SY20703

3A, 55V Fast-Response LDO Regulator

General Description

The SY20703 is a high-voltage, low-dropout LDO regulator with a 3A current capability. It features fast recovery from input voltage surges and output load current changes.

The SY20703 offers protection features, including over-current limit, output short protection, over-input voltage protection, and over-temperature protection. The SY20703 has an adjustable output, which can be set to a voltage between 1.24V and 29.6V using an external resistor divider.

The SY20703 is available in a compact TO263-5 package.

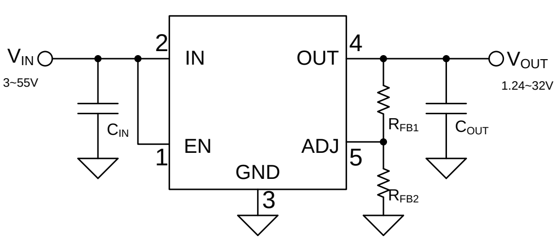
Features

- 3V to 55V Input Voltage Range
- Adjustable Output Voltage
- Low Dropout Voltage: 450mV at Full Load 3A (Typ.)
- High Current Capability: 3A Over Full Temperature Range
- Fast Transient Response
- Low Current Shutdown Mode (1 µA Typ.)
- Low Ground Current
- Current Limiting Protection
- Over Temperature Protection
- Input Voltage Protection
- Package: TO263-5
- RoHS Compliant and Halogen Free

Applications

- Industrial Applications
- Medical Imaging
- Smart Metering

Typical Application



$$V_{OUT} = 1.24 \times (\frac{R_{FB1} + R_{FB2}}{R_{FB2}})$$

Figure 1. Adjustable Output Regulator

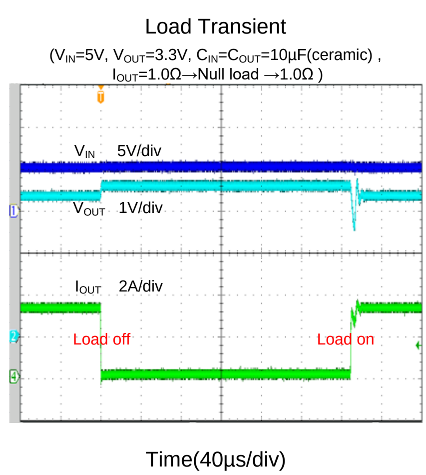


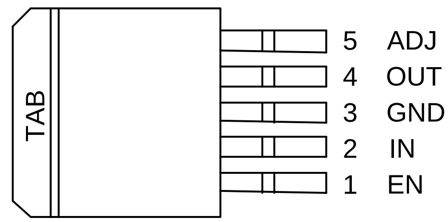
Figure 2. Load Transient

Ordering Information

Ordering Part Number	Package Type	Top Mark
SY20703MAC	TO263-5 RoHS Compliant and Halogen Free	**BIlxyz**

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

Pinout (top view)



Pin Description

Pin Name	Pin Number	Pin Description
EN	1	Enable (Input): Active-high CMOS compatible control input. Do not leave floating.
IN	2	INPUT: Unregulated input, +3V to +55V maximum. A 10μF capacitor connected from this pin to GND is recommended.
GND	3, TAB	GND: Ground pin.
OUT	4	OUTPUT: Regulator output voltage. A 10μF capacitor connected from this pin to GND is recommended.
ADJ	5	Feedback voltage: 1.24V. Use an external resistor divider to configure the output voltage.

Block Diagram

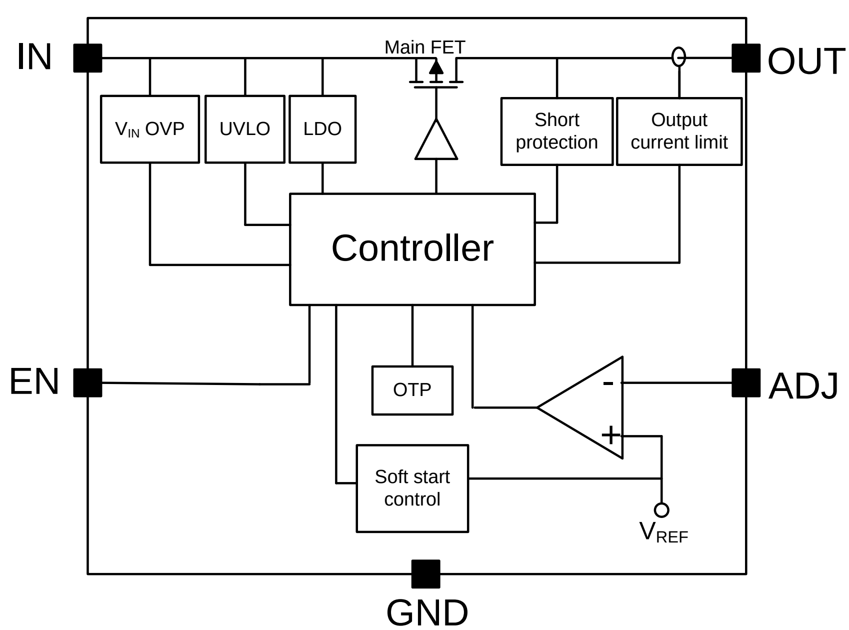


Figure 3. Block Diagram

Absolute Maximum Ratings

Parameter (Note 1)	Min	Max	Unit
IN, EN, OUT, ADJ	-0.3	55	V
Lead Temperature (Soldering, 10s)		260	°C
Junction Temperature, Operating	-40	150	
Storage Temperature	-65	150	

Thermal Information

Parameter (Note 2)	Typ	Unit
θ_{JA} Junction-to-Ambient Thermal Resistance	26.5	°C/W
θ_{JC} Junction-to-Case Thermal Resistance	24.1	
P_D Power Dissipation TA = 25°C	3.8	W

Recommended Operating Conditions

Parameter (Note 3)	Min	Max	Unit
IN	3	55	V
EN, OUT, ADJ	0	55	
Junction Temperature, Operating	-40	125	°C
Ambient Temperature	-40	85	

Electrical Characteristics

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

Parameter	Symbol	Test Conditions	Min	Typical	Max	Unit
Input Voltage	V_{IN}		3		55	V
Input Voltage UVLO Threshold	V_{UVLO}	V_{IN} rising		2.6	2.8	V
Input OVP Threshold			30	34	38	V
UVLO Hysteresis	V_{UVLO_th}			200		mV
Soft-start Time	t_{SS}		1	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}		3.7	4.5	5.4	A
Thermal Shutdown Temperature	T_{SD}			150		°C
Thermal Shutdown Hysteresis	T_{HYS}			20		°C
Output Short Protection Threshold	$V_{ADJ,SHORT}$	V_{FB} falling	40	50	60	$\%V_{REF}$
Output Short off Time	t_{short_off}			15		ms
IN Pin to OUT pin Leakage Current	$I_{Leakage}$	EN=0,V_{IN-OUT}=55V			1.2	µA
Line Regulation	ΔV_{LNR}	I_{OUT} = 10mA, (V_{OUT} + 1V) ≦ V_{IN} ≦ 55V, T_A=25°C		0.1	0.5	%

Parameter	Symbol	Test Conditions	Min	Typical	Max	Unit
Load Regulation	ΔV_{LDR}	$V_{IN} = V_{OUT} + 1V$, 10mA ≦ I_{OUT} ≦ 3A, T_A=25°C		0.2	1	%
Dropout Voltage	ΔV_{DROP}	I_{OUT} = 100mA		15	29	mV
		I_{OUT} = 750mA		115	213	mV
		I_{OUT} = 1.5A		225	432	mV
		I_{OUT} = 3A		450	863	mV
Power Supply Rejection	PSRR	Frequency=100Hz, C_{OUT}=10µF，T_A=25°C		70		dB
		Frequency=100kHz, C_{OUT}=10µF，T_A=25°C		40		
Ground Current						
Ground Current	I_{GND}	IC shut down		1	5	µA
		I_{OUT} = 0, V_{IN}=V_{OUT}+1V		80	120	µA
		I_{OUT} = 1.5A, V_{IN}=V_{OUT}+1V		0.73	5	mA
		I_{OUT} = 3A V_{IN}=V_{OUT}+1V		5	8	mA
Reference Voltage						
Reference Voltage	V_{REF}		1.215	1.24	1.265	V
ADJ Pin Bias Current	I_{ADJ_Bias}	EN=0, ADJ pin floating			50	nA

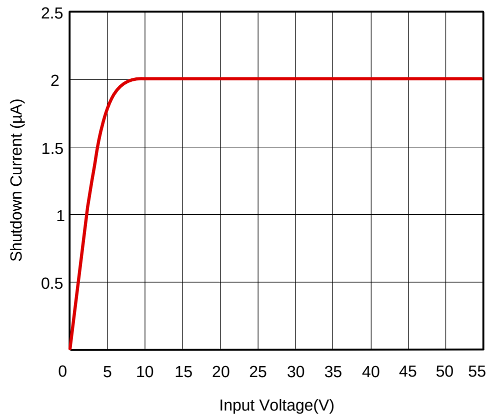
Note 1: Stresses beyond "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective single-layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

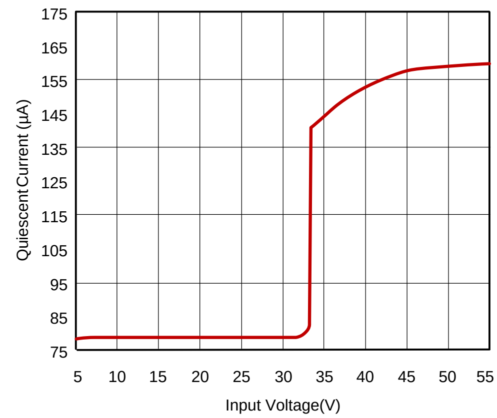
Note 3: The device is not guaranteed to function outside its operating conditions.

Typical Performance Characteristics

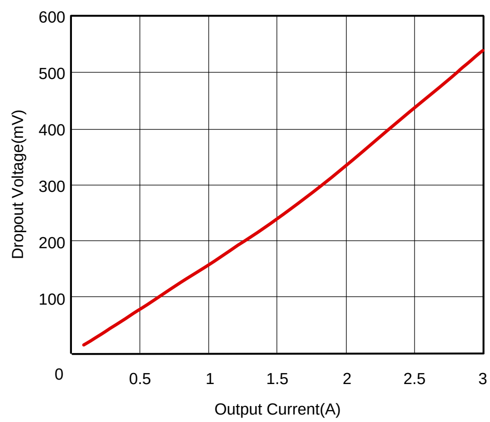
Shutdown Current vs. Input Voltage
(EN OFF, Output to Ground)



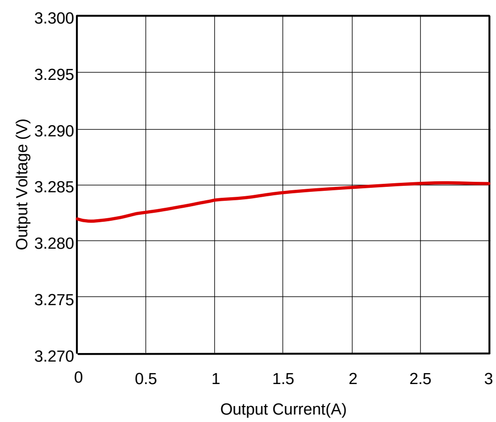
Quiescent Current vs. Input Voltage
(V_{ADJ}=1.5V, V_{EN}=3V, Null Load)



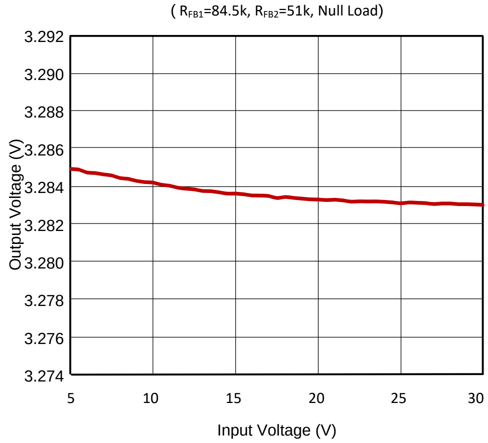
Dropout Voltage vs. Output Current
(V_{IN}=5V, V_{ADJ}=1V)



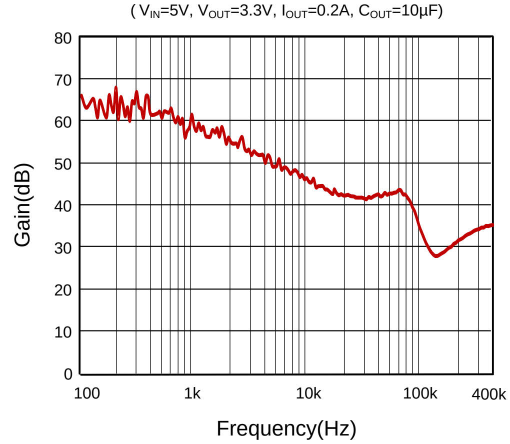
Load Regulation
(V_{IN}=5V, R_{FB1}=84.5k, R_{FB2}=51k)



Line Regulation
(R_{FB1}=84.5k, R_{FB2}=51k, Null Load)

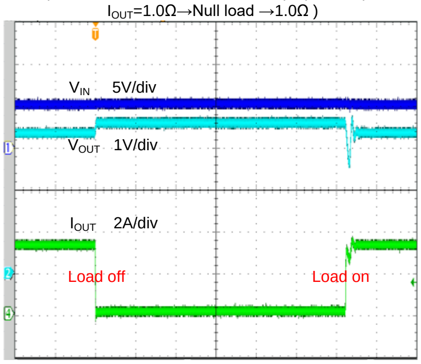


PSRR
(V_{IN}=5V, V_{OUT}=3.3V, I_{OUT}=0.2A, C_{OUT}=10μF)



Load Transient

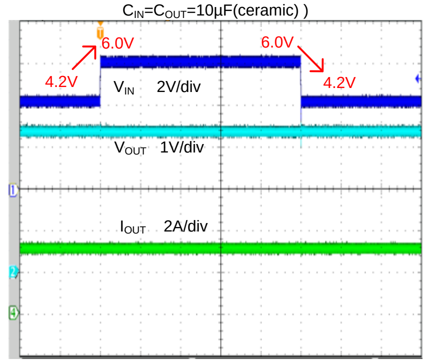
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=C_{OUT}=10μF(ceramic) , I_{OUT}=1.0Ω→Null load →1.0Ω)



Time(40μs/div)

Line Transient

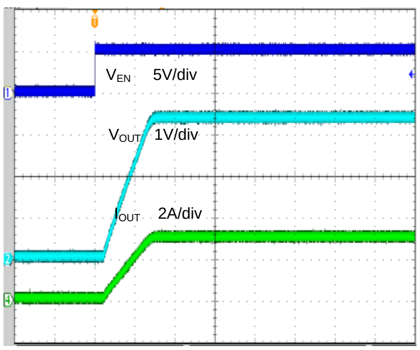
(V_{IN}=4.2V→6V→4.2V, V_{OUT}=3.3V, I_O=1.1Ω load, C_{IN}=C_{OUT}=10μF(ceramic))



Time(2ms/div)

Startup From Enable

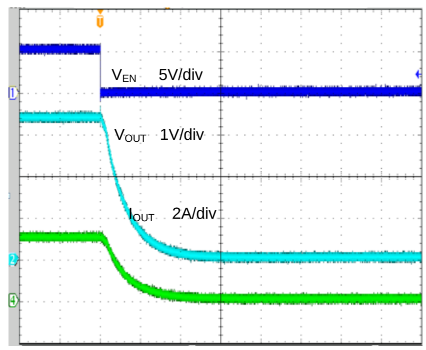
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=C_{OUT}=10μF, I_{OUT}=1.1Ω)



Time(2ms/div)

Shutdown From Enable

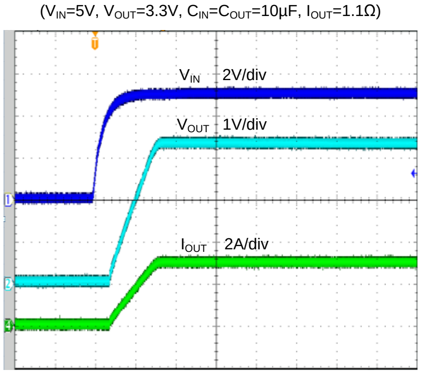
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=C_{OUT}=10μF, I_{OUT}=1.1Ω)



Time(20μs/div)

Vin Start up

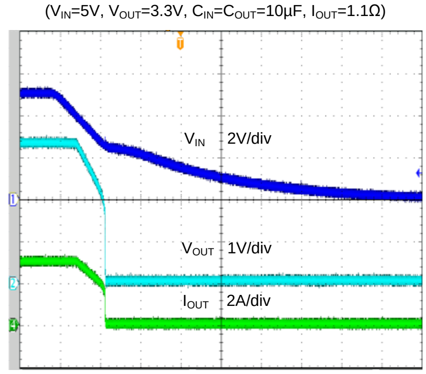
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=C_{OUT}=10μF, I_{OUT}=1.1Ω)



Time(2ms/div)

Vin Shut Down

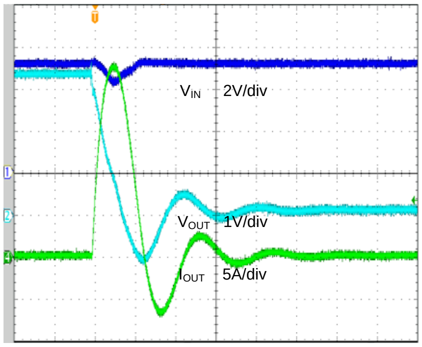
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=C_{OUT}=10μF, I_{OUT}=1.1Ω)



Time(2ms/div)

Short Circuit Response

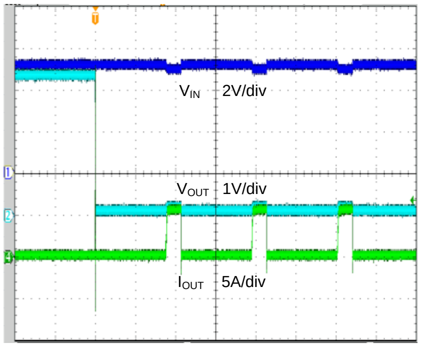
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=C_{OUT}=10μF)



Time(4μs/div)

Output Short Off Time Test

(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=C_{OUT}=10μF)



Time(10ms/div)

Application Information

The SY20703 is a high input voltage, 3A linear regulator with a low dropout voltage. The device is designed to provide very good line and load regulation, making it suitable for use in different industrial applications.

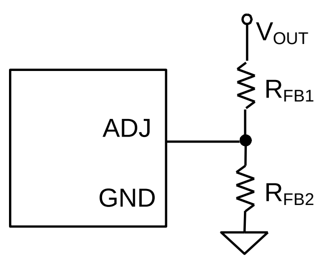
The SY20703 offers protection features, including over-current limit, output short protection, over-input voltage protection, and over-temperature protection.

The following paragraphs offer information on the selection of the external components.

Feedback Resistor Divider $R_{FB1}$and R_{FB2}:

Choose R_{FB1} and R_{FB2} to program the output voltage. To minimize the power consumption under light loads, choosing large resistance values for both R_{FB1} and R_{FB2} is recommended. A value of between 10kΩ and 1MΩ is recommended for both resistors. If the target V_{OUT} is 3.3V, and R_{FB1} =84.5k is selected, then using the following equation, R_{FB2} can be calculated to be 50.8k:

$$R_{FB2} = \frac{1.24V}{V_{OUT} - 1.24V} R_{FB1}$$



Input Capacitor C_{IN}:

An input capacitor with a voltage range 20% higher than the maximum input voltage and capacitance higher than 10µF is required between the device input and ground pins. A typical X5R or better grade ceramic capacitor is recommended for most applications. Place the input and output capacitors as close as practical to the device to minimize the input noise.

Output Capacitor C_{OUT}:

The SY20703 is designed to operate using small ceramic output capacitors for transient stability. A capacitor with a capacitance of 10µF or higher is desired for most applications. Higher capacitance values help to improve transient response. A low output capacitor's ESR is critical because it forms a zero to provide phase lead which is required for loop stability.

Dropout Voltage:

The dropout voltage is determined by the $R_{DS(ON)}$ of the power MOSFET. The SY20703 features a low dropout voltage due to its low MOSFET $R_{DS(ON)}$, which determines the lowest usable supply voltage required for a target output 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 protections. The current limit circuit regulates the output current to its target threshold, I_{limit} to protect the IC from damage. During over-current or short-circuit conditions, the device power dissipation ca be relatively high, which may trigger thermal protection.

When short-circuit protection is triggered, the device will restart after about 15ms.

Thermal Considerations:

The SY20703 can source 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. The junction temperature must be within the operating range specified under all operating conditions. The LDO power dissipation can be calculated based on the output current and the voltage drop across the regulator.

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

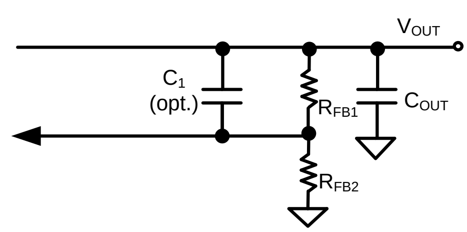
The operating junction temperature can be estimated by using the following thermal formula:

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

Where $T_{J(MAX)}$ is the maximum junction temperature of die (125°C) and T_A is the maximum ambient temperature. The junction to ambient thermal resistance (θ_{JA}) footprint is 26.5°C /W for the TO263-5 package.

Load Transient Considerations:

The SY20703 integrates the compensation components to achieve good stability and fast transient response. In some applications, adding a small ceramic capacitor in parallel with R_{FB1} may further speed up the load transient response and is thus recommended for applications with large load transient step requirements.



PCB Layout Design

Good board layout practices must be used for stable operation, and a large PCB copper area connected to the exposed package pad can improve the thermal performance. The input and output capacitors must be directly connected to the input, output, and ground pins using traces with 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 is the recommended PCB layout:

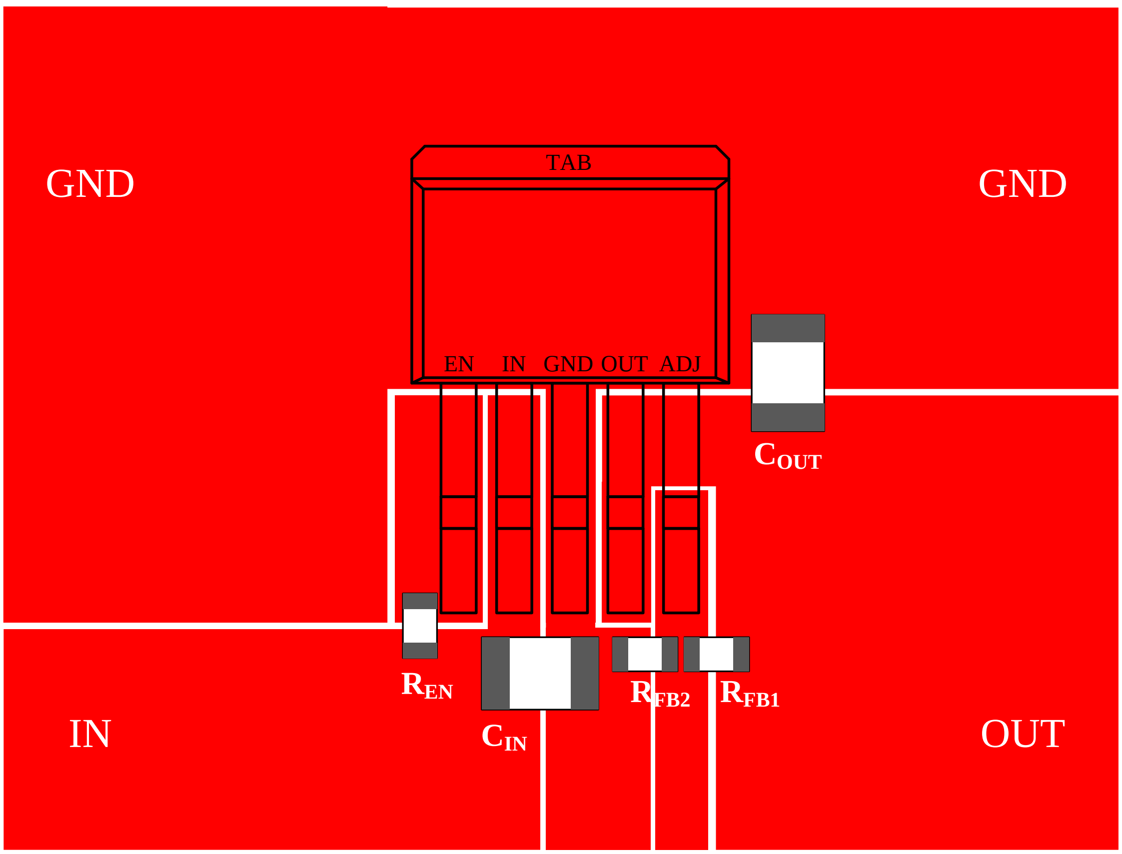
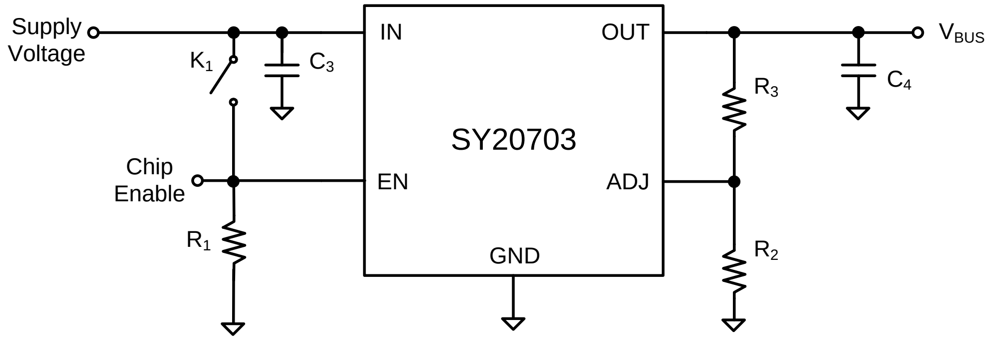


Figure 4. SY20703MAC PCB Layout Example

Application Schematic

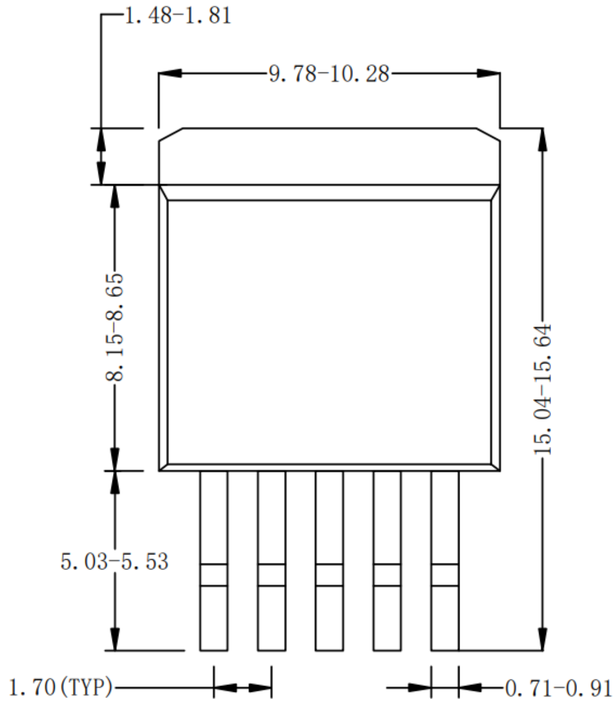


BOM List

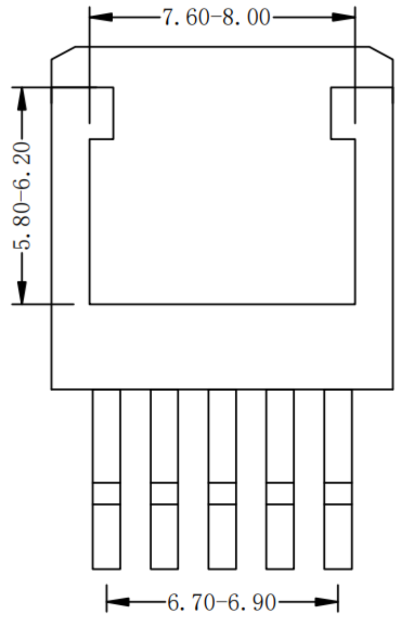
V_{OUT}=3.3V			
Reference Designator	**Description**	**Part Number**	**Manufacturer**
C_3	10µF/50V,1206	C3216X5R1H106K	TDK
C_4	10µF/16V,1206	C3216X5R1C106K	TDK
R_1	1MΩ, 0603	RC0603FR-071ML	YAGEO
R_2	51KΩ, 0603	RC0603FR-0751KL	YAGEO
R_3	84.5KΩ, 0603	RC0603FR-0784K5L	YAGEO

V_{OUT}=5V			
Reference Designator	**Description**	**Part Number**	**Manufacturer**
C_3	10µF/50V,1206	C3216X5R1H106K	TDK
C_4	10µF/16V,1206	C3216X5R1C106K	TDK
R_1	1MΩ, 0603	RC0603FR-071ML	YAGEO
R_2	30KΩ, 0603	RC0603FR-0730KL	YAGEO
R_3	91KΩ, 0603	RC0603FR-0791KL	YAGEO

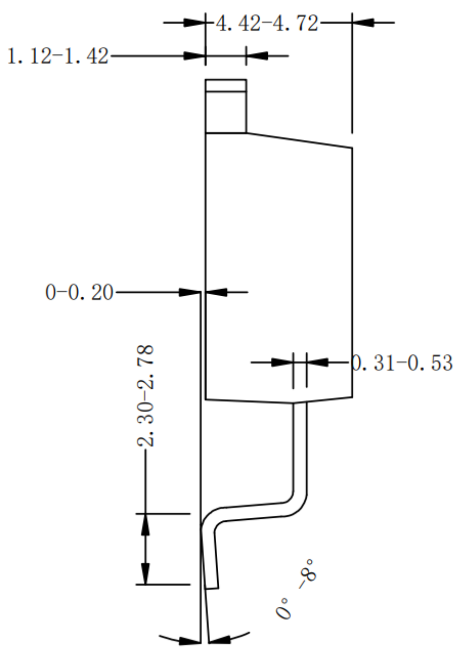
TO263-5 Package Outline Drawing



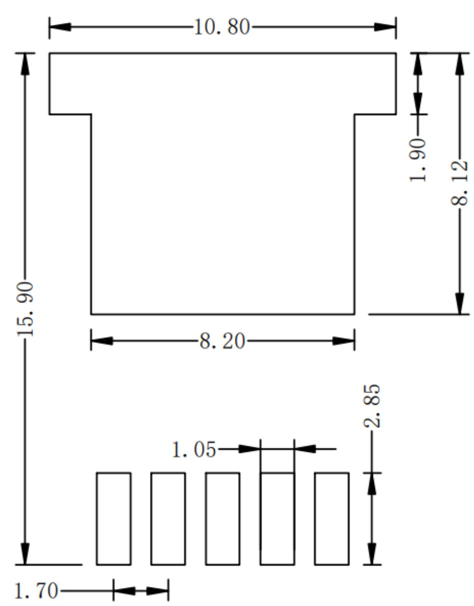
Top View



Bottom View



Side View

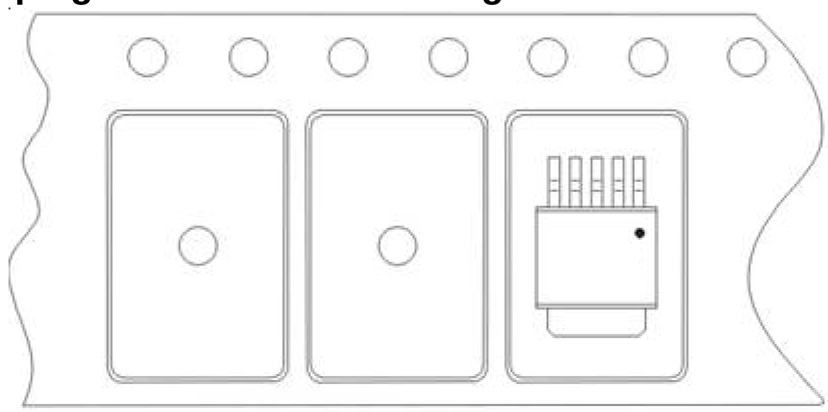


Recommended PCB Layout (Reference only)

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

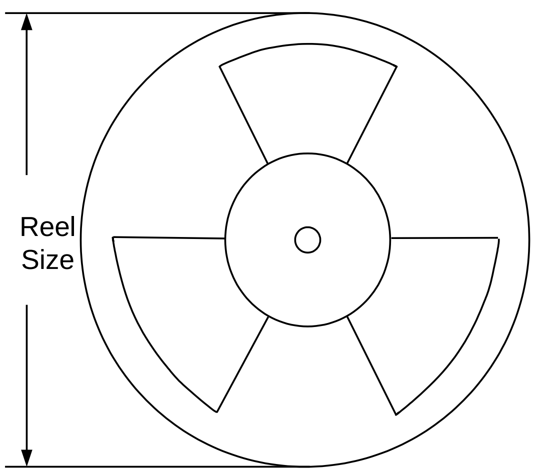
Taping & Reel Specification

1. 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

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
Dec.04, 2024	Revision 1.0A	Update the package outline drawing (page 11)
Sep. 27, 2023	Revision 1.0	Language improvements for clarity.
Aug.19, 2020	Revision 0.9A	Add taping and reel specification (page 12).
Jan. 08, 2020	Revision 0.9	Initial Release

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