AME8901A

5.5V 500mA, High PSRR, Low Output Noise, Ultra-Low Dropout Voltage Regulator

■ General Description

The AME8901A is a CMOS-based positive voltage regulator featuring 500mA that provides high ripple rejection, low dropout voltage, high output voltage accuracy and low supply current. Internally, it consists of voltage reference unit, error amplifier, resistor-net for output voltage setting, current limit circuit, thermal shutdown circuit and reverse current protection circuit.

AME8901A is available in following packages: SOT-89, SOT-25 & DFN-6D (2x2x0.75mm).

■ Features

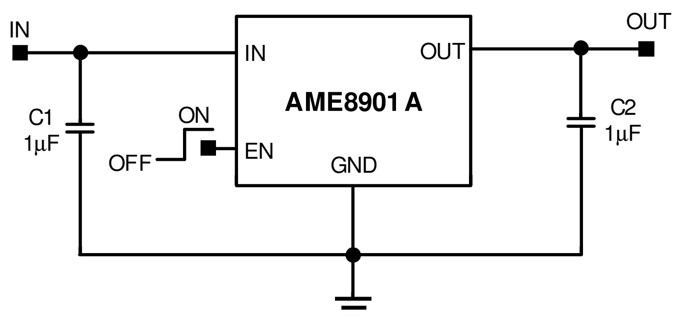
- Input Voltage Range: 1.32V to 5.5V
- Output Voltage Range:
  Fixed Version_from 0.9V to 4.3V
  ADJ Version_from 0.85V to 5.0V
- Output Voltage Tolerance: ±1%
- Dropout Voltage: 156mV @0.5A
- Maximum Output Current: 500mA
- High PSRR: 80dB @1kHz
- Output Noise: 10µVrms
- Shutdown Current: 0.1µA (typical)
- Internal Over Temperature Protection
- Internal Over Current Protection
- Built-in Soft-Start and Inrush Current Limit
- Fast Auto Discharge Function for Power Down

■ Applications

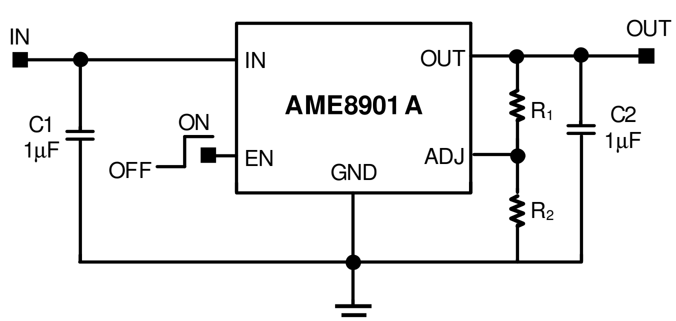
- Portable Device, Tablet and Smartphone
- Camera, VCR and Car Dashboard Camera
- Cam Application Required Low Noise and Illuminance
- Communications and Infrastructure
- AR and VR Application
- Motor and Lighting accompanied by Self-Heating
- FA Equipment, Smart Meter
- Vending Machines under High Temperature

■ Typical Applications

A. Fixed Mode

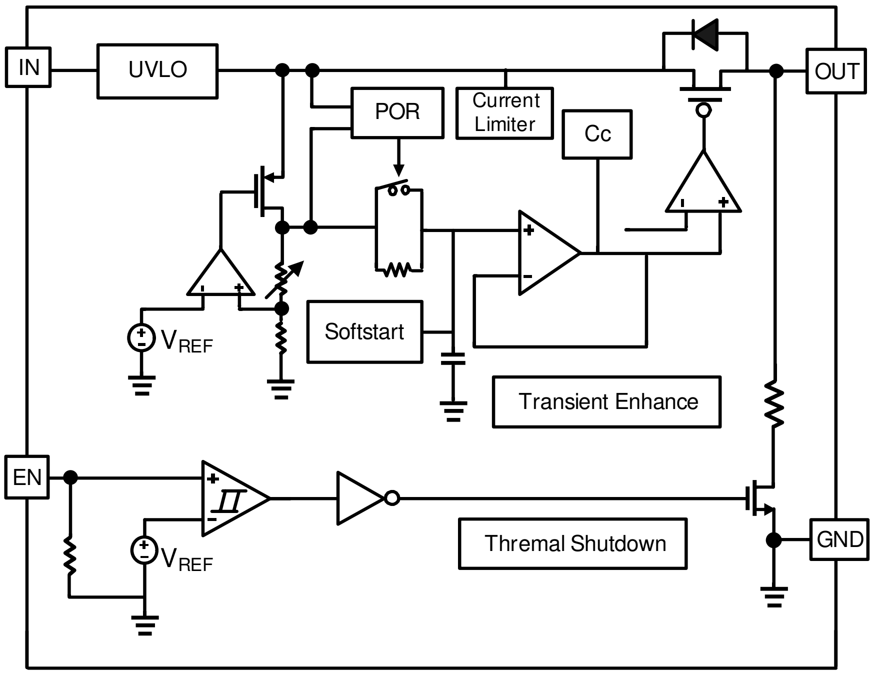


B. ADJ Mode

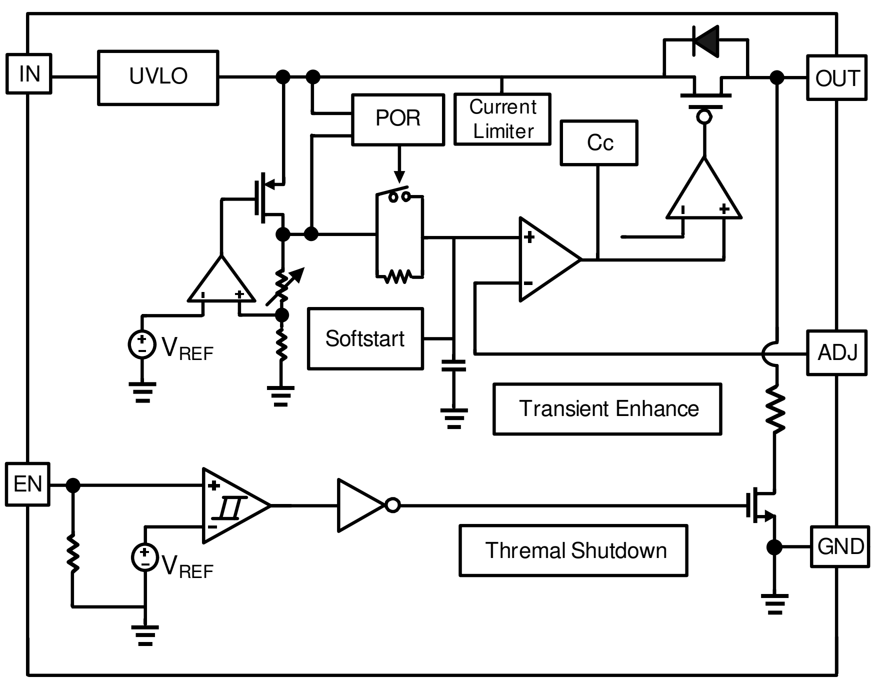


■ Functional Block Diagram

Fixed Version

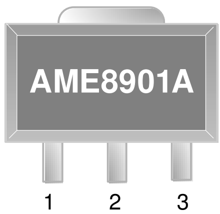


ADJ Version



■ Pin Configuration

SOT-89
Top View

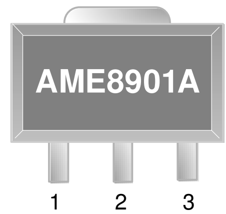


AME8901A-AFTxxx

1. IN
2. GND(TAB)
3. OUT

*** Die Attach:**
Conductive Epoxy

SOT-89
Top View

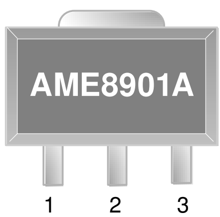


AME8901A-BFTxxx

1. GND
2. IN (TAB)
3. OUT

*** Die Attach:**
Non-Conductive Epoxy

SOT-89
Top View

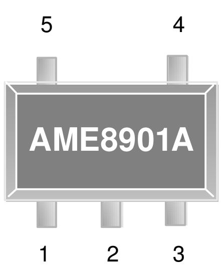


AME8901A-CFTxxx

1. OUT
2. GND (TAB)
3. IN

*** Die Attach:**
Conductive Epoxy

SOT-25
Top View

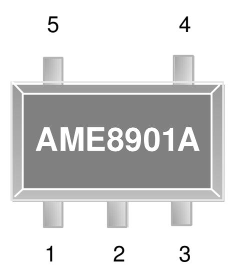


AME8901A-AEVxxx

1. IN
2. GND
3. EN
4. NC
5. OUT

*** Die Attach:**
Conductive Epoxy

SOT-25
Top View



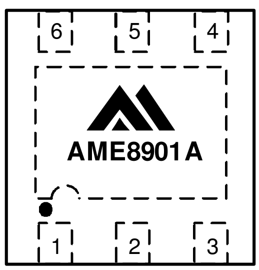
AME8901A-DEVADJ

1. IN
2. GND
3. EN
4. ADJ
5. OUT

*** Die Attach:**
Conductive Epoxy

■ Pin Configuration

DFN-6D
(2x2x0.75mm)
Top View

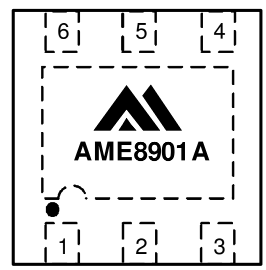


AME 8901A-AVYxxx

1. OUT
2. NC
3. GND
4. EN
5. NC
6. IN

*** Die Attach:**
Conductive Epoxy

DFN-6D
(2x2x0.75mm)
Top View



AME 8901A-BVYADJ

1. OUT
2. ADJ
3. GND
4. EN
5. NC
6. IN

*** Die Attach:**
Conductive Epoxy

Note: Connect exposed pad (heat sink on the back) to GND.

■ Pin Description

Pin Name	Pin Description	Pin Number						
		SOT-89			SOT-25		DFN-6D (2x2x0.75mm)	
		A	B	C	A	D	A	B
IN	Input Voltage pin	1	2	3	1	1	6	6
GND	Ground pin	2	1	2	2	2	3	3
OUT	Output Voltage pin	3	3	1	5	5	1	1
EN	Enable pin	NA	NA	NA	3	3	4	4
ADJ	ADJ pin	NA	NA	NA	NA	4	NA	2
NC	No connection	NA	NA	NA	4	NA	2/5	5

■ Ordering Information

AME8901 x - x x x xxx

- xxx: **Output Voltage**
- x: **Number of Pins**
- x: **Package Type**
- x: **Pin Configuration**
- x: **Version**

Version	Pin Configuration	Package Type	Number of Pins	Output Voltage
AME8901A 1. V_{ADJ} = 0.85V	A (SOT-89): 1. IN 2. GND 3. OUT B (SOT-89): 1. GND 2. IN 3. OUT C (SOT-89): 1. OUT 2. GND 3. IN A (SOT-25): 1. IN 2. GND 3. EN 4. NC 5. OUT D (SOT-25) (ADJ Version): 1. IN 2. GND 3. EN 4. ADJ 5. OUT A (DFN-6D): 1. OUT 2. NC 3. GND 4. EN 5. NC 6. IN B (DFN-6D) (ADJ Version): 1. OUT 2. ADJ 3. GND 4. EN 5. NC 6. IN	E: SOT-2X F: SOT-89 V: DFN	T: 3 V: 5 Y: 6	100: 1.0V 120: 1.2V 150: 1.5V 180: 1.8V 250: 2.5V 280: 2.8V 300: 3.0V 330: 3.3V ADJ: ADJ

■ Absolute Maximum Ratings

Parameter		Maximum	Unit
Input Voltage		-0.3 to 6	V
Enable Voltage		-0.3 to 6	V
Output Voltage		-0.3 to 6	V
ESD Classification	HBM	± 4	kV
	MM	± 200	V
	CDM	± 1000	V

■ Recommended Operating Conditions

Parameter	Symbol	Rating	Unit
Input Voltage	V_{IN}	1.32 to 5.5	V
Ambient Temperature Range	T_A	-40 to +85	^oC
Junction Temperature Range	T_J	-40 to +125	
Storage Temperaturen Range	T_{STG}	-55 to +150	

■ Thermal Information

Parameter	Package	Die Attach	Symbol	Maximum	Unit
Thermal Resistance* (Junction to Case)	SOT-89	Conductive Epoxy	θ_{JC}	40	^oC / W
		Non-Conductive Epoxy		46	
	SOT-25	Conductive Epoxy		81	
	DFN-6D (2x2x0.75mm)	Conductive Epoxy		16	
Thermal Resistance (Junction to Ambient)	SOT-89	Conductive Epoxy	θ_{JA}	180	^oC / W
		Non-Conductive Epoxy		180	
	SOT-25	Conductive Epoxy		260	
	DFN-6D (2x2x0.75mm)	Conductive Epoxy		66	
Internal Power Dissipation	SOT-89	Conductive Epoxy	P_D	550	mW
		Non-Conductive Epoxy		550	
	SOT-25	Conductive Epoxy		400	
	DFN-6D (2x2x0.75mm)	Conductive Epoxy		1515	
Lead Temperature (soldering 10 sec)**				300	^oC

* Measure θ_{JC} on backside center of Exposed Pad.
** MIL-STD-202G210F

■ Electrical Specifications

$V_{IN} = V_{OUT}$+1V , I_{OUT} = 1mA , $C_{IN} = C_{OUT}$ = 1.0µF , T_A = 25°C unless otherwise noted.

Parameter	Symbol	Test Condition		Min	Typ	Max	Units
Input Voltage	V_{IN}			1.32		5.5	V
Output Voltage Accuracy	$V_{OUT,ACC}$	$V_{OUT} < 1.8V$		-20		+20	mV
		$V_{OUT} \geqq 1.8V$		-1.0		+1.0	%
Output Voltage Range	V_{OUT}	Fix	AME8901A	0.9		4.3	V
		ADJ		0.85		5	V
ADJ Referenca Voltage	V_{REF}	AME8901A		0.8415	0.85	0.8585	V
Dropout Voltage *Note1	V_{DROP}	I_{OUT} = 500mA	$V_{OUT(NOM)} \leqq 1.10V$		*Note2		mV
			$1.10V < V_{OUT(NOM)} \leqq 1.8V$		155	235	
			$1.8V < V_{OUT(NOM)} \leqq 2.5V$		105	175	
			$2.5V < V_{OUT(NOM)} \leqq 3.3V$		85	150	
			$3.3V < V_{OUT(NOM)} \leqq 5.0V$		60	130	
Output Current	I_{OUT}	$V_{OUT} > 0.8V$		500			mA
Current Limit	I_{LIM}	$V_{OUT} > 0.8V$		0.6	0.78		A
Short Circuit Current	I_{SC}	V_{OUT} = 0V				186	mA
Quiescent Current	I_Q	I_{OUT} = 0mA , $V_{EN} = V_{IN}$			85	130	µA
Shutdown Current	I_{SHDN}	V_{IN} = 5V , V_{OUT} = 0V , V_{EN} = 0V			0.1	2	µA
Line Regulation	REG_{LINE}				0.01		%/V
Load Regulation	REG_{LOAD}	I_{OUT} = 10mA to 500mA			1	20	mV
EN Low Level	$V_{EN(LO)}$	$V_{IN(MIN)} \leqq V_{IN} \leqq 5.5V$				0.4	V
EN High Level	$V_{EN(HI)}$	$V_{IN(MIN)} \leqq V_{IN} \leqq 5.5V$		1		V_{IN}	V
Output Voltage Noise	eN				10		μV_{RMS}
Power Supply Ripple Rejection	PSRR	I_{OUT} = 1mA, f = 1kHz			80		dB
Undervoltage Lockout	UVLO	Rising Edge			1.3		V
Over Temperature Shutdown	OTS				165		°C
Over Temperature Hysteresis	OTH				35		°C

*Note1: Dropout Voltage is measure at $V_{OUT} = V_{OUT(NOM)}$ x 99%.

*Note2: For V_{OUT} below 1.1V, Dropout Voltage is the $V_{IN(MIN)}$ to Output Differential.

■ Detailed Description (Contd.)

Overview

The AME8901A is a low-dropout linear regulator (LDO) featuring low quiescent current with excellent line and load transient performance.

This LDO is designated for power-sensitive applications. The precision of band gap and error amplifier provides overall 1% accuracy together with low-output noise, high power supply rejection ratio(PSRR) and low-dropout voltage.

Enable Pin

The function of enable pin is activated in Active-High mode. During pulled-low mode, the MOS pass transistor is shut-off and all of internal circuits are powered down. When the EN pin is floating, the internal mode is pulled-down.

Adjustable Version

The output voltage of regulator is determind by external resistor dividers. While the external resistor divider is connected to ADJ pin, the output voltage is calculated by the following equation:

$$V_{OUT} = V_{ADJ} \times (1 + \frac{R1}{R2})$$

For AME8901A, the range of output voltage is from 0.85V to 5V.

The value of R1 and R2 should be high enough to keep low quiescent current but the exceeding value of R1+R2 will reduce stability. In general, when the value of R1 and R2 is above 10KΩ, LDO will reach adequate stability and generate reasonable layout precautions. To improve stability characteristics, keep parasitics on the ADJ pin to a minimum and lower R1 and R2 values.

Under-Voltage Lockout(UVLO)

The AME8901A uses an undervoltage lockout circuit to keep the output shut-off until the internal circuitry is operating properly.

Input and Output Capacitor Selection

The AME8901A regulator is designed to stabilize a wide range of output capacitors. The ESR of output capacitor affects stability. Larger ESR value of the output capacitor decreases the peak deviations and improves transient response during large changes of current.

The different types of capacitor(aluminum, ceramic and tantalum) are with different characterizations, such as temperature and voltage coefficients. All of ceramic capacitors are manufactured with a variety of dielectrics, each with different behavior across temperature and applications. Commom dielectrics used are X5R, X7R and Y5V. It is recommended to use 1µF to 10µF X5R or X7R dielectric ceramic capacitors with 30mΩ to 50mΩ ESR range between device outputs and ground for stability. The AME8901A is designed to stabilize with low ESR ceramic capacitors and higher values of cpacitors and ESR could improve output stability. The ESR of output capacitor is very important because it generates a zero to provide phase lead for loop stability.

There is no requirement for the ESR on the input capacitor but it is voltage and temperature coefficient must be considered for the environment of device application.

Auto Discharge

The auto discharge function of AME8901A could quickly force the output voltage to zero. When the LDO is disabled, the auto discharge function quickly discharges the output capacitor, thereby reducing the output voltage to nearly zero. This function is very useful for the applications with quick ON/OFF function.

■ Detailed Description

Thermal Consideration

The power handling capability of device will be limited by allowable operation junction temperature(125°C).

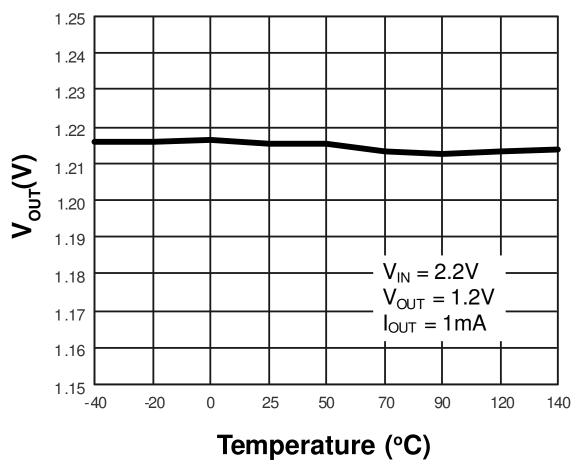
The maximum output power of AME8901A is limited by the package's maximum power dissipation. The calculation of package's power dissipation is related to input voltage, output voltage and output current. The maximum of power dissipation should not exceed the package's maximum power rating.

$$P_{MAX} = (V_{IN-MAX} - V_{OUT}) \times I_{OUT}$$

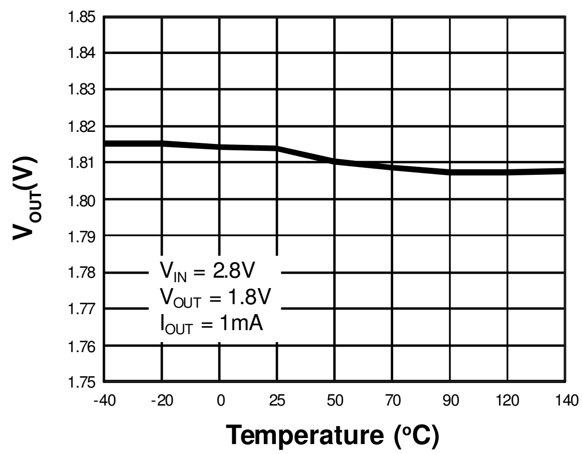
Where:
V_{IN-MAX} = maximum input voltage
P_{MAX} = maximum power dissipation of the package

■ Characterization Curve

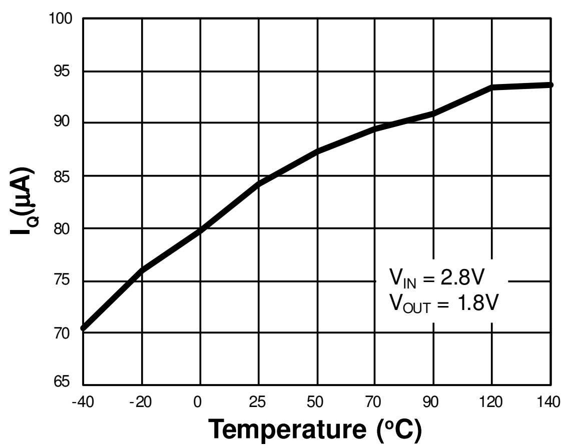
Output Voltage



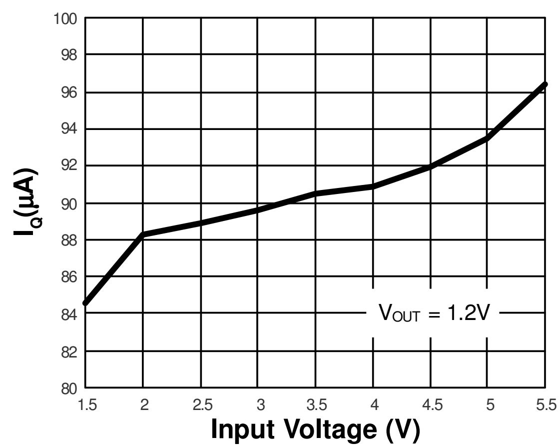
Output Voltage



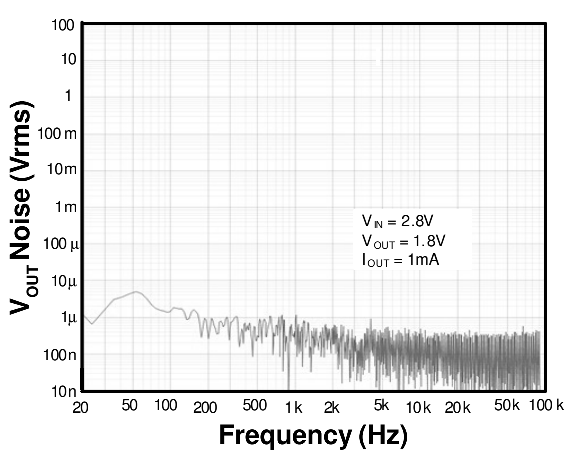
Quiescent Current



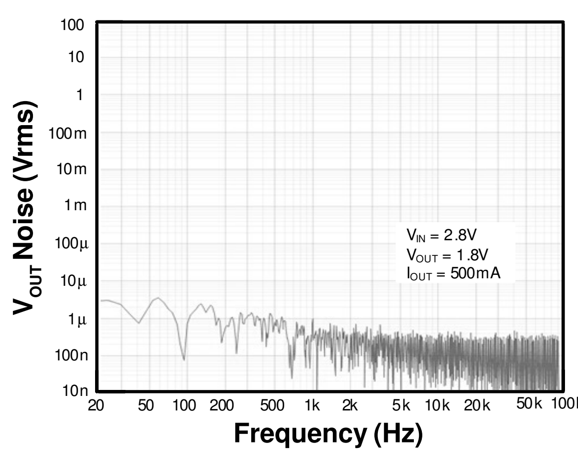
Quiescent Current



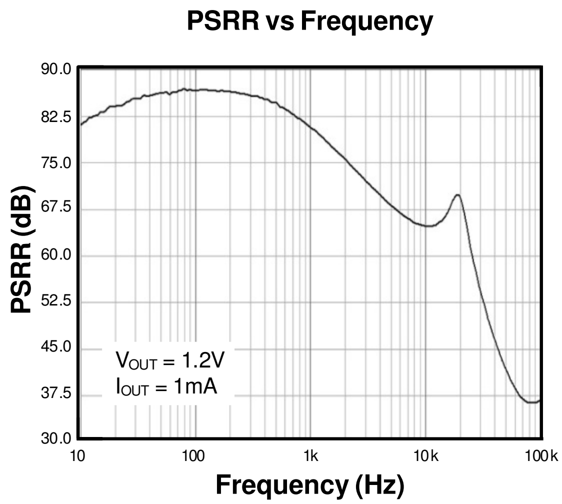
Output Noise

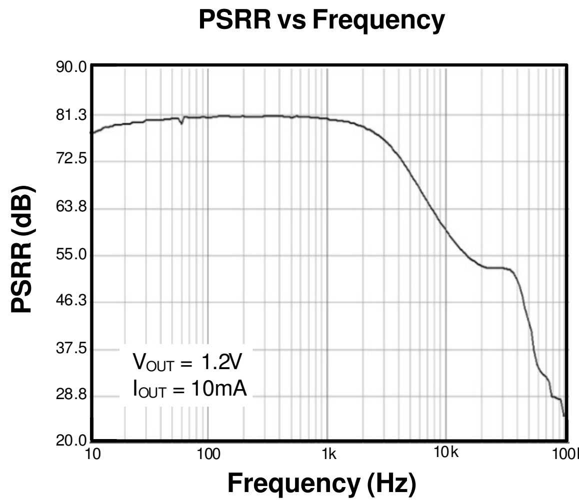


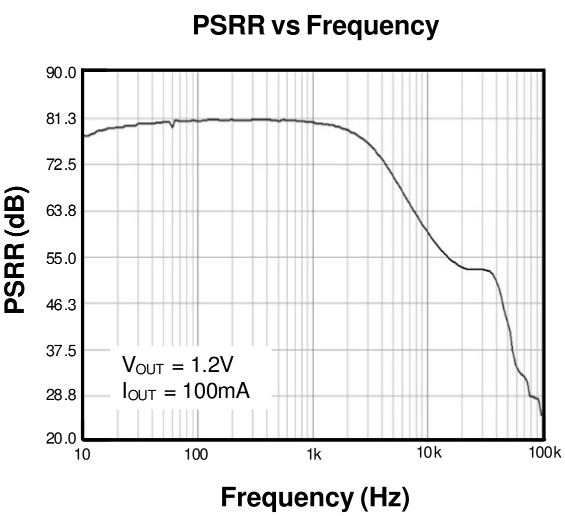
Output Noise

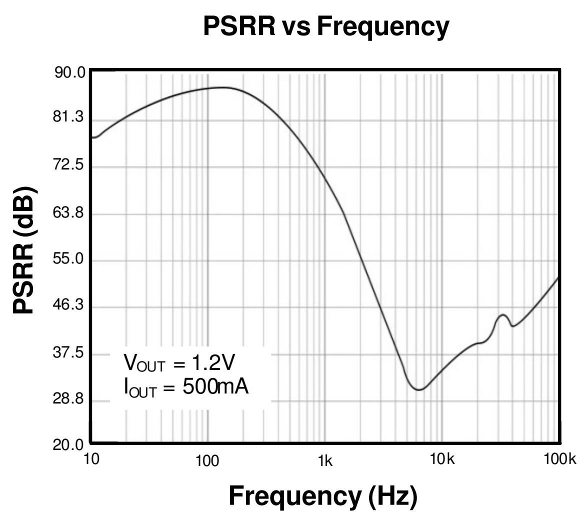


■ Characterization Curve



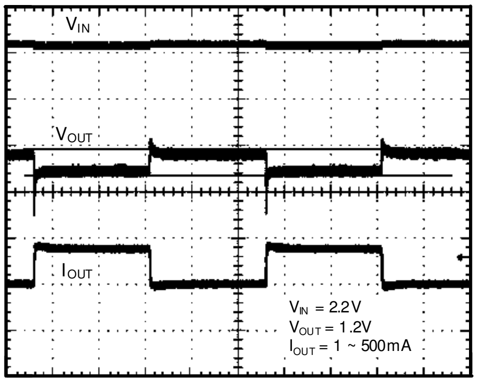






■ Characterization Curve

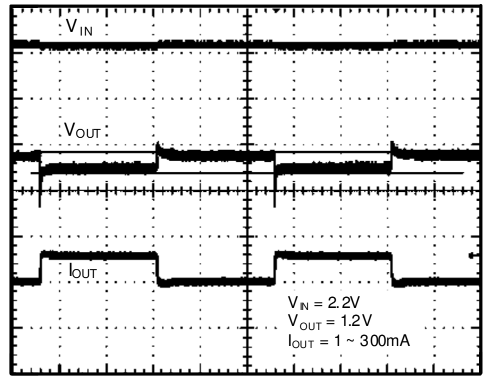
Load Transient Response



400µS / Div

1. V_{IN} = 2V/DIV
2. V_{OUT} = 20mV/DIV
3. I_{OUT} = 500mA/DIV

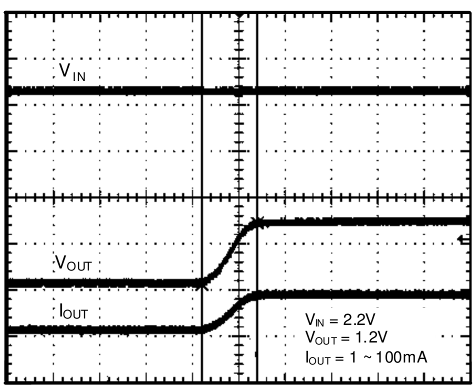
Load Transient Response



400µS / Div

1. V_{IN} = 2V/DIV
2. V_{OUT} = 20mV/DIV
3. I_{OUT} = 500mA/DIV

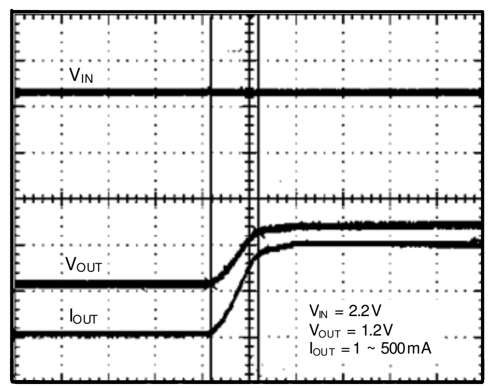
V_{OUT} Rise Time



10µS / Div

1. V_{IN} = 10V/DIV
2. V_{OUT} = 1V/DIV
3. I_{OUT} = 100mA/DIV

V_{OUT} Rise Time

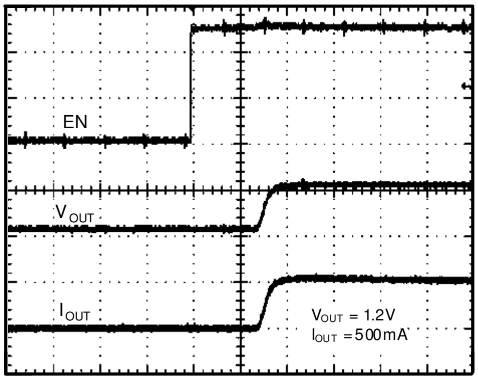


10µS / Div

1. V_{IN} = 10V/DIV
2. V_{OUT} = 1V/DIV
3. I_{OUT} = 200mA/DIV

■ Characterization Curve

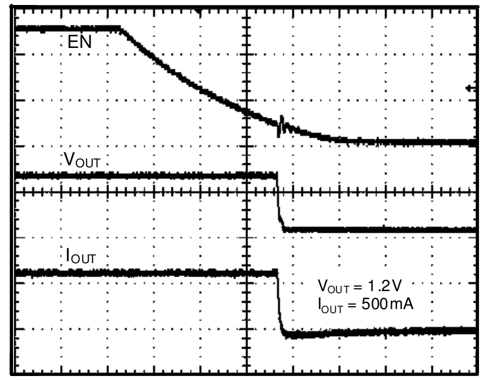
Chip Enable Transient Response



20µS / Div

1. EN = 2V/Div
2. V_{OUT} = 1V/Div
3. I_{OUT} = 500mA/Div

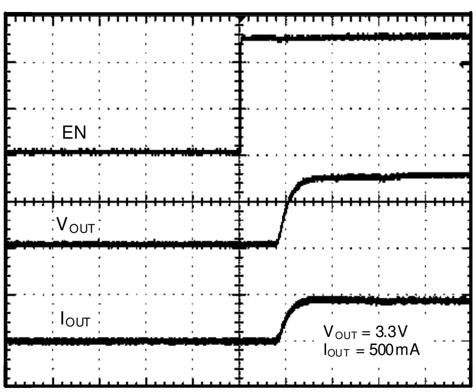
Chip Enable Transient Response



40µS / Div

1. EN = 2V/Div
2. V_{OUT} = 1V/Div
3. I_{OUT} = 500mA/Div

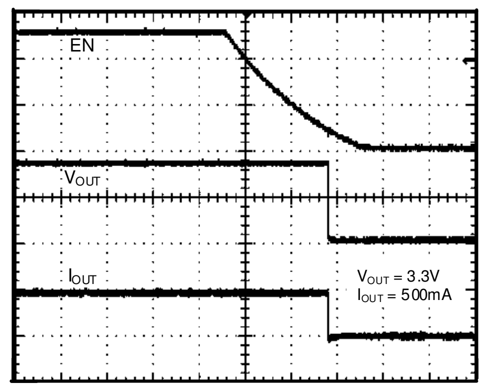
Chip Enable Transient Response



40µS / Div

1. EN = 2V/Div
2. V_{OUT} = 2V/Div
3. I_{OUT} = 500mA/Div

Chip Enable Transient Response

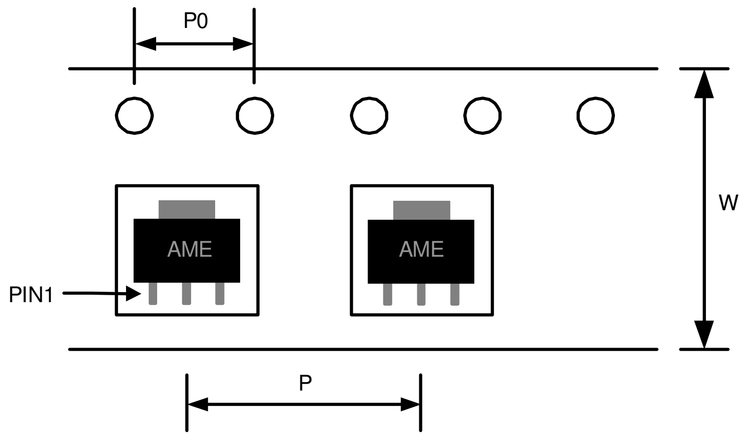


40µS / Div

1. EN = 2V/Div
2. V_{OUT} = 2V/Div
3. I_{OUT} = 500mA/Div

■ Tape and Reel Dimension (Contd.)

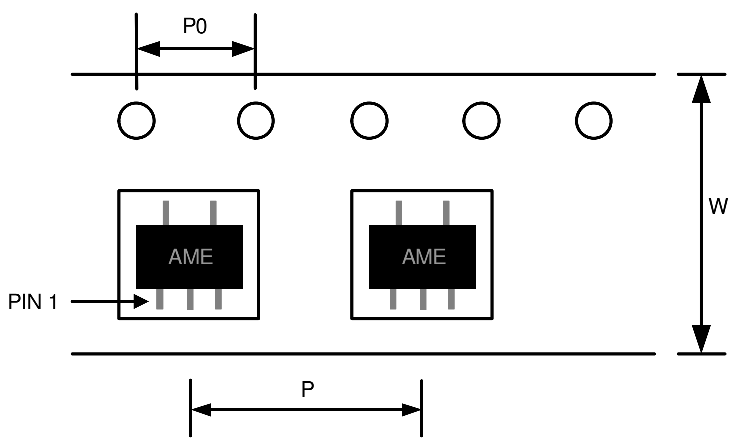
SOT-89



Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Pitch (P0)	Part Per Full Reel	Reel Size
SOT-89	12.0±0.1 mm	8.0±0.1 mm	4.0±0.1 mm	1000pcs	180±1 mm

SOT-25

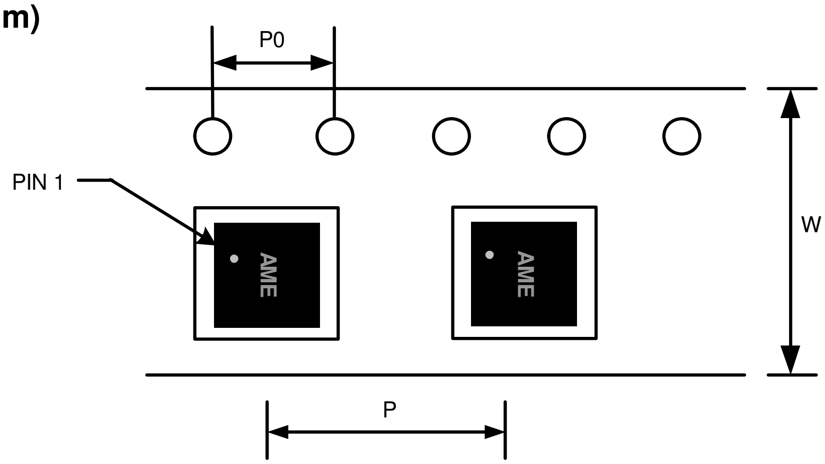


Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Pitch (P0)	Part Per Full Reel	Reel Size
SOT-25	8.0±0.1 mm	4.0±0.1 mm	4.0±0.1 mm	3000pcs	180±1 mm

■ Tape and Reel Dimension

DFN-6D
(2x2x0.75mm)

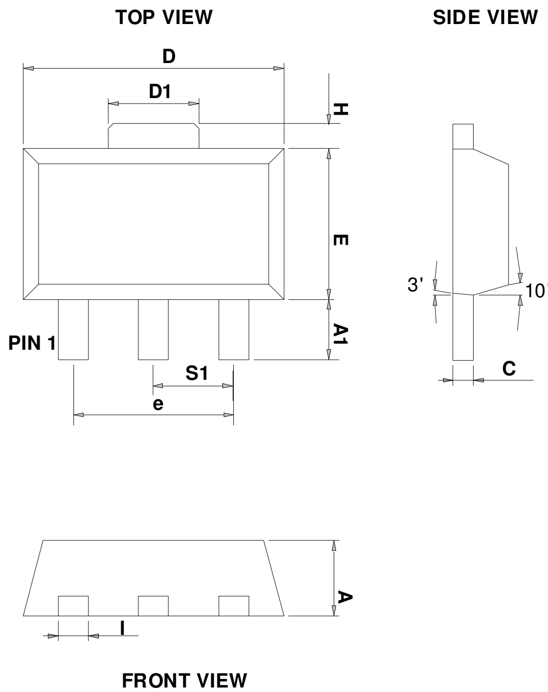


Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Pitch (P0)	Part Per Full Reel	Reel Size
DFN-6D (2x2x0.75mm)	8.0±0.1 mm	4.0±0.1 mm	4.0±0.1 mm	3000pcs	180±1 mm

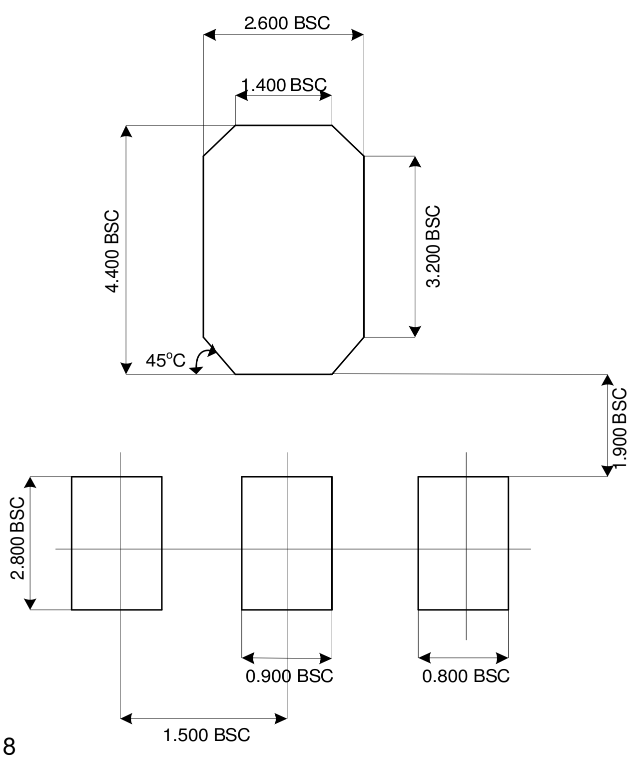
Package Dimension (Contd.)

SOT-89



SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.39	1.60	0.0547	0.0630
A_1	0.8 REF		0.0315 REF	
C	0.35	0.44	0.0138	0.0173
D	4.39	4.60	0.1728	0.1811
D_1	1.35	1.85	0.0531	0.0728
E	2.28	2.60	0.0898	0.1024
I	0.32	0.56	0.0126	0.0220
e	3.00 REF		0.1181 REF	
H	0.70 REF		0.0276 REF	
S1	1.50 REF		0.0591 REF	

Lead Pattern

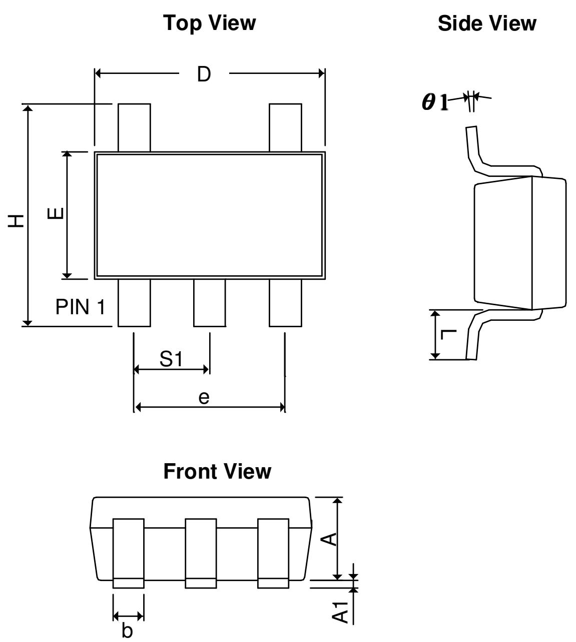


Note:

1. Lead pattern unit description:
   BSC: Basic. Represents theoretical exact dimension or dimension target.
2. Dimensions in Millimeters.
3. General tolerance ±0.05mm unless otherwise specified.

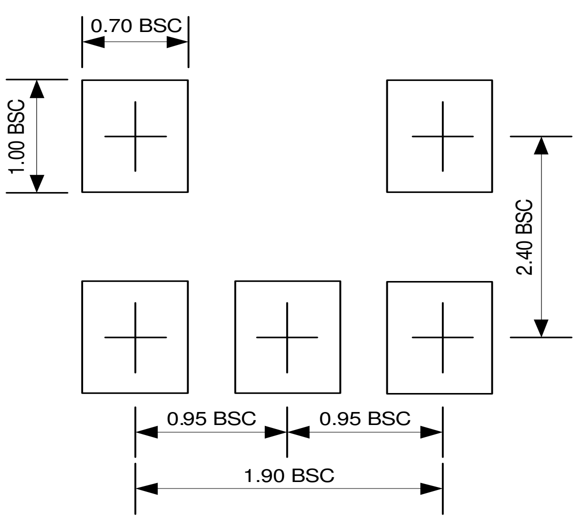
■ Package Dimension (Contd.)

SOT-25



SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.90	1.30	0.0354	0.0512
A_1	0.00	0.15	0.0000	0.0059
b	0.30	0.55	0.0118	0.0217
D	2.70	3.10	0.1063	0.1220
E	1.40	1.80	0.0551	0.0709
e	1.90 BSC		0.0748 BSC	
H	2.60	3.00	0.1024	0.1181
L	0.37 BSC		0.0146 BSC	
θ1	0^o	10^o	0^o	10^o
S_1	0.95 BSC		0.0374 BSC	

■ Lead Pattern

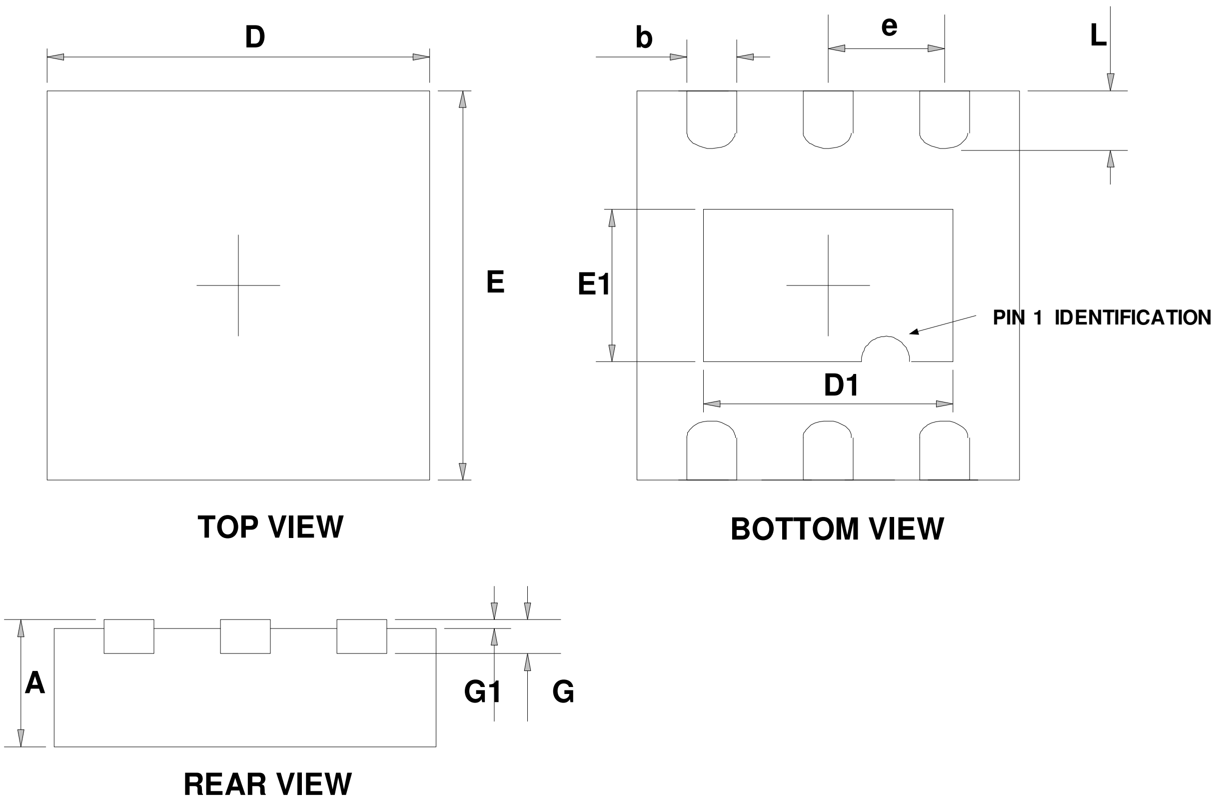


Note:

1. Lead pattern unit description:
   BSC: Basic. Represents theoretical exact dimension or dimension target.
2. Dimensions in Millimeters.
3. General tolerance $\pm$0.05mm unless otherwise specified.

■ Package Dimension

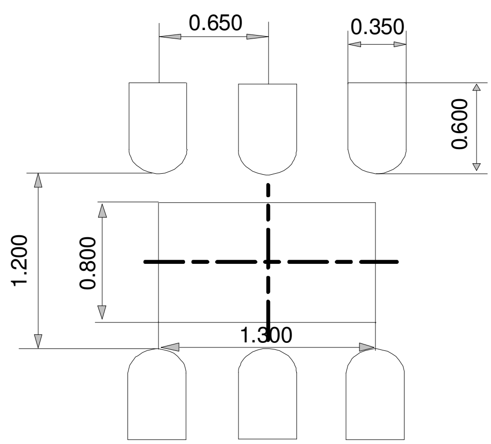
DFN-6D
(2x2x0.75mm)



SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
D	1.900	2.100	0.075	0.083
E	1.900	2.100	0.075	0.083
e	0.650 TYP		0.026 TYP	
D1	1.100	1.650	0.043	0.065
E1	0.600	1.050	0.024	0.041
b	0.180	0.350	0.007	0.014
L	0.200	0.450	0.008	0.018
G	0.178	0.228	0.007	0.009
G1	0.000	0.050	0.000	0.002

■ Lead Pattern Drawing

DFN-6D
(2x2x0.75mm)



Note:
1. Dimensions in Millimeters.
2. General tolerance ±0.05mm unless otherwise specified.

www.ame.com.tw
E-Mail: sales@ame.com.tw

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Corporate Headquarter

AME, Inc.

8F-1, 12, WenHu St., Nei-Hu
Taipei 114, Taiwan .
Tel: 886 2 2627-8687
Fax: 886 2 2659-2989