT}:

The SY20728 is designed to operate using very small ceramic output capacitors. A capacitor with 2.2μF or higher capacitance is required for most applications. The output capacitor's ESR is important because it forms a zero to provide phase lead which is required for loop stability. Higher capacitance values help to improve transient response.

Output Voltage Setting:



Choose R2 and R3 to configure the output voltage. Choosing large resistance values for both R2 and R3 is recommended to minimize power consumption under light loads. A value of between 1kΩ and 1MΩ is highly recommended for both resistors.

The output voltage can be calculated using the following equation:

$$V_{OUT} = 1.24 \times \frac{R_3 + R_2}{R_2}$$

No Load Stability:

The device is designed to remain stable and in regulation with no external load. This is especially important in CMOS RAM keep-alive applications.

Dropout Voltage:

The SY20728 has a very low dropout voltage due to its extra low $R_{DS(ON)}$ of the main PMOS, which determines the lowest usable supply for a given target output voltage.

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

Over-Current and Short-Circuit Protection:

The minimum current limit of the SY20728 is 4A. The device includes over-current and short-circuit protection. The current limit circuit regulates the output current to its threshold I_{limit} to protect the device from damage. Under over-current or short-circuit conditions, the dissipated power on the device is relatively high, which may trigger the thermal protection.

Load Transient Considerations:

The SY20728 integrates the compensation components to achieve stability and fast transient responses. In some applications, adding a small ceramic capacitor in parallel with R1 may further speed up the load transient responses and is thus recommended for applications with large load transient step requirements.

Thermal Considerations:

The SY20728 can source a current of up to 3A over the full operating junction temperature range. However, the maximum output current must be derated when used at higher ambient temperatures, to limit the junction temperature to a maximum of 125°C. The junction temperature must be within the specified range under all operating conditions. The LDO power dissipation can be calculated based on the output current and the voltage drop across the regulator.

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 using the following formula:

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

Where $T_{J(MAX)}$ is the maximum junction temperature of the die (125°C), and T_A is the maximum ambient temperature.

Layout Design:

Good board layout practices must be used for stable operation, and a large PCB copper area connected directly to the exposed package pad can help improve the overall thermal performance.

The input and output capacitors must be directly connected to the device's input, output, and ground pins using traces with no other currents flowing through them.

The feedback loop formed by R_1, R_2, and the trace connecting to the FB pin and OUT must be minimized. 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 is the recommended PCB layout diagram:

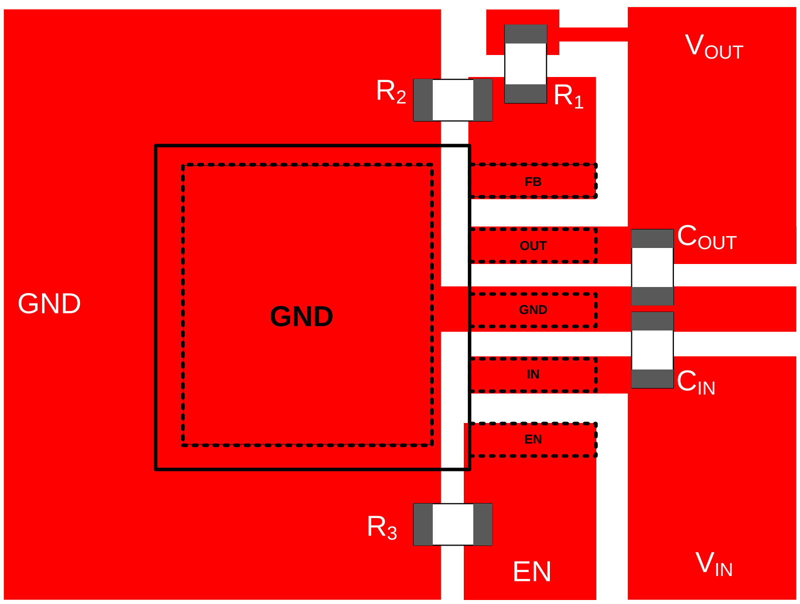
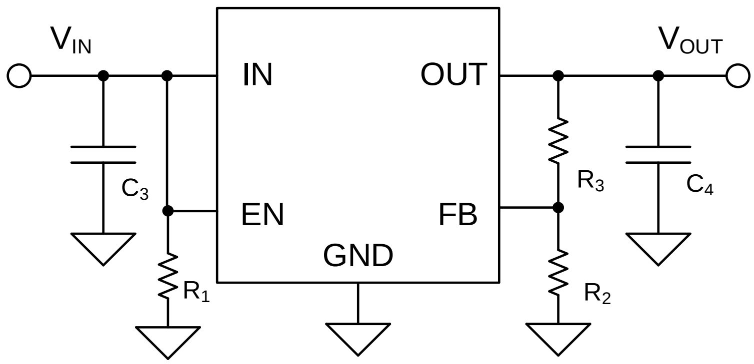


Figure 3. PCB Layout Example

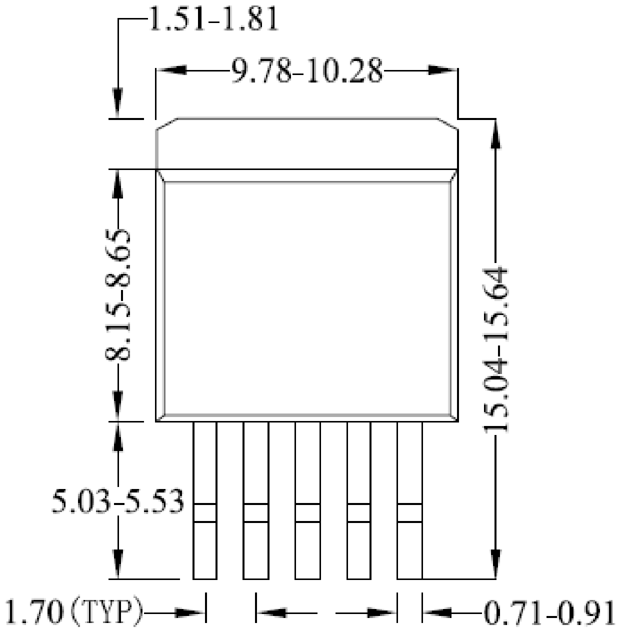
Application Schematic (V$_{OUT}$=5V)



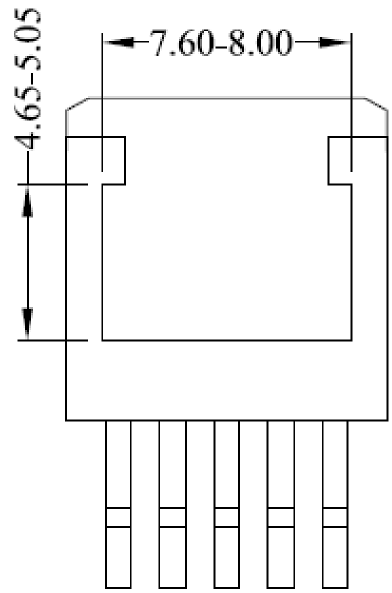
BOM List

Reference Designator	Description	Part Number	Manufacturer
U1	20V,3A,LDO	SY20728	Silergy
C3	10µF/50V,1206	C3216X5R1H106K	TDK
C4	10µF/16V,1206	C3216X7R1C106K	TDK
R1	1MΩ,1%, 0603	RC0603FR-071ML	YAGEO
R2	33k,1%,0603	RC0603FR-0733K2L	YAGEO
R3	100k,1%,0603	RC0603FR-07100KL	YAGEO

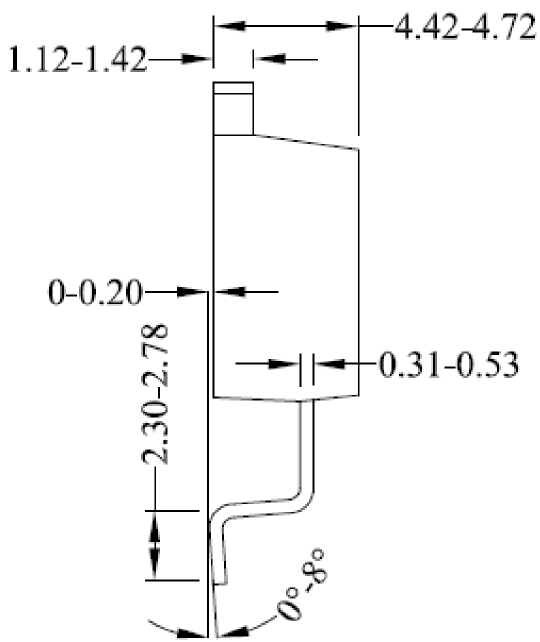
TO263-5 Package Outline Drawing



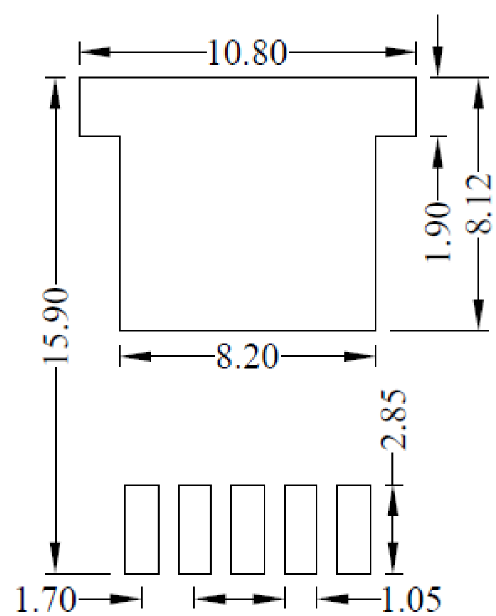
Top View



Bottom View



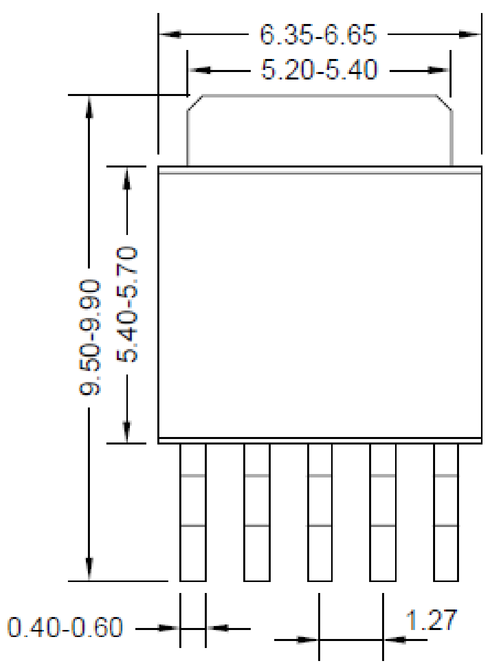
Side View



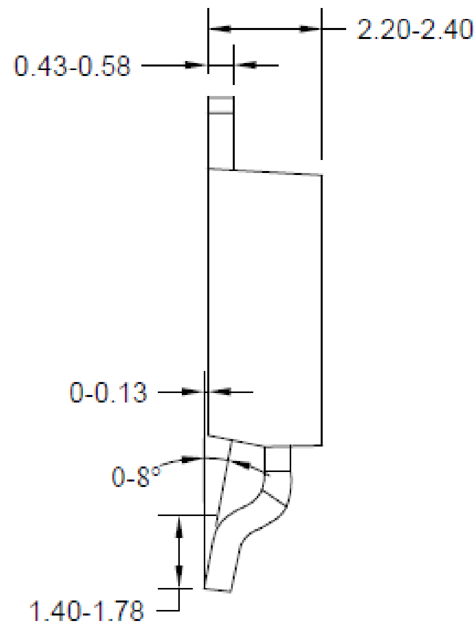
Recommended PCB Layout (Reference Only)

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

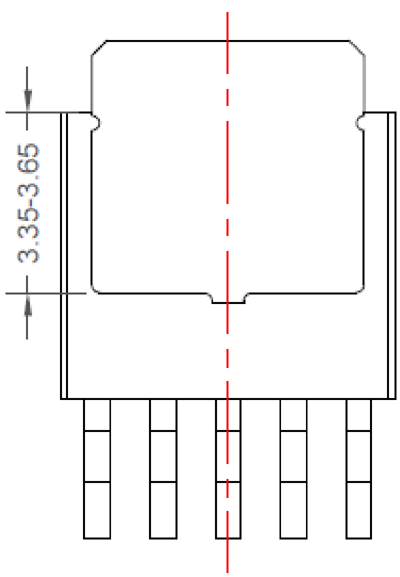
TO252-5 Package Outline & PCB Layout



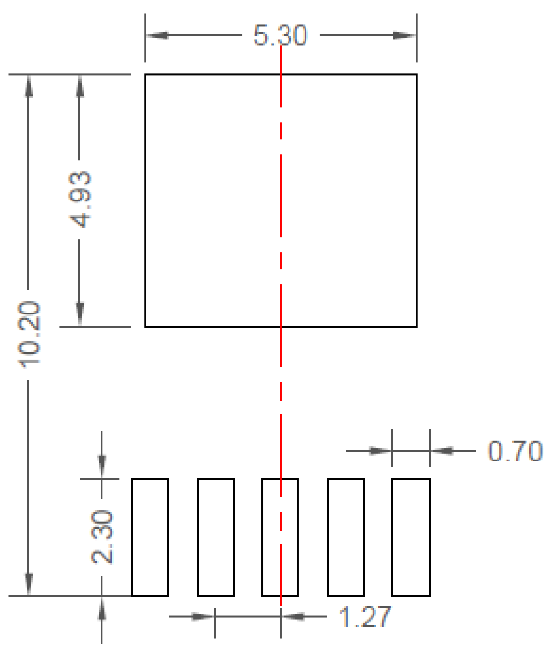
Top View



Side View



Bottom View

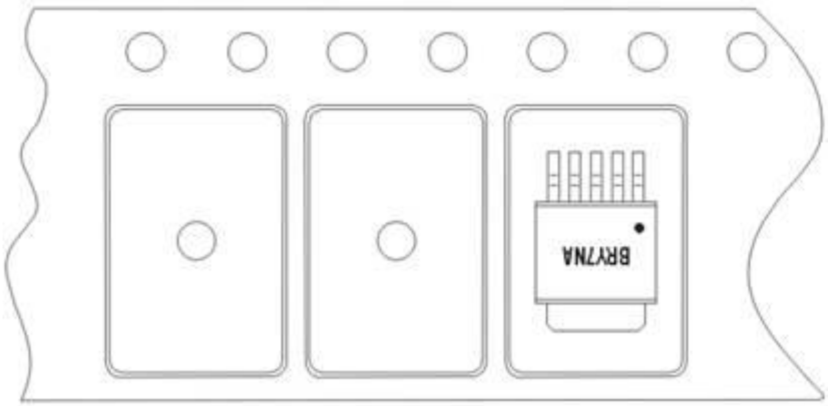


PCB Layout (Recommended)

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

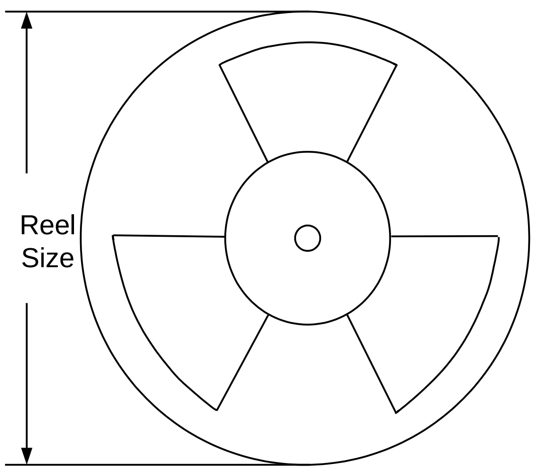
Taping & Reel Specification

1. TO252-5, TO263-5 Taping Orientation for Packages



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(pcs)
TO263-5	12	8	13"	400	400	800
TO252-5	12	8	13"	400	400	2500

3. Others: NA

Revision History

The revision history provided is for informational purposes only and is believed to be accurate; however, it is not warranted. Please reference the latest revision.

Date	Revision	Change
Sep. 27, 2023	Revision 1.0	Language improvements for clarity.
Jun. 17, 2021	Revision 0.9A	Update the package outline for TO252-5 (page 12).
Dec. 27, 2017	Revision 0.9	Initial Release

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