Application Note: SY6103

3A Fast-Response LDO Regulator

General Description

SY6103 is a 3A current capacity and low drop out voltage regulator, which features very fast transient recovery from input voltage surges and output load current changes. SY6103 with fully protection includes over current limit, output short protection, over temperature operation.

Ordering Information

SY6103 □(□ □)□
- Temperature Code
- Package Code
- Optional Spec Code

Ordering Number	Package type	Note
SY6103MAC	TO263-5	----
SY6103JBC	TO252-5	----

Features

- High Current Capability:3A Over Full Temperature Range
- Low Dropout Voltage of 480mV at Full Load 3A.
- Extremely 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

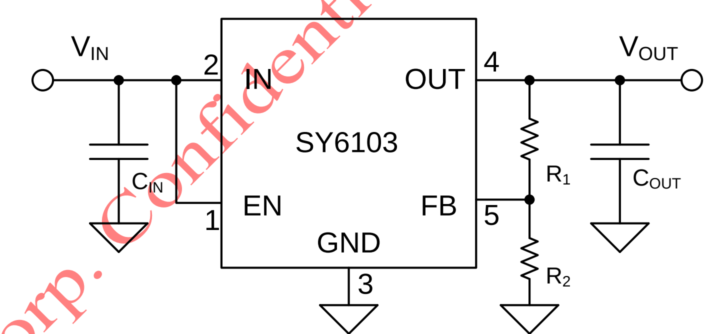
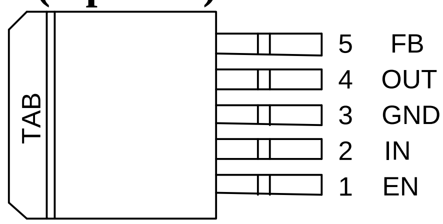
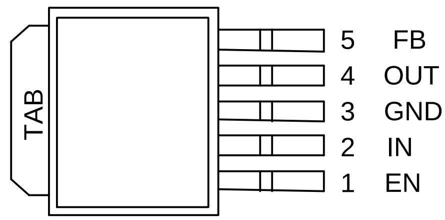


Figure1. Adjustable Output Regulator

Pinout (top view)



TO263-5 (D^2 Pak)



TO252-5 (D-Pak)

Part Number	Package type	Top Mark①
SY6103MAC	TO263-5	BIJxyz
SY6103JBC	TO252-5	BRYxyz

Note①： ***x=year code, y=week code, z= lot number code.***

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 IC'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

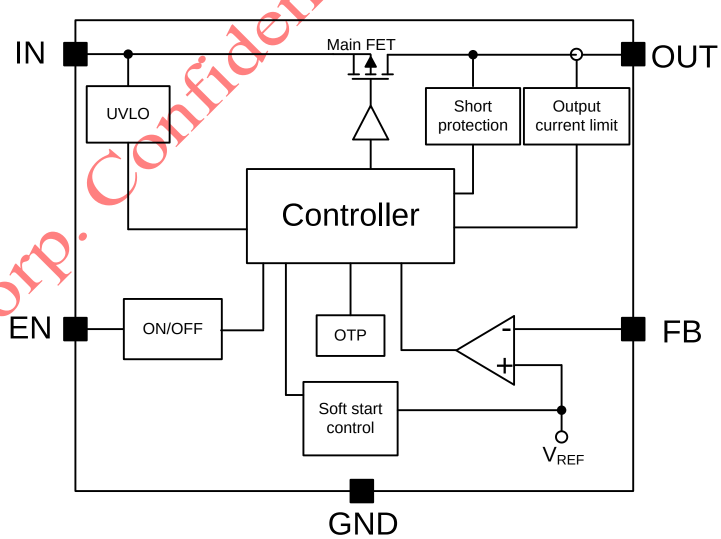


Figure2. Block Diagram

Absolute Maximum Ratings (Note 1)

IN, EN, OUT, FB-- 19V
Package Thermal Resistance (Note 2)
TO263/TO252, θ_{JA} -- 24.5°C/W/26°C/W
TO263/TO252, θ_{JC} -- 1.4°C/W/1.2°C/W
Junction Temperature Range --- 150°C
Lead Temperature (Soldering, 10 sec.) --- 260°C
Storage Temperature Range -- -65°C to 150°C

Recommended Operating Conditions (Note 3)

IN --- 3V to 18V
EN, OUT, FB-- 0V to 18V
Junction Temperature Range -- -40°C to 125°C
Ambient Temperature Range --- -40°C to 85°C

Electrical Characteristics

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

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) ≦ V_{IN} ≦ 16V		0.1	0.5	%
Load Regulation	ΔV_{LDR}	V_{IN} = V_{OUT} + 1V, 100mA ≦ I_{OUT} ≦ 3A		0.2	1	%

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 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. Exposure to absolute maximum rating conditions may affect device reliability.

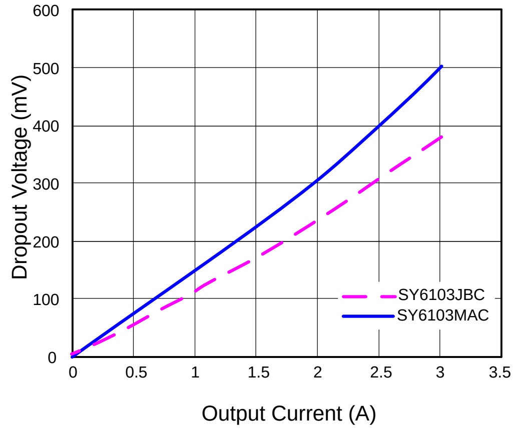
Note 2: θ_{JA} was measured according to JESD51-2 and chip mounted on Silergy PCB. Exposed paddle of TO263-5/TO252-5 is the case position for θ_{JC} measurement.

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

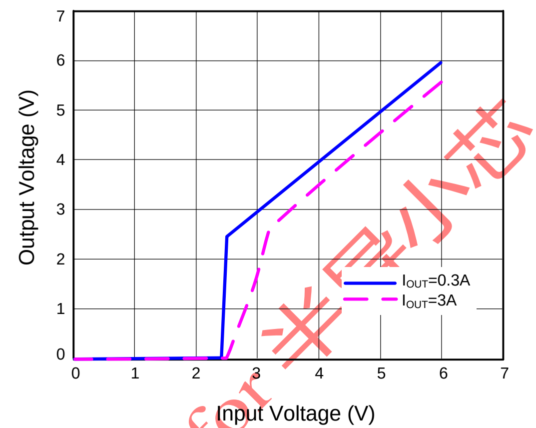
Note 4: Guaranteed by design.

Typical Performance Characteristics

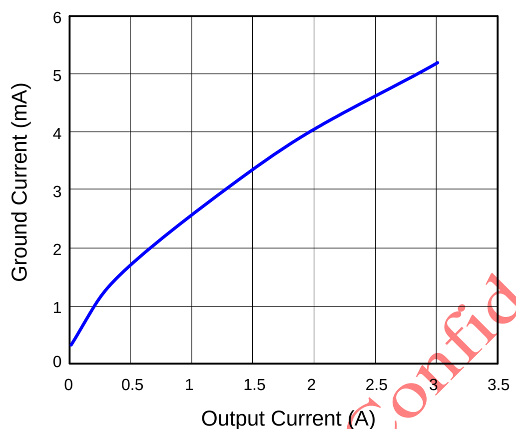
Dropout Voltage vs. Output Current
($V_{IN}=V_{EN}=5V$, $V_{FB}=1.1V$)



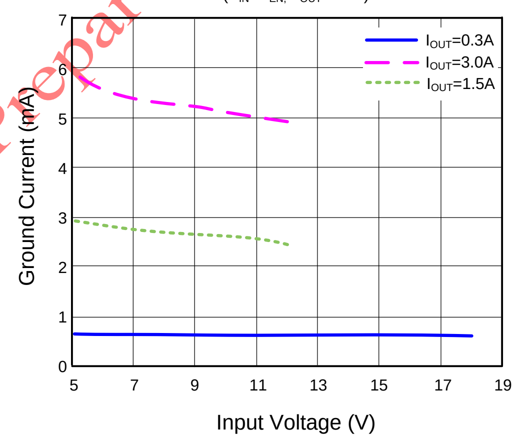
Output Voltage vs. Input Voltage
($V_{IN}=V_{EN}$, $V_{FB}=1.1V$)



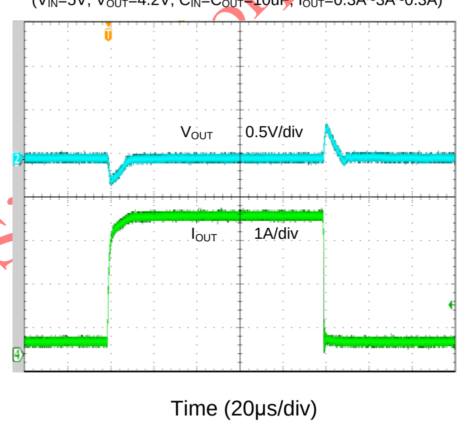
Ground Current vs. Output Current
($V_{IN}=V_{EN}=5V$, $V_{OUT}=4.2V$)



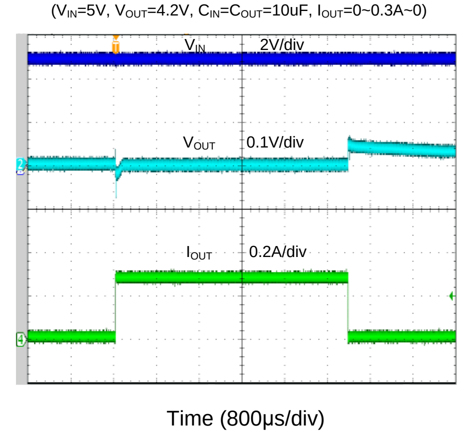
Ground Current vs. Input Voltage
($V_{IN}=V_{EN}$, $V_{OUT}=4.2V$)



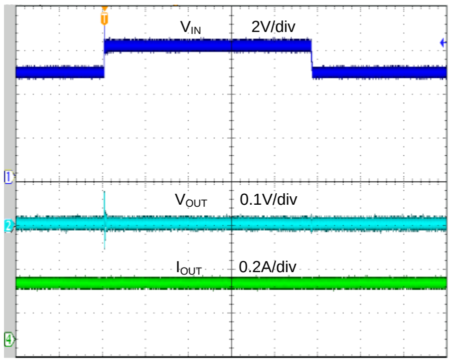
Load Transient
($V_{IN}=5V$, $V_{OUT}=4.2V$, $C_{IN}=C_{OUT}=10uF$, $I_{OUT}=0.3A\sim3A\sim0.3A$)



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

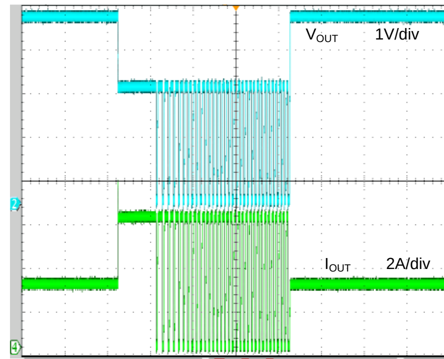


Line Transient
(V_{IN}=5V~6V~5V, C_{IN}=C_{OUT}=10uF, I_{OUT}=0.3A)



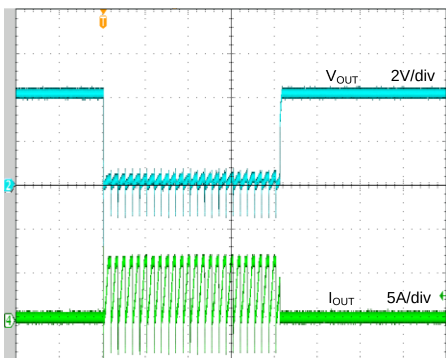
Time (800μs/div)

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



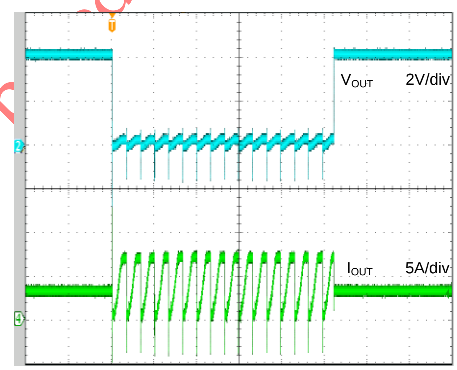
Time (100ms/div)

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



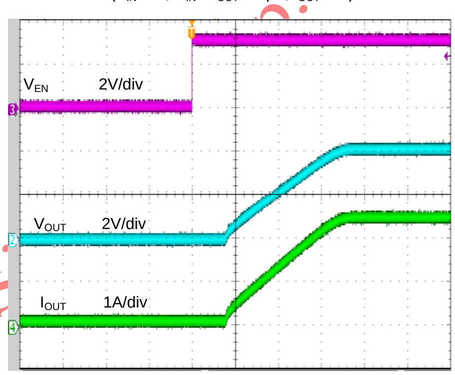
Time (20ms/div)

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



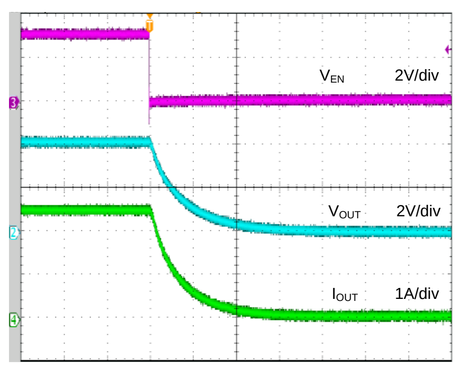
Time (10ms/div)

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



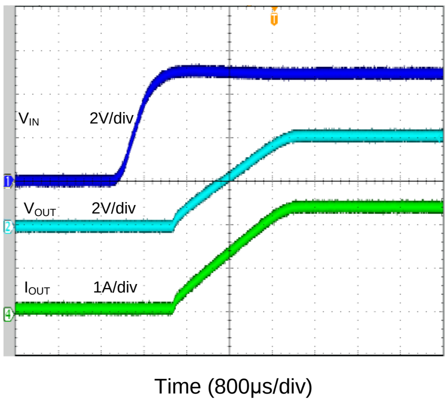
Time (800μs/div)

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

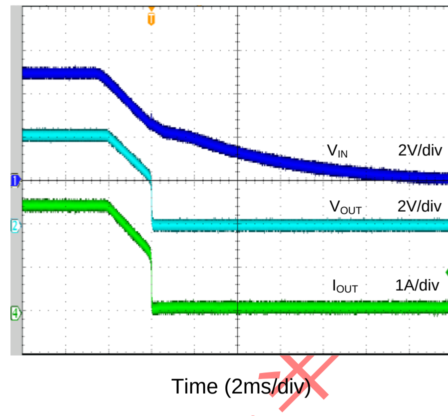


Time (20μs/div)

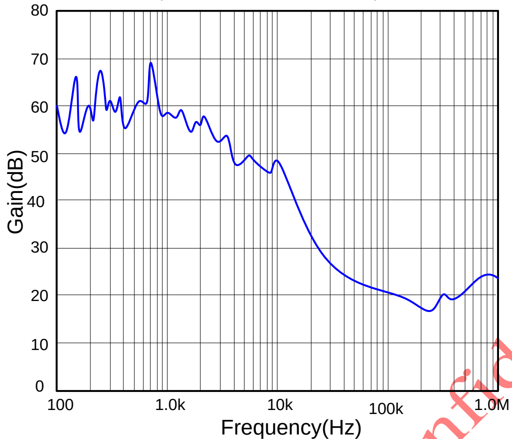
Startup from V_{IN}
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=3A)



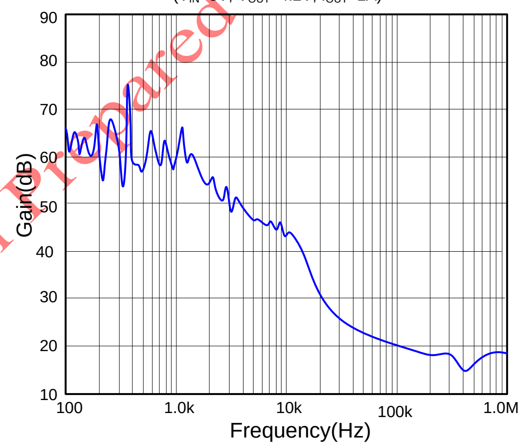
Shutdown from V_{IN}
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=3A)



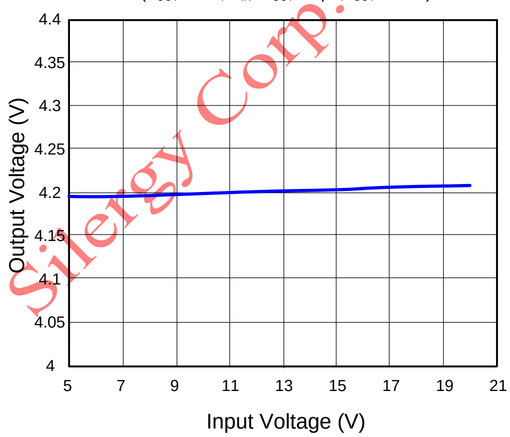
Power Supply Rejection Ratio
(V_{IN}=5V, V_{OUT}=4.2V, I_{OUT}=0.3A)



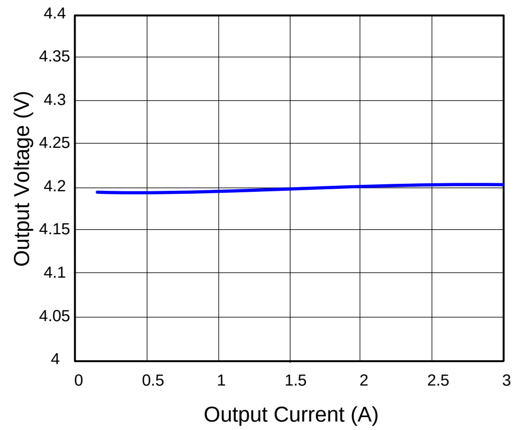
Power Supply Rejection Ratio
(V_{IN}=5V, V_{OUT}=4.2V, I_{OUT}=1A)



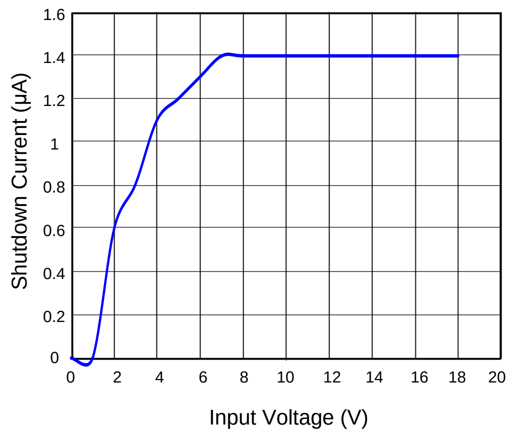
Line Regulation
(V_{OUT}=4.2V, C_{IN}=C_{OUT}=10μF, I_{OUT}=0.15A)



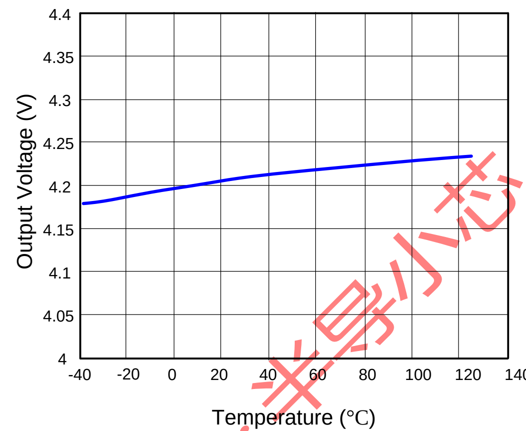
Load Regulation
(V_{IN}=5V, V_{OUT}=4.2V, C_{IN}=C_{OUT}=10μF)



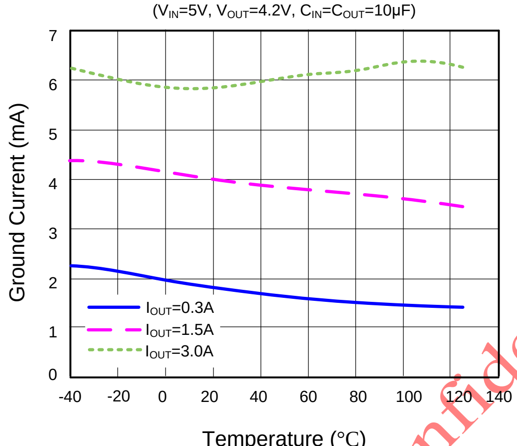
Shutdown Current vs. Input Voltage



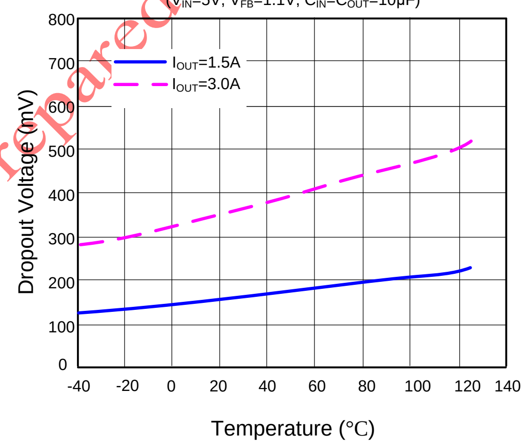
Output Voltage vs. Temperature
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=no load)



Ground Current vs. Temperature
(V_{IN}=5V, V_{OUT}=4.2V, C_{IN}=C_{OUT}=10μF)



Dropout Voltage vs. Temperature
(V_{IN}=5V, V_{FB}=1.1V, C_{IN}=C_{OUT}=10μF)



Operation Information

SY6103 is a 3A current capacity and low dropout voltage regulator, which features very fast transient recovery from input voltage surges and output load current changes. SY6103 with fully protection includes over current limit, output short protection, over input voltage protection and over temperature operation.

Input Capacitor C_{IN}

An input capacitance about 10μF is required between the device input pin and ground pin. A typical X5R or better grade ceramic capacitor with 25V rating is recommended in this application. This input capacitor must be located close to the device to assure input stability. A lower ESR capacitor allows the use of less capacitance, while higher ESR type requires more capacitance.

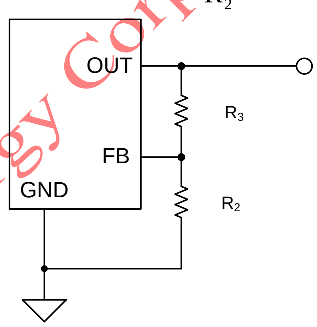
Output Capacitor C_{OUT}

For transient stability, SY6103 is designed specifically to work with very small ceramic output capacitors. 2.2uF output capacitance can be used in this application. Higher capacitance values help to improve transient. The output capacitor's ESR is critical because it forms a zero to provide phase lead which is required for loop stability.

Output Voltage Setting

Choose R2 and R3 to program the proper output voltage. To minimize the power consumption under light loads, it is desirable to choose large resistance values for both R2 and R3. A value of between 1kΩ and 1MΩ is highly recommended for both resistors. The complete equation for the output voltage is described as follows;

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



No Load Stability

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

Dropout Voltage

SY6103 has a very low dropout voltage due to its extra low $R_{DS(ON)}$ of the main PMOS determines the lowest usable supply .

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

Over Current and Short Circuit Protection

The minimum current limit of SY6103 is 4A. The device includes over current and short circuit protection. The current limitation circuit regulates the output current to its limitation threshold to protect IC from damage. Under over current or short circuit condition, the power loss of the IC is relative high. And that may trigger the thermal protection.

Load Transient Considerations

The SY6103 regulator IC integrates the compensation components to achieve good 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 SY6103 can deliver a current of up to 3A over the full operating junction temperature range. However, the maximum output current must be derated at higher ambient temperature to ensure the junction temperature does not exceed 125°C. With all possible conditions, the junction temperature must be within the range specified under operating conditions. Power dissipation can be calculated based on the output current and the voltage drop across regulator.

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

The final operating junction temperature for any set of conditions can be estimated by the following thermal equation:

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

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

Layout Design

Good board layout practices must be used or instability can be induced because of ground loops and voltage drops, and large PCB copper area can improve the 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. The feedback loop formed by R_1, R_2 and the trace connecting to the FB pin and OUT must be minimize. The best way to do this is to layout 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:

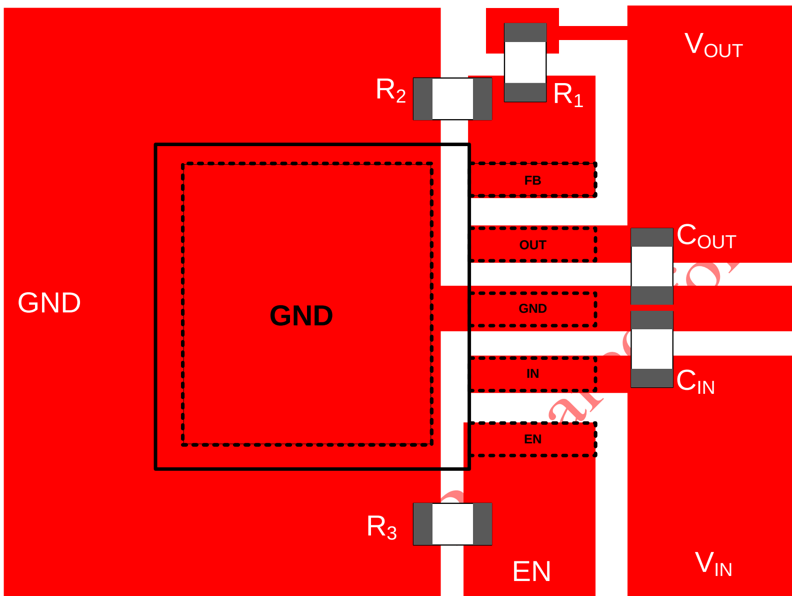
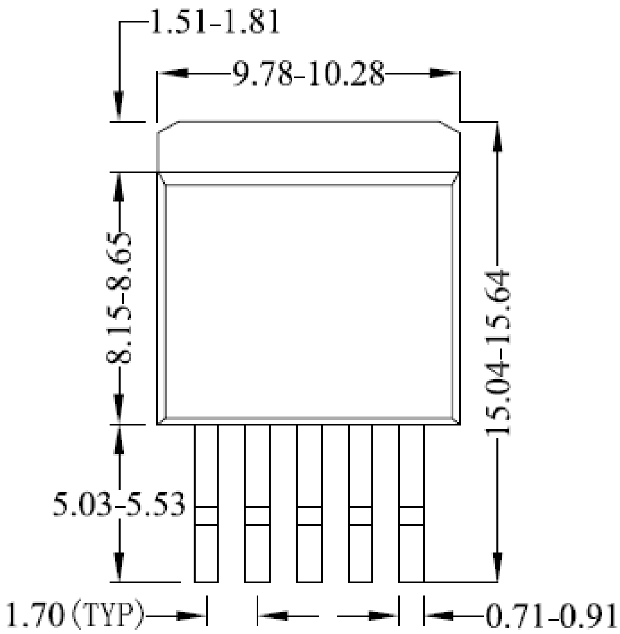
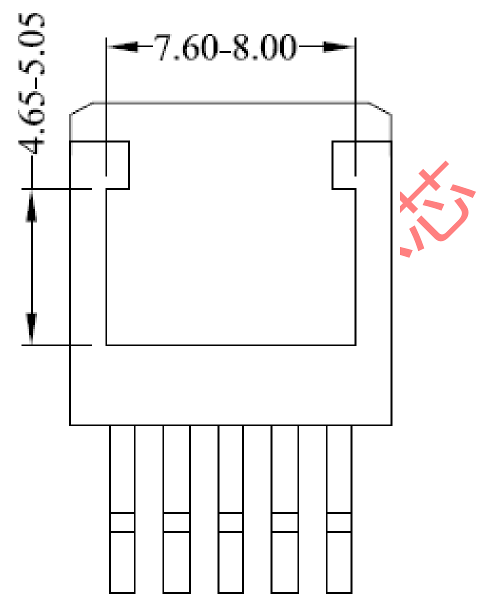


Figure3. PCB Layout Suggestion

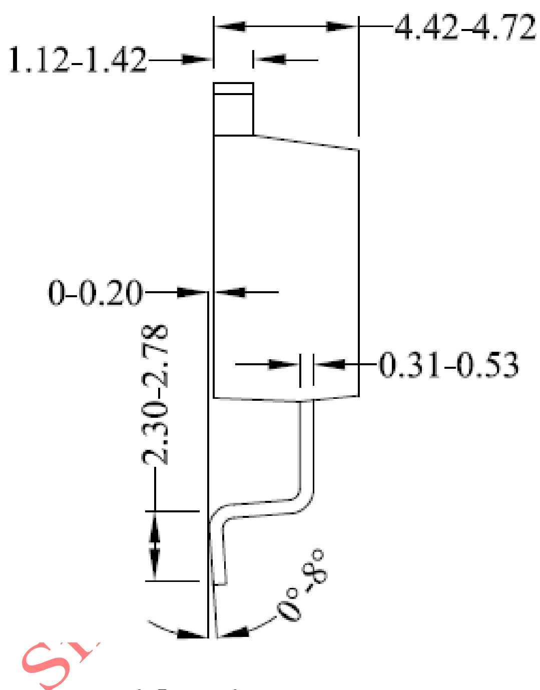
TO263-5 Package Outline Drawing



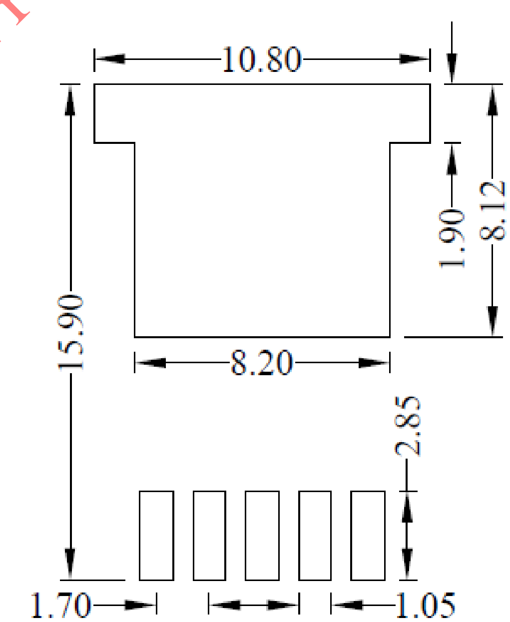
Top View



Bottom View



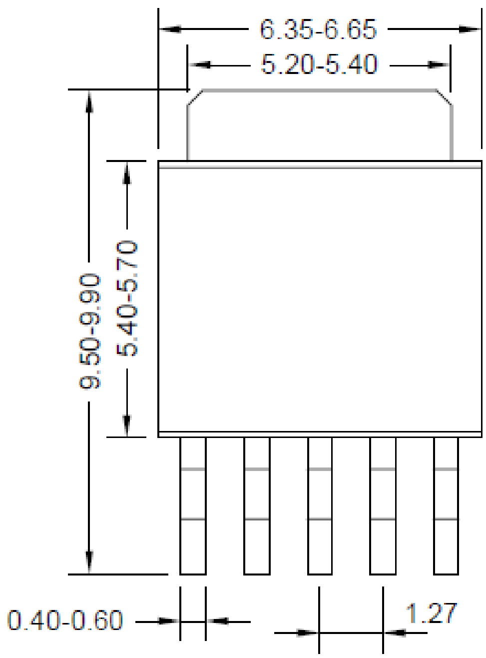
Side View



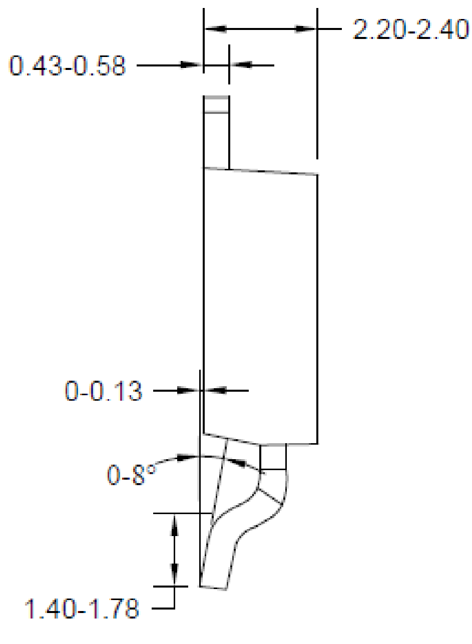
Recommended PCB Layout (Reference only)

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

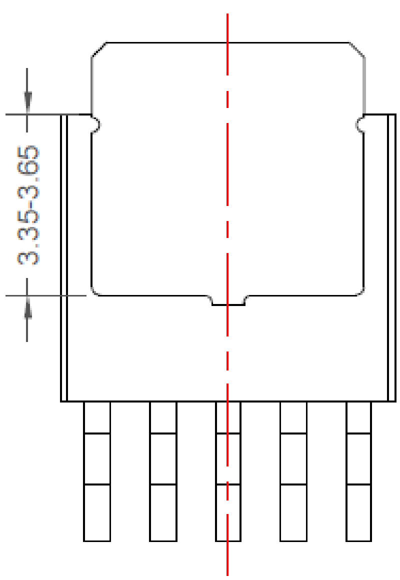
TO252-5 Package Outline & PCB Layout



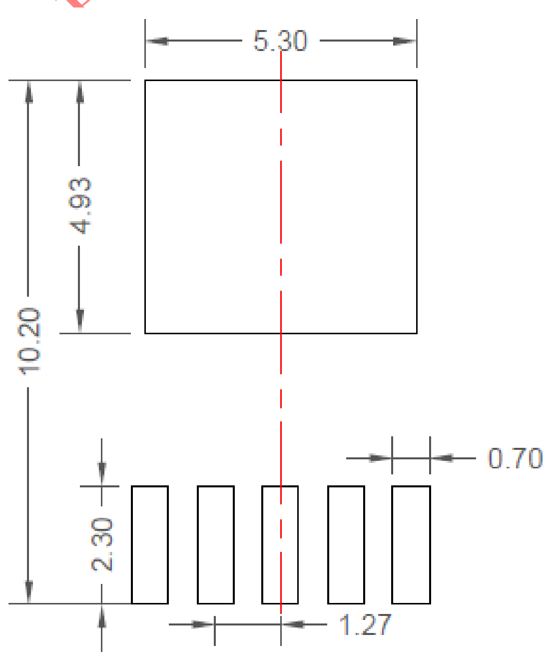
Top View



Side View



Bottom View



PCB layout (Recommended)

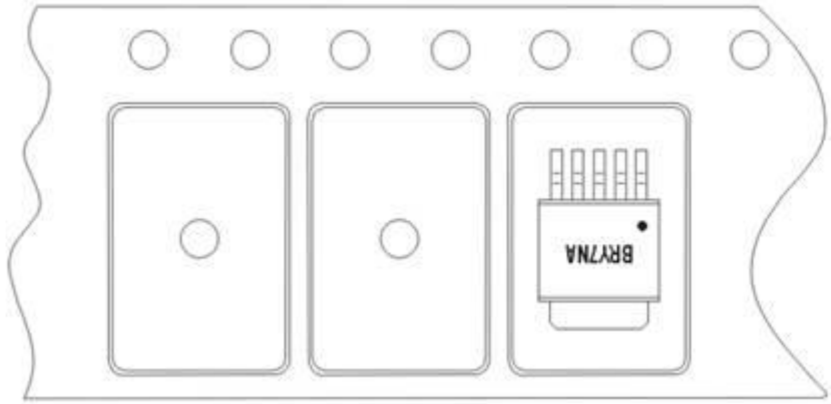
Notes: 1, All dimension in MM and exclude mold flash & metal burr

2, Recommended PCB layout only for reference.

Taping & Reel Specification

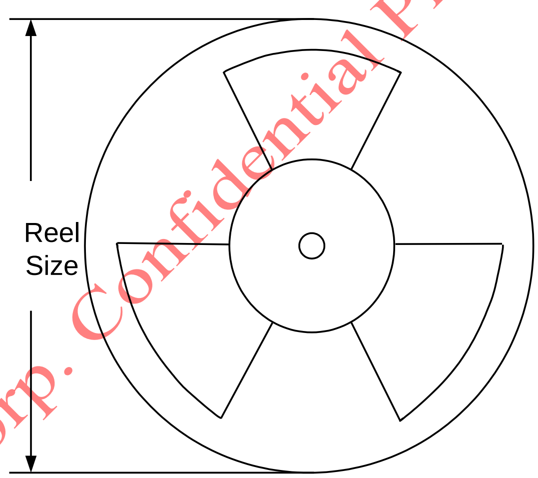
1. Taping Orientation for Packages

TO252-5, TO263-5



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(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 purpose only and is believed to be accurate, however, not warranted. Please make sure that you have the latest revision.

Date	Revision	Change
Jun.17, 2021	Revision 0.9A	Update the package outline for TO252-5 (page12).
Dec.27, 2017	Revision 0.9	Initial Release

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