CR2503

LDO

Data Sheet

500nA I_Q, 300mA Low-Dropout Linear Regulator

Version: V1.3

2024/11 version 1.3

1. General Description

The CR2503 ultra-low quiescent current regulator features low dropout voltage and low current in the standby mode. With less than 500nA quiescent current at no load, the CR2503 is ideally suited for standby micro-control-unit systems, especially for always-on applications like portable, and other battery-operated systems. The CR2503 retains all the features that are common to low dropout regulators including a low dropout PMOS pass device, short circuit protection, and thermal shutdown.

The CR2503 has a 6V maximum operating voltage limit, a -40°C to 125°C junction operating temperature range, and ±2% output voltage tolerance. The CR2503 is available in SOT23-3 and SOT23-5 surface mount packages.

2. Ordering Information

Part Number	Package	XX: Voltage
CR2503_XX_233A	SOT23-3	33 : 3.3V
CR2503_XX_235	SOT23-5	

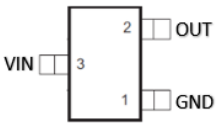
3. Features

- VIN Range up to 6V
- Output Voltage Tolerances of ±2%
- Output Current of 300mA
- Ultra Low Quiescent Current (IQ = 500nA)
- Dropout Voltage Typically 500mV at IOUT = 300mA
- Internal Thermal Overload Protection
- Internal Short-Circuit Current Limit
- Ceramic Capacitor Stable

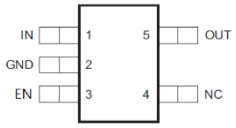
4. Applications

- Portable, Battery Powered Equipment
- Ultra Low Power Microcontroller
- Notebook computers

5. Pin Configuration

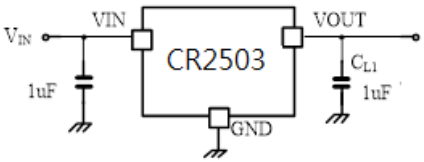


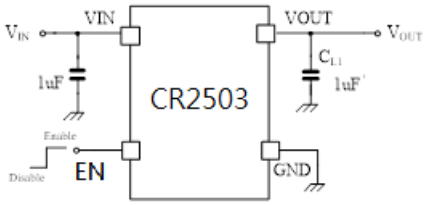
SOT23-3



SOT23-5

6. Typical Application Circuit





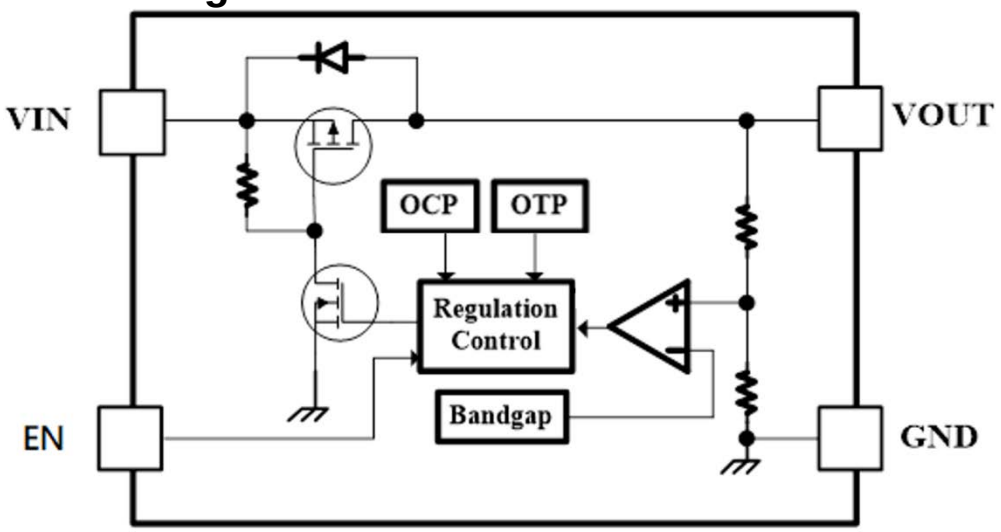
Stable with ceramic capacitor

7. List of Contents

8. Pin Assignment

Pin Name	Pin No. SOT23-3	Pin No. SOT23-5	Pin Function
VOUT	2	5	Output Voltage Pin
GND	1	2	Ground
VIN	3	1	Input Voltage pin.
EN	--	3	Enable

9. Function Block Diagram



10. Absolute Maximum Ratings (Note1)

- VIN ---------- -0.3V to +6.5V
- Power Dissipation, PD@TA=25°C, SOT23-3----------0.4W
- Thermal Resistance, θJA, SOT23-3----------250°C/W
- Power Dissipation, PD@TA=25°C, SOT23-5----------0.45W
- Thermal Resistance, θJA, SOT23-5----------218.1°C/W
- Junction Temperature---------- 125°C
- Lead Temperature (Soldering, 10 sec.)---------- 300°C
- Storage Temperature ---------- -65°C to 150°C

11. Recommended Operating Conditions

- Input Voltage, VIN ---------- +2.5V to +6V
- Junction Temperature ---------- -40°C to 125°C
- Ambient Temperature---------- -40°C to 85°C

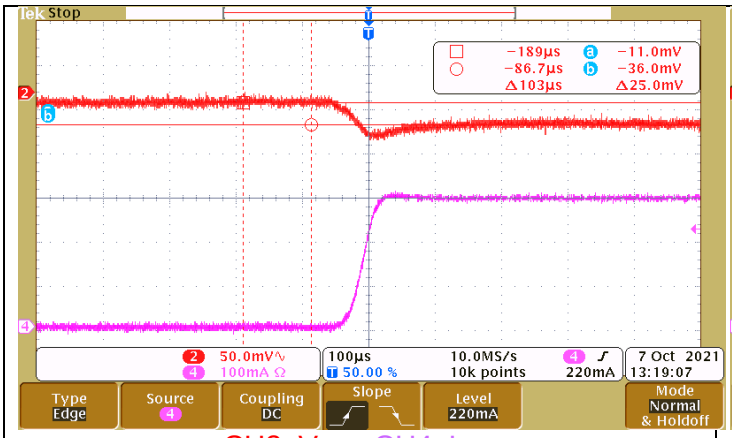
12. Electrical Characteristics

V_{IN} = V_{OUT} + 1V, I_{OUT} = 1mA, C_{IN} = C_{OUT} = 1uF, T_J = 25℃, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Ma	Units
Output Voltage Accuracy	$\triangle V_{OUT}$		-2%		2%	V
Line Regulation	$\triangle V_{LINE}$	V_{IN} = V_{OUT} + 1V to 5.5V, V_{OUT}=3.3V		0.6	1.5	%
Load Regulation	$\triangle V_{LOAD}$	I_{OUT} = 1mA to 150mA, V_{OUT}=3.3V			1	%
		I_{OUT} = 1mA to 300mA, V_{OUT}=3.3V			3	
Dropout Voltage	V_{DROP}	I_{OUT} = 100mA, V_{OUT} = 3.3V		130		mV
		I_{OUT} = 300mA, V_{OUT} = 3.3V		500		mV
Quiescent Current	I_Q	T_J= 25°C		0.5	1	uA
Current Limit	I_{CL}		360	560		mA
Enable high level	V_{ENHI}		0.6			V
Enable low level	V_{ENLO}				0.2	V
Power-supply rejection ratio	PSRR	f = 1kHz		60		dB
Thermal Shutdown	T_{SD}			150		°C
Thermal Shutdown Hy	T_{SDHY}			20		°C

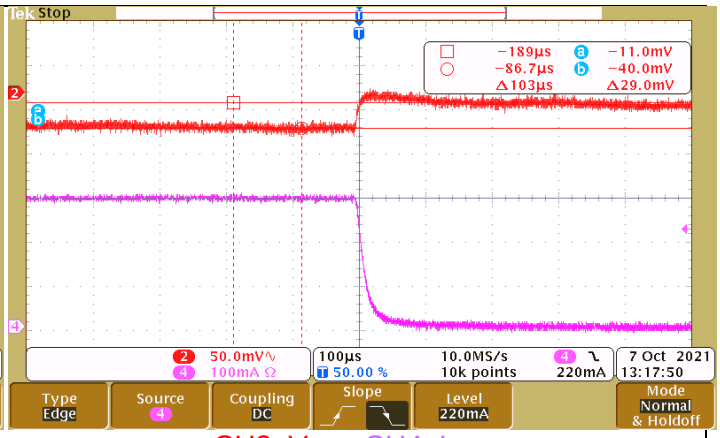
13. Typical Characteristics

V_{IN} = V_{OUT} + 1V, I_{OUT} = 1mA, V_{OUT} = 3.3V, C_{IN} = C_{OUT} = 1uF, T_J = 25℃, unless otherwise specified



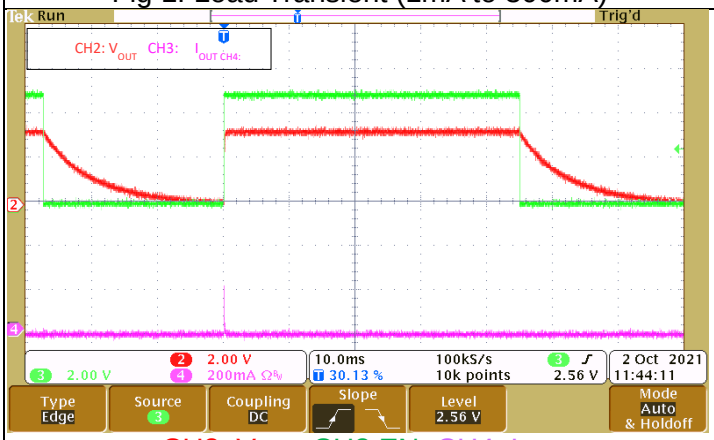
CH2: V_{OUT}, CH4: I_{OUT}

Fig 1. Load Transient (1mA to 300mA)



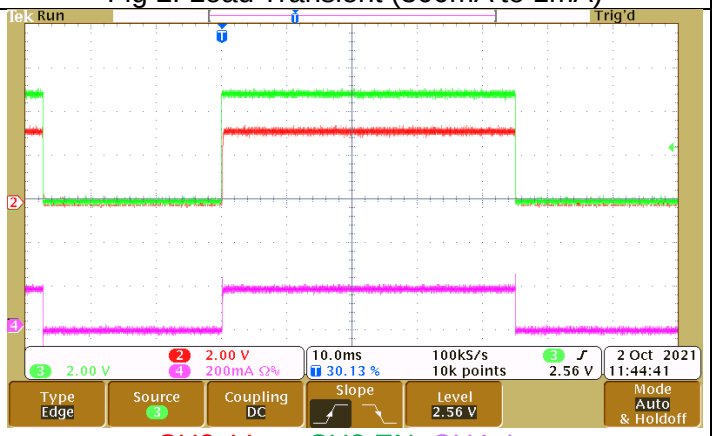
CH2: V_{OUT}, CH4: I_{OUT}

Fig 2. Load Transient (300mA to 1mA)



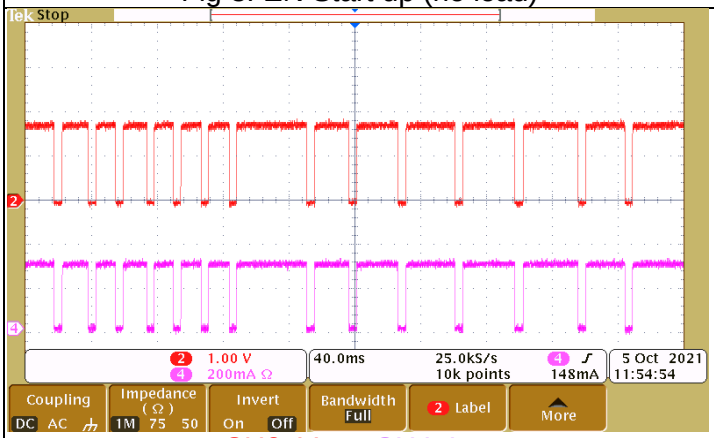
CH2: V_{OUT}, CH3:EN, CH4: I_{OUT}

Fig 3. EN Start up (no load)



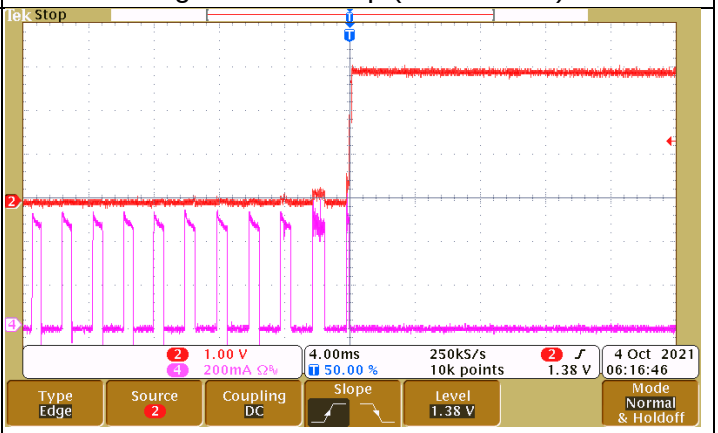
CH2: V_{OUT}, CH3:EN, CH4: I_{OUT}

Fig 4. EN Start up (200mA load)



CH2: V_{OUT}, CH4: I_{OUT}

Fig 5. V_{IN} = 5V, V_{OUT} = 1.8V, heavy load OTP



CH2: V_{OUT}, CH4: I_{OUT}

Fig 6. V_{OUT} short to GND and release

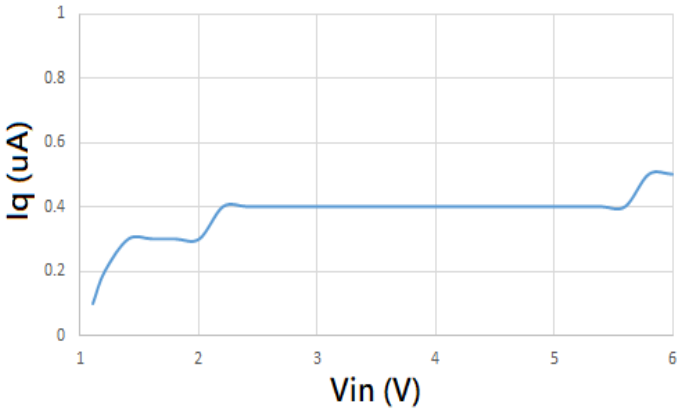


Fig 7. I_Q vs V_{IN} (I_{OUT} = 0mA)

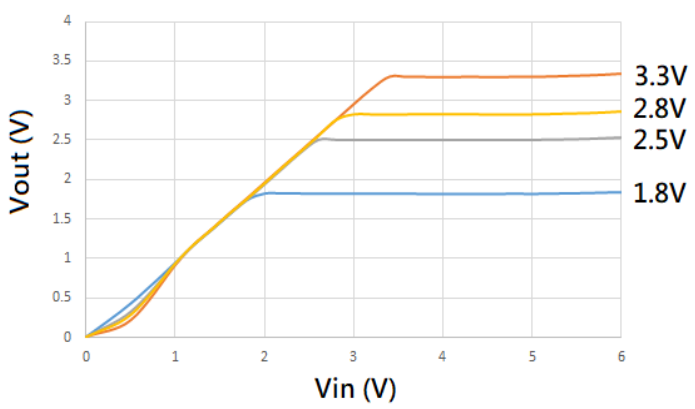


Fig 8. V_{OUT} vs V_{IN} (I_{OUT} = 1mA)

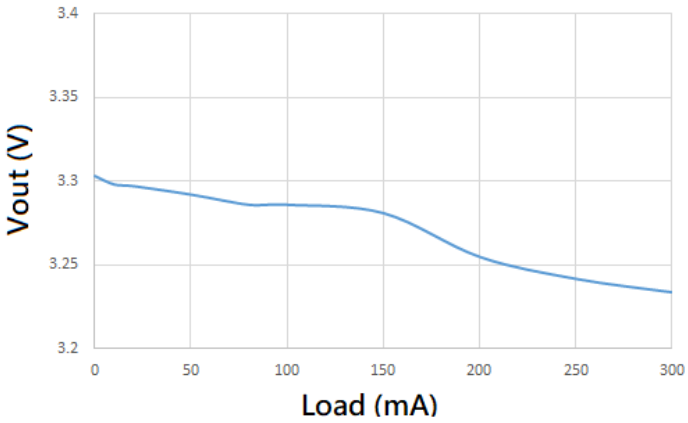


Fig 9. V_{OUT} vs Load

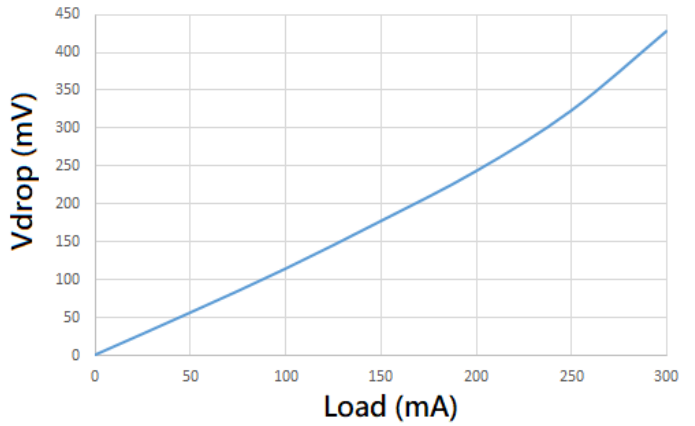


Fig 10. V_{DROP} vs Load

14. IC Operation Information

14.1. Basic Operation

The CR2503 is a high performance positive low dropout (LDO) regulator designed for applications requiring very low dropout voltage, ultra-high Power Supply Ripple Rejection (PSRR), low noise and low quiescent current that can supply up to 300mA output current. The input voltage range is from 2.5V to 6V. The CR2503 features a precise 2% output regulation. The output voltage is available from 1.2V to 5.0V in 100mV steps.

The minimum required output capacitance for stable operation is 1uF (X5R or X7R) effective capacitance after consideration of the temperature and voltage coefficient of the capacitor.

14.2. Enable and Shutdown Operation

The CR2503 goes into shutdown mode when the EN pin is in a logic low condition. In this condition, the pass transistor, error amplifier, and bandgap are all turned off, reducing the supply current to only 0.1uA (max.). If the shutdown mode is not required, the EN pin can be directly tied to VIN pin to keep the LDO on.

14.3. Over-Temperature Protection (OTP)

The over-temperature protection function will turn off the P-MOSFET when the junction temperature exceeds 150℃ (typ.). Once the junction temperature cools down by approximately 20℃ (typ.), the regulator will automatically resume operation.

14.4. Current-limit Protection

The CR2503 provides current limit function to prevent the device from damages during overload or shorted-circuit condition. This current is detected by an internal sensing transistor.

14.5. Error Amplifier

The Error Amplifier compares the internal reference voltage with the output feedback voltage from the internal divider, and controls the Gate voltage of P-MOSFET to support good line regulation and load regulation at output voltage.

14.6. Output Automatic Discharge

The CR2503 output employs an internal 2KΩ(typ.) pulldown resistance to discharge the output when the EN pin is low, and the device is disabled.

15. IC Application Information

Like any low dropout linear regulator, the CR2503's external input and output capacitors must be properly selected for stability and performance. Use a 1μF (X5R or X7R) or larger input capacitor and place it close to the IC's VIN and GND pins. Any output capacitor meeting the minimum 1mΩ ESR (Equivalent Series Resistance) and effective capacitance larger than 1μF (X5R or X7R) requirement may be used. Place the output capacitor close to the IC's VOUT and GND pins. Increasing capacitance and decreasing ESR can improve the circuit's PSRR and line transient response.

15.1. Enable Operation

The CR2503 has an EN pin to turn on or turn off the regulator, When the EN pin is in logic high, the regulator will be turned on. The

shutdown current is almost 0μA typical. The EN pin may be directly tied to VIN to keep the part on. The Enable input is CMOS logic and cannot be left floating.

15.2. Current Limit

The CR2503 contains an independent current limiter, which monitors and controls the pass transistor's gate voltage, limiting the output current to 0.56A (typ.). The output can be shorted to ground indefinitely without damaging the part.

15.3. Dropout Voltage

The dropout voltage refers to the voltage difference between the VIN and VOUT pins while operating at specific output current. The dropout voltage V_{DROP} can also be expressed as the voltage drop on the pass-FET at specific output current (I_{RATED}) while the pass-FET is fully operating at ohmic region and the pass-FET can be characterized as an resistance $R_{DS(ON)}$. Thus the dropout voltage can be defined as ($V_{DROP} = V_{VIN} - V_{VOUT} = R_{DS(ON)} \times I_{RATED}$). For normal operation, the suggested LDO operating range is ($V_{VIN} > V_{VOUT} + 1V$) for good transient response and PSRR ability. Conversely, operating at the ohmic region will degrade these performance severely.

15.4. Minimum Operating Input Voltage (VIN)

The CR2503 does not include any dedicated UVLO circuitry. The CR2503 at least 2.5V. The output voltage is not regulated until VIN has reached at least the greater of 2.5 V or (VOUT + 0.2V)

15.5. Thermal Considerations

For continuous operation, do not exceed absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. The maximum power dissipation can be calculated by the following formula :

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

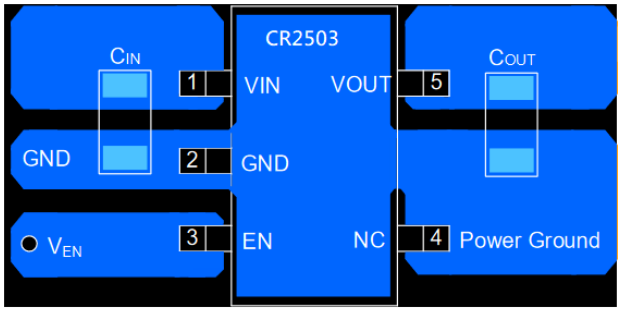
$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$ where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction to ambient thermal resistance. For recommended operating condition specifications the maximum junction temperature is 125°C and T_A is the ambient temperature. For SOT235 package, the thermal resistance, θ_{JA}, is 218.1°C/W on a standard JEDEC 51-7 four-layer thermal test board. The maximum power dissipation at T_A = 25°C can be calculated by the following formula :

$P_{D(MAX)}$ = (125°C − 25°C) / (218.1°C/W) = 0.45W for SOT235 package The maximum power dissipation depends on the operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance, θ_{JA}.

15.6. Layout Considerations

The dynamic performance of the CR2503 is dependent on the layout of the PCB. PCB layout practices that are adequate for typical LDOs may degrade the PSRR, noise, or transient performance of the CR2503. Best performance is achieved by placing CIN and COUT on the same side of the PCB as the CR2503, and as close to the package as possible is practical. The ground connections for C_{IN} and C_{OUT} must be back to the CR2503

ground pin using a copper trace as wide and short as possible. Connections using long trace lengths, narrow trace widths, and/or connections through vias must be avoided. These added parasitic inductances and resistance may result in inferior performance especially during transient conditions.

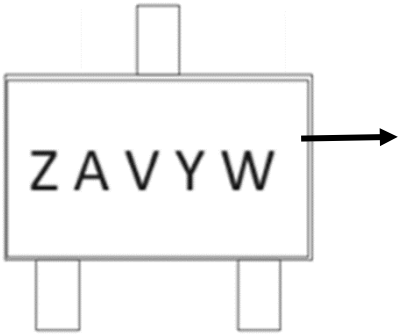


GND Pin (2) connect to second layer ground path by Via to increase cooling area directly.

SOT-23-5

16. Ordering & Marking Information

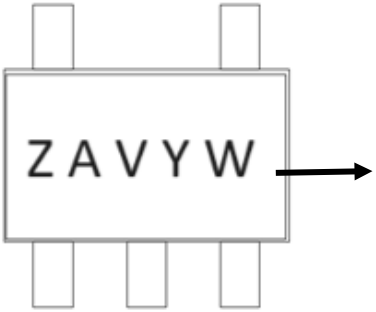
Device Name: CR2503 for SOT23-3



Device Name: ZA
YW: Date Code

V	Output Voltage
3	3.3V

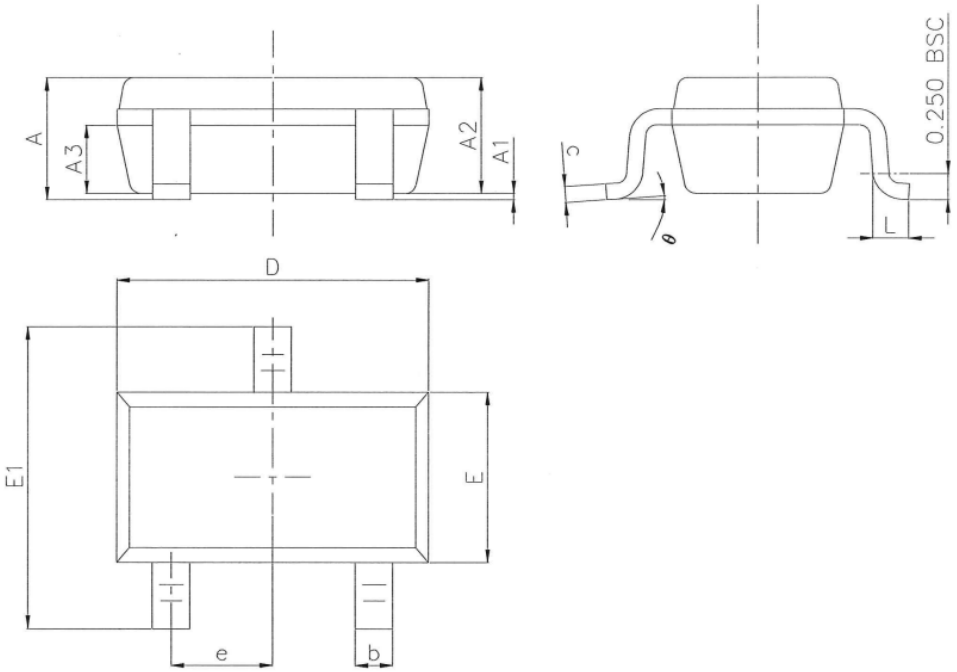
Device Name: CR2503 for SOT23-5



Device Name: ZA
YW: Date Code

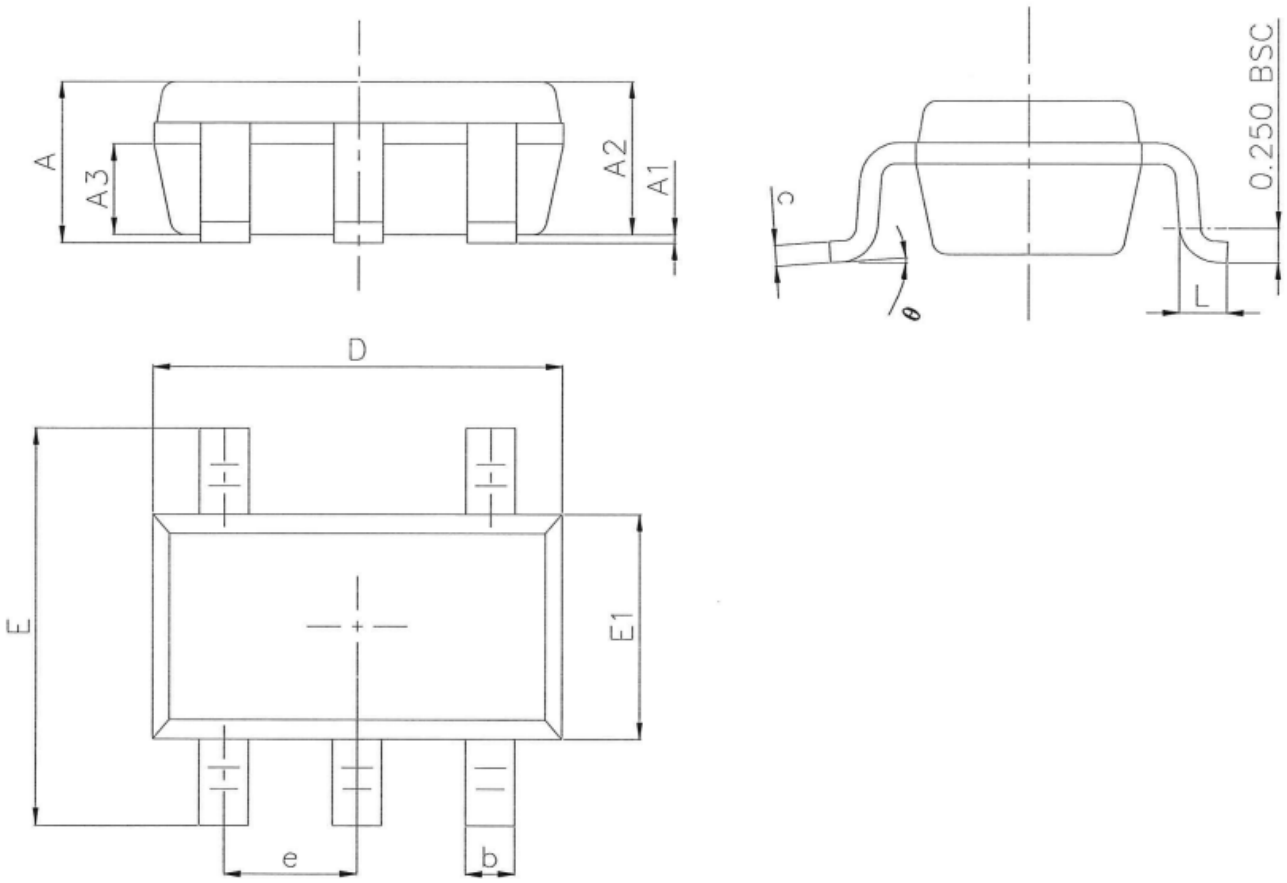
17. Package Information

17.1. SOT23-3



Symbol	Dimension in mm			Dimension in inch		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.050	1.150	1.250	0.041	0.045	0.049
A1	0.000	0.060	0.100	0.000	0.002	0.004
A2	1.000	1.100	1.200	0.039	0.043	0.047
A3	0.550	0.650	0.750	0.022	0.026	0.030
D	2.820	2.920	3.020	0.111	0.115	0.119
E	1.510	1.610	1.700	0.059	0.063	0.067
E1	2.650	2.800	2.950	0.104	0.110	0.116
b	0.300	0.400	0.500	0.012	0.016	0.020
e	0.95BSC			0.037BSC		
θ	0°	4°	8°	0°	4°	8°
L	0.300	0.420	0.570	0.012	0.017	0.022
c	0.100	0.152	0.200	0.004	0.006	0.008

17.2. SOT23-5



Symbol	Dimension in mm			Dimension in inch		
	Min.	Min.	Nom.	Max.	Min.	Nom.
A	1.050	1.150	1.250	0.041	0.045	0.049
A1	0.000	0.060	0.100	0.000	0.002	0.004
A2	1.000	1.100	1.200	0.039	0.043	0.047
A3	0.550	0.650	0.750	0.022	0.026	0.030
D	2.820	2.920	3.020	0.111	0.115	0.119
E	2.650	2.800	2.950	0.104	0.110	0.116
E1	1.510	1.610	1.700	0.059	0.063	0.067
b	0.300	0.400	0.500	0.012	0.016	0.020
e	0.95BSC			0.037BSC		
θ	0°	4°	8°	0°	4°	8°
L	0.300	0.420	0.570	0.012	0.017	0.022
c	0.100	0.152	0.200	0.004	0.006	0.008

18. Revision History

Rev	Descriptions	Date
V1.1	Initial version preliminary released	2024/08/26
V1.2	1. Add Revision History table 2. Modify the errors in the minimum, maximum, and nominal dimensions. 3. Correct the order errors of dimensions **E1** and **E**.	2024/11/08
V1.3	Update document Layout Configuration	2024/11/27

19. Disclaimers

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