

■ General Description

The AME7720 / 7721 is switched-capacitor voltage doublers that delivers a regulated output. No external inductor is required for operation. Using three small capacitors, the AME7720 / 7721 can deliver up to 60mA to the voltage regulated output. The AME7720 / 7721 features very low output ripple and high efficiency over a large portion of its load range making this device ideal for battery-powered applications. Furthermore, the combination of few external components and small package size keeps the total converter board area to a minimum in space restricted applications.

The AME7720 / 7721 contains a thermal management circuit to protect the device under continuous output short circuit conditions.

The AME7720 / 7721 is available in SOT-25 / SOT-26 package and is rated from -40°C to 85°C.

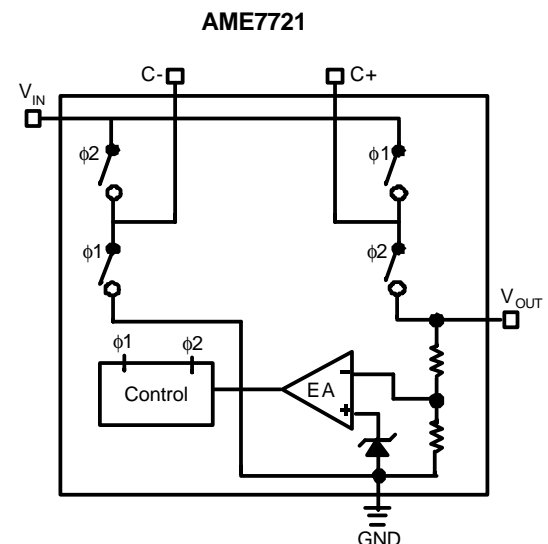
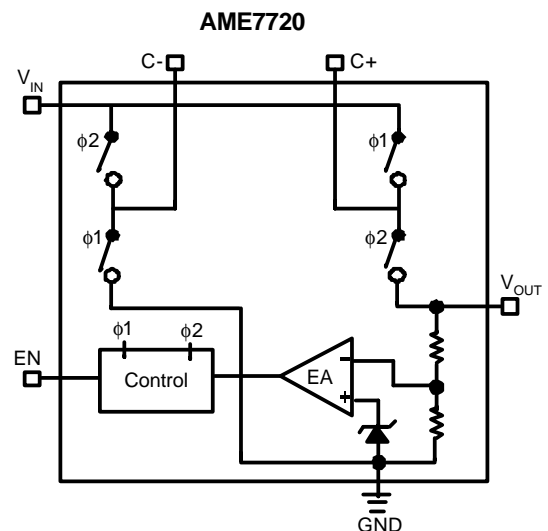
■ Features

- Input Voltage Range:
 - 5V Version: 2.7V to 5.5V
 - 3.3V Version: 1.8V to 5.5V
- Accurate to with $\pm 5\%$
- Output Current:
 - 5V Version: 60mA with $V_{IN} \geq 3.0V$
 - 3.3V Version: 60mA with $V_{IN} \geq 2.2V$
- 1MHz_z Switching Frequency
- Shutdown Mode < 1μA (AME7720)
- Short Circuit Protection: Typ. 80mA
- Over Temperature Protection
- All AME' s Lead Free Product Meet RoHS Standards

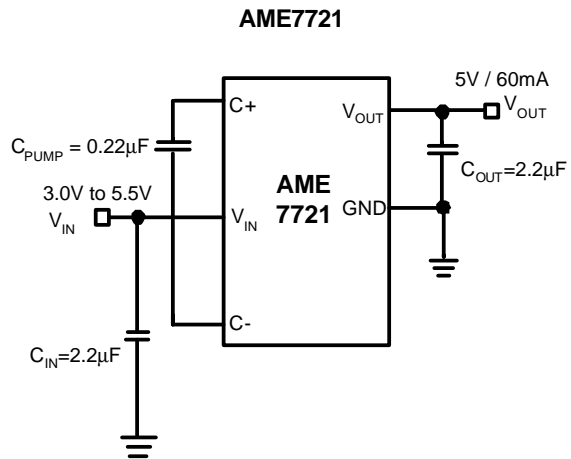
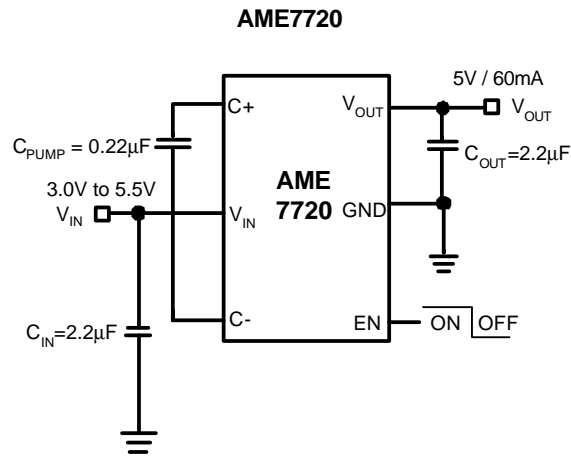
■ Applications

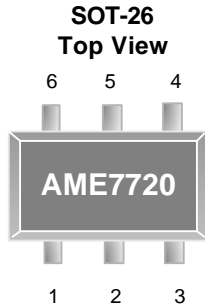
- Cellular Phone
- Digital Camera
- PDAs LCD display
- LED/Display Back Light Driver
- Smart Card Reader
- SIM Card Supply
- PCMCIA Card
- LCD Display

■ Functional Block Diagram



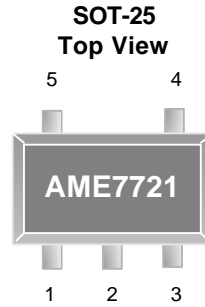
■ Typical Application



■ Pin Configuration

AME7720BEEY

1. V_{OUT}
2. GND
3. C-
4. V_{IN}
5. C+
6. EN

* **Die Attach:**
Conductive Epoxy

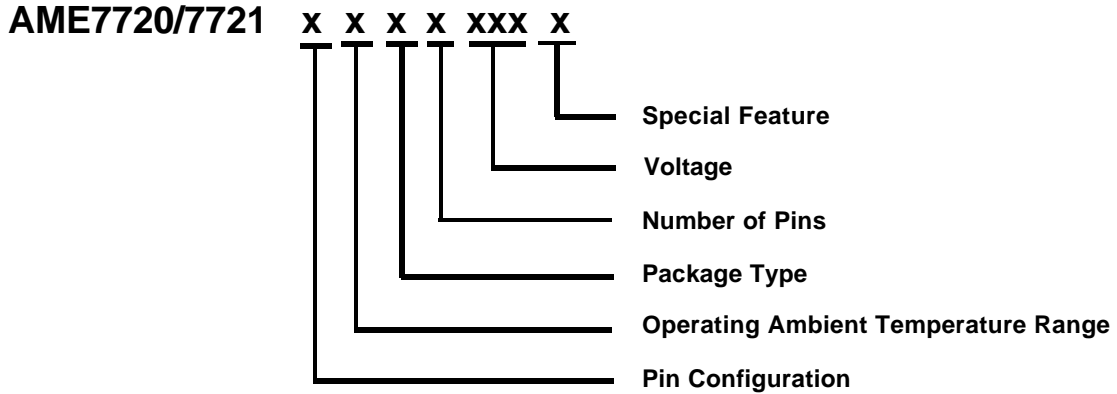

AME7721BEEV

1. V_{OUT}
2. GND
3. C-
4. V_{IN}
5. C+

* **Die Attach:**
Conductive Epoxy

■ Pin Description

Pin Number		Pin Name	Pin Description
AME7720	AME7721		
1	1	V_{OUT}	Regulator output pin. V_{OUT} should be bypassed with a 2.2 μ F low ESR ceramic capacitor.
2	2	GND	Ground pin connection.
3	3	C-	Pump capacitor negative terminal.
4	4	V_{IN}	Input supply pin. V_{IN} should be bypassed with a 2.2 μ F low ESR ceramic capacitor.
5	5	C+	Pump capacitor positive terminal.
6	N/A	EN	Shutdown input. Active Low disable the regulator.

■ Ordering Information


Pin Configuration	Operating Ambient Temperature Range	Package Type	Number of Pins	Voltage	Special Feature
AME7720 B 1. V _{OUT} (SOT-26) 2. GND 3. C- 4. V _{IN} 5. C+ 6. EN	E: -40°C to 85°C	E: SOT-2X	V: 5 Y: 6	500: V=5V	Y: Lead free & Low profile Z: Lead free
AME7721 B 1. V _{OUT} (SOT-25) 2. GND 3. C- 4. V _{IN} 5. C+					

■ Ordering Information

Part Number	Marking*	Output Voltage	Package	Operating Ambient Temperature Range
AME7720BEEY500Z	BECww	5V	SOT-26	- 40°C to + 85°C
AME7720BEEY500Y	BECww	5V	TSOT-26	- 40°C to + 85°C
AME7721BEEV500Z	BEGww	5V	SOT-25	- 40°C to + 85°C
AME7721BEEV500Y	BEGww	5V	TSOT-25	- 40°C to + 85°C

Note: ww represents the date code and pls refer to Date Code Rule before Package Dimension.

* A line on top of the first letter represents lead free plating such as $\overline{\text{B}}\text{ECww}$.

Please consult AME sales office or authorized Rep./Distributor for the availability of package type.

■ Absolute Maximum Ratings

Parameter	Maximum	Unit
Input Voltage	5.5	V
ESD Classification	C*	

Caution: Stress above the listed absolute maximum rating may cause permanent damage to the device.

* HBM C:4000V+

■ Recommended Operating Conditions

Parameter	Symbol	Rating	Unit
Ambient Temperature Range	T_A	- 40 to + 85	°C
Junction Temperature Range	T_J	- 40 to + 125	°C

■ Thermal Information

Parameter	Package	Die Attach	Symbol	Maximum	Unit
Thermal Resistance* (Junction to Case)	SOT-26	Conductive Epoxy	θ_{JC}	81	°C/W
	SOT-25	Conductive Epoxy			
Thermal Resistance (Junction to Ambient)	SOT-26	Conductive Epoxy	θ_{JA}	260	
	SOT-25	Conductive Epoxy			
Internal Power Dissipation	SOT-26	Conductive Epoxy	P_D	400	mW
	SOT-25	Conductive Epoxy			
Maximum Junction Temperature				150	°C
Solder Iron (10Sec)**				350	

* Measure θ_{JC} on center of molding compound if IC has no tab.

** MIL-STD-202G 210F

■ Electrical Specifications(AME7720)

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, $V_{IN} = V_{OUT}/2 + 0.75\text{V}$, $I_{OUT} = 5\text{mA}$, $C_{IN} = C_{OUT} = 2.2\mu\text{F}$, $C_{PUMP} = 0.22\mu\text{F}$, $V_{EN} = 1.3\text{V}$
 Typical Values are at $T_A = 25^{\circ}\text{C}$.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units	
Input Voltage	V_{IN}	$V_{OUT} = 5\text{V}$	2.7		5.5	V	
		$V_{OUT} = 3.3\text{V}$	1.8		5.5		
Output Voltage	V_{OUT}	$I_{OUT} \leq 15\text{mA}$, $2.7\text{V} < V_{IN} < 5.5\text{V}$	4.75	5	5.25	V	
		$I_{OUT} \leq 60\text{mA}$, $3.0\text{V} < V_{IN} < 5.5\text{V}$					
		$I_{OUT} \leq 15\text{mA}$, $1.8\text{V} < V_{IN} < 5.5\text{V}$	3.14	3.3	3.46		
		$I_{OUT} \leq 60\text{mA}$, $2.2\text{V} < V_{IN} < 5.5\text{V}$					
Quiescent Current	I_Q	$1.8\text{V} < V_{IN} < 5.5\text{V}$, $I_{OUT} = 0\text{mA}$	$T_A = -40 \sim +85^{\circ}\text{C}$		60	100	μA
		$1.8\text{V} < V_{IN} < 5.5\text{V}$, $\text{EN} = \text{GND}$			0.01	0.1	
Output Current	I_{OUT}	$V_{OUT} = 5\text{V}$	60			mA	
Short Circuit Current Limit	I_{SC}	$V_{OUT} = \text{GND}$		80		mA	
Ripple Voltage ¹	V_{RIPPLE}	$V_{IN} = 3\text{V}$, $I_{OUT} = 60\text{mA}$		50		mVp-p	
Efficiency	η	$I_{OUT} = 15\text{mA}$, $V_{IN} = 2.7\text{V}$		90		%	
Frequency	f_{OSC}	Oscillator Free Running		1.0		MHz	
EN Input Threshold High	V_{IH}		1.3			V	
EN Input Threshold Low	V_{IL}				0.6	V	
EN Input Current High	I_{IH}	$\text{EN} = V_{IN}$			0.1	μA	
EN Input Current Low	I_{IL}	$\text{EN} = \text{GND}$			0.1	μA	
V_{OUT} Turn-on time	t_{ON}	$V_{IN} = 3\text{V}$, $I_{OUT} = 60\text{mA}$		0.15		ms	
Over Temperature Shutdown	OTS			160		$^{\circ}\text{C}$	
Over Temperature Hysteresis	OTH			20			

Note 1: Effective series resistance (ESR) of capacitors is $< 0.1\Omega$.

■ Electrical Specifications(AME7721)

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, $V_{IN} = V_{OUT}/2 + 0.75\text{V}$, $I_{OUT} = 5\text{mA}$, $C_{IN} = 2.2\mu\text{F}$, $C_{PUMP} = 0.22\mu\text{F}$
 Typical Values are at $T_A = 25^{\circ}\text{C}$

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Input Voltage	V_{IN}	$V_{OUT} = 5\text{V}$	2.7		5.5	V
		$V_{OUT} = 3.3\text{V}$	1.8		5.5	
Output Voltage	V_{OUT}	$I_{OUT} \leq 15\text{mA}$, $2.7\text{V} < V_{IN} < 5.5\text{V}$	4.75	5	5.25	V
		$I_{OUT} \leq 60\text{mA}$, $3.0\text{V} < V_{IN} < 5.5\text{V}$				
		$I_{OUT} \leq 15\text{mA}$, $1.8\text{V} < V_{IN} < 5.5\text{V}$	3.14	3.3	3.46	
		$I_{OUT} \leq 60\text{mA}$, $2.2\text{V} < V_{IN} < 5.5\text{V}$				
Quiescent Current	I_Q	$1.8\text{V} < V_{IN} < 5\text{V}$, $I_{OUT} = 0\text{mA}$		60	100	μA
Output Current	I_{OUT}	$V_{OUT} = 5\text{V}$	60			mA
Short Circuit Current Limit	I_{SC}	$V_{OUT} = \text{GND}$		80		mA
Ripple Voltage ¹	V_{RIPPLE}	$V_{IN} = 3\text{V}$, $I_{OUT} = 60\text{mA}$		50		mVp-p
Efficiency	η	$I_{OUT} = 15\text{mA}$, $V_{IN} = 2.7\text{V}$		90		%
Frequency	f_{OSC}	Oscillator Free Running		1.0		MHz
V_{OUT} Turn-on time	t_{ON}	$V_{IN} = 3\text{V}$, $I_{OUT} = 60\text{mA}$		0.15		ms
Over Temperature Shutdown	OTS			160		$^{\circ}\text{C}$
Over Temperature Hysteresis	OTH			20		

Note 1: Effective series resistance (ESR) of capacitors is $< 0.1\Omega$.



■ Detailed Description

The AME7720 / 7721 regulated charge pump provides a regulated output voltages ranging from less than the output to greater than the output. This is accomplished by automatic mode switching within the device.

■ Short Circuit and Thermal Protection

The AME7720 / 7721 has a thermal protection and shutdown circuit that continuously monitors the IC junction temperature. If the thermal protection circuit senses the die temperature exceeding approximately 160°C, the thermal shutdown will disable the charge pump switching cycle operation. The thermal limit system has 20°C of system hysteresis before the charge pump can reset. Once the over current event is removed from the output and the junction temperature drops below 140°C, the charge pump will become active again. The thermal protection system will cycle on and off if an output short circuit condition persists. This will allow the AME7720 / 7721 to operate indefinitely a short circuit condition without damage to the device.

■ Shutdown Mode

A control pin on the regulator can be used to place the device into an energy-saving shutdown mode. In this mode, the output is disconnected from the input as long as V_{IN} is greater than or equal to minimum V_{IN} and input quiescent current is reduced to 1μA maximum.

■ Capacitor Selection

For minimum output voltage ripple, the output capacitor C_{OUT} should be a ceramic, surface-mount type. Tantalum capacitors generally have a higher Effective Series Resistance (ESR) and may contribute to higher output voltage ripple. Leaded capacitors also increase ripple due to the higher inductance of the package itself. To achieve best operation with low input voltage and high load current, the input and pump capacitors (C_{IN} , C_{PUMP} respectively) should also be surface-mount ceramic types. In all cases, X7R or X5R dielectric are recommended.

With light loads or higher input voltage, a smaller 0.1μF pump capacitor (C_{PUMP}) and smaller 1μF input and output capacitor (C_{IN} and C_{OUT} , respectively) can be used. To minimize output voltage ripple, increase the output capacitor, C_{OUT} , to 10μF or larger.

■ Efficiency

The efficiency of the charge pump regulator varies with the output voltage version, the applied input voltage, the load current, and the internal operation mode of the device.

The approximate efficiency is given by:

$$\begin{aligned} & \text{5V Version } (V_{IN} \leq V_{OUT}) \\ \text{Efficiency (\%)} &= V_{OUT} / 2V_{IN} \cdot I_D \cdot 100 \end{aligned}$$

$$\begin{aligned} & \text{3.3V Version } (V_{IN} > V_{OUT}) \\ \text{Efficiency (\%)} &= V_{OUT} / V_{IN} \cdot I_D \cdot 100 \end{aligned}$$

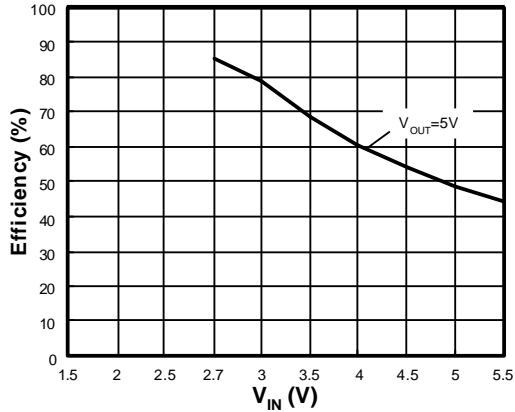
■ Layout

Large ripple currents flow in the V_{IN} and V_{OUT} traces. To minimize both input and output ripple, keep the capacitors as close as possible to the regulator using short, direct circuit traces.

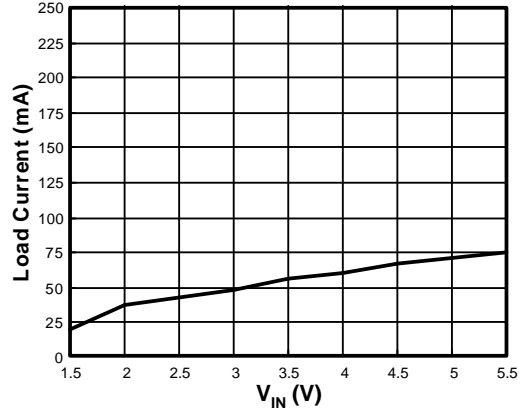
The trace lengths from the input and output capacitors have been kept as short as possible. A star ground system has been implemented, with GND pin as the center of the star. No ground plane is provided in other layers, as this will provide capacitive coupling for noise spikes.



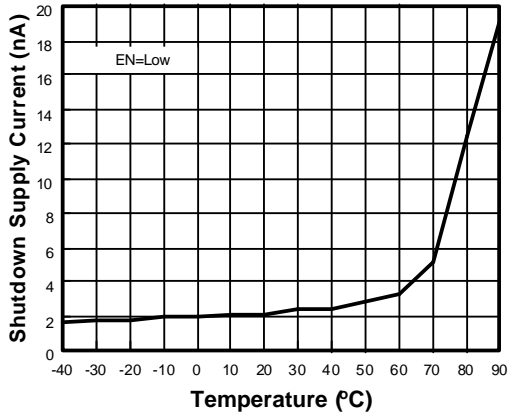
Efficiency vs. V_{IN}



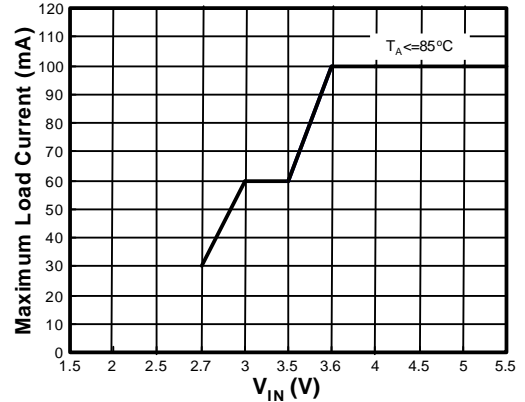
Short-Circuit Load Current vs V_{IN}



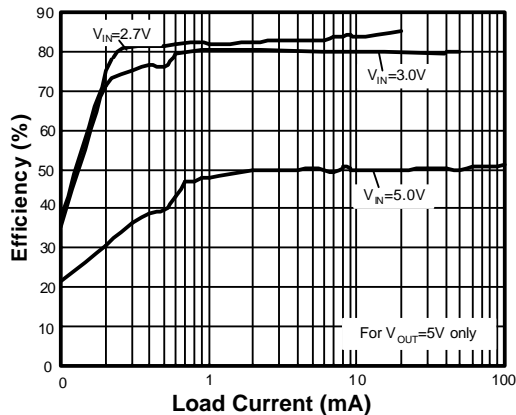
Shutdown Supply Current vs Temperature



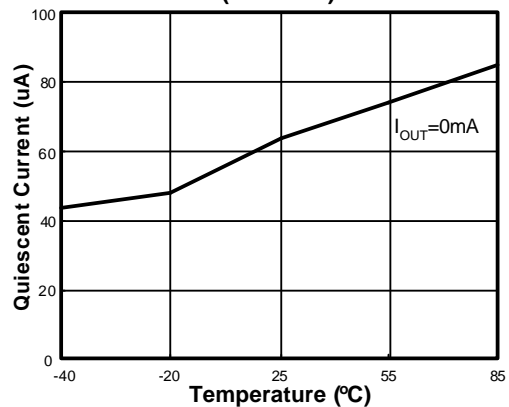
Maximum Load Current vs Input Voltage



Efficiency vs Load Current

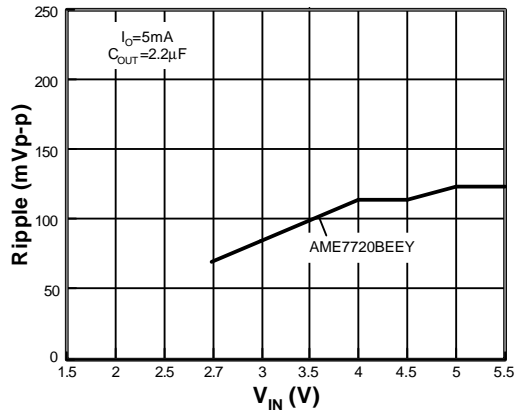


Quiescent Current vs Temperature (No Load)

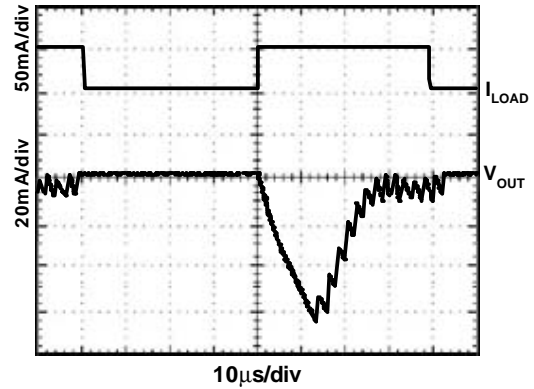




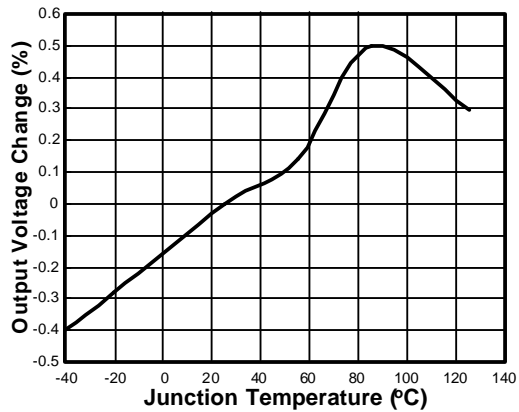
Output Ripple Voltage vs V_{IN}



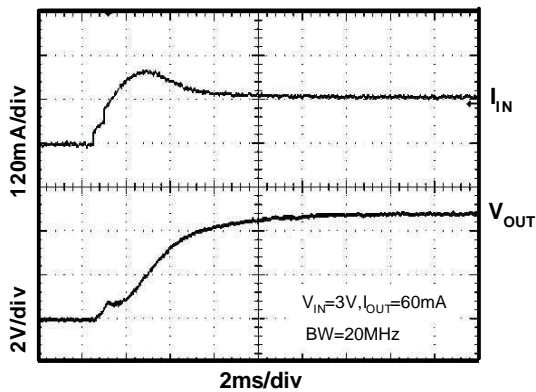
Load Transient Response



Output Voltage vs Temperature

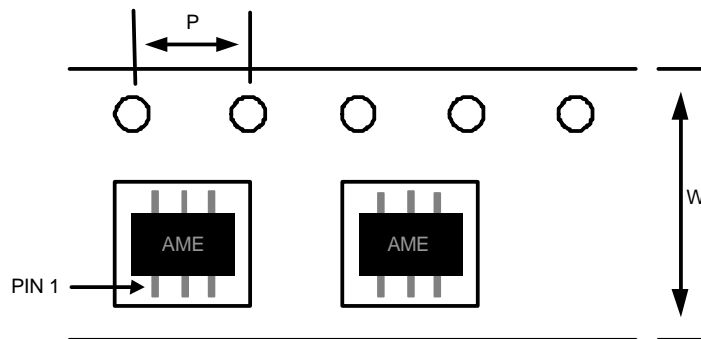


Input Current at Turn-On

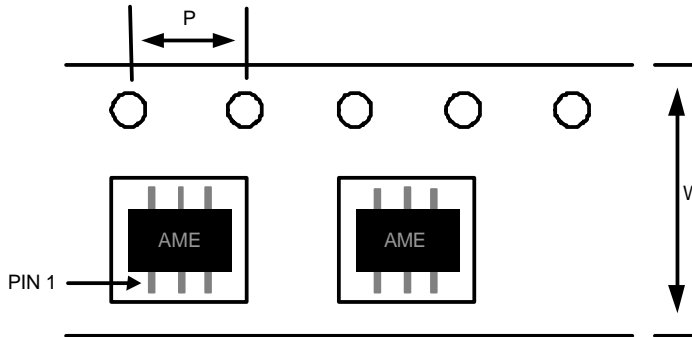


■ Date Code Rule

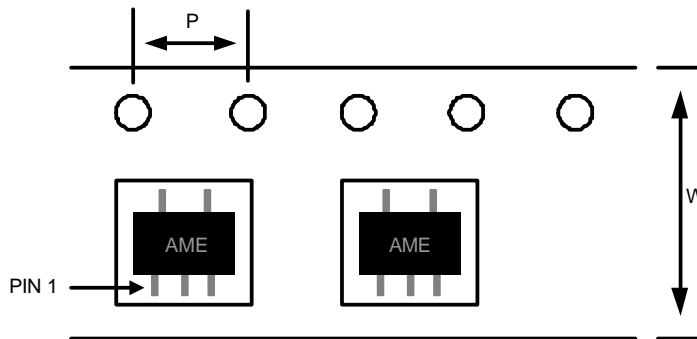
Marking			Date Code		Year
A	A	A	W	W	xxx0
A	A	A	W	<u>W</u>	xxx1
A	A	A	<u>W</u>	W	xxx2
A	A	A	<u>W</u>	<u>W</u>	xxx3
A	A	<u>A</u>	W	W	xxx4
A	A	<u>A</u>	W	<u>W</u>	xxx5
A	A	<u>A</u>	<u>W</u>	W	xxx6
A	A	<u>A</u>	<u>W</u>	<u>W</u>	xxx7
A	<u>A</u>	A	W	W	xxx8
A	<u>A</u>	A	W	<u>W</u>	xxx9

■ Tape & Reel Dimension
SOT-26

Carrier Tape, Number of Components Per Reel and Reel Size

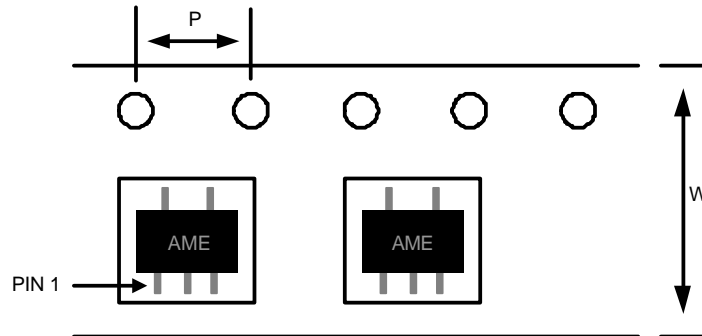
Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
SOT-26	8.0±0.1 mm	4.0±0.1 mm	3000pcs	180±1 mm

■ Tape & Reel Dimension
TSOT-26


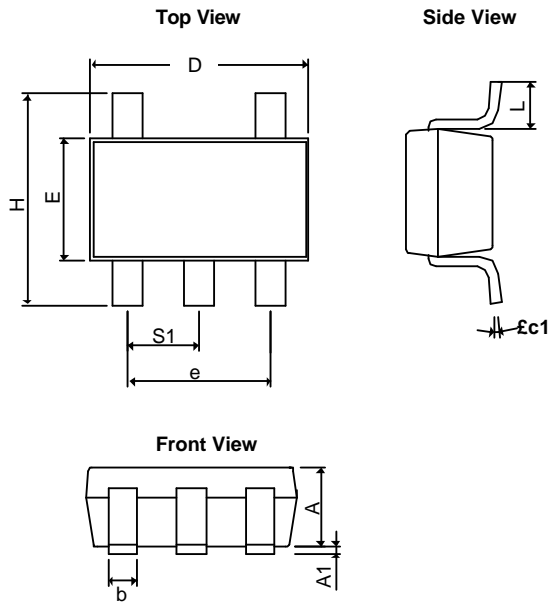
Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
TSOT-26	8.0±0.1 mm	4.0±0.1 mm	3000pcs	180±1 mm

SOT-25

Carrier Tape, Number of Components Per Reel and Reel Size

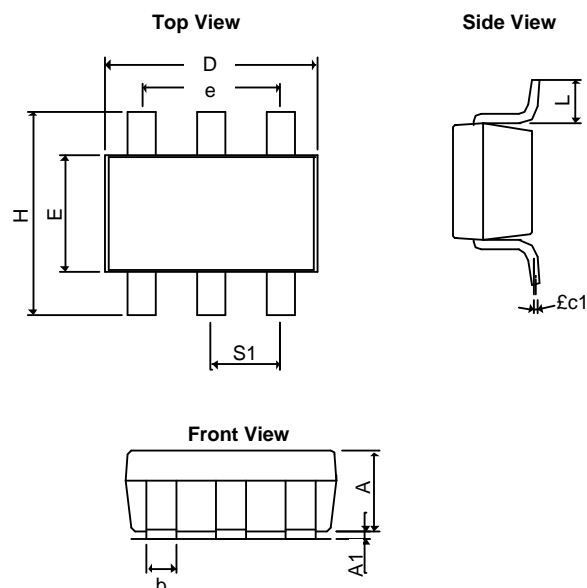
Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
SOT-25	8.0±0.1 mm	4.0±0.1 mm	3000pcs	180±1 mm

■ Tape and Reel Dimension
TSOT-25

Carrier Tape, Number of Components Per Reel and Reel Size

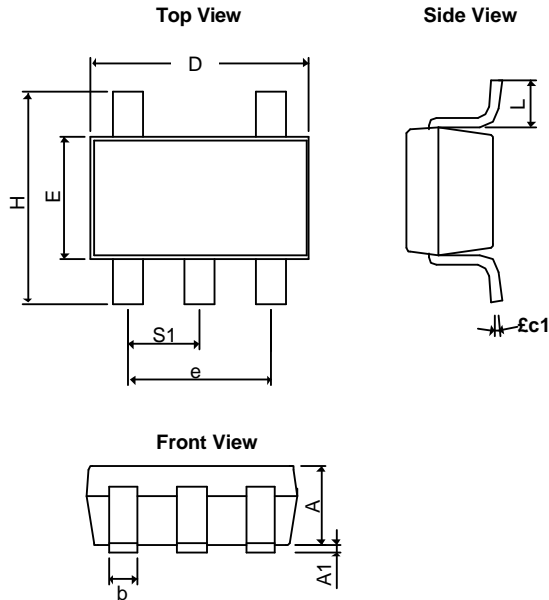
Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
TSOT-25	8.0±0.1 mm	4.0±0.1 mm	3000pcs	180±1 mm

■ Package Dimension
SOT-25


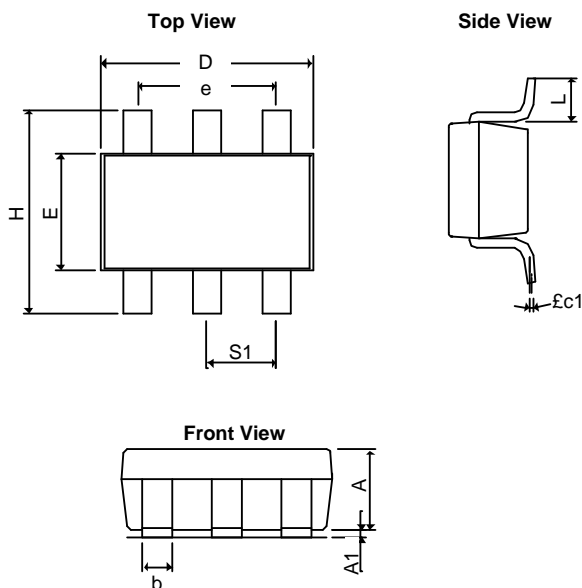
SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.20REF		0.0472REF	
A₁	0.00	0.15	0.0000	0.0059
b	0.30	0.55	0.0118	0.0217
D	2.70	3.10	0.1063	0.1220
E	1.40	1.80	0.0551	0.0709
e	1.90 BSC		0.07480 BSC	
H	2.60	3.00	0.10236	0.11811
L	0.37BSC		0.0146BSC	
?1	0°	10°	0°	10°
S₁	0.95BSC		0.0374BSC	

SOT-26


SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.20REF		0.0472REF	
A₁	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	0.10236	0.11811
L	0.37REF		0.0146REF	
?1	0°	10°	0°	10°
S₁	0.95REF		0.0374REF	

■ Package Dimension
TSOT-25


SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
$A+A_1$	1.00	1.30	0.0394	0.0512
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		0.07480 BSC	
H	2.60	3.00	0.10236	0.11811
L	0.37BSC		0.0146BSC	
θ_1	0°	10°	0°	10°
S_1	0.95BSC		0.0374BSC	

TSOT-26


SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
$A+A_1$	1.00	1.30	0.0394	0.0512
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	0.10236	0.11811
L	0.37REF		0.0146REF	
θ_1	0°	10°	0°	10°
S_1	0.95REF		0.0374REF	



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