

20V/500mA, 0.8uA Ultra-Low Power High Precision Linear Regulator

1 Description

The CN8501 is an ultra-low quiescent power, low dropout linear regulator fabricated in CMOS process. The regulator consumes about 0.8uA and 0.01uA (typical) after enable/shutdown. Built-in enable control, output discharge, short circuit protection, and thermal shutdown are available in SOT89-3, SOT23-5, and SOT23-3 packages.

2 Features

- Ultra-low Quiescent Current: 0.8μA(VIN=12V)
- Shutdown Current: 0.01uA
- Input Range: 2.5V-20V
- Output Range: 1.8V-5V (0.1V interval)
- High Precision: ±2%
- Maximum Output Current: 500mA
- Enabling Control
- Output Discharge
- Output Short Circuit Protection
- Thermal Shutdown

3 Applications

- Cell Phone
- Battery powered equipment
- Wireless Telephones,
Wireless Communication Equipment
- Camera Recorder
- Portable Audio-Visual Equipment
- PDA (Personal Digital Assistant)
- Smart electricity/water/gas meters
- Industrial instruments

4 Ordering Information

Product Number	Package	Quantity/Tape
CN8501MXXXOGR	SOT89-3	1000/Tape
CN8501MXXXAOG	SOT89-3	1000/Tape
CN8501MXXXTCR	SOT23-5	3000/Tape
CN8501MXXXTGR	SOT23-3	3000/Tape
CN8501MXXXTCRA	SOT23-5	3000/Tape

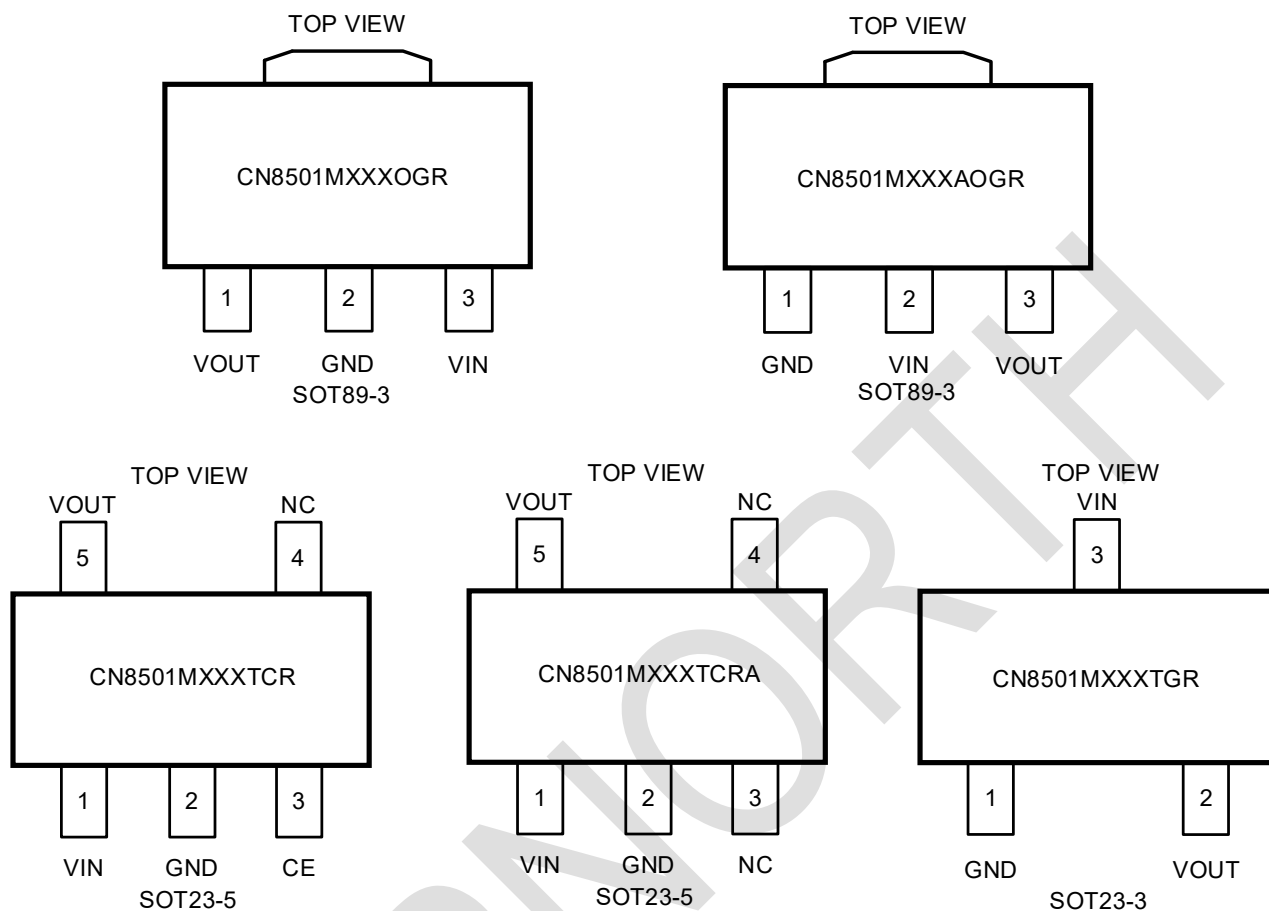
5 Marking

Product Number	Marking*
CN8501MXXXAOG	01MXXXA YYWW
CN8501MXXXOGR	01MXXX YYWW
CN8501MXXXTCR	MXXX YYWW
CN8501MXXXTGR	MXXX YYWW
CN8501MXXXTCRA	MXXXA YYWW

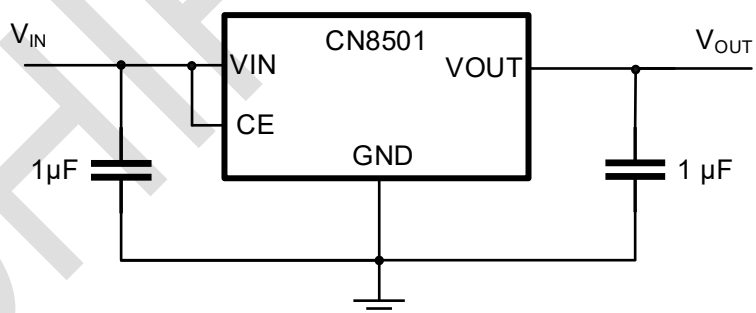
Note: YY=Year WW=Week; 8501MXXX=Product Name, XXX= Output Voltage

Green (RoHS & HF): CHIPNORTH defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your CHIPNORTH representative directly.
Moisture sensitivity level(MSL):3

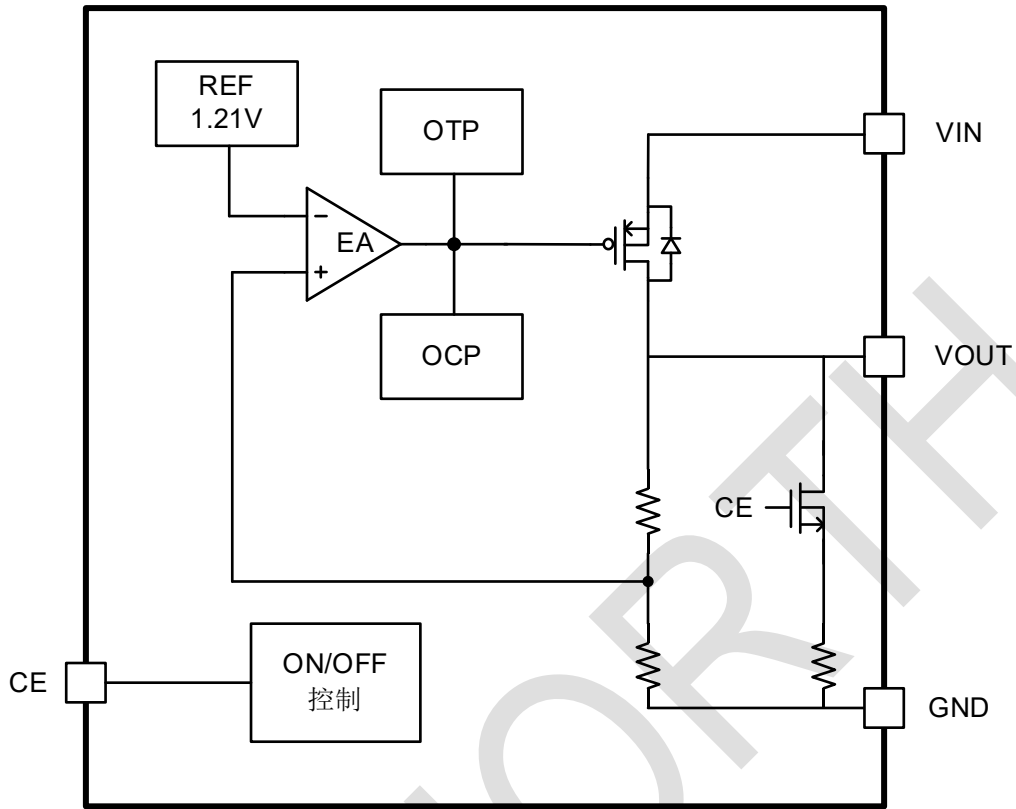
6 Pinout



7 Typical Application



8 Block Diagram



9 Pin Descriptions

CN8501M XXXOGR	CN8501M XXXAOG	CN8501M XXXTCR	CN8501M XXXTCRA	CN8501M XXXTGR	Pin Name	Descriptions
SOT89-3	SOT89-3	SOT23-5	SOT23-5	SOT23-3		
/	/	3	/	/	CE	Enable pin
2	1	2	2	1	GND	Ground
		4	3、4		NC	No Connection
3	2	1	1	3	VIN	Power supply input
1	3	5	5	2	VOUT	Voltage output

10 Specifications

10.1 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Supply Input Voltage	V_{IN}	28	V
Output Voltage	V_{OUT}	-0.3 ~ 7	V
CE Voltage	V_{CE}	-0.3 ~ 28	V
Soldering Temperature	T_{LEAD}	260(soldering,10s)	°C
Storage Temperature Range	T_{STG}	-55 ~ 150	°C

Note1: Stress exceeds these ratings listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Expose to absolute-maximum-rated conditions for extended periods may affect device reliability.

10.2 ESD Ratings

Discharge mode	Standardize	Value	Units
HBM	ESDA/JEDEC JS-001-2017	±4000	V
CDM	ESDA/JEDEC JS-002-2018	±2000	V

10.3 Recommended Operating Range

Parameter	Symbol	Min.	Max.	Units
Input Voltage Range	V_{IN}	$V_{OUT}+1$	20	V
Output Voltage Range	V_{OUT}	1.8	5	V
Operating Ambient Temperature Range	T_A	-40	105	°C
Atmosphere Pressure	p	63	106	kPa
Output Current	I_{OUT}	0	500	mA
Input Capacitor	C_{IN}	1		μF
Output Capacitor	C_{OUT}	1		μF

10.4 Thermal Information

Parameter		CN8501					Units
		OGR [SOT89-3]	AOGR [SOT89-3]	TCR [SOT23-5]	TCRA [SOT23-5]	TGR [SOT23-3]	
$R_{\theta JA}$	Junction to ambient	100	165	188	188	220	°C/W

(1) Thermal resistance is not a fixed constant; its value is influenced by the following factors: PCB heat dissipation capacity, number and thickness of copper layers, ambient temperature, airflow velocity, etc.

(2) The thermal resistance values listed in the datasheet are provided solely for customers to compare the thermal performance of different packages. Since the heat dissipation conditions of the PCB in actual customer applications differ from those of our test boards, the actual measured thermal resistance values may vary from the nominal values in the datasheet. Customers should conduct verification on their own system boards to ensure that the thermal design meets the requirements of the product application.

10.5 Electrical Characteristics

CN8501M050

(VIN=VOUT+1V, CIN=1μF, COUT=1μF, TA=25°C, unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Output Voltage	V _{OUT}	I _{OUT} = 30mA	4.9	5	5.1	V
Maximum Output Current	I _{OUTMAX}	V _{IN} = V _{OUT} + 1V	500			mA
Load regulation	ΔV _{OUT}	1mA ≤ I _{OUT} ≤ 500mA		15	23	mV
Dropout voltage	V _{DIF1}	I _{OUT} = 100mA		100	203	mV
Input Quiescent Current	I _Q	V _{IN} = 6V		0.5	1	μA
Shutdown Current	I _{SD}	V _{CE} = 0V		0.01		μA
Line regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} * V_{OUT}}$	I _{OUT} = 1mA ΔV _{OUT} + 1V ≤ ΔV _{IN} ≤ 18V		0.001	0.025	%/V
CE Rising Threshold	V _{CEH}	On, output voltage stabilized	1.3			V
CE Falling Threshold	V _{CEL}	Off, output voltage is 0			0.4	V
Short-Circuit Current	I _{SHORT}	V _{IN} = V _{OUT} + 1V, V _{CE} = V _{IN} V _{OUT} = 0V		50		mA
Current Limiting	I _{limit}	V _{OUT} = V _{OUT(E)} × 0.95 V _{IN} = V _{OUT} + 2V	500	800		mA
Load Capacitor Discharge Resistance	R _{DCHG}	V _{CE} = V _{SS} , V _{OUT} = V _{OUT}		500		Ω
Output Voltage Temperature Coefficient	TC _{VOUT}	T _A = -40°C ~ 105°C, I _{OUT} = 50mA		32		ppm/°C
Thermal Shutdown Temperature	OTP			160		°C
Thermal Shutdown Hysteresis	OTP_HYS			30		°C

CN8501M040

(VIN=VOUT+1V, CIN=1μF, COUT=1μF, TA=25°C, unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Output Voltage	V _{OUT}	I _{OUT} = 30mA	3.92	4	4.08	V
Maximum Output Current	I _{OUTMAX}	V _{IN} = V _{OUT} + 1V	500			mA
Load regulation	ΔV _{OUT}	1mA ≤ I _{OUT} ≤ 500mA		10	23	mV
Dropout voltage	V _{DIF1}	I _{OUT} = 100mA		110	203	mV
Input Quiescent Current	I _Q	V _{IN} = 5V		0.5	0.8	μA
		V _{IN} = 7.5V		0.7	1	μA
Shutdown Current	I _{SD}	V _{CE} = 0V		0.01		μA
Line regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} * V_{OUT}}$	I _{OUT} = 1mA ΔV _{OUT} + 1V ≤ ΔV _{IN} ≤ 18V		0.007	0.029	%/V
CE Rising Threshold	V _{CEH}	On, output voltage stabilized	1.3			V
CE Falling Threshold	V _{CEL}	Off, output voltage is 0			0.4	V
Short-Circuit Current	I _{SHORT}	V _{IN} = V _{OUT} + 1V, V _{CE} = V _{IN} V _{OUT} = 0V		50		mA
Current Limiting	I _{limit}	V _{OUT} = V _{OUT(E)} × 0.95 V _{IN} = V _{OUT} + 2V	500	800		mA
Load Capacitor Discharge Resistance	R _{DCHG}	V _{CE} = V _{SS} , V _{OUT} = V _{OUT}		500		Ω
Output Voltage Temperature Coefficient	TC _{VOUT}	T _A = -40°C ~ 105°C, I _{OUT} = 50mA		32		ppm/°C
Thermal Shutdown Temperature	OTP			160		°C
Thermal Shutdown Hysteresis	OTP_HYS			30		°C

CN8501M033

(VIN=VOUT+1V, CIN=1μF, COUT=1μF, TA=25°C, unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Output Voltage	V _{OUT}	I _{OUT} = 30mA	3.234	3.3	3.366	V
Maximum Output Current	I _{OUTMAX}	V _{IN} = V _{OUT} +1V	500			mA
Load regulation	ΔV _{OUT}	1mA ≤ I _{OUT} ≤ 500mA		10	23	mV
Dropout voltage	V _{DIF1}	I _{OUT} = 100mA		120	203	mV
Input Quiescent Current	I _Q	V _{IN} = 5V		0.5	0.8	μA
Shutdown Current	I _{SD}	V _{CE} = 0V		0.01		μA
Line regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} * V_{OUT}}$	I _{OUT} =1mA ΔV _{OUT} +1V≤ΔV _{IN} ≤18V		0.01	0.033	%/V
CE Rising Threshold	V _{CEH}	On, output voltage stabilized	1.3			V
CE Falling Threshold	V _{CEL}	Off, output voltage is 0			0.4	V
Short-Circuit Current	I _{SHORT}	V _{IN} = V _{OUT} +1V, V _{CE} = V _{IN} V _{OUT} = 0V		50		mA
Current Limiting	I _{limit}	V _{OUT} = V _{OUT(E)} X 0.95 V _{IN} = V _{OUT} +2V	500	800		mA
Load Capacitor Discharge Resistance	R _{DCHG}	V _{CE} = V _{SS} , V _{OUT} = V _{OUT}		500		Ω
Output Voltage Temperature Coefficient	TC _{VOUT}	T _A =-40°C~105°C, I _{OUT} =50mA		32		ppm/°C
Thermal Shutdown Temperature	OTP			160		°C
Thermal Shutdown Hysteresis	OTP_HYS			30		°C

Notes:

*1. V_{OUT(E)}: output voltage when V_{IN} = V_{OUT} + 1V, I_{OUT} = 1mA.

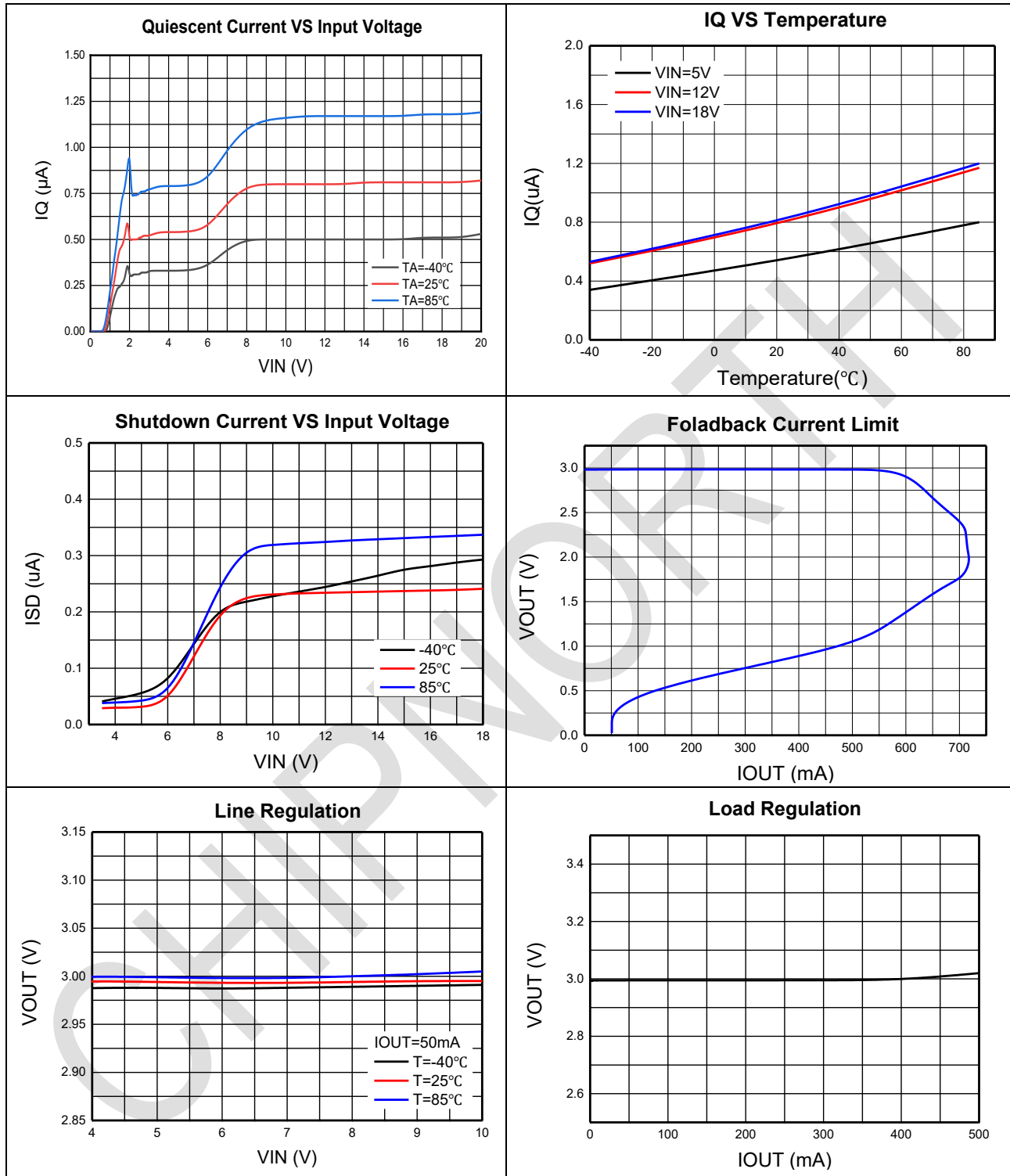
*2. V_{DROP}=V_{IN}-(V_{OUT_REG}*0.98), V_{OUT_REG} is the output voltage when V_{IN} = V_{OUT} + 1.0V and I_{OUT} = 100mA.

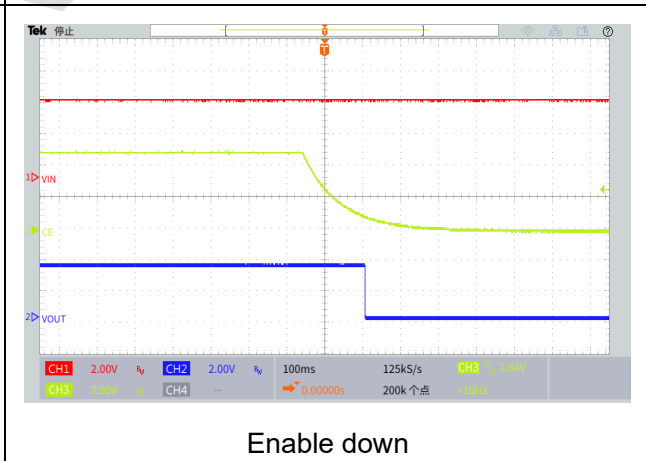
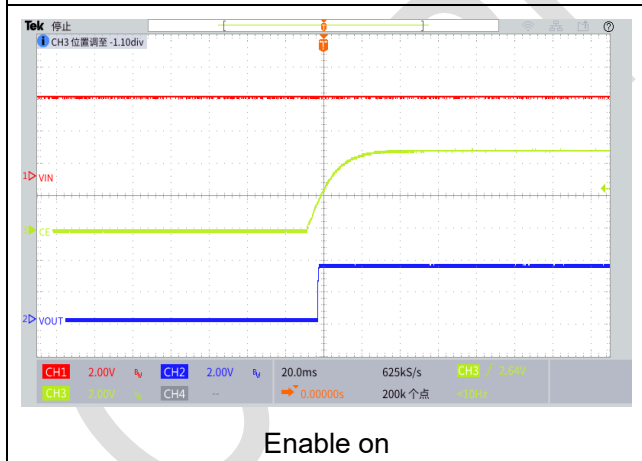
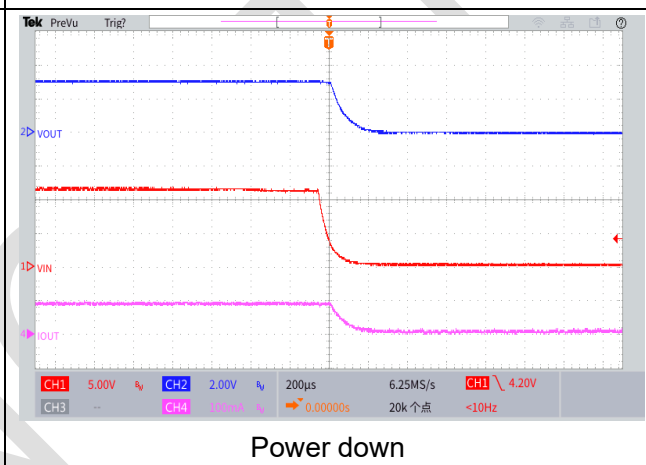
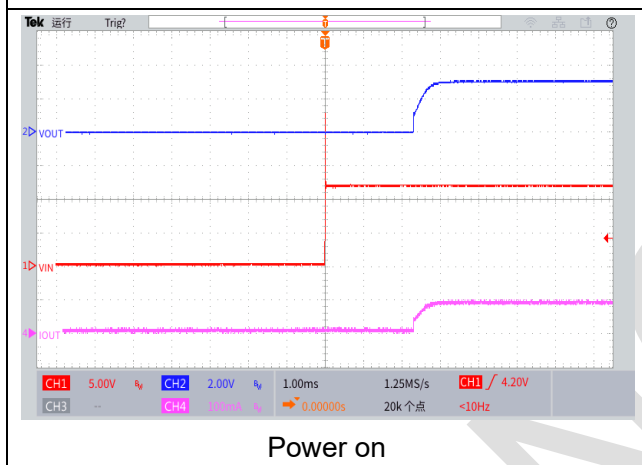
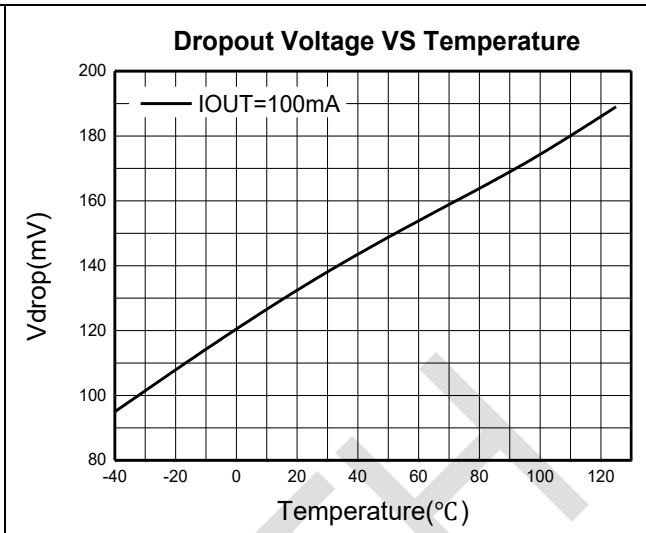
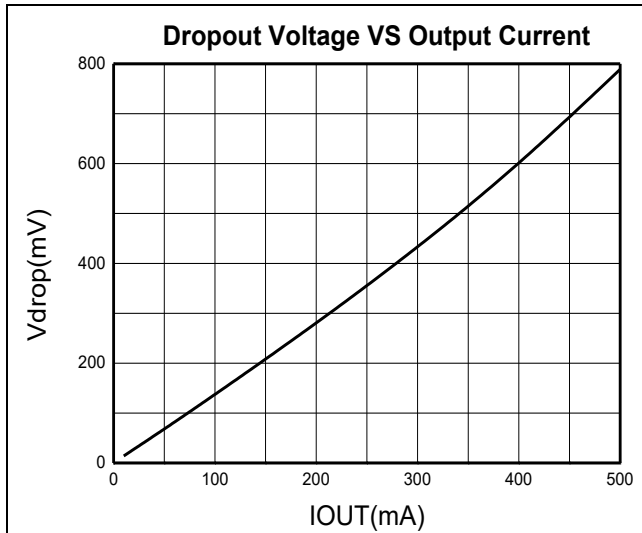
V_{IN} is the input voltage, and when the input voltage is gradually reduced, the output voltage becomes 98% of V_{OUT_REG}.

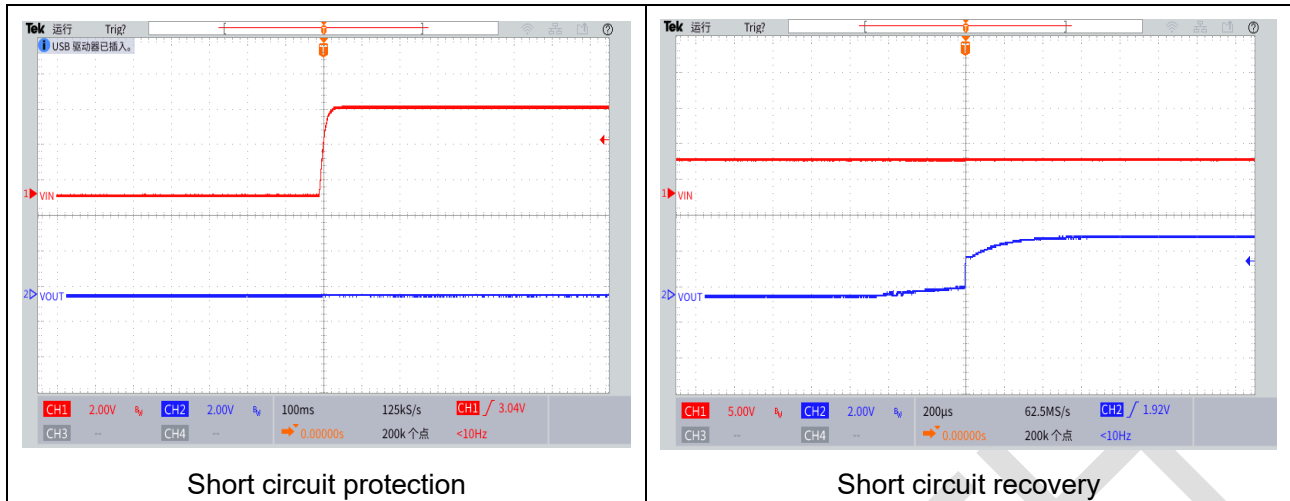
*3. I_{LIMIT}: Output current when V_{IN} = V_{OUT} + 1V and V_{OUT} = 0.95 X V_{OUT(E)}.

10.6 Characteristics Curve

(VIN=12V, CIN=1uF, COUT= 1uF, TA=25°C, unless otherwise specified.)







11 Application Information

CN8501M is a low-dropout linear regulator fabricated with CMOS process, with a maximum input voltage of 20 V. The device offers a series of fixed output voltages ranging from 1.8 V to 5.0 V, featuring an output current capacity of 500 mA, and integrates short-circuit, over-current and thermal shutdown protection functions.

11.1 Over-current protection (current-limiting type)

The CN8501M integrates a current-limiting protection circuit. When the output current exceeds the current limit value, the output voltage drops.

11.2 Short-circuit protection (current-limiting type)

When the output is shorted to ground, the output current will be limited to a typical value of 50 mA, and the output voltage will automatically recover after the fault is removed.

11.3 Output voltage tracking mode

Under normal regulation conditions, the CN8501M requires the input voltage V_{IN} to be at least 1 V higher than the set output voltage V_{OUT} , to ensure the internal error amplifier has sufficient headroom to maintain a constant output voltage. When V_{IN} drops below $V_{OUT} + V_{DROPOUT}$, the regulator automatically enters the output voltage tracking mode. In this mode, the internal power transistor is fully turned on and the feedback loop saturates. The output voltage is no longer controlled by the reference voltage and is approximately equal to the input voltage.

$$V_{OUT} \approx V_{IN} - I_{OUT} * R_{DS(on)}$$

Since the on-resistance $R_{DS(on)}$ of the power transistor is very small, we can approximate $V_{OUT} \approx V_{IN}$.

This tracking feature supplies the maximum available voltage to the subsequent circuits under input undervoltage conditions, preventing sudden output collapse or power transistor overload caused by forced operation of the regulation loop. Meanwhile, the chip's internal short-circuit, over-current and thermal protection remain functional in this mode to safeguard the device under abnormal conditions.

When the input voltage rises back above $V_{OUT} + V_{DROPOUT}$, the error amplifier regains adequate supply headroom. The regulator smoothly exits tracking mode and automatically resumes precise regulation of the output voltage. It should be noted that in tracking mode, the power transistor operates in the linear region with zero loop gain, resulting in slightly worse output ripple and load regulation performance compared to normal regulation. This is an abnormal operating region and shall not be used for continuous operation.

11.4 Thermal protection

The CN8501M integrates an internal thermal protection circuit to limit the total power consumption of the chip and prevent damage caused by excessive junction temperature. When the chip junction temperature exceeds the preset safety threshold of 160° C, the thermal protection circuit activates and turns off the power transistor to cool down the device. The power transistor will turn back on after the junction temperature drops by approximately 30° C, which may result in pulsed output waveforms under continuous overload conditions.

11.5 Operating Range and Power Dissipation

The maximum power dissipation of CN8501M is determined by package thermal resistance, PCB copper area, ambient temperature and ventilation. Its internal power dissipation can be calculated via the formula below:

$$P_D = (V_{IN} - V_{OUT}) * I_{OUT} + V_{IN} * I_Q$$

where I_Q stands for quiescent current. The maximum allowable power dissipation is:

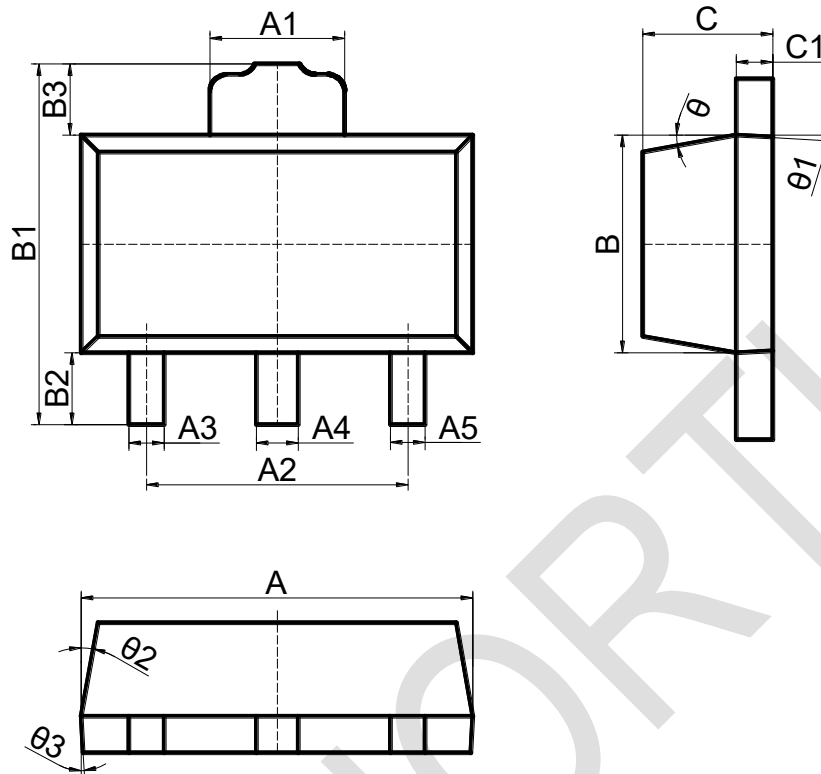
$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JA}}$$

where $T_{J(MAX)}$ is maximum junction temperature, T_A ambient temperature, θ_{JA} junction-to-ambient thermal resistance.

As CN8501M supports up to 20V input voltage, pay close attention to power dissipation for large voltage drop and high current applications to ensure $P_D \leq P_{D(MAX)}$.

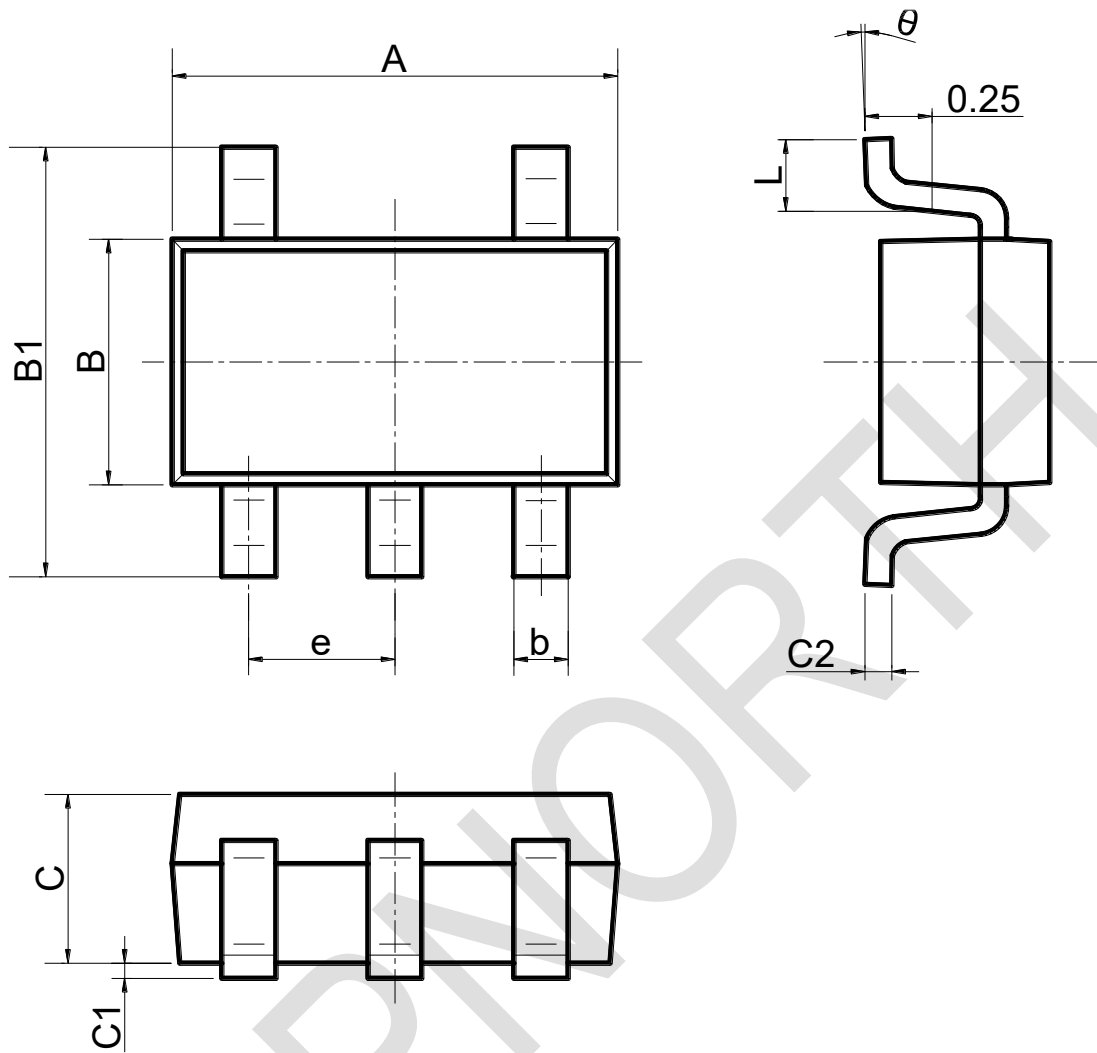
11 Package Information

SOT89-3



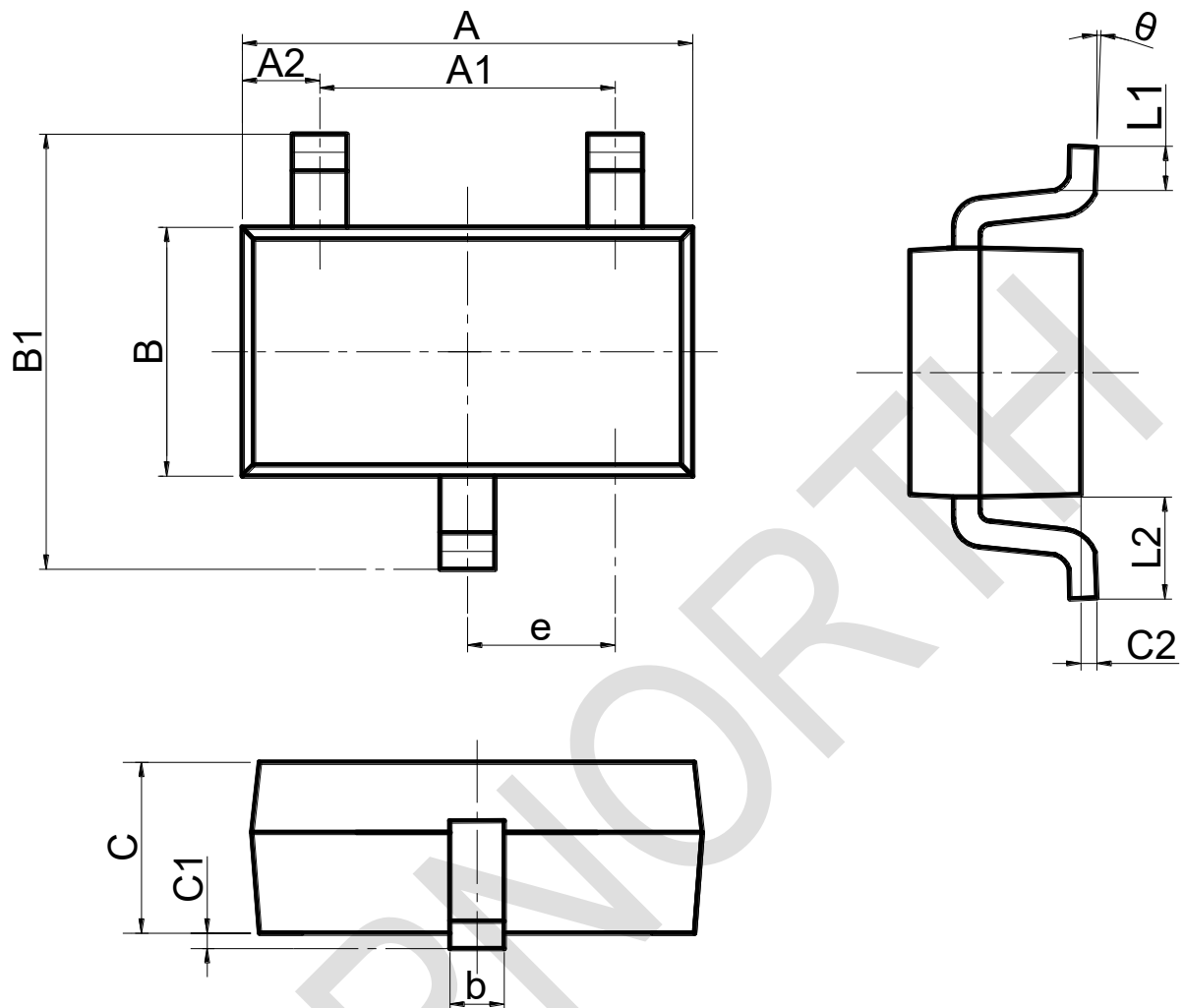
Size Symbol	Min(mm)	Max(mm)
A	4.40	4.60
A1	1.65	1.75
A2	2.95	3.05
A3	0.35	0.45
A4	0.43	0.53
A5	0.35	0.45
B	2.40	2.60
B1	4.05	4.25
B2	0.82	0.83
B3	0.82	0.83
C	1.40	1.60
C1	0.35	0.45
θ	6°TYP4	
θ1	3°TYP4	
θ2	6°TYP4	
θ3	3°TYP4	

SOT23-5



Size Symbol	Min(mm)	Max(mm)
A	2.82	3.02
e	0.95(BSC)	
b	0.27	0.35
B	1.50	1.70
B1	2.60	3.00
C	1.05	1.15
C1	0.03	0.15
C2	0.135	0.23
L	0.35	0.55
θ	0°	8°

SOT23-3



Size Symbol	Min(mm)	Typ(mm)	Max(mm)
A	2.70	2.90	3.10
A1	1.70	1.90	2.10
A2			0.60
e	0.85	0.95	1.05
b	0.30	0.40	0.50
B	1.50	1.60	1.80
B1	2.60	2.80	3.00
C	1.00	1.10	1.20
C1			0.10
C2	0.02		0.08
L1	0.20		0.55
L2		0.60	
θ	0°		15°

12 Important Statement

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13 Revision History

Date	Version Number	Revision Notes
2026/05/07	R1.7	Update package information
2026/06/10	R1.8	Update thermal resistance information
2026/08/05	R1.9	Update Applications
2026/09/08	R2.0	Update LNR