DESCRIPTION

The A6110 is a low-dropout regulator that operates the input voltage from 2.5V to 6V and delivers 1 A load current. The A6110 is available in two types, either fixed or adjustable output voltage. The output voltage of the fixed types is preset at an internally trimmed voltage 1V, 1.2V, 1.3V, 1.5V, 1.8V, 2.5V, 2.7V, 2.8V, 2.85V, 3.0V, 3.2V, 3.3V, 5V or can be made with options of the output range from 1V to 5V in 50mV increments. The output range of adjustable types is from 1V to 5V. The adjustable output voltage is only available in SOT-89-5 package.
The A6110 consists of a voltage reference unit, an error amplifier, resistor net for setting output voltage, a current limit circuit for over-current and a thermal-shutdown circuit.
A standby mode with ultra low supply current can be realized with the chip enable function.
The A6110 is available in DFN-6, SOT-89-5, SOT-89-3, SOT-223-5, SOT-223-3, TO-263-3, TO-220-3, TO-252-3 and TO-252-5 packages.

ORERING INFORMATION

Package Type	Part Number	
DFN-6	J6	A6110J6R-XX
		A6110J6VR-XX
SOT-89-5	K5	A6110K5R-XXZ
		A6110K5VR-XXZ
SOT-89-3	K3	A6110K3R-XXZ
		A6110K3VR-XXZ
SOT-223-5	N5	A6110N5R-XX
		A6110N5VR-XX
SOT-223-3	N	A6110NR-XXZ
		A6110NVR-XXZ
TO-263-3	S3	A6110S3R-XXZ
		A6110S3VR-XXZ
TO-220-3	T3	A6110T3U-XX
		A6110T3VU-XX
TO-252-3	D3	A6110D3R-XXZ
		A6110D3VR-XXZ
TO-252-5	D5	A6110D5R-XX
		A6110D5VR-XX
Note	XX: Output Voltage 25=2.5V, 33=3.3V V: Green Package Z: Package Type see pin description R: Tape & Reel	
AiT provides all Pb free products Suffix " V " means Green Package		

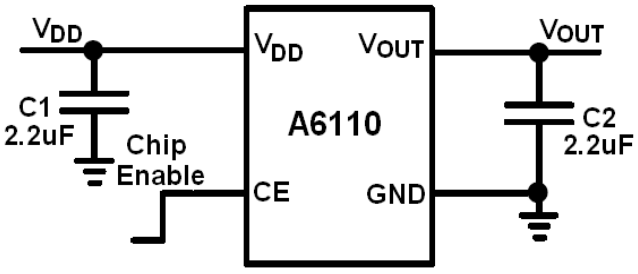
FEATURES

- Up to 1A Output Current
- 65uA Operating Supply Current
- Excellent Line Regulation: 0.05%/V
- Low Dropout: 300mV@1A(V_{OUT}=3.3V)
- High Power Supply Rejection Ratio
- Wide Operating Voltage Range: 2.5V to 6.0V
- High Accuracy:±2%
- Built-in Auto Discharge Function
- 500mA in-rush Current Limit
- Fold-back Current Limit Protection
- Thermal Shutdown Protection
- Available in DFN-6, SOT-89-5, SOT-89-3, SOT-223-5, SOT-223-3, TO-263-3, TO-220-3, TO-252-3 and TO-252-5 packages.

APPLICATION

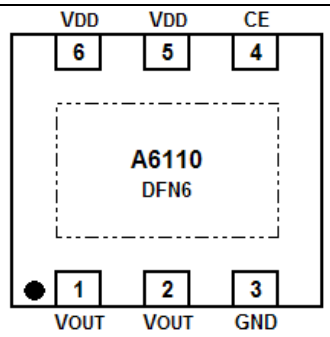
- Portable Communication Equipment
- Battery-Powered Equipment
- Laptop, Palmtops, Notebook Computers
- Hand-Held Instruments
- PCMCIA Cards and Wireless LAN
- Cameras & VCRs

TYPICAL APPLICATION

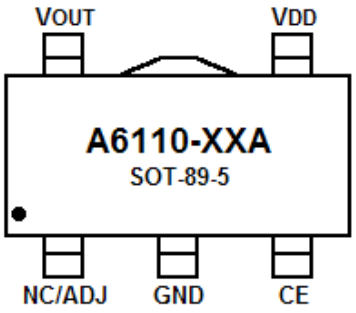


A6110 in Fixed Output Voltage Version

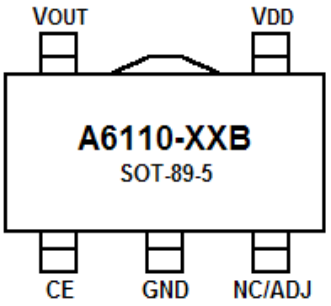
PIN DESCRIPTION



Top View



Top View



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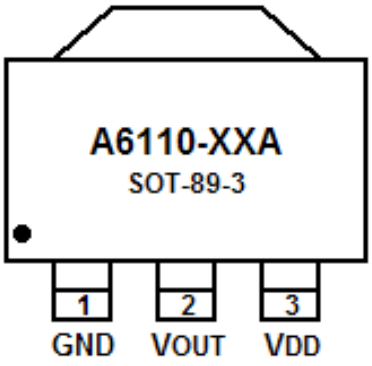

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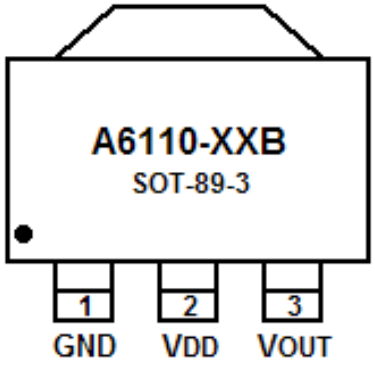

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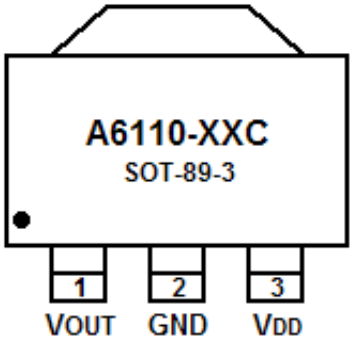
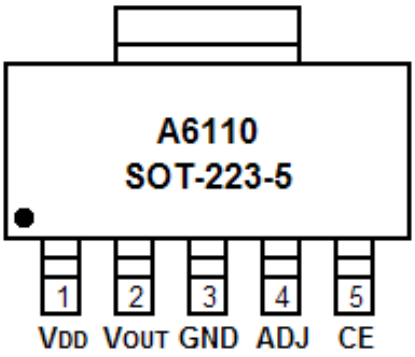
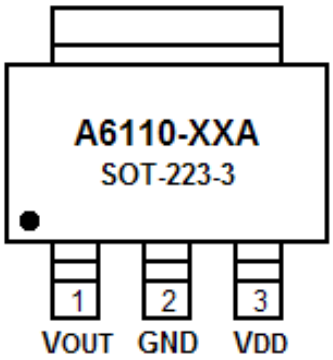


Top View

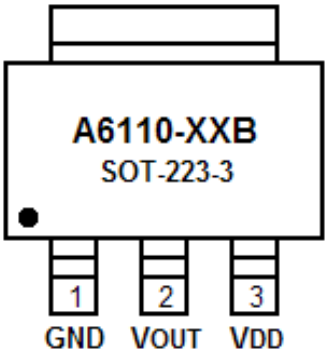
Pin Number						Symbol	Functions
DFN6	SOT-89-5		SOT-89-3				
	A	B	A	B	C		
1,2	5	5	2	3	1	V_{OUT}	Output Pin
3	2	2	1	1	2	GND	Ground Pin
4	3	1	-	-	-	CE	Chip Enable Pin (High active)
5,6	4	4	3	2	3	V_{DD}	Input Pin
-	1	3	-	-	-	ADJ/ NC	Adjustable/ Fixed Output Voltage



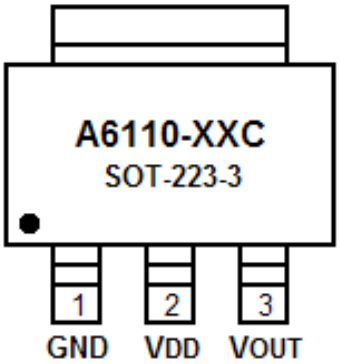
Top View



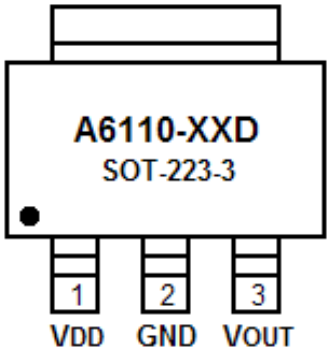
Top View



Top View

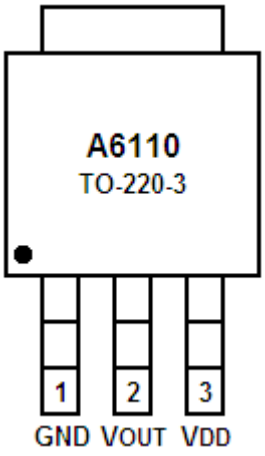


Top View

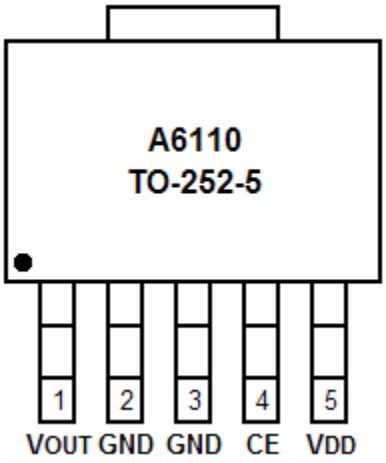


Top View

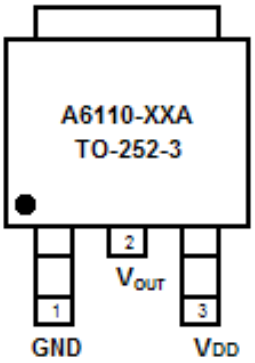
Pin Number					Symbol	Functions
SOT-223-5	SOT-223-3					
	A	B	C	D		
2	1	2	3	3	V_{OUT}	Output Pin
3	2	1	1	2	GND	Ground Pin
5	-	-	-	-	CE	Chip Enable Pin (High active)
1	3	3	2	1	V_{DD}	Input Pin
4	-	-	-	-	ADJ	Adjustable



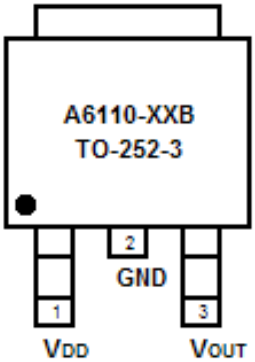
Top View



Top View

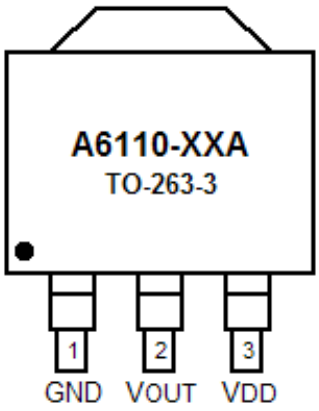
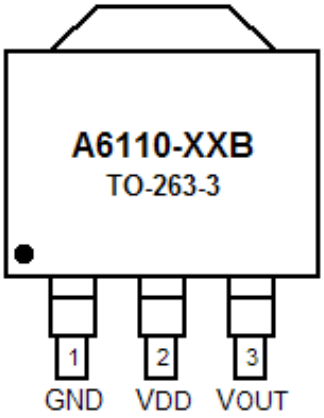
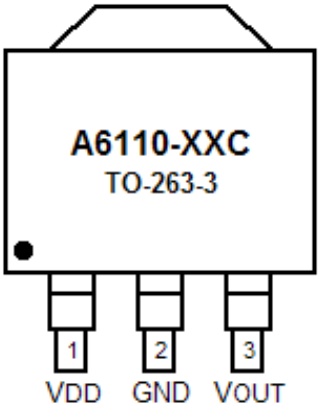


Top View



Top View

Pin Number				Symbol	Functions
TO-220-3	TO-252-5	TO-252-3			
		A	B		
2	1	2	3	V_{OUT}	Output Pin
1	2,3	1	2	GND	Ground Pin
-	4	-	-	CE	Chip Enable Pin (High active)
3	5	3	1	V_{DD}	Input Pin

 Top View	 Top View	 Top View

Pin Number			Symbol	Functions
TO-263-3				
A	B	C		
2	3	3	V_{OUT}	Output Pin
1	1	2	GND	Ground Pin
3	2	1	V_{DD}	Input Pin

ABSOLUTE MAXIMUM RATINGS

V_{DD}, Input Supply Voltage	-0.3V to +7V
CE Input Voltage	-0.3V to +7V
Output Voltage	-0.3V to V_{IN}+0.3V
Output Current	1.4A
Maximum Junction Temperature	125°C
Operating Temperature Range NOTE1	-40°C to 85°C
Storage Temperature Range	-65°C to 125°C
Lead Temperature (Soldering, 10s)	300°C

Stresses above 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 in the Electrical Characteristics are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

NOTE1: The A6110 is guaranteed to meet performance specifications from 0°C to 70°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with statistical process controls.

THERMAL RESISTANCE

Package	θ_{JA}	θ_{JC}
DFN-6	95°C/W	10°C/W
SOT-89-5	160°C/W	45°C/W
TO-252-5	90°C/W	10°C/W
SOT-223-5	160°C/W	20°C/W
TO-252-3	90°C/W	10°C/W
SOT-223-3	160°C/W	20°C/W
TO-263-3	65°C/W	7°C/W
TO-220-3	50°C/W	7°C/W
SOT89-3	180°C/W	50°C/W

NOTE: Thermal Resistance is specified with approximately 1 square of 1 oz copper.

ELECTRICAL CHARACTERISTICS

V_{DD}=V_{OUT}+1V, if V_{OUT}<1.5V, V_{DD}=2.5V, CE=V_{DD}, C_{IN}=2.2μF, C_{OUT}=2.2μF, T_A=25°C, unless otherwise specified.

Parameter		Symbol	Conditions	Min	Typ	Max	Units
Input Voltage		V_{DD}		2.5	-	6	V
Output Voltage		-		1	-	5	V
Current Limit		I_{LIM}		-	1.0	-	A
Short Circuit Current		I_{SCC}	V_{OUT}=0	-	250	-	mA
Quiescent Current		IQ	V_{CE}>1.2V, I_{OUT}=0mA	-	65	120	μA
Standby Current		I_{STBY}	V_{CE}=GND, Shutdown	-	0.01	1	μA
Dropout Voltage		V_{DROP}	I_{OUT}=300mA, V_{OUT}=3.3V	-	90	-	mV
			I_{OUT}=1A, V_{OUT}=3.3V	-	300	-	
Line Regulation NOTE1		ΔV_{LINE}	V_{DD}=V_{OUT}+0.5V to 6.0V I_{OUT}=100mA	-	0.05	0.2	%/V
Load Regulation NOTE2		ΔV_{LOAD}	V_{DD}=V_{OUT}+0.3V, 1mA≤I_{OUT}≤1A	-	20	-	mV
Output Voltage NOTE3 Temperature Coefficient		TC_{VOUT}	I_{OUT}=100mA, -40°C≤T≤85°C	-	±100	-	ppm/°C
CE Input Threshold	Logic Low	V_{IL}	V_{DD}=3V to 5.5V, Shutdown	-	-	0.4	V
	Logic High	V_{IH}	V_{DD}=3V to 5.5V, Start up	1.0	-	-	V
CE Pull-down Resistance		R_{CE}		-	5	-	MΩ
Output Noise Voltage		e_{NO}	10Hz to100KHz, I_{OUT}=1mA	-	45	-	μV_{RMS}
Power Supply Rejection Ratio	f=1kHz (V_{OUT}≤3.3V)	PSRR	0.2V_{P-P} Ripple, I_{OUT}=100mA	-	70	-	dB
	f=1kHz (V_{OUT}>3.3V)			-	60	-	
Thermal Shutdown Temperature		T_{SD}	Shutdown, Temp increasing	-	165	-	°C
Thermal Shutdown Hysteresis		T_{SDHY}		-	30	-	°C
Output Discharge Resistance		R_{DSC}		-	50	-	Ω

NOTE1: Line regulation is calculated by $DV_{LINE} = \Delta V_{LINE} = [(V_{OUT1} - V_{OUT2})/ (\Delta V_{DD} \times V_{OUT})] \times 100$

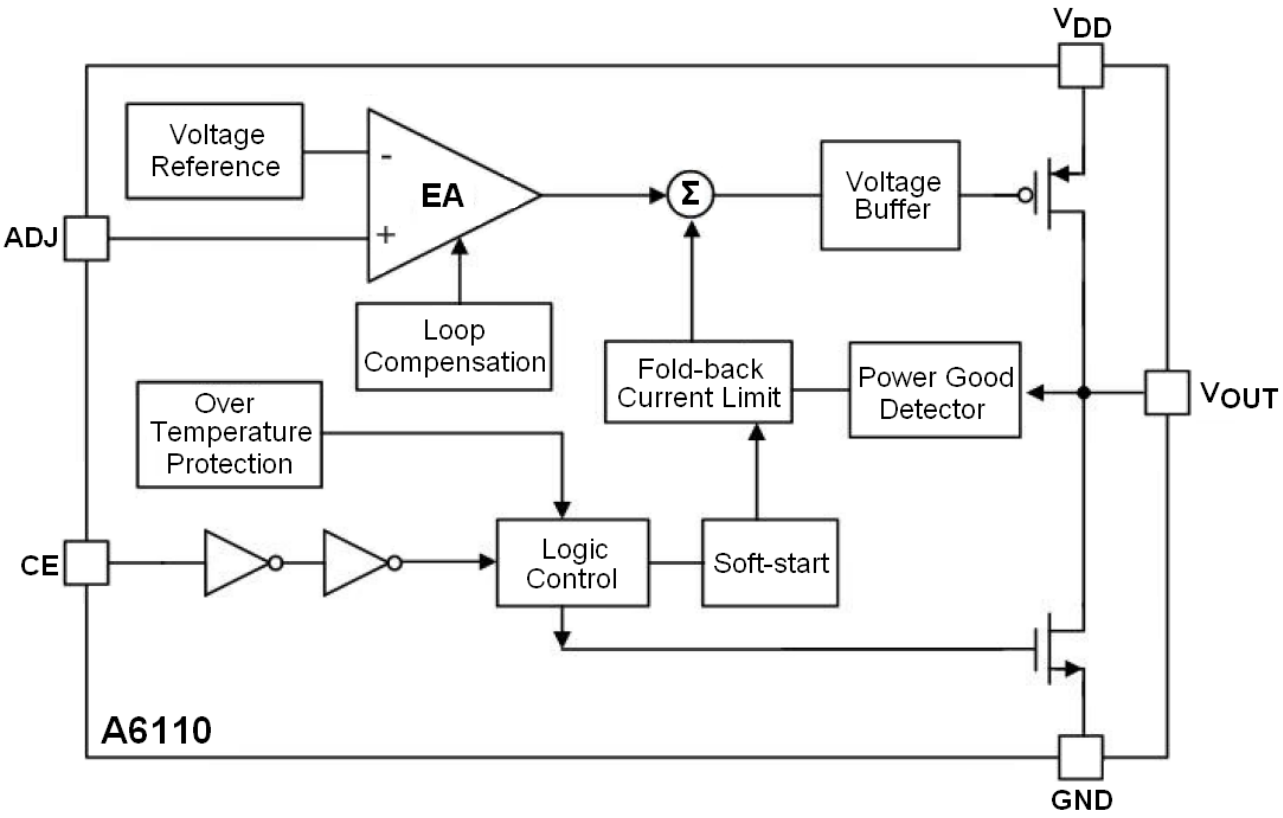
Where V_{OUT1} is the output voltage when V_{DD1}=6.0V, and V_{OUT2} is the output voltage when V_{DD2}=V_{OUT}+0.5V, ΔV_{DD}=V_{DD1}-V_{DD2}. V_{OUT} is the normal output voltage, e.g. V_{OUT}=2.8V for 2.8V fixed output version.

NOTE2: Load regulation is calculated by $V_{LOAD} = V_{OUT1} - V_{OUT2}$

Where V_{OUT1} is the output voltage when I_{OUT1}=1mA, and V_{OUT2} is the output voltage when I_{OUT2}=1A.

NOTE3: The temperature coefficient is calculated by $TC_{VOUT} = V_{OUT}/ (\Delta T \times \Delta V_{OUT})$

BLOCK DIAGRAM



DETAILED INFORMATION

The A6110 is a low dropout CMOS-based positive voltage regulator that operates the input voltage from +2.5V to 6.0V. Output voltages are optional ranging from 1.0V to 5.0V, and can supply current up to 1.0A.

Enable Function

The A6110 is shutdown by pulling the CE input low, and turn on by driving the input high. If this feature is not be used, the CE input should be floating or tied to V_{DD} to keep the regulator on at all times.

Programming the A6110 Adjustable LDO regulator

The A6110 is available in two types, either fixed or adjustable output voltage. The output range of the adjustable types is from 1V to 5V. The output voltage of the A6110 adjustable regulator is programmed using an external resistor divider as show in Figure as below. The output voltage is calculated using equation as below:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R1}{R2} \right)$$

Where: V_{REF}=1V typ (the internal reference voltage)

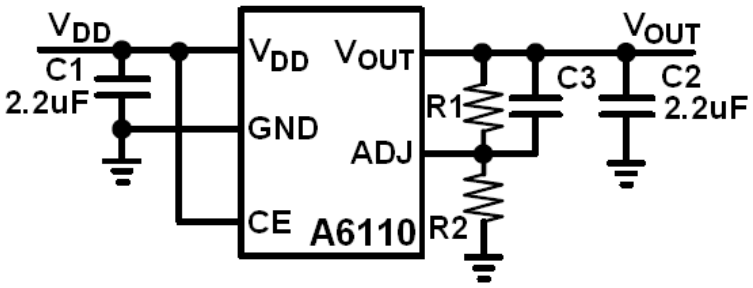
Resistors R1 and R2 should be chosen for approximately 50uA divider current. Lower value resistors can be used for improved noise performance, but the solution consumes more power. Higher resistor values should be avoided as leakage current at ADJ increases the output voltage error. The recommended design procedure is to choose R2=20KΩ to set the divider current at 50uA, C1=22pF for stability, and then calculate R1 using Equation as below:

$$R1 = \left(\frac{V_{OUT}}{V_{REF}} - 1 \right) \times R2$$

In order to improve the stability of the adjustable version, it is suggested that a small compensation capacitor be placed between V_{OUT} and ADJ. The suggested value of this capacitor for several resistor ratios is shown in the table below.

OUTPUT VOLTAGE PROGRAMMING GUIDE

OUTPUT VOLTAGTE	R1	R2	C3
1.8V	16kΩ	20kΩ	22pF
2.5V	30kΩ	20kΩ	22pF
3.3V	51kΩ	22kΩ	22pF
3.6V	62kΩ	24kΩ	22pF



A6110K5R Adjustable LDO regulator Programming

Thermal Protection

Thermal overload protection limits total power dissipation in the A6110. When the junction temperature exceeds T_J=165°C, the OTP circuit starts the thermal shutdown function and turn the pass element off allowing the IC to cool. The OTP circuit turn on the pass element again after IC's junction temperature cool by 30°C, result in a pulsed output during continuous thermal overload conditions. Thermal-overloaded protection is designed to protect the A6110 in the event of fault conditions. Do not exceed the absolute maximum junction temperature rating of T_J=125°C for continuous operation. The build-in fold-back current limit protection circuit will reduce current value as output voltage drops. When output is shorted to ground, current limit is reduced to 250mA, avoiding damaging the device.

Operating Region and Power Dissipation

The maximum power dissipation of A6110 depends on the thermal resistance of the case and circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow. The power

dissipation across the device is

$$P_D = (V_{DD}-V_{OUT}) \times I_{OUT} + V_{DD} \times I_Q$$

The maximum power dissipation is

$$P_D(MAX) = (T_J(MAX) - T_A) / \theta_{JA}$$

Where T_J (MAX) is the maximum operation junction temperature 125°C, T_A is the ambient temperature and the θ_{JA} is the junction to ambient thermal resistance. The GND pin of the A6110 performs the dual function of providing an electrical connection to ground and channeling heat away. Connect the GND pin to ground using a large pad or ground plane.

Capacitor Selection and Regulator Stability

Like any low-dropout regulator, the external capacitors used with the A6110 must be carefully selected for regulator stability and performance. The A6110 requires an output capacitor between the V_{OUT} and GND pins for phase compensation. Using a capacitor whose value is ≥1μF on the A6110 input and the amount of capacitance can be increased without limit. The input capacitor must be located a distance of not more than 0.5 inch from the input pin of the IC and returned to a clean analog ground. Any good quality ceramic or tantalum can be used for this capacitor. The capacitor with larger value and lower ESR (equivalent series resistance) provides better PSRR and line-transient response. The output capacitor must meet both requirements for minimum amount of capacitance and ESR in all LDOs applications. The A6110 is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. In the A6110, phase compensation is made with the output capacitor for securing stable operation even if the load current is varied. For this purpose, use a 2.2uF capacitor between V_{OUT} pin and GND pin as close as possible.

Load-Transient Considerations

The A6110 load-transient response graphs show two components of the output response: a DC shift from the output impedance due to the load current change, and the transient response. The DC shift is quite small due to the excellent load regulation of the IC. Typical output voltage transient spike for a step change in the load current from 0mA to 50mA is tens of mV, depending on the ESR of the output capacitor. Increasing the output capacitor's value and decreasing the ESR attenuates the overshoot.

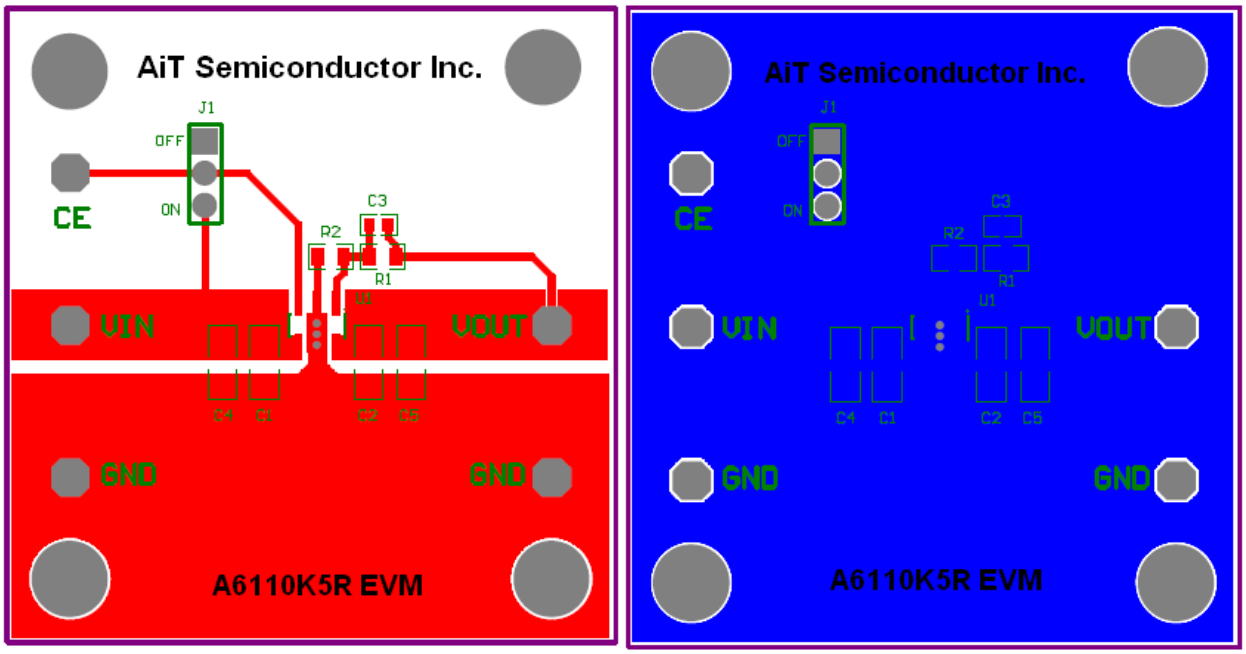
Input-Output (Dropout) Voltage

A regulator's minimum input-output voltage differential (or dropout voltage) determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. Because the A6110 uses a P-Channel MOSFET pass transistor, the dropout voltage is a function of drain-to-source on resistance [$R_{DS(ON)}$] multiplied by the load current.

Layout Considerations

To improve AC performance such as PSRR, output noise, and transient response, it is recommended that the PCB be designed with separate ground planes for V_{DD} and V_{OUT}, with each ground plane connected only at the GND pin of the device. Make V_{DD} and GND lines sufficiently wide. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 between V_{DD} and GND pin, as close as possible to the pins. Set external components, especially the output capacitor C2, as close as possible to the IC, and make wiring as short as possible.

A6110 SOT89-5 PCB Layout for Reference

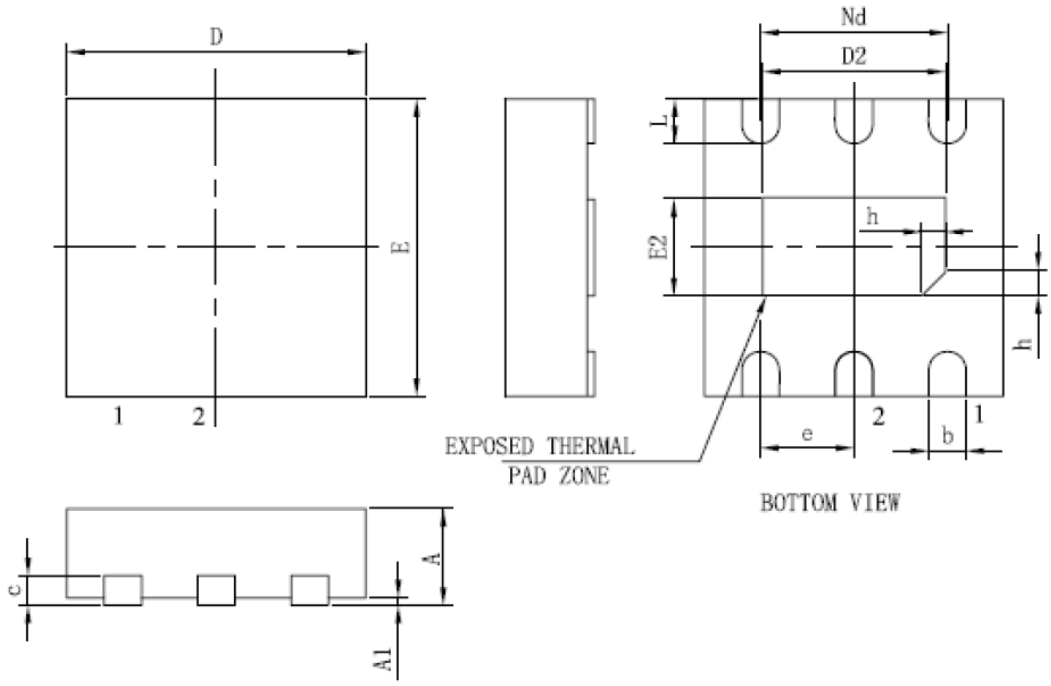


Top Layer

Bottom Layer

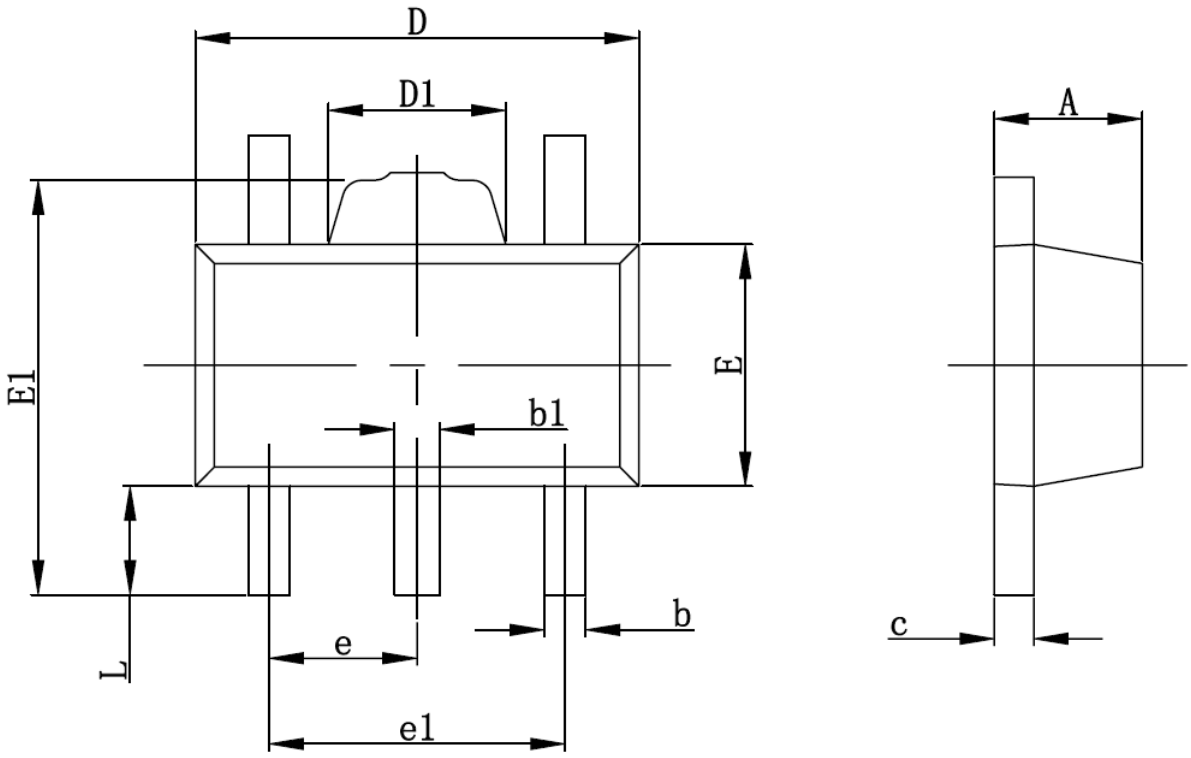
PACKAGE INFORMATION

Dimension in DFN-6 (Unit: mm)



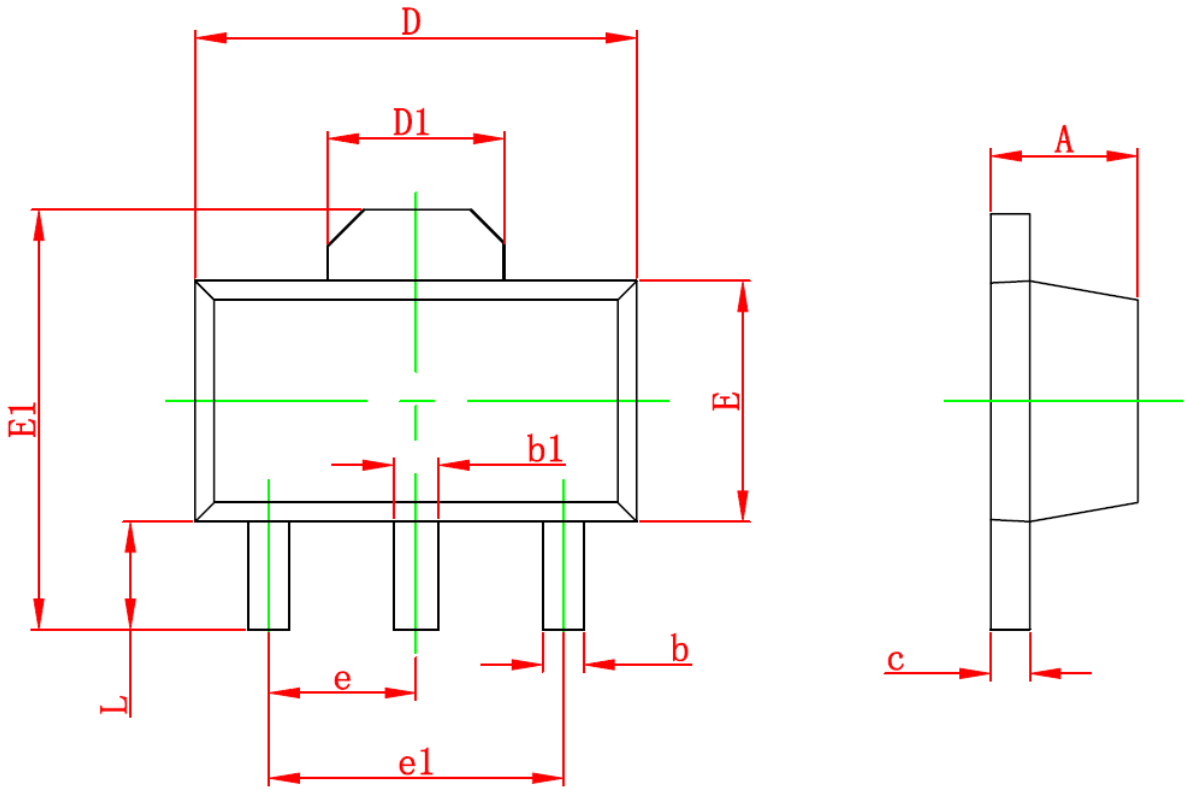
Symbol	Min	Max
A	0.7	0.8
A1	-	0.05
b	0.25	0.35
c	0.18	0.25
D	1.95	2.05
D2	1	1.45
e	0.65BSC	
Nd	1.30BSC	
E	1.95	2.05
E2	0.50	0.85
L	0.25	0.40
h	0.1	0.2

Dimension in SOT-89-5 (Unit: mm)



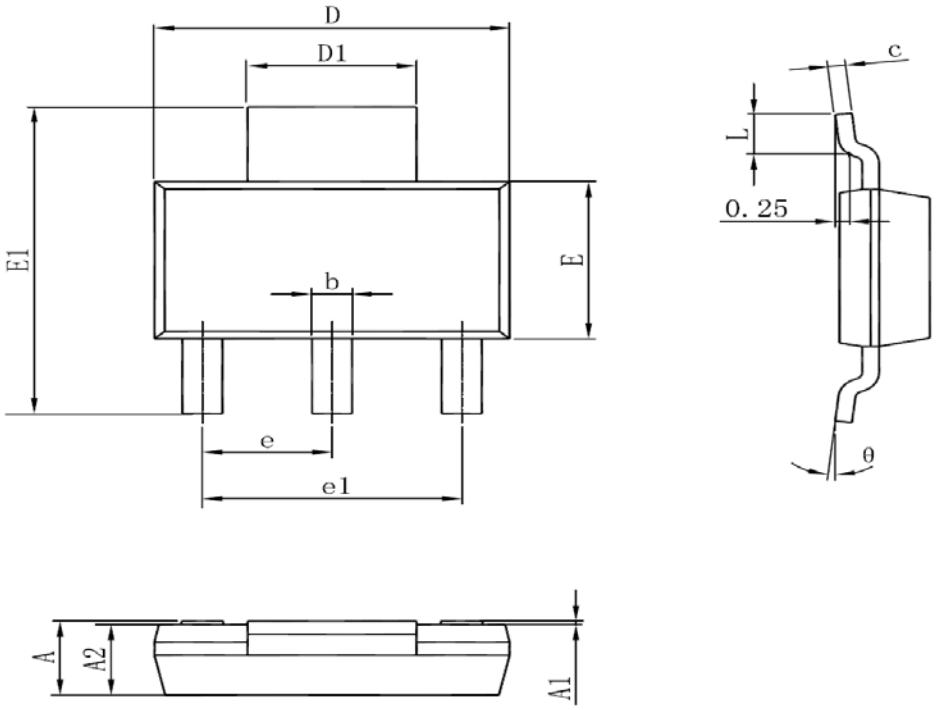
Symbol	Min	Max
A	1.400	1.600
b	0.320	0.520
b1	0.360	0.560
c	0.350	0.440
D	4.400	4.600
D1	1.400	1.800
E	2.300	2.600
E1	3.940	4.250
e	1.500 TYP	
e1	2.900	3.100
L	0.900	1.100

Dimension in SOT-89-3 (Unit: mm)



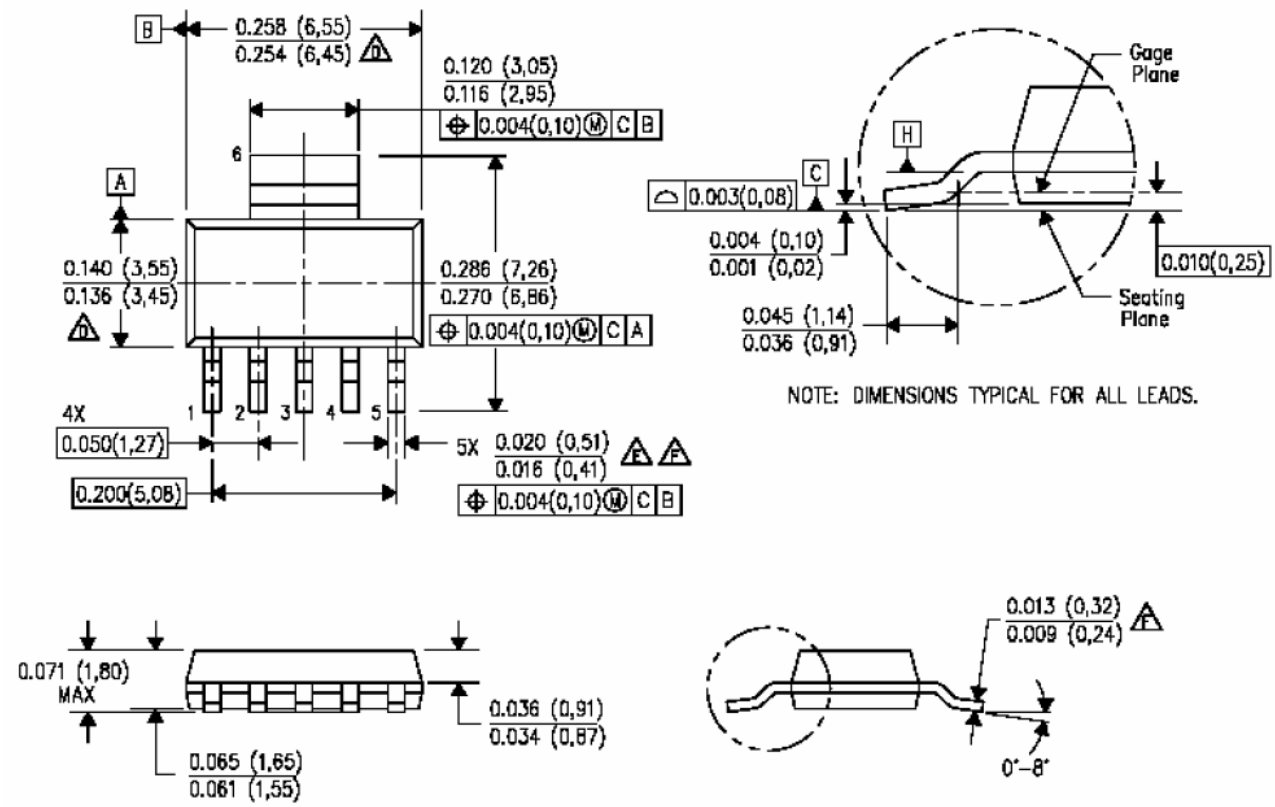
Symbol	Min	Max
A	1.400	1.600
b	0.320	0.520
b1	0.400	0.580
c	0.350	0.440
D	4.400	4.600
D1	1.550 REF	
E	2.300	2.600
E1	3.940	4.250
e	1.500 TYP	
e1	3.000 TYP	
L	0.900	1.200

Dimension in SOT-223-3 (Unit: mm)

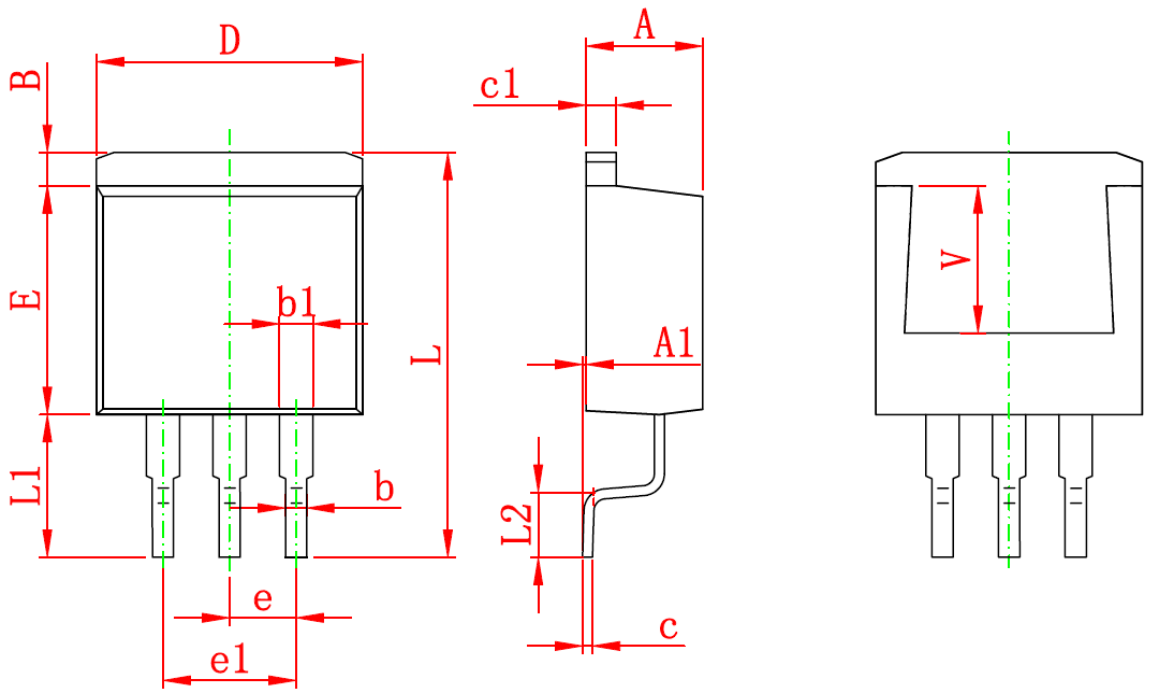


Symbol	Min	Max
A	1.520	1.800
A1	0.000	0.100
A2	1.500	1.700
b	0.660	0.820
c	0.250	0.350
D	6.200	6.400
D1	2.900	3.100
E	3.300	3.700
E1	6.830	7.070
e	2.300(BSC)	
e1	4.500	4.700
L	0.900	1.150
θ	0°	10°

Dimension in SOT-223-5 (Unit: mm)

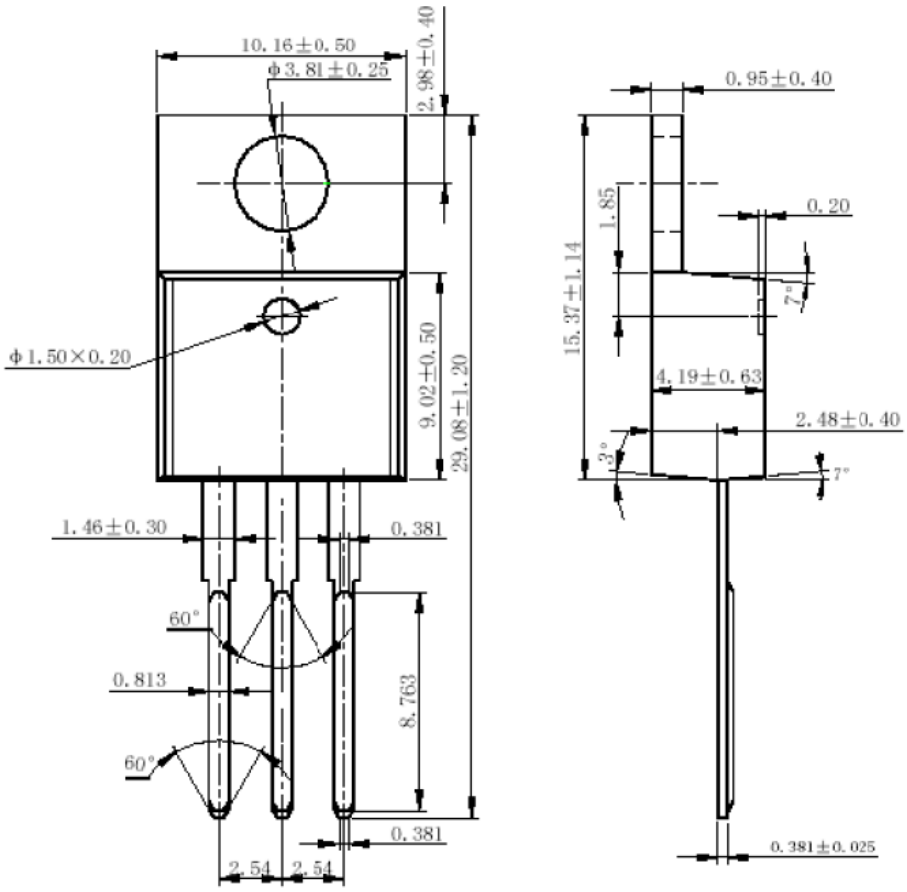


Dimension in TO-263-3 (Unit: mm)

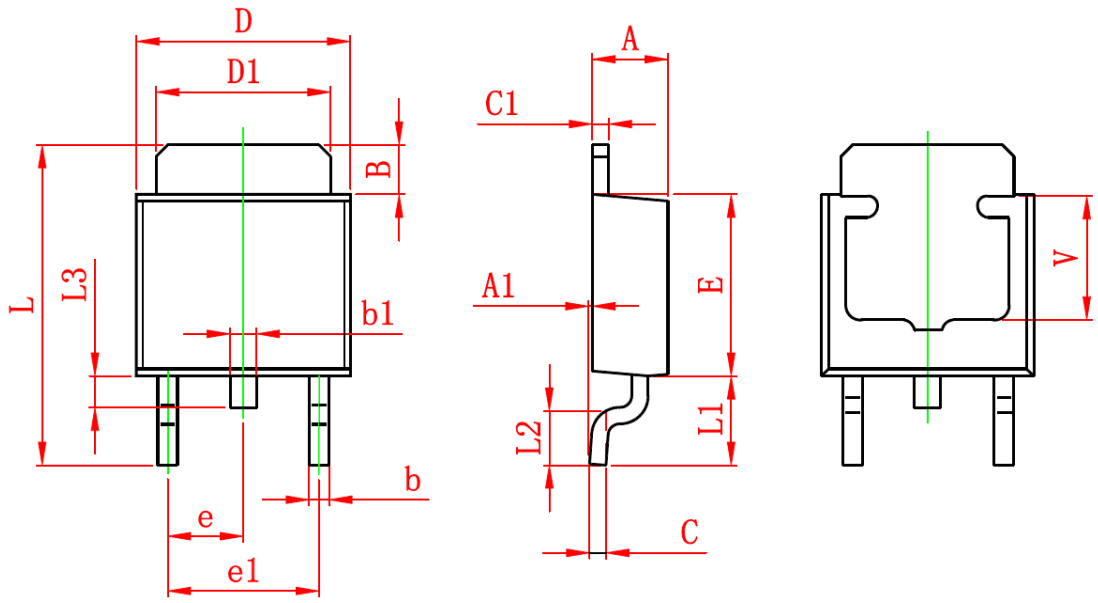


Symbol	Min	Max
A	4.470	4.670
A1	0.000	0.150
B	1.170	1.370
b	0.710	0.910
b1	1.170	1.370
c	0.310	0.530
c1	1.170	1.370
D	10.010	10.310
E	8.500	8.900
e	2.540 TYP	
e1	4.980	5.180
L	15.050	15.450
L1	5.080	5.480
L2	2.340	2.740
V	5.600 REF	

Dimension in TO-220-3 (Unit: mm)

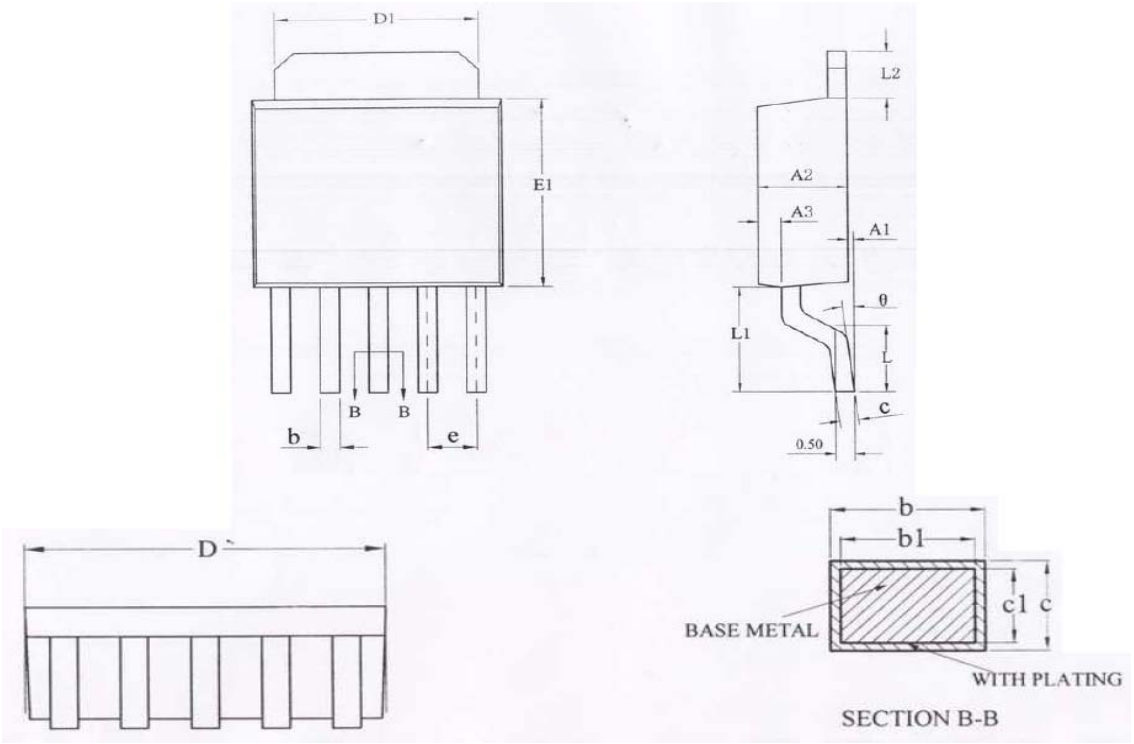


Dimension in TO-252-3 (Unit: mm)



Symbol	Min	Max
A	2.200	2.400
A1	0.000	0.127
B	1.350	1.650
b	0.500	0.700
b1	0.700	0.900
c	0.430	0.580
c1	0.430	0.580
D	6.350	6.650
D1	5.200	5.400
E	5.400	5.700
e	2.300 TYP.	
e1	4.500	4.700
L	9.500	9.900
L1	2.550	2.900
L2	1.400	1.780
L3	0.600	0.900
V	3.800 REF.	

Dimension in TO-252-5 (Unit: mm)



Symbol	Min	Max
A1	0.05	0.25
A2	2.1	2.5
A3	0.5	0.7
b	0.46	0.6
b1	0.45	0.55
c	0.49	0.56
c1	0.48	0.52
D	6.3	6.7
D1	5.30 REF	
E1	5.30	5.70
e	1.27BSC	
L	1.40	1.60
L1	3.0	3.2
L2	1.40BSC	
θ	0°	10°

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