# 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

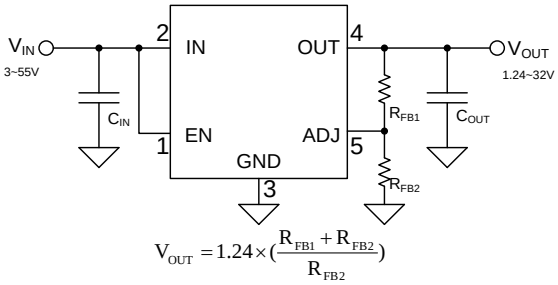



*Figure 1. Adjustable Output Regulator*

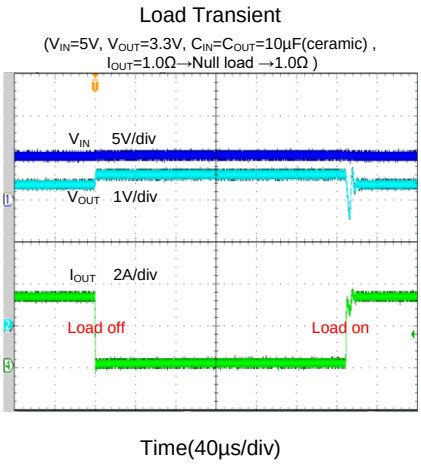


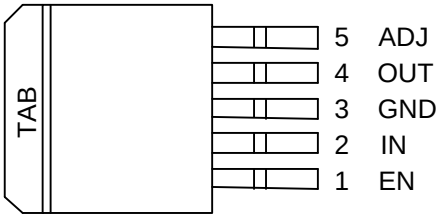

*Figure 2. Load Transient*

## Ordering Information

| Ordering Part Number | Package Type | Top Mark |
|---|---|---|
| SY20703MAC | TO263-5<br>RoHS Compliant and Halogen Free | **BIIxyz** |

***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

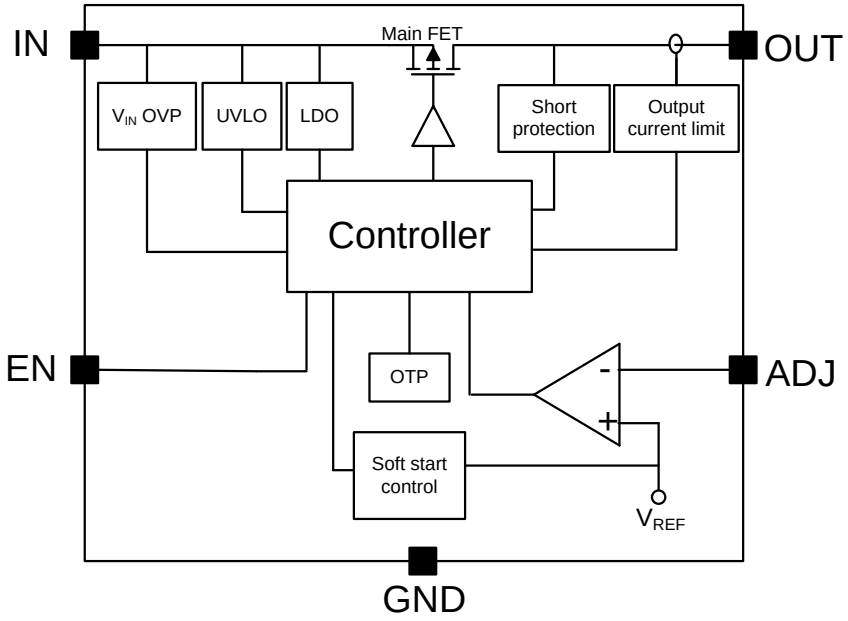



*Figure 3. Block Diagram*

## 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 |
|---|---|---|
| $\theta_{JA}$ Junction-to-Ambient Thermal Resistance | 26.5 | °C/W |
| $\theta_{JC}$ 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 | $\Delta V_{LNR}$ | $I_{OUT}$ = 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 | $\Delta V_{LDR}$ | $V_{IN}$ = $V_{OUT}$ + 1V,<br>10mA ≦ $I_{OUT}$ ≦ 3A,<br>$T_A$=25°C | | 0.2 | 1 | % |
| Dropout Voltage | $\Delta V_{DROP}$ | $I_{OUT}$ = 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,<br>$C_{OUT}$=10μF，$T_A$=25°C | | 70 | | dB |
| | | Frequency=100kHz,<br>$C_{OUT}$=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<br>$V_{IN}$=$V_{OUT}$+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 |

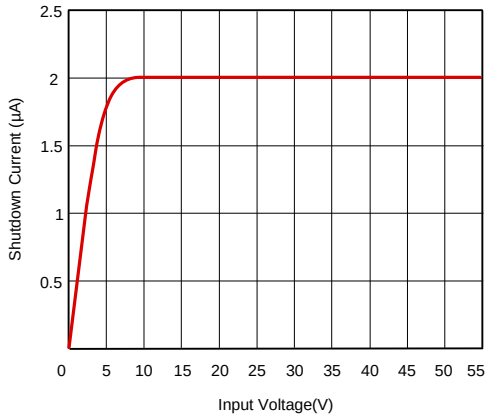
**Note 1**: Stresses beyond "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute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

**Note 2**: $\theta_{JA}$ 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.

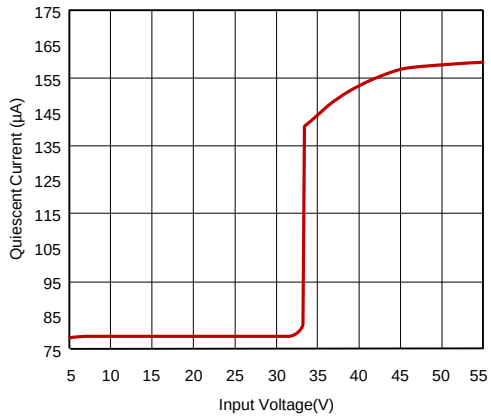
**Note 3:** The device is not guaranteed to function outside its operating conditions.

# Typical Performance Characteristics

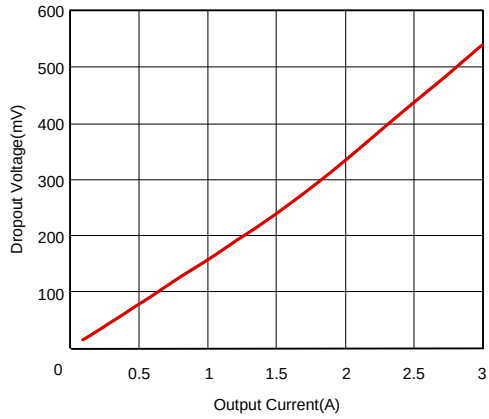
Shutdown Current vs. Input Voltage
(EN OFF, Output to Ground)



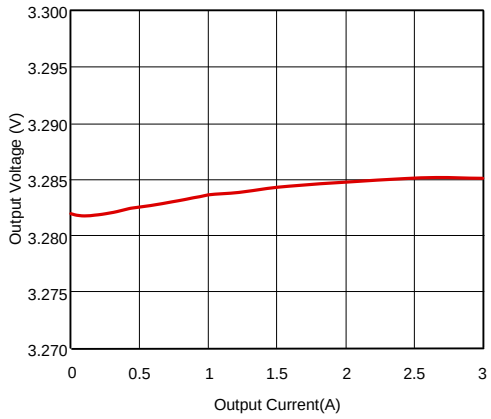

Quiescent Current vs. Input Voltage
($V_{ADJ}$=1.5V, $V_{EN}$=3V, Null Load)



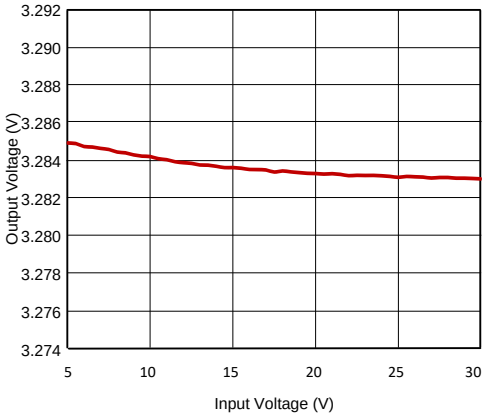

Dropout Voltage vs. Output Current
($V_{IN}$=5V, $V_{ADJ}$=1V)



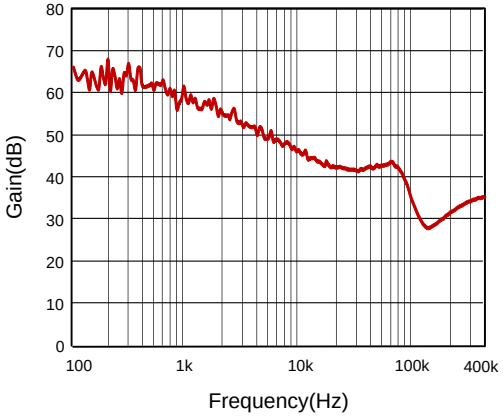

Load Regulation
($V_{IN}$=5V, $R_{FB1}$=84.5k, $R_{FB2}$=51k)




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

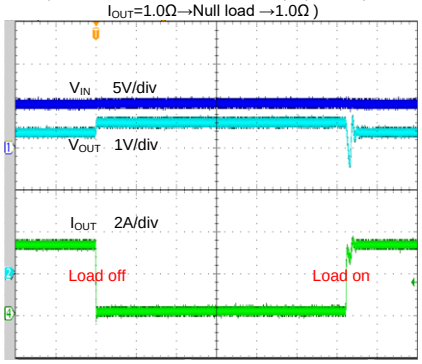



PSRR
( $V_{IN}$=5V, $V_{OUT}$=3.3V, $I_{OUT}$=0.2A, $C_{OUT}$=10μF)



Load Transient

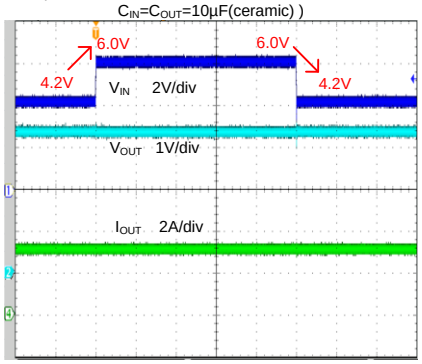
($V_{IN}$=5V, $V_{OUT}$=3.3V, $C_{IN}$=$C_{OUT}$=10μF(ceramic) , $I_{OUT}$=1.0Ω→Null load →1.0Ω )




Time(40μs/div)

Line Transient

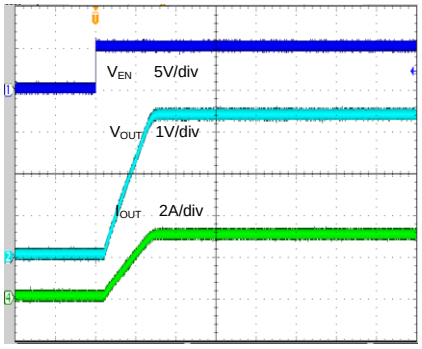
($V_{IN}$=4.2V→6V→4.2V, $V_{OUT}$=3.3V, $I_O$=1.1Ω load, $C_{IN}$=$C_{OUT}$=10μF(ceramic) )




Time(2ms/div)

Startup From Enable

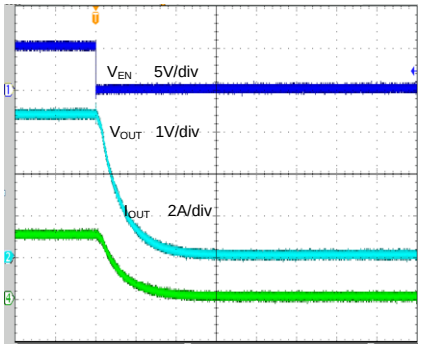
($V_{IN}$=5V, $V_{OUT}$=3.3V, $C_{IN}$=$C_{OUT}$=10μF, $I_{OUT}$=1.1Ω)




Time(2ms/div)

Shutdown From Enable

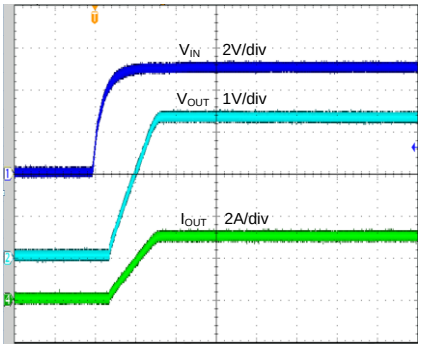
($V_{IN}$=5V, $V_{OUT}$=3.3V, $C_{IN}$=$C_{OUT}$=10μF, $I_{OUT}$=1.1Ω)




Time(20μs/div)

Vin Start up

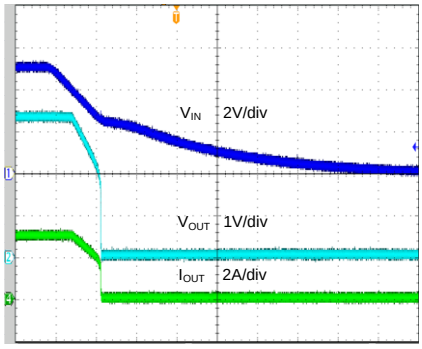
($V_{IN}$=5V, $V_{OUT}$=3.3V, $C_{IN}$=$C_{OUT}$=10μF, $I_{OUT}$=1.1Ω)




Time(2ms/div)

Vin Shut Down

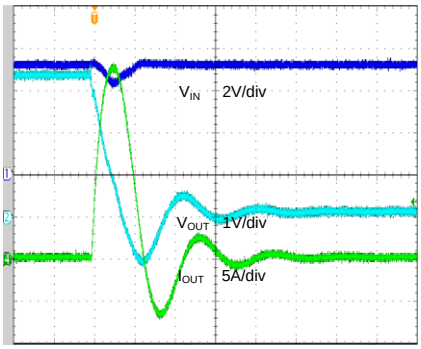
($V_{IN}$=5V, $V_{OUT}$=3.3V, $C_{IN}$=$C_{OUT}$=10μF, $I_{OUT}$=1.1Ω)




Time(2ms/div)

Short Circuit Response

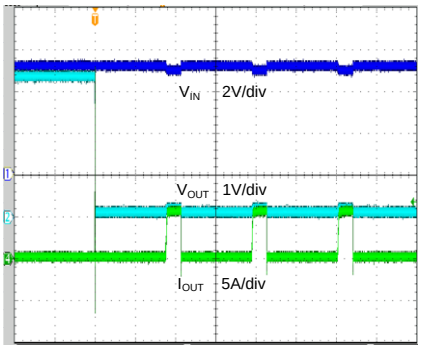
($V_{IN}$=5V, $V_{OUT}$=3.3V, $C_{IN}$=$C_{OUT}$=10μF)




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.

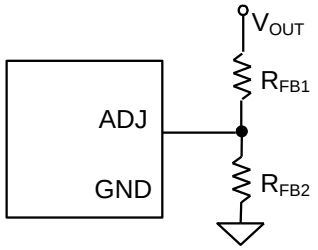
The SY20703 offers protection features, including over-current limit, output short protection, over-input voltage protection, and over-temperature protection.

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.

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

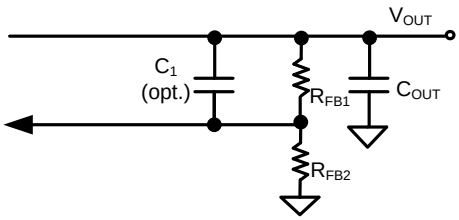
The operating junction temperature can be estimated by using the following thermal formula:

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

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 ($\theta_{JA}$) 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:

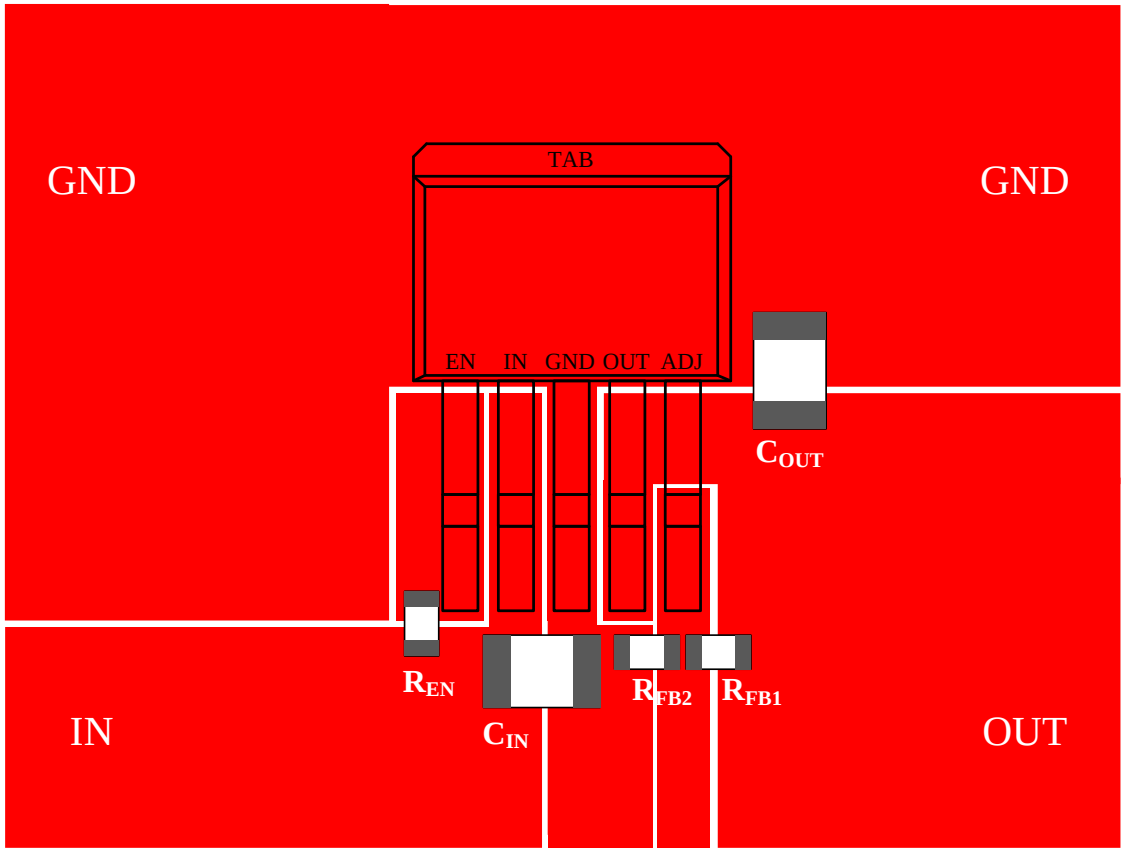
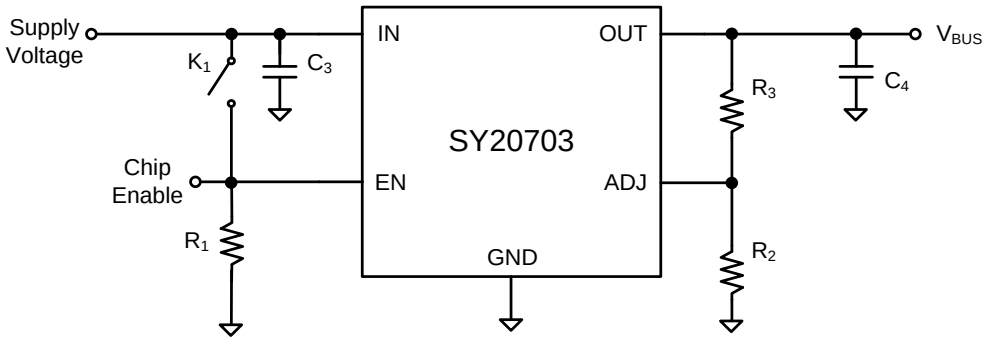



*Figure 4. SY20703MAC PCB Layout Example*

## Application Schematic

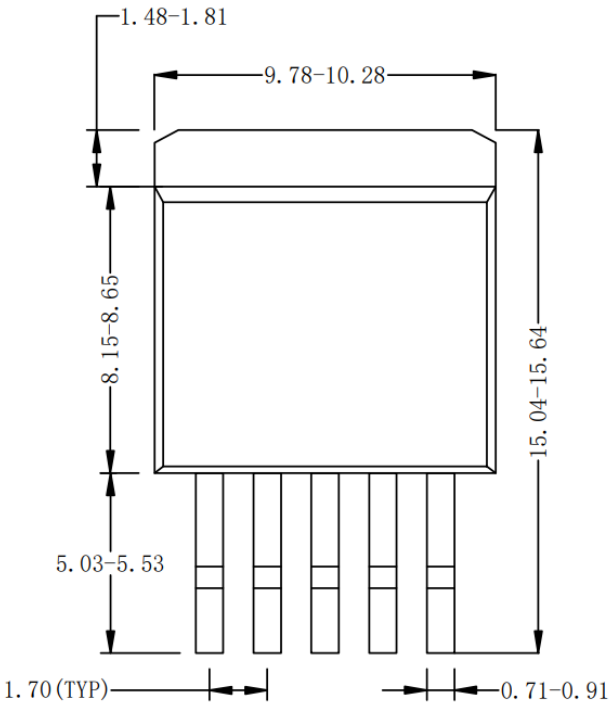



## BOM List

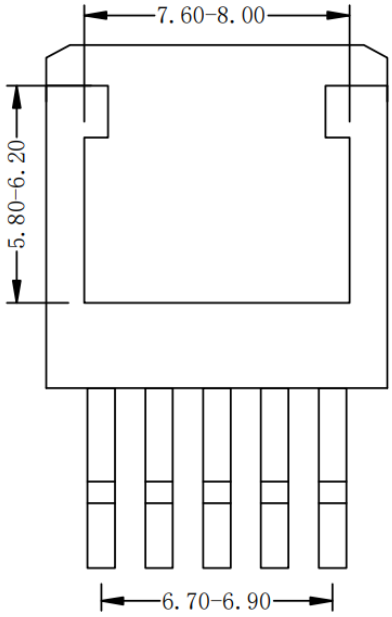
| $V_{OUT}$=3.3V | | | |
|---|---|---|---|
| **Reference Designator** | **Description** | **Part Number** | **Manufacturer** |
| $C_3$ | 10μF/50V,1206 | C3216X5R1H106K | TDK |
| $C_4$ | 10μF/16V,1206 | C3216X5R1C106K | TDK |
| $R_1$ | 1MΩ, 0603 | RC0603FR-071ML | YAGEO |
| $R_2$ | 51KΩ, 0603 | RC0603FR-0751KL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

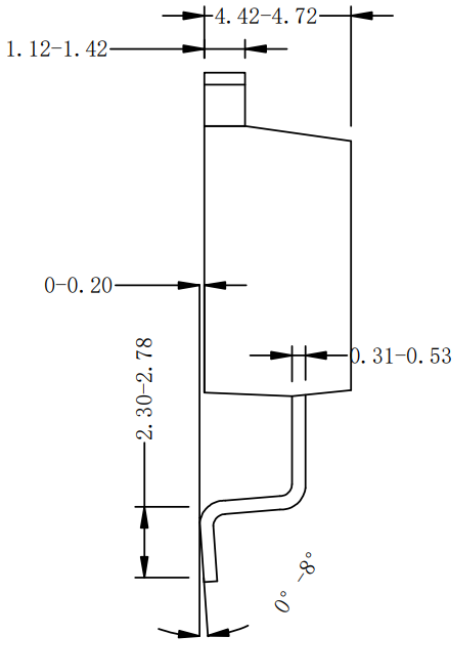
# TO263-5 Package Outline Drawing



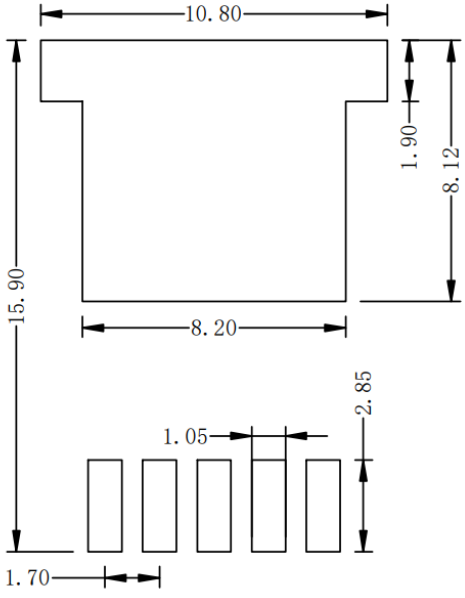

**Top View**




**Bottom View**




**Side View**

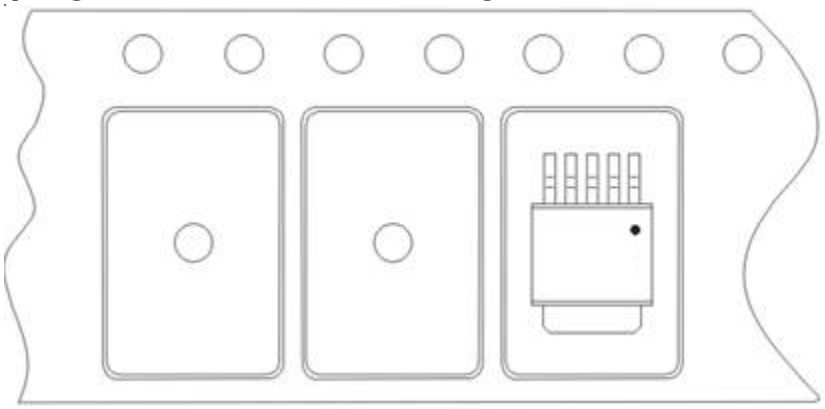



**Recommended PCB Layout (Reference only)**

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

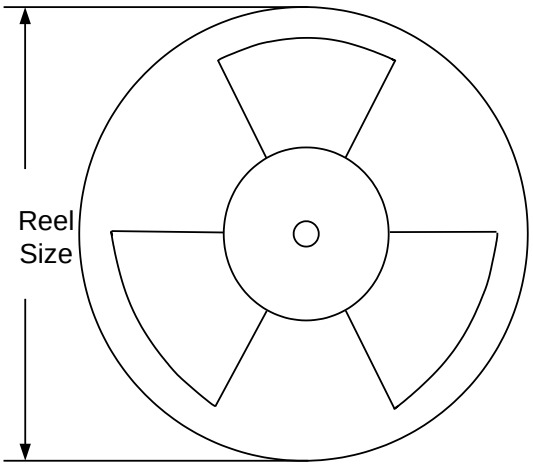
# Taping & Reel Specification

## 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 |

## 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