SY20787

3A Fast-Response LDO Regulator

General Description

The SY20787 is a low-dropout LDO regulator with a wide input voltage range of 3V to 18V and 3A current capability. It features fast recovery from input voltage surges and output load current changes.

The Enable input can be used to disable the operation and reduce current consumption in the system.

The SY20787 offers protection features, including an over-current limit, output short protection, input over-voltage protection, and over-temperature protection. It also offers an adjustable output, which can be set by two external resistors.

The SY20787 is available in a compact TO263-5 package.

Features

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

Applications

- High Efficiency Linear Low Power Supply Applications
- Battery-Powered Equipment
- Hand-Held Instruments
- Notebook PCs

Typical Applications

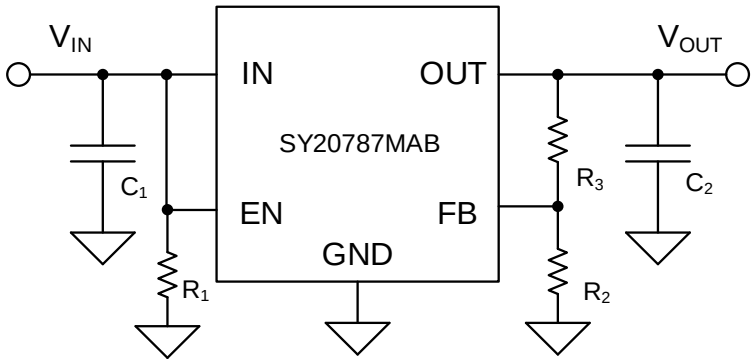


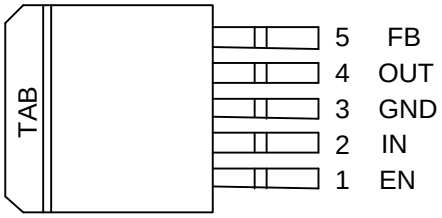
Figure 1. Adjustable Output Regulator

Ordering Information

Ordering Part Number	Package Type	Top Mark
SY20787MAB	TO263-5 RoHS Compliant and Halogen Free	**EAG*xyz***

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 it floating.
IN	2	INPUT: Unregulated input, +3V to +18V maximum.
GND	3, TAB	GND: TAB is also connected internally to the device ground.
OUT	4	OUTPUT: The regulator output voltage.
FB	5	Feedback Voltage: 1.24V feedback from external resistor divider. $V_{OUT} = 1.24 \times (\frac{R_1 + R_2}{R_2})$

Block Diagram

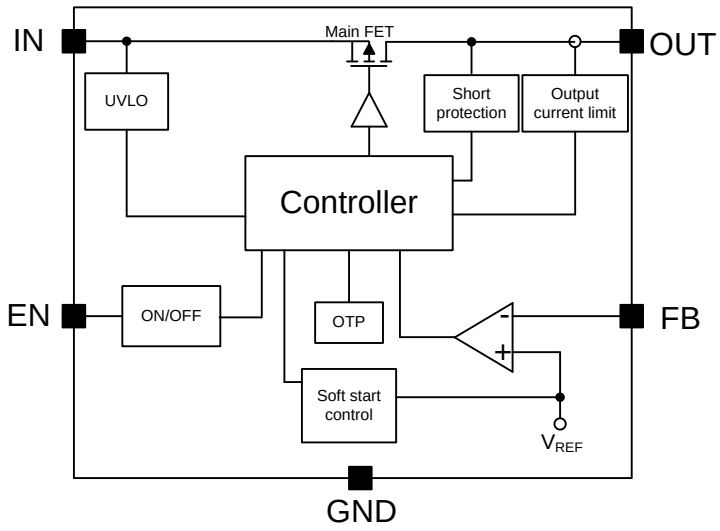


Figure 2. Block Diagram

Absolute Maximum Ratings

Parameter (Note1)	Min	Max	Unit
IN, EN, OUT, FB	-0.3	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	24.5	°C/W
θ_{JC} Junction-to-case Thermal Resistance	1.4	

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_J= -40°C to +125°C, unless otherwise specified. The values are guaranteed by test, design or statistical correlation.)

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	2.3	2.5	2.7	V
UVLO Hysteresis	V_{UVLO_HYS}			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}	V_{OUT}=0.9×V_{OUT_normal}	3.5	4.5	5.5	A
Thermal Shutdown Temperature	T_{SD}			150		°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}			24		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	%

Electrical Characteristics (Cont.)

(V_{IN} = 5V, V_{OUT}=3.3V, I_{OUT} = 100mA, T_J = -40°C to 125°C unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Unit
Dropout Voltage	ΔV_{DROP}	V_{FB}=1V, I_{OUT} = 100mA		16	24	mV
		V_{FB}=1V, I_{OUT} = 750mA		120	175	
		V_{FB}=1V, I_{OUT} = 1.5A		240	350	
		V_{FB}=1V, I_{OUT} = 3A		480	730	
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	165	μA
		I_{OUT} = 1.5A, V_{IN}=V_{OUT}+1V (**Note 4)**		2.75	5.5	mA
		I_{OUT} = 3A, V_{IN}=V_{OUT}+1V (**Note 4**)		5.2	10.4	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.

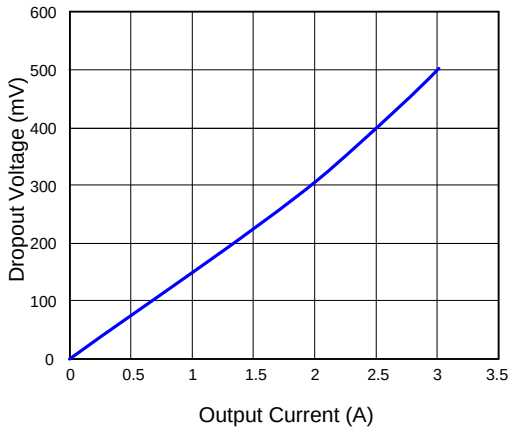
Note 2: θ_{JA} was measured according to JESD51-2 and chip mounted on Silergy PCB. Exposed paddle of TO263-5 is the case position for θ_{JC} measurement.

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

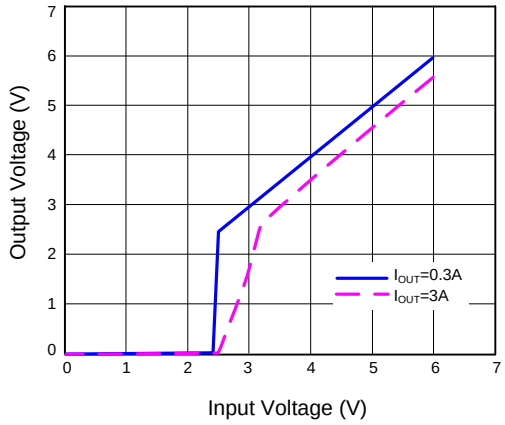
Note 4: Guaranteed by design.

Typical Performance Characteristics

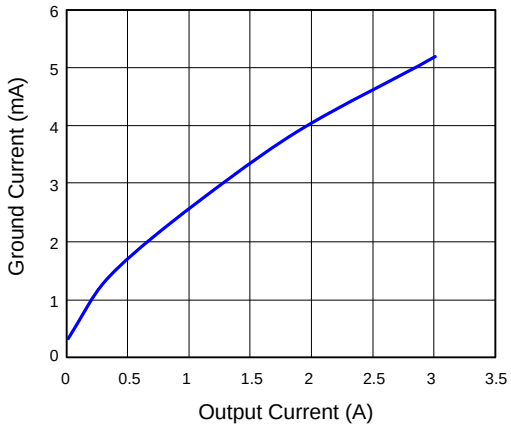
Dropout Voltage vs. Output Current
(V_{IN}=V_{EN}=5V, V_{FB}=1.1V)



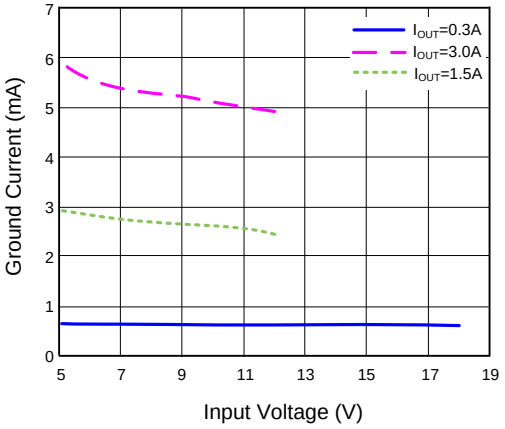
Output Voltage vs. Input Voltage
(V_{IN}=V_{EN}, V_{FB}=1.1V)



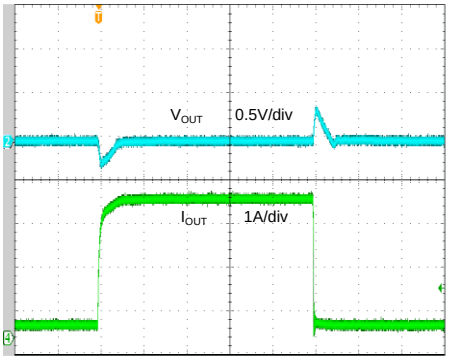
Ground Current vs. Output Current
(V_{IN}=V_{EN}=5V, V_{OUT}=4.2V)



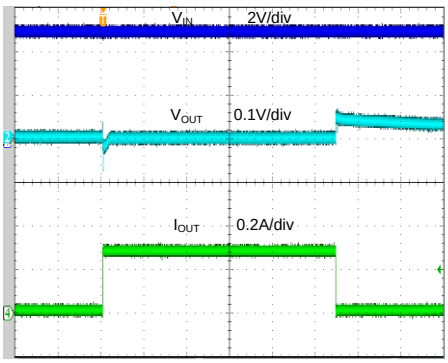
Ground Current vs. Input Voltage
(V_{IN}=V_{EN}, V_{OUT}=4.2V)



Load Transient
(V_{IN}=5V, V_{OUT}=4.2V, C_{IN}=C_{OUT}=10uF, I_{OUT}=0.3A~3A~0.3A)

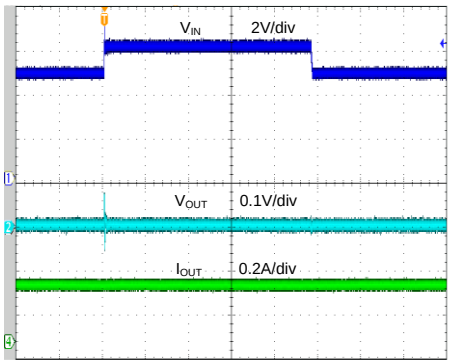


Load Transient
(V_{IN}=5V, V_{OUT}=4.2V, C_{IN}=C_{OUT}=10uF, I_{OUT}=0~0.3A~0)



Line Transient

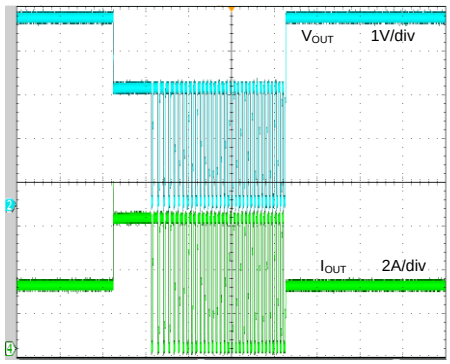
(V_{IN}=5V~6V~5V, C_{IN}=C_{OUT}=10uF, I_{OUT}=0.3A)



Time (800μs/div)

Over Current

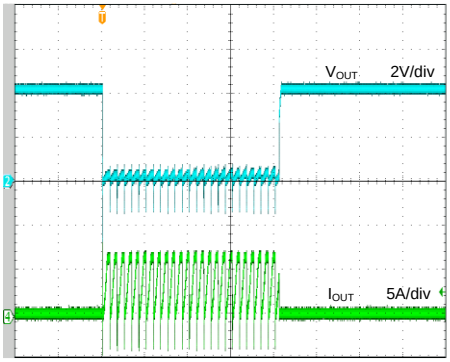
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, OUT=1.4Ω to 0.42Ω to1.4Ω)



Time (100ms/div)

Short Current

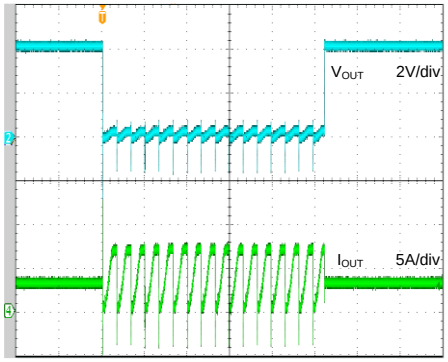
(V_{IN}=5V, C_{IN}=C_{OUT}=10uF, I_{OUT}=0A to short to 0A)



Time (20ms/div)

Short Current

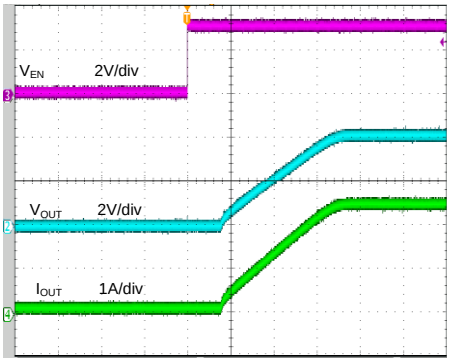
(V_{IN}=5V, C_{IN}=C_{OUT}=10uF, I_{OUT}=3A to short to 3A)



Time (10ms/div)

Startup from EN

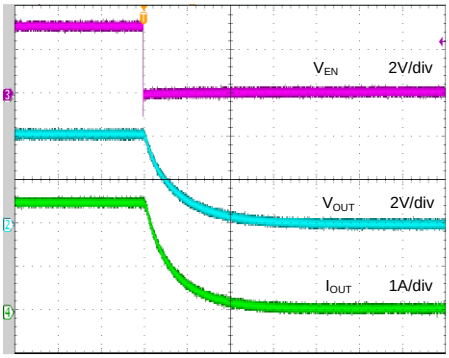
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=3A)



Time (800μs/div)

Shutdown from EN

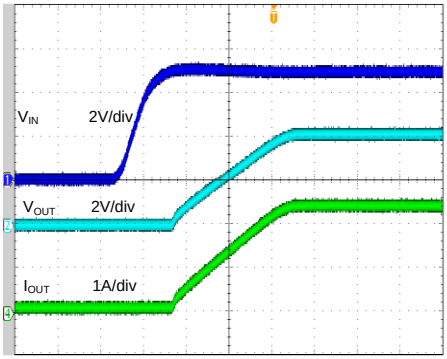
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=3A)



Time (20μs/div)

Startup from V_{IN}

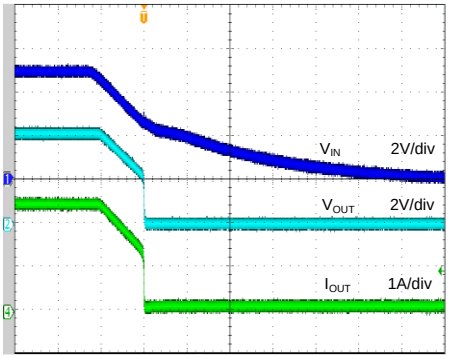
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=3A)



Time (800μs/div)

Shutdown from V_{IN}

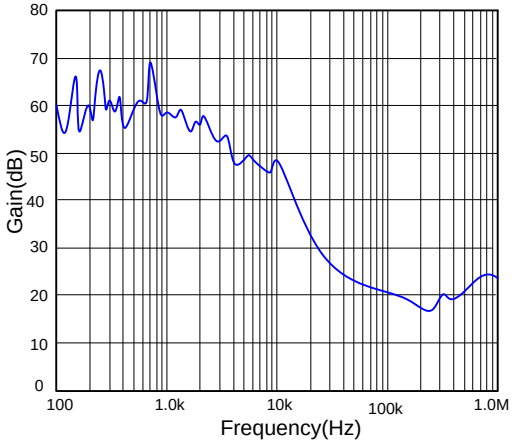
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=3A)



Time (2ms/div)

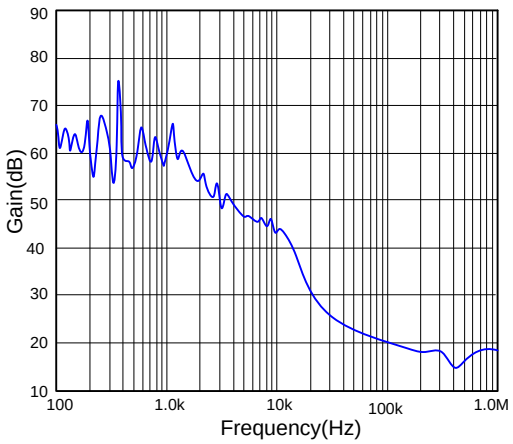
Power Supply Rejection Ratio

(V_{IN}=5V, V_{OUT}=4.2V, I_{OUT}=0.3A)



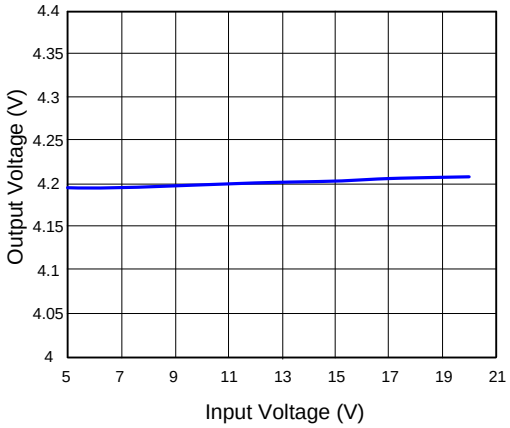
Power Supply Rejection Ratio

(V_{IN}=5V, V_{OUT}=4.2V, I_{OUT}=1A)



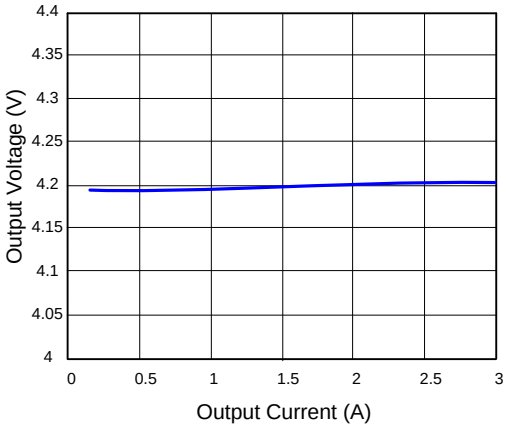
Line Regulation

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

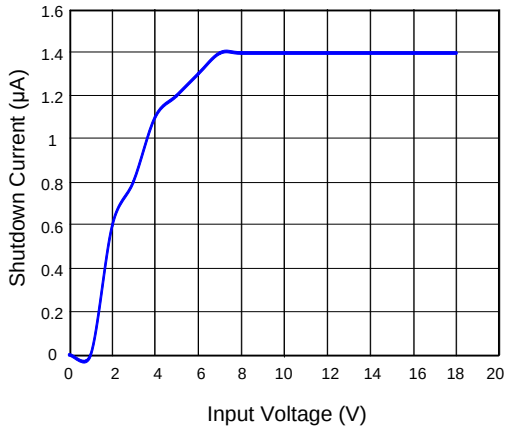


Load Regulation

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

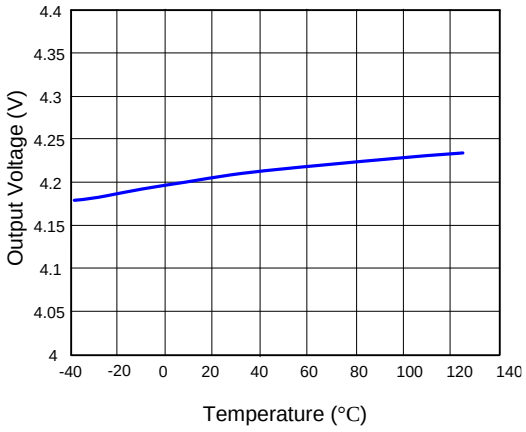


Shutdown Current vs. Input Voltage



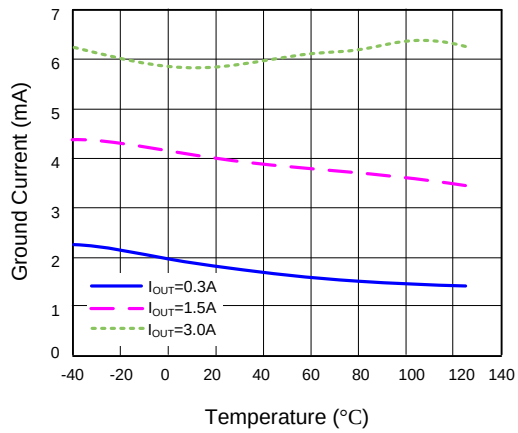
Output Voltage vs. Temperature

(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, I_{OUT}=no load)



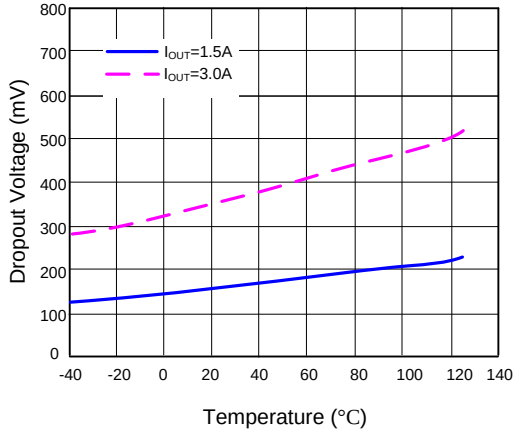
Ground Current vs. Temperature

(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)



Application Information

The SY20787 is a low-dropout LDO regulator with a wide input voltage range of 3V to 18V and 3A current capability. It features fast recovery from input voltage surges and output load current changes.

The Enable input can be used to disable the operation and reduce current consumption in the system.

Protection features, including an over-current limit, output short protection, input over-voltage protection, and over-temperature protection ensure reliable operation across different demanding applications.

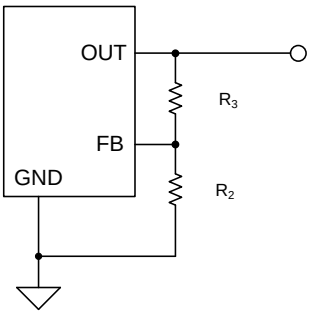
Input Capacitor C_{IN}:

An input capacitance of about 10μF is required between the device input and ground pins. A typical X5R or better grade ceramic capacitor with a 25V rating 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 SY20787 is designed to operate using very small ceramic output capacitors. A 2.2μF output capacitance can be used in this application. The output capacitor's ESR is critical 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 program the proper output voltage. Choosing large resistance values for both R2 and R3 is recommended to minimize power consumption under light loads. A value of between 10kΩ and 1MΩ is 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 will remain stable and in regulation with no external load. This is especially important in CMOS RAM keep-alive applications.

Dropout Voltage:

The SY20787 has a very low dropout voltage due to the low $R_{DS(ON)}$ of the main PMOS, which 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 the SY20787 is 4A. The device includes over-current and short-circuit protection. The current limiting circuit regulates the output current to its limit threshold to protect the device from damage. Under over-current or short-circuit conditions, the dissipated power on the device is high, which may trigger thermal protection.

Load Transient Considerations:

The SY20787 integrates the compensation components to achieve stability and fast transient response. 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 SY20787 can source a current of up to 3A 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 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.

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 die (125°C), T_A is the maximum ambient temperature and θ_{JA} is the package junction-to-ambient thermal resistance.

Layout Design:

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 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:

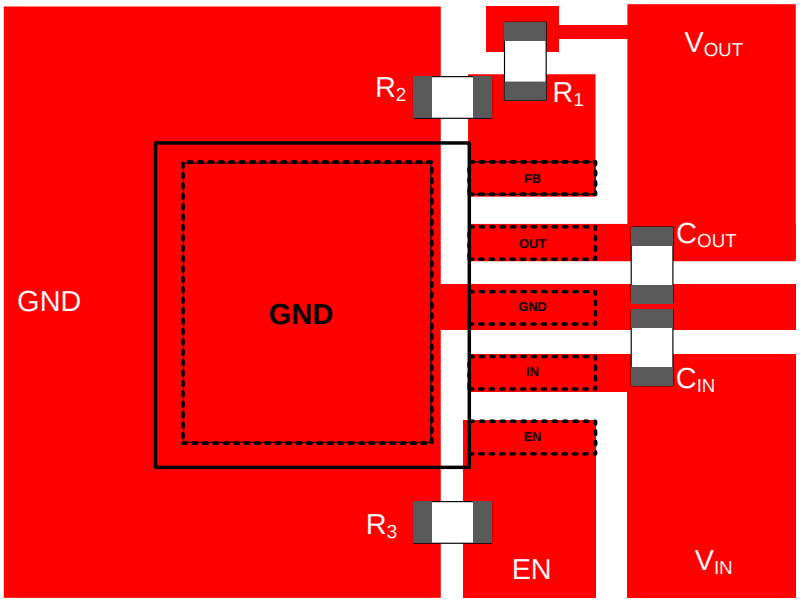
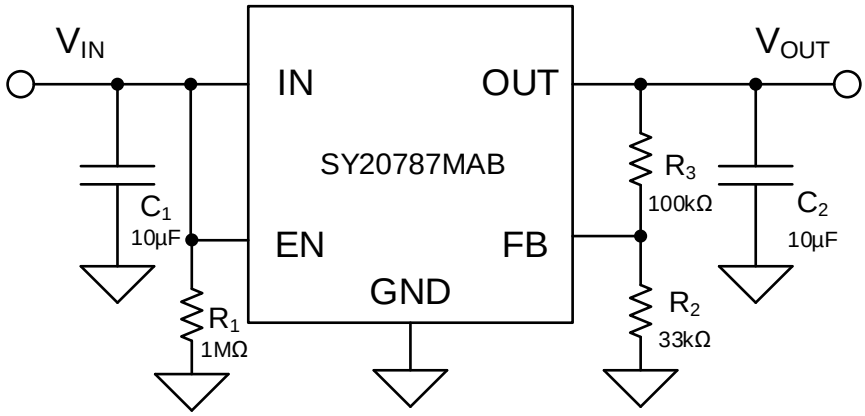


Figure 3. PCB Layout Suggestion

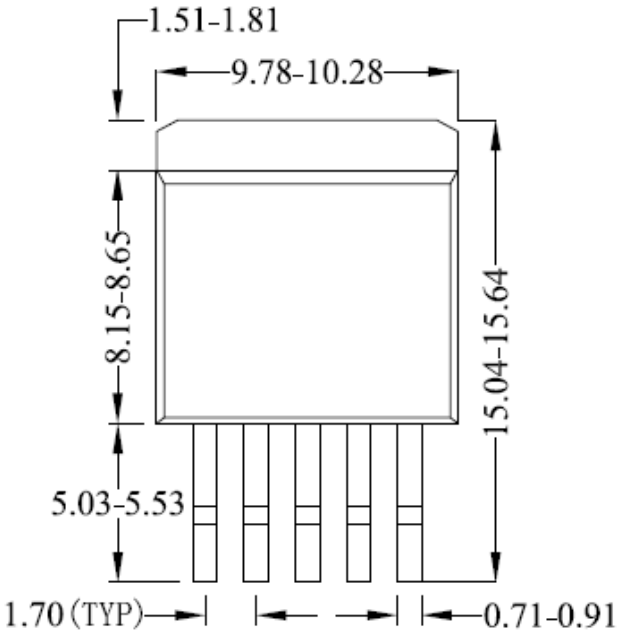
Application Schematic (V_{OUT}=5V)



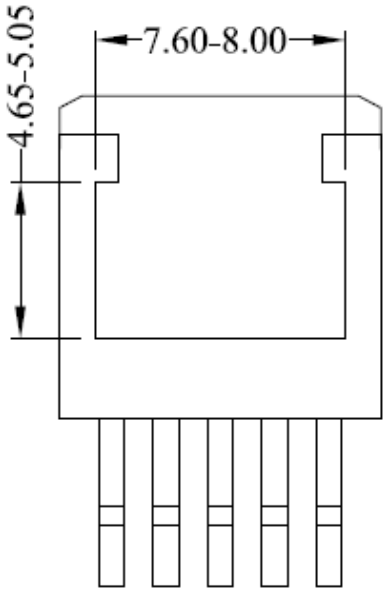
BOM List

Reference Designator	Description	Part Number	Manufacturer
C_1	10µF/50V,1206	C3216X5R1H106K	TDK
C_2	10µF/16V,1206	C3216X7R1C106K	TDK
R_1	1MΩ,1%, 0603	RC0603FR-071ML	YAGEO
R_2	33k,1%,0603	RC0603FR-0733K2L	YAGEO
R_3	100k,1%,0603	RC0603FR-07100KL	YAGEO

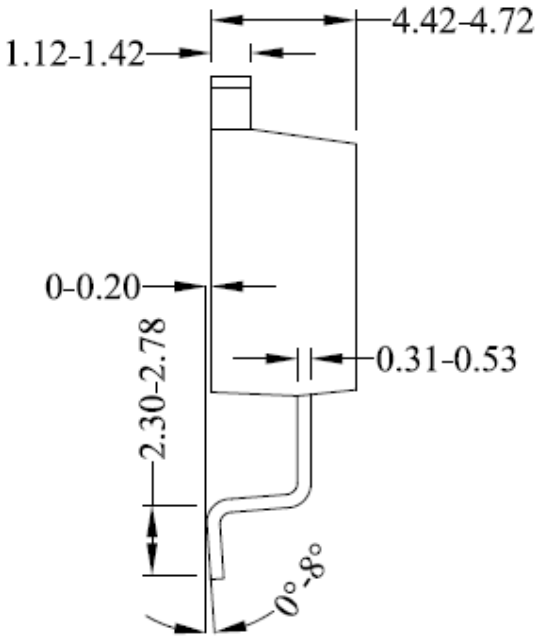
TO263-5 Package Outline Drawing



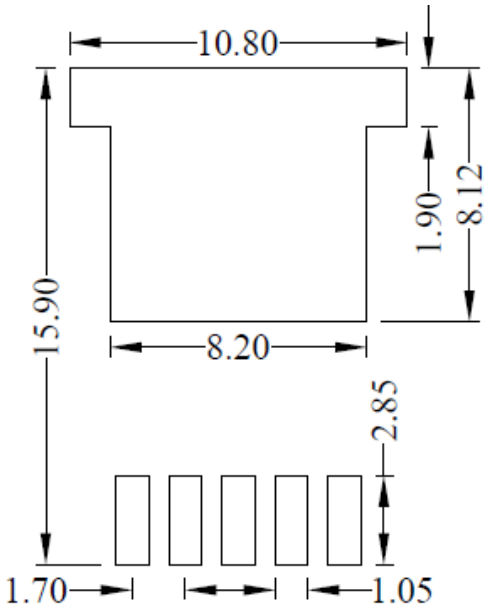
Top View



Bottom View



Side View

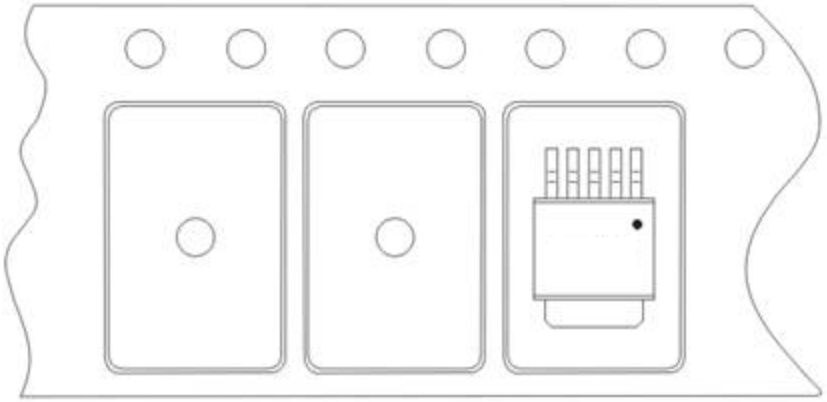


Recommended PCB Layout
(Reference Only)

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

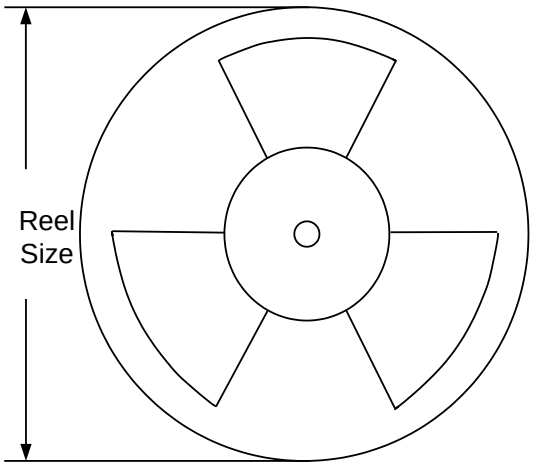
Taping & Reel Specification

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
Apr.21, 2023	Revision 1.0	Language improvements for clarity.
Apr.08, 2021	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