PAM3112

300mA CMOS LINEAR REGULATOR

Description

The PAM3112 regulator features low quiescent current (65μA Typ) and excellent line/load regulation, making it ideal for battery powered applications. The output voltage can be 1.2V or 1.3V. Space-saving packages SOT23, TSOT25, SOT-89 and SC70 are attractive for portable and handheld applications. It has both thermal shutdown and a current limit features to prevent device failure under extreme operating conditions. The device is stable with an output capacitance of 2.2μF or greater.

Features

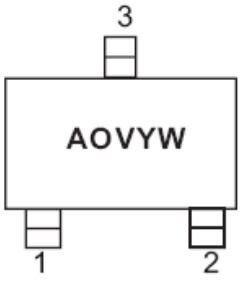
- Accuracy within ±2%
- Quiescent Current: 65μA Typ.
- Excellent Line/Load Regulation
- Guaranteed 300mA Output Current
- Fast Response
- Current Limiting
- Short Circuit Protection
- Low Temperature Coefficient
- Thermal Shutdown
- Space Saving Package: SOT23, TSOT25, SOT-89 and SC70
- Pb-Free Package

Applications

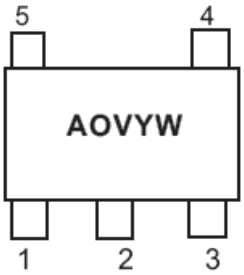
- Cordless Phone
- Cellular Phone
- Bluetooth Earphone
- Digital Camera
- Portable Electronics
- WLAN
- MP3 Player

Pin Assignments

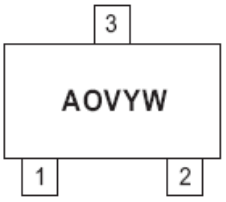
Top View
SOT23



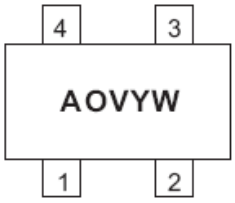
Top View
TSOT25



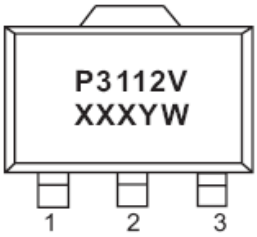
Top View
SC70-3L



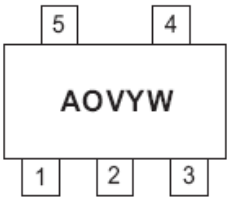
Top View
SC70-4L



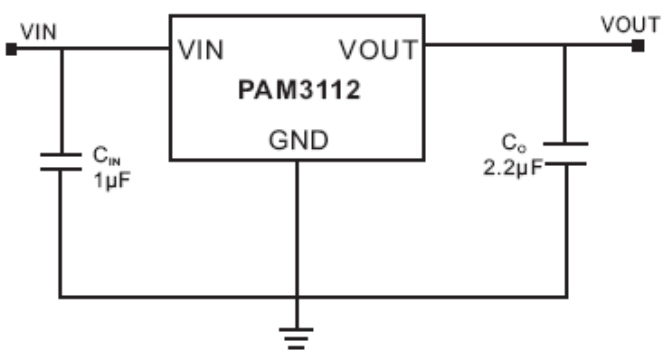
Top View
SOT89-3

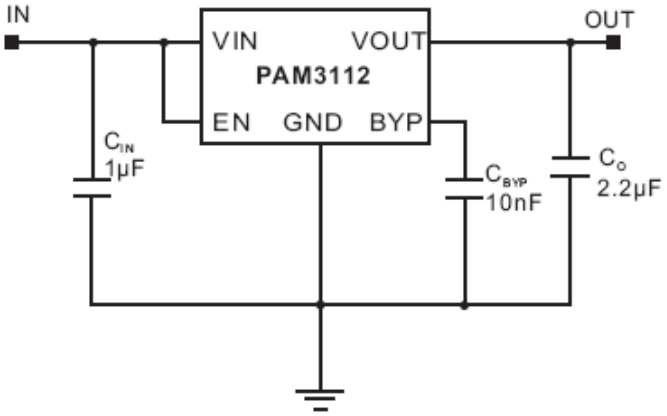


Top View
SC70-5L



Typical Applications Circuit



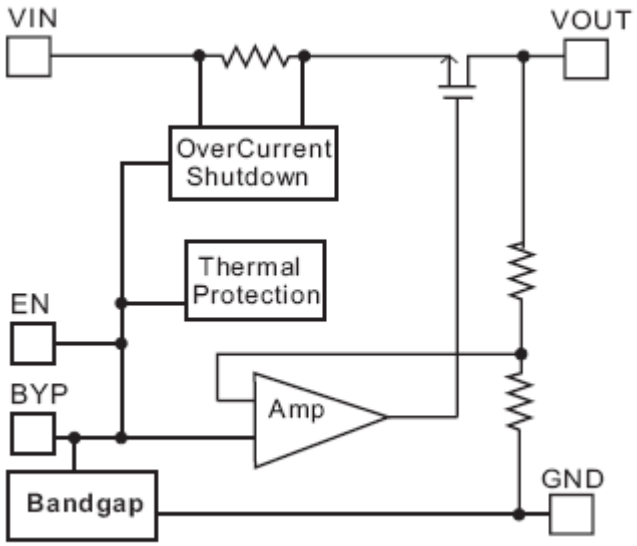


Pin Configuration and Description

Package Type	Pin Number				
	1	2	3	4	5
SOT23	VOUT	GND	VIN	—	—
	GND	VOUT	VIN	—	—
TSOT25	VIN	GND	EN	BYP	VOUT
SOT89-3	GND	VIN	VOUT	—	—
	VOUT	GND	VIN	—	—
SC70-3L	VIN	VOUT	GND		—
SC70-4L	EN	GND	VOUT	VIN	
SC70-5L	VIN	GND	EN	BYP	VOUT

Pin Name	Function
VIN	Input
GND	Ground
EN	Chip Enable (active high)
BYP	Bypass Pin, need a 10nF capacitor connect to GND
VOUT	Output

Functional Block Diagram



Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.)

These are stress ratings only and functional operation is not implied. Exposure to absolute maximum ratings for prolonged time periods may affect device reliability. All voltages are with respect to ground.

Parameter	Rating	Unit
Input Voltage	6.0	V
Output Current	$P_D/(V_{IN} – V_O)$	—
Output Pin Voltage	GND -0.3 to V_{IN} +0.3V	V
Lead Soldering Temperature	300, (5sec)	°C
Maximum Junction Temperature	150	°C
Storage Temperature	-65 to +150	°C
ESD Rating	Class B	—

Recommended Operating Conditions (@T_A = +25°C, unless otherwise specified.)

Parameter	Rating	Unit
Junction Temperature	-40 to +125	°C
Ambient Temperature	-40 to +85	

Thermal Information

Parameter	Symbol	Package	Max	Unit
Thermal Resistance (Junction to Case)	θ_{JC}	SOT23/ TSOT25	130	°C/W
		SOT-89	45	
		SC70	TBD	
Thermal Resistance (Junction to Ambient)	θ_{JA}	SOT23/ TSOT25	250	
		SOT-89	160	
		SC70	300	
Internal Power Dissipation (@T_A = +25°C)	P_D	SOT23/ TSOT25	400	mW
		SOT-89	550	
		SC70	300	

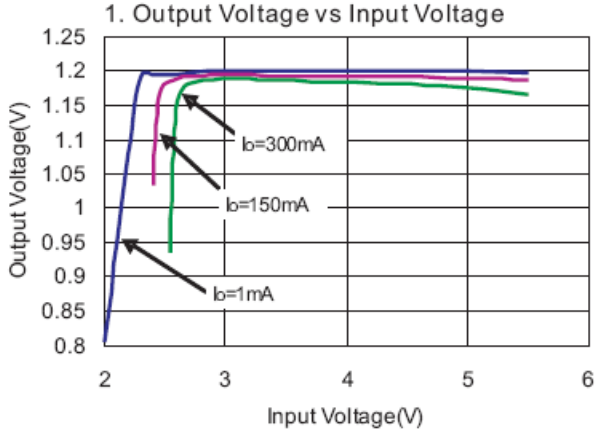
Electrical Characteristics (@T_A = +25°C, V_{IN} = 3V, C_{IN} = 1µF, C_O = 2.2µF, unless otherwise specified.)

Parameter	Symbol	Test Conditions		Min	Typ	Max	Units
Input Voltage	V_{IN}			2.5		5.5	V
Output Voltage Accuracy	V_O	I_O = 1mA		-2		+2	%
Output Current	I_O			300		Note 1	mA
Ground Current	I_{GND}	I_O = 1mA to 300mA			70	90	µA
Quiescent Current	I_Q	I_O = 0mA			65	90	µA
Line Regulation	LNR	V_{IN} = 2.5V to 5.0V I_O = 10mA		-0.15	0.10	0.15	%/V
Load Regulation	LDR	I_O = 1mA to 300mA			30	60	mV
Short Circuit Current	I_{SC}	V_O = 0V			130		mA
Temperature Coefficient	T_C				40		ppm/°C
Over Temperature Shutdown	OTS	I_O = 1mA			150		°C
Over Temperature Hysteresis	OTH	I_O = 1mA			30		°C
Power Supply Ripple Rejection	PSRR	I_O = 100mA	f = 100Hz		70		dB
		C_{BYP} = 10nF	f = 1kHz		65		
Output Noise	V_N	f = 10Hz to 100kHz, C_{BYP} = 10nF			50		μV_{RMS}
EN Input High Threshold	V_{IN}	V_{IN} = 2.5V to 5V		1.5			V
EN Input Low Threshold	V_{IL}	V_{IN} = 2.5V to 5V				0.3	V
Shutdown Current	I_{SD}	V_{EN} = 0V			0.01	1	µA

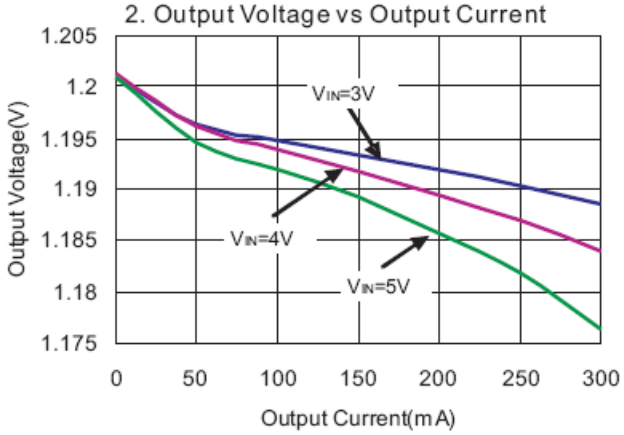
Notes: 1. Output current is limited by P_D, maximum I_O = 400mW/ ($V_{IN(MAX)}$ – V_O).

Typical Performance Characteristics (@T_A = +25°C, C_{IN} = 1μF, C_O = 2.2μF, V_O = 1.2V, unless otherwise specified.)

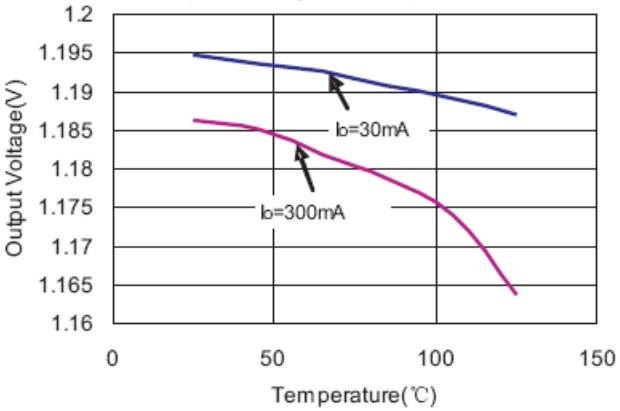
1. Output Voltage vs Input Voltage



2. Output Voltage vs Output Current

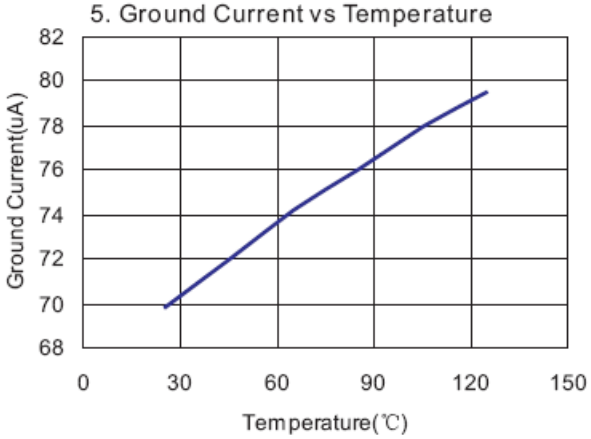


3. Output Voltage vs Temperature

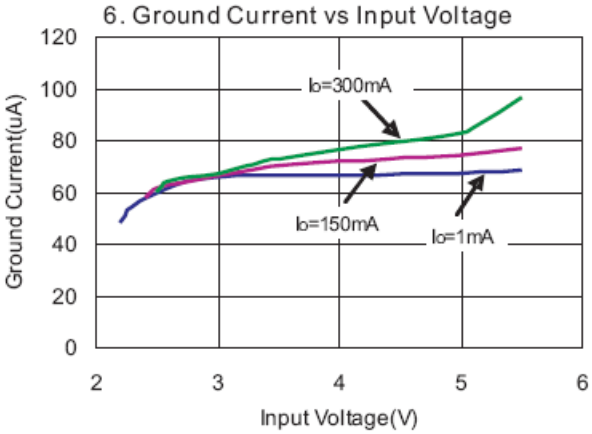


4. Quiescent Current vs Input Voltage

5. Ground Current vs Temperature

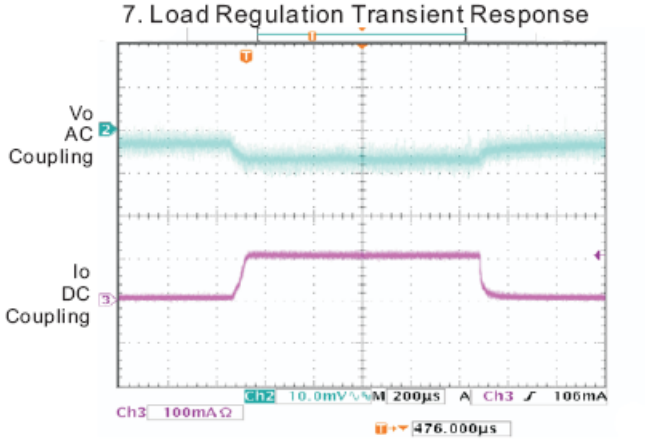


6. Ground Current vs Input Voltage



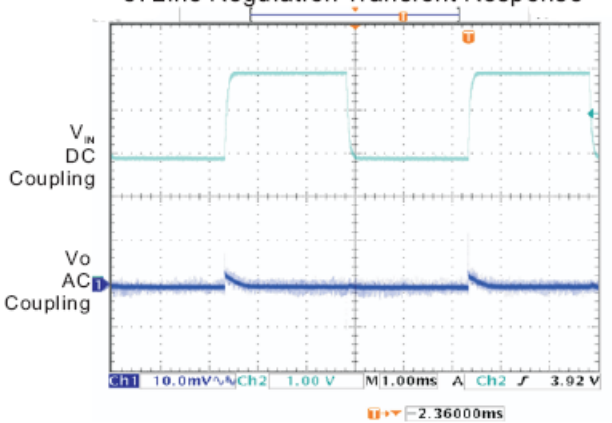
Typical Performance Characteristics (cont.) (@T_A = +25°C, C_{IN} = 1μF, C_O = 2.2μF, V_O = 1.2V, unless otherwise specified.)

7. Load Regulation Transient Response

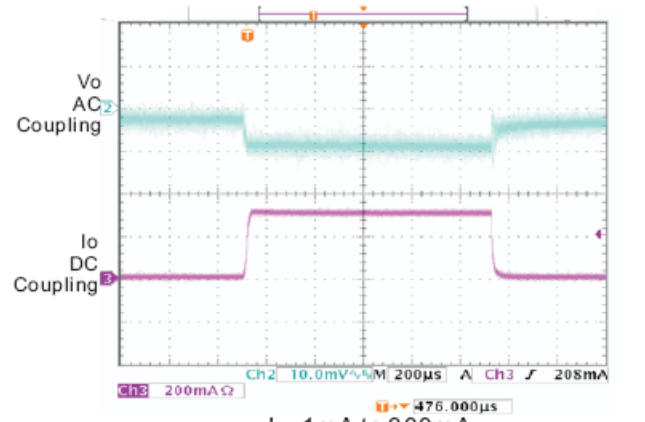


I_O=1mA to 100mA

8. Line Regulation Transient Response

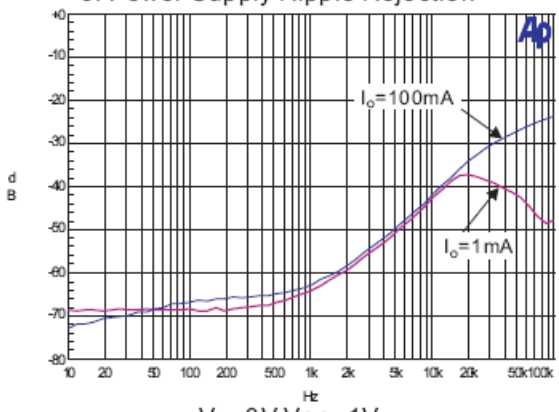


Io=1mA,V_{IN}=3V to 5V

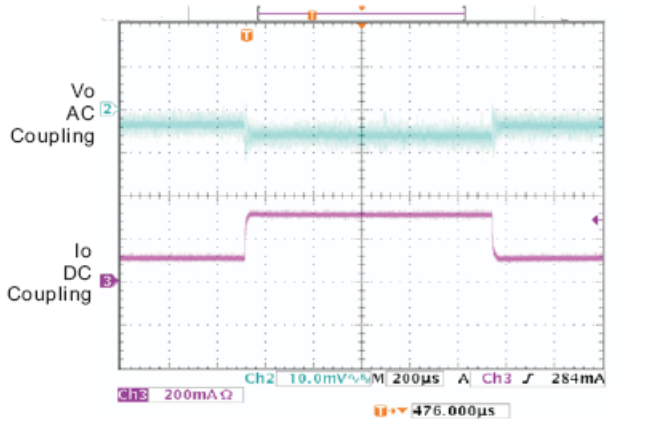


I_O=1mA to 300mA

9. Power Supply Ripple Rejection



V_{IN}=3V,Vpp=1V



I_O=100mA to 300mA

Application Information

Capacitor Selection and Regulator Stability

Similar to any low dropout regulator, the external capacitors used with the PAM3112 must be carefully selected for regulator stability and performance.

A capacitor C_{IN} of more than 1µF can be used at the PAM3112 input pin, while there is no upper limit for the capacitance of C_{IN}. Please note that the distance between C_{IN} and the input pin of the PAM3112 should not exceed 0.5 inch. Ceramic capacitors are suitable for the PAM3112. Capacitors with larger values and lower ESR (equivalent series resistance) provide better PSRR and line-transient response.

The PAM3112 is designed specifically to work with low ESR ceramic output capacitors in order to save space and improve performance. Using an output ceramic capacitor whose value is >2.2µF with ESR>5mΩ ensures stability.

A 10nF bypass capacitor connected to BYP pin is suggested for suppressing output noise. The capacitor, in series connection with an internal 200kΩ resistor, forms a low-pass filter for noise reduction. Increasing the capacitance will slightly decrease the output noise, but increase the startup time.

Load Transient Consideration

Curve 7 of the PAM3112 load-transient response on page 6 shows two components of the output response, a DC shift from the output impedance due to the load current change and transient response. The DC shift is quite small due to excellent load regulation of the PAM3112. The transient spike, resulting from a step change in the load current from 1mA to 300mA, is 20mV. The ESR of the output capacitor is critical to the transient spike. A larger capacitance along with smaller ESR results in a smaller spike.

Shutdown Input Operation

The PAM3112 is shut down by pulling the EN input low and turned on by tying the EN input to V_{IN} or leaving the EN input floating.

Internal P-Channel Pass Transistor

The PAM3112 features a 0.75Ω P-Channel MOSFET device as a pass transistor. The P-MOS pass transistor enables the PAM3112 to consume only 65µA of ground current during low dropout, light-load, or heavy-load operation. These features increase the battery operation life time.

Input-Output (Dropout) Voltage

A regulator's minimum input-output voltage difference (or dropout voltage) determines the lowest usable supply voltage. The PAM3112 has a typical 300mV dropout voltage. In batterypowered systems, this will determine the useful end-of-life battery voltage.

Current Limit and Short Circuit Protection

The PAM3112 features a current limit, which monitors and controls the gate voltage of the pass transistor. The output current can be limited to 400mA by regulating the gate voltage. The PAM3112 also has a built-in short circuit current limit.

Thermal Considerations

Thermal protection limits power dissipation in the PAM3112. When the junction temperature exceeds +150°C, the OTP (Over Temperature Protection) starts the thermal shutdown and turns the pass transistor off. The pass transistor resumes operation after the junction temperature drops below +120°C.

For continuous operation, the junction temperature should be maintained below +125°C.
The power dissipation is defined as:

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

The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surrounding airflow and temperature difference between junction and ambient. The maximum power dissipation can be calculated by the following formula:

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

Application Information (cont.)

Thermal Considerations

Where $T_{J(MAX)}$ is the maximum allowable junction temperature +125°C, T_A is the ambient temperature and is the thermal resistance from the junction to the ambient.

For example, as θ_{JA} is 250°C/W for the SOT23 and TSOT25 packages based on the standard JEDEC 51-3 for a single-layer thermal test board, the maximum power dissipation at T_A = +25°C can be calculated by following formula:

$$P_{D(MAX)} = (125°C - 25°C)/250 = 0.4W \quad \text{SOT-23}$$

It is also useful to calculate the junction temperature of the PAM3112 under a set of specific condition. Suppose the input voltage V_{IN} =3.3V, the output current I_O =150mA and the case temperature T_A = +40°C measured by a thermal couple during operation, the power dissipation is defined as:

$$P_D = (3.3V - 1.2V) * 150mA + 3.3V * 70\mu A \cong 315mW$$

And the junction temperature, T_J can be calculated as follows:

$T_J = T_A + P_D * \theta_{JA}$

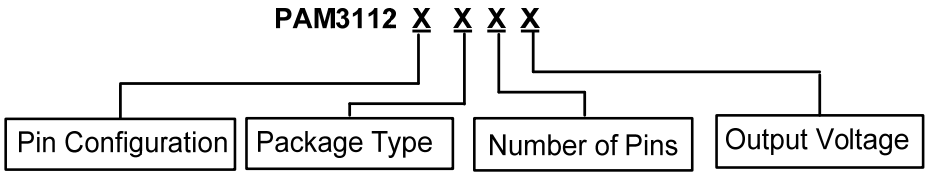
T_J = 40°C +0.35W*250°C/W

= 40°C +78.75°C

= 118.75°C<$T_{J(MAX)}$ = +125°C

For this application, T_J is lower than the absolute maximum operating junction temperature +125°C, so it is safe to use the PAM3112 in this configuration.

Ordering Information

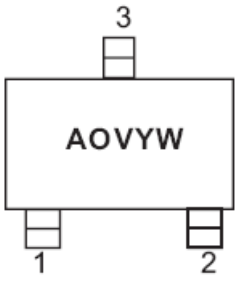


Pin Configuration		Package Type	Number of Pins	Output Voltage
A Type: 1. VOUT 2. GND 3. VIN B Type: 1. GND 2. VOUT 3. VIN D Type: 1. VIN 2.GND 3.EN 4.BYP 5.VOUT	F Type: 1. EN 2. GND 3. VOUT 4. VIN G Type: 1. VIN 2. VOUT 3. GND H Type: 1. GND 2. VIN 3. VOUT	A: SOT23/TSOT25 C: SOT-89 U: SC70	A: 3 K: 4 B: 5 F: 6	120: 1.2V 130: 1.3V

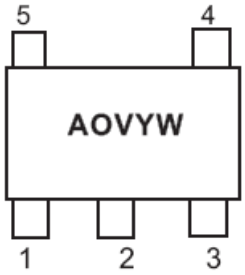
Part Number	Output Voltage	Marking	Package Type	Standard Package
PAM3112AAA120	1.2V	AOBYW	SOT23	3000 Units/ Tape&Reel
PAM3112BAA120	1.2V	AOBYW	SOT23	3000 Units/ Tape&Reel
PAM3112DAB120	1.2V	AOBYW	TSOT25	3000 Units/ Tape&Reel
PAM3112ACA120	1.2V	P3112B XXXYW	SOT89-3	1000 Units/ Tape&Reel
PAM3112HCA120	1.2V	P3112B XXXYW	SOT89-3	1000 Units/ Tape&Reel
PAM3112GUA120	1.2V	AOBYW	SC70-3	3000 Units/ Tape&Reel
PAM3112FUK120	1.2V	AOBYW	SC70-4	3000 Units/ Tape&Reel
PAM3112DUB120	1.2V	AOBYW	SC70-5	3000 Units/ Tape&Reel
PAM3112AAA130	1.3V	AOWYW	SOT23	3000 Units/ Tape&Reel
PAM3112BAA130	1.3V	AOWYW	SOT23	3000 Units/ Tape&Reel
PAM3112DAB130	1.3V	AOWYW	TSOT25	3000 Units/ Tape&Reel
PAM3112ACA130	1.3V	P3112W XXXYW	SOT89-3	1000 Units/ Tape&Reel
PAM3112HCA130	1.3V	P3112W XXXYW	SOT89-3	1000 Units/ Tape&Reel
PAM3112GUA130	1.3V	AOWYW	SC70-3	3000 Units/ Tape&Reel
PAM3112FUK130	1.3V	AOWYW	SC70-4	3000 Units/ Tape&Reel
PAM3112DUB130	1.3V	AOWYW	SC70-5	3000 Units/ Tape&Reel

Marking Information

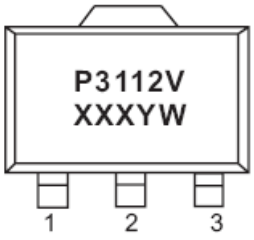
Top View
SOT23



Top View
TSOT25

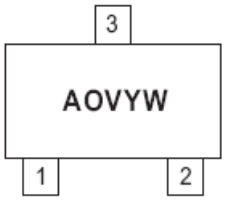


Top View
SOT89-3

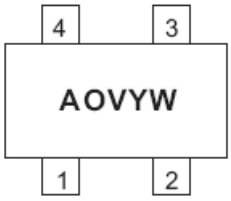


AO: Product Code
of PAM3112
X: Internal Code
V: Voltage Code
Y: Year
W: Week

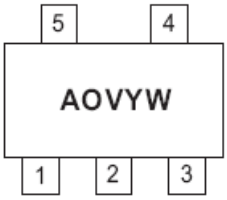
Top View
SC70-3L



Top View
SC70-4L

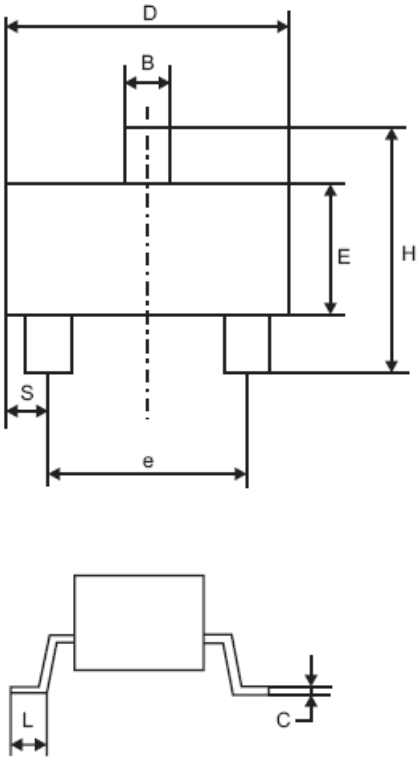


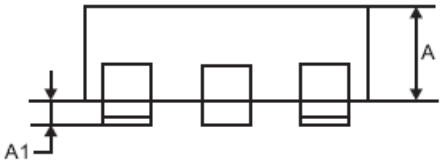
Top View
SC70-5L



Package Outline Dimensions (All dimensions in mm.)

SOT23

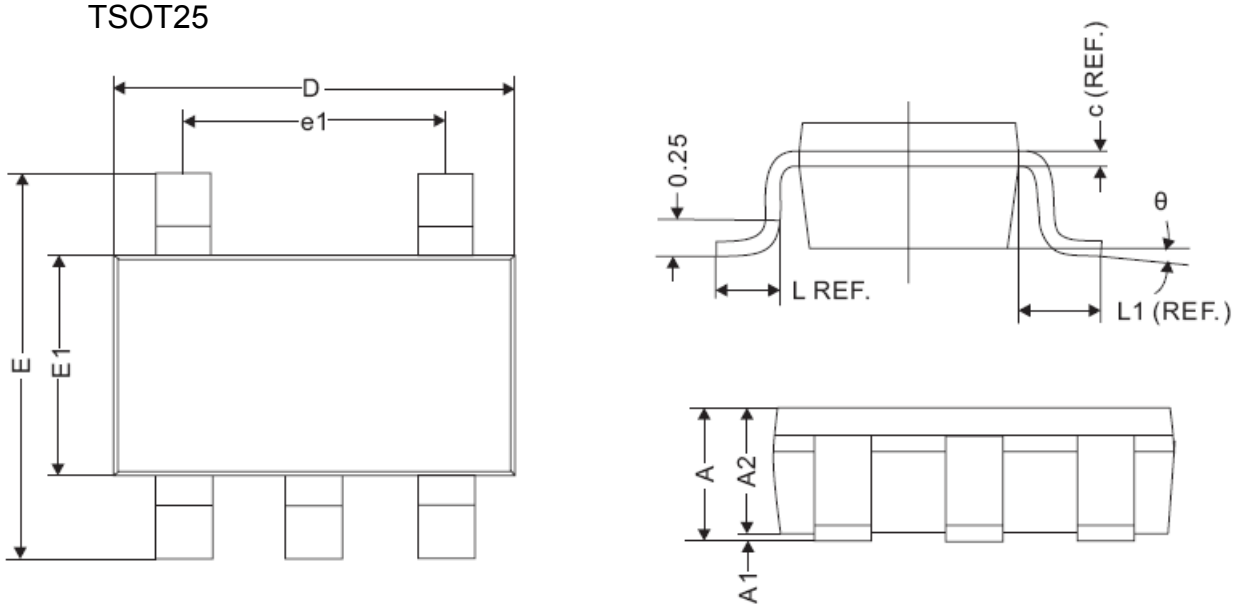




Dim	Millimeters		
	Min.	Typ.	Max.
A	1.00	1.15	1.30
A1	0.00	0.05	0.10
B	0.35	0.43	0.51
C	0.10	0.175	0.25
D	2.70	2.90	3.10
E	1.40	1.60	1.80
e	1.90BSC		
H	2.40	2.70	3.00
L	0.37		

Package Outline Dimensions (cont.) (All dimensions in mm.)

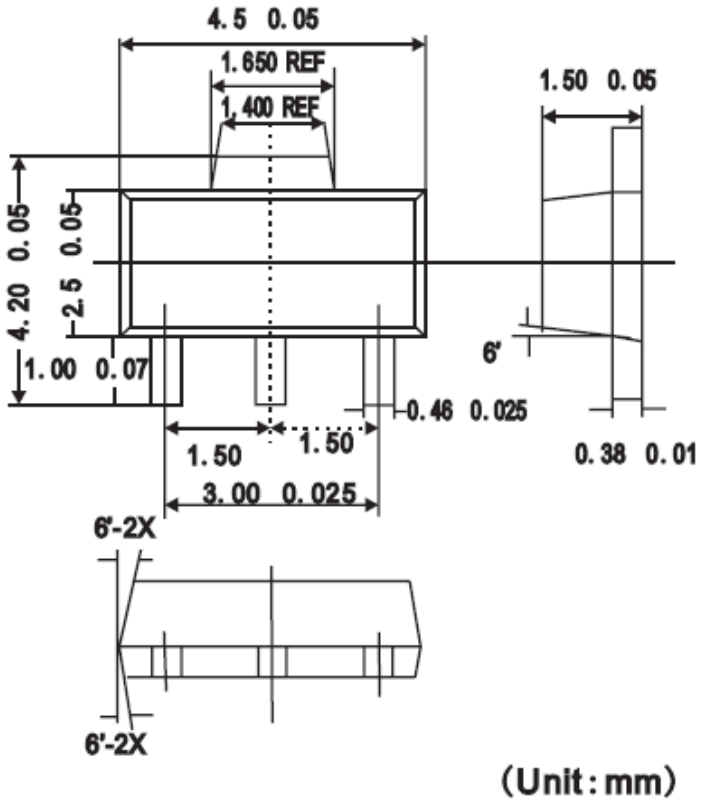
TSOT25



REF.	Millimeter		
	Min	Nom	Max
A		1.10MAX	
A1	0	0.05	0.10
A2	0.70	1.00	1.295
c		0.12REF.	
D	2.70	2.90	3.10
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
L		0.45REF.	
L1		0.60REF.	
θ	0°	5°	10°
b	0.30	0.40	0.50
e		0.95REF.	
e1		1.90REF.	

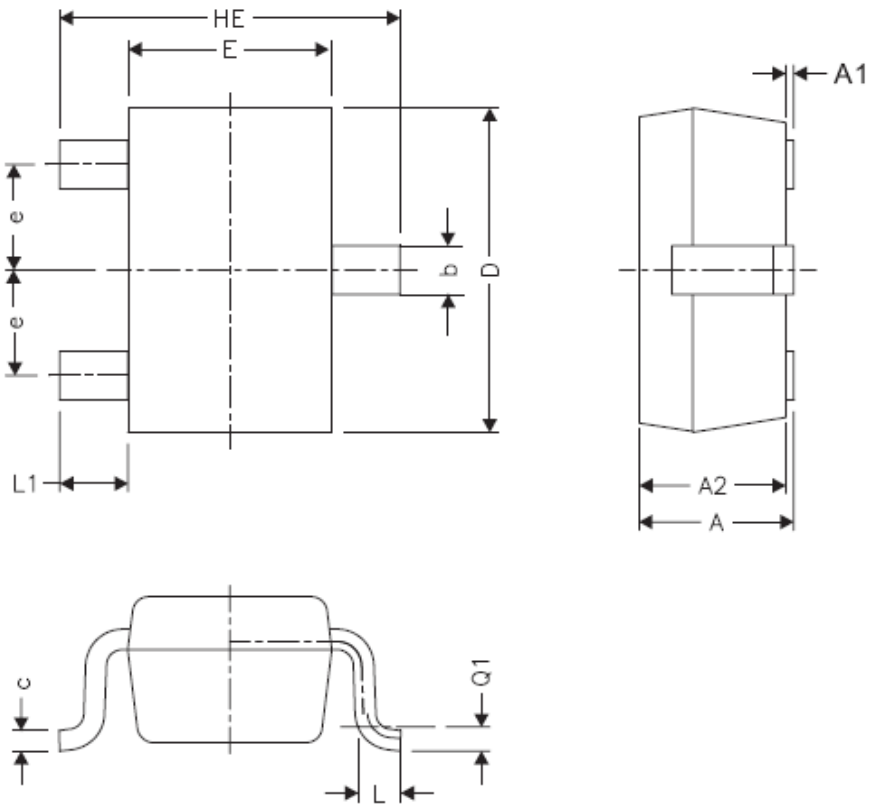
Package Outline Dimensions (cont.) (All dimensions in mm.)

SOT89-3



Package Outline Dimensions (cont.) (All dimensions in mm.)

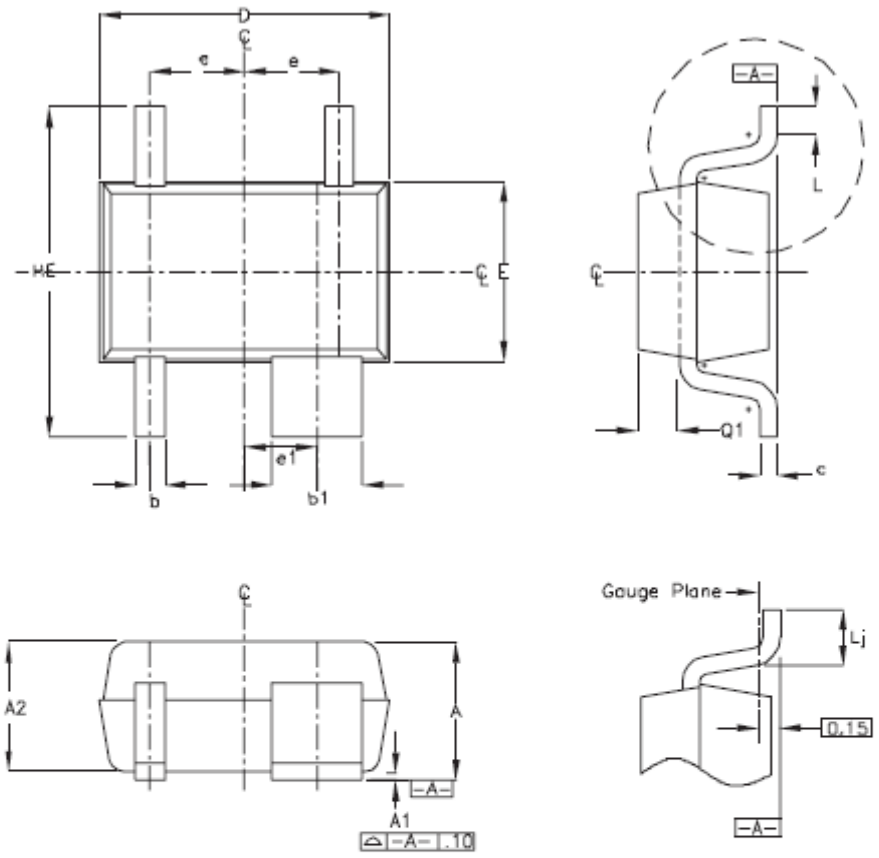
SC70-3



REF.	Millimeter		REF.	Millimeter	
	Min.	Max.		Min.	Max.
A	0.80	1.10	L1	0.42 REF.	
A1	0	0.10	L	0.15	0.35
A2	0.80	1.00	b	0.25	0.40
D	1.80	2.20	c	0.10	0.25
E	1.15	1.35	e		
HE	1.80	2.40			

Package Outline Dimensions (cont.) (All dimensions in mm.)

SC70-4

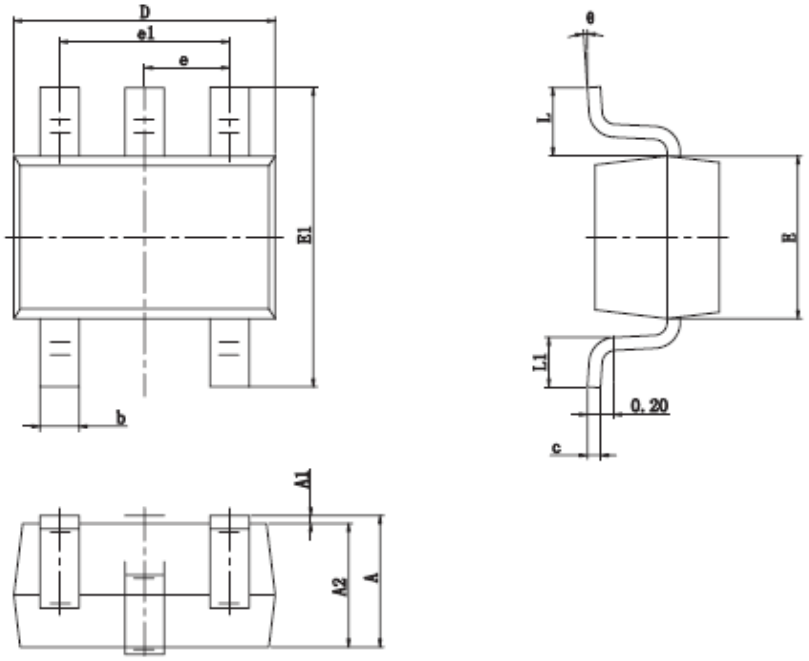


SYMBOL	MIN	MAX
e	0.65 BSC	
e1	0.50 BSC	
D	1.80	2.20
b	0.15	0.30
b1	0.575	0.700
E	1.15	1.35
HE	1.80	2.40
Q1	0.10	0.40
A2	0.80	1.00
A1	0.00	0.10
A	0.80	1.10
c	0.10	0.18
L	0.10	0.30
Lj	0.26	0.46

1) ALL DIMENSIONS ARE IN MILLIMETERS
2) DIMENSIONS ARE INCLUSIVE OF PLATING
3) DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR
4) CUSTOM LEADCOUNT VARIATION OF JEITA SC70

Package Outline Dimensions (cont.) (All dimensions in mm.)

SC70-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650 TYP		0.026 TYP	
e1	1.200	1.400	0.047	0.055
L	0.525 REF		0.021 REF	
L1	0.260	0.460	0.010	0.018
θ	0	8	0	8

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