v General Description

The GA6120 is a low-dropout linear regulator that operates in the input voltage range from 2.5V to 7V and delivers 500mA output current.

The GA6120 provides fixed output voltage for customers in application. The fixed output voltage type is preset at an internally trimmed voltage 1.8V, 2.5V or 3.3V. About other options are available by special order only. The other voltage option range of the GA6120 is from 1.25V to 5V

The GA6120 consists of a 1.25V bandgap reference, an error amplifier and a P-channel pass transistor. Other features include current limit, short-circuit protection and thermal shutdown protection. The GA6120 devices are available in space-saving SOT-89 package.

This chip is stable with an input capacitor of 1uF and output capacitor of 3.3uF or greater.

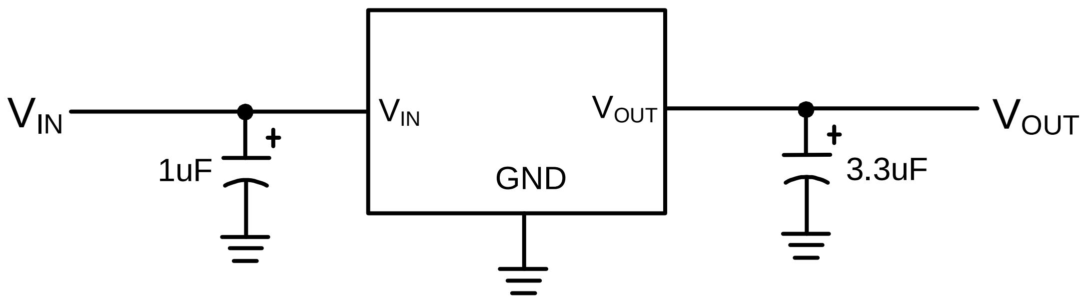
v Features

- Low Dropout Voltage
- High Output Voltage Accuracy: ± 1.5%
- Great Output Capability
- Custom Output Voltage
- Current Limit
- Thermal Shutdown Protection
- SOT-89 Package
- All GA's Products meet Rohs Standard

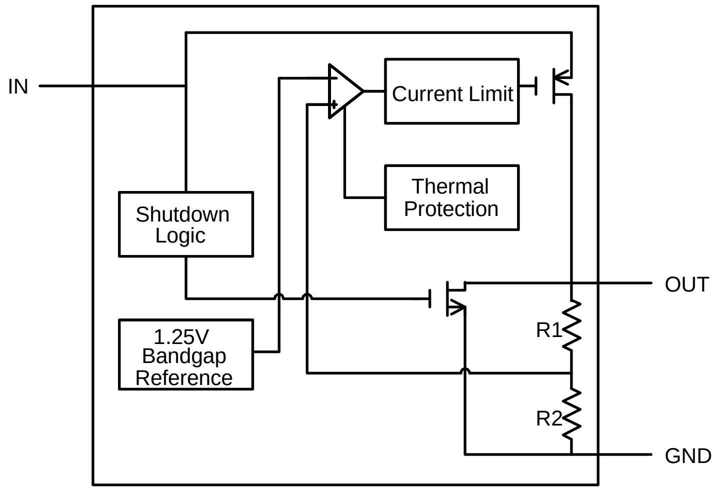
v Applications

- Broadband Communication Device
- LCD Monitor
- Storage Device
- PC Peripherals

v Typical Application



v Functional Block Diagram

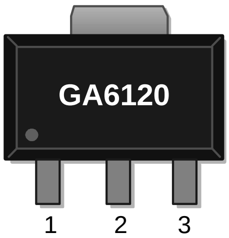


Fixed Output Voltage

v Pin Configurations

Top View

SOT-89

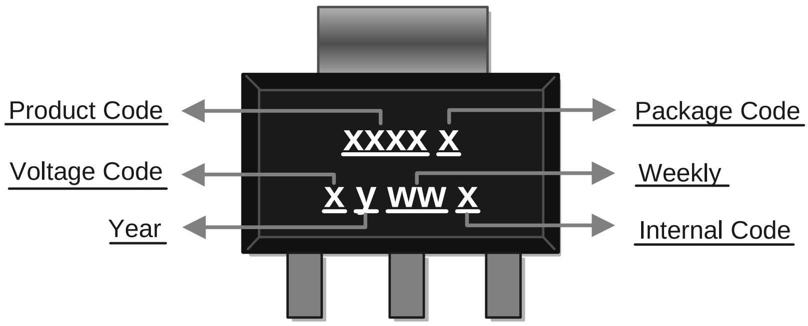


GA6120xEEZ Description

Pin No.	Name	Function
1	GND	Ground
2	V_{IN}	Input Voltage
3	V_{OUT}	Output Voltage

v Marking Information

SOT-89



v Ordering Information

GA6120□□□□

- Output Voltage
- Operating Temperature
- Package Type
- Feature

Output Voltage	Operating Temperature	Package Type	Feature
A: 3.3V B: 2.5V C: 1.8V	E: - 40°C ~ 85°C	E: SOT-89	Z: Lead Free

Part Number	Marking	Output Voltage	Package Type	Operating Temperature	Standard Package
GA6120AEEZ	6120E Aywwx	3.3V	SOT-89	- 40°C ~ + 85°C	1,000pcs / T&P
GA6120BEEZ	6120E Bywwx	2.5V	SOT-89	- 40°C ~ + 85°C	1,000pcs / T&P
GA6120CEEZ	6120E Cywwx	1.8V	SOT-89	- 40°C ~ + 85°C	1,000pcs / T&P

Please consult GA sales office or authorized Rep./Distributor for output voltage and package type availability.

Absolute Maximum Ratings

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	Maximum Ratings
Input Voltage	8V
Input, Output Voltage	GND - 0.3 to V_{IN} + 0.3
Lead Soldering Temperature (10 sec)	300°C
Storage Temperature	- 55°C ~ 150°C

Recommended Operating Conditions

Parameter	Rating
Junction Temperature	- 40°C ~ 125°C
Ambient Temperature	- 40°C ~ 85°C

Package Information

Parameter	Package	Symbol	Maximum	Unit
Thermal Resistance (Junction to Case)	SOT-89	θ_{JC}	50	°C / W
Thermal Resistance (Junction to Ambient)	SOT-89	θ_{JA}	180	°C / W
Internal Power Dissipation	SOT-89	P_D	550	mW

v Electrical Specifications

V_{IN} = V_{OUT}+1V, T_A =25°C, C_{IN}=1uF, C_{OUT}=3.3uF, unless otherwise noted.

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Input Voltage	V_{IN}		2.5		7	V
Output Voltage Accuracy	V_O	I_O=1mA	-1.5		1.5	%
Output Current	I_{OUT}	V_{OUT} >=1.25V	500			mA
Dropout Voltage	$V_{DROPOUT}$	I_O=500mA		650	800	mV
Current Limit	I_{LIM}	V_O>1.2V, V_{IN}=V_O+1V		800		mA
Ground Current	I_{GND}	I_O=1mA to 500mA		30	50	uA
Quiescent Current	I_Q	I_O=0mA to 500mA		30	50	uA
Line Regulation	△V_{LINE}	I_O=1mA V_{IN}=V_O+1 to V_O+2		0.2	0.3	% / V
Load Regulation	△V_{LOAD}	I_O=1mA to 500mA		0.02	0.03	% / mA
Temperature Coefficient	T_C			40		ppm/°C
Over Temperature Shutdown	T_{SD}	I_O=1mA		155		°C
Over Temperature Shutdown Hysteresis	T_{HYS}	I_O=1mA		20		°C
Power Supply Rejection	PSRR	f=1kHz, C_O=3.3uF, V_{IN}=2.8V V_{OUT}=1.8V, I_{OUT}=300mA		55		dB
Output Voltage Noise	eN	f=1Hz to 10kHz, C_O=3.3uF		75		uVrms

Application Information

Capacitor Selection and Regulator Stability

Like any low-dropout regulator, the next external capacitors used with the GA6120 must be carefully selected for regulator stability and performance.

Using a capacitor whose value is >1uF on the GA6120 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″ 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 with both requirements for minimum amount of capacitance and ESR in all LDOs application. The GA6120 is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. Using a ceramic capacitor whose value is at least 3.3uF with ESR is >5mΩ on the GA6120 output ensures stability. The GA6120 still work well with output capacitor of other types due to the wide stable ESR range.

Note at some ceramic dielectrics exhibit large capacitance and ESR variation with temperature. It may be necessary to use 3.3uF or more to ensure stability at temperature below -10°C in this case. Also, tantalum capacitors, 3.3uF or more may be needed to maintain capacitance and ESR in the stable region for strict application environment.

Tantalum capacitors maybe suffer failure due to surge current when it is connected to a low-impedance source of power (like a battery or very large capacitor). If a tantalum capacitor is used at the input, it must be guaranteed to have a surge current rating sufficient for the application by the manufacture.

Load-Transient Considerations

The GA6120 Load-Transient response graphs (see Typical Operating Characteristics) 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 excellent load regulation of the IC. Typical output voltage transient spike for a step change in the load current from 1mA to 500mA is 100mV, depending on the ESR of the output capacitor. Increasing the output capacitor's value and decreasing the ESR attenuates the overshoot.

Internal P-Channel Pass Transistor

The GA6120 features a typical 0.7Ω P-Channel MOSFET pass transistor. It provides several advantages over similar designs using PNP pass transistors, including longer battery life. The P-Channel MOSFET requires no base drive, which reduces quiescent current considerably. PNP-based regulators waste considerable current in dropout when the pass transistor saturates. They also use high base-drive currents under lager loads. The GA6120 does not suffer from these problems and consume only 60uA of quiescent current whether in dropout, light-load, or heavy-load applications.

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 GA6120 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.

Reverse Current Path

The power transistor used in the GA6120 has an inherent diode connected between the regulator input and output (see Figure 1). If the output is forced above the input by more than a diode-drop, this diode will become forward biased and current will follow from the V_{OUT} terminal to V_{IN} .The diode will also be turned on the by abruptly stepping the input voltage to a value below the output voltage. To prevent regulator mis-operation, a Schottky diode should be used in any applications where input/output voltage conditions can cause the internal diode to be turned on (see Figure 2). As shown, the Schottky diode is connected in parallel with the internal parasitic diode and prevents it from being turned on by limiting the voltage drop across it to about 0.3V<100mA to prevent damage to the part.

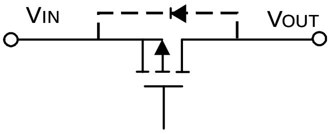


Figure1

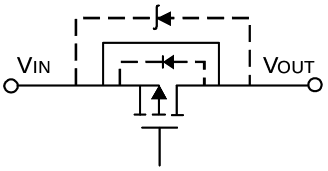


Figure2

Operating Region and Power Dissipation

The maximum power dissipation of GA6120 depends of 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 $P=I_{OUT}(V_{IN}-V_{OUT})$. The maximum power dissipation is :

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

where $T_J - T_A$ is the temperature difference between the GA6120 die junction and surrounding environment, θ_{JA} is the thermal resistance from the junction to the surrounding environment. The GND pin of the GA6120 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.

Current Limit and Thermal Protection

GA6120 includes a current limit which monitors and controls the pass transistor's gate voltage limiting the output current to 800mA Typ. Thermal overload protection limits total power dissipation in the GA6120. When the junction temperature exceeds $T_J=+150^oC$, the thermal sensor signals the shutdown logic turning off the pass transistor and allowing the IC to cool. The thermal sensor will turn the pass transistor on again after the IC's junction temperature cools by 20^oC resulting in a pulsed output during continuous thermal-overload conditions. Thermal overload protection is designed to protect the GA6120 in the event of fault conditions. Do not exceed the absolute maximum junction -temperature rating of $T_J=+150^oC$ for continuous operation. The output can be shorted to ground for an indefinite amount of time without damaging the part by cooperation of current limit and thermal protection.

Thermal considerations

Thermal protection limits power dissipation in GA6120. When the operation junction temperature exceeds 150^oC the OTP circuit starts the thermal shutdown function and turns the pass element off. The pass element turn on again after the junction temperature cools by 20^oC.

For continuous operation, do not exceed absolute maximum operation junction temperature 125^oC The power dissipation definition in device is:

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

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

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

Where $T_{J(MAX)}$ is the maximum operation junction temperature 125^oC, TA is the ambient thermal resistance. For recommended operating conditions specification of GA6120, where $T_{J(MAX)}$ is the maximum junction temperature of the die (125^oC) and T_A is the operated ambient temperature. The junction to ambient thermal resistance θ_{JA} is layout dependent .For SOT-89 package, the thermal resistance θ_{JA} is $180^oC/W$ on the standard JEDEC 51-3 single-layer thermal test board. The maximum power dissipation at $T_A=25^oC$ can be calculated by following formula:

$$P_{D(MAX)} = (125^oC - 25^oC) / 180 = 0.55W$$

for SOT-89 package

The value of junction to case thermal resistance θ_{JC} is popular to users. This thermal parameter is convenient for users to estimate the internal junction operated temperature of packages while IC operating. It's independent of PCB layout, the surroundings airflow effects and temperature difference between junction to ambient. The operated junction temperature can be calculated by following formula:

$$T_J = T_C + P_D * \theta_{JC}$$

Where T_C is the package case temperature measured by thermal sensor, P_D is the power dissipation defined by user's function and the θ_{JC} is the junction to case thermal resistance provided by IC manufacturer. Therefore it's easy to estimate the junction temperature by any condition.

For example, how to calculate the junction temperature of GA6120 SOT-89 package? If we use input voltage V_{IN} =3.3V, at an output current I_O = 300mA and the case temperature T_C =60°C measured by the thermal couple while operating, then our power dissipation is as follows:

$$P_D = (3.3V-2.5V) * 300mA + 3.3V * 60uA$$

$$\approx 240mW$$

And the junction temperature T_J could be calculated as following:

$$T_J = T_C + P_D * \theta_{JC}$$

$$T_J = 60^oC + 0.24W * 50^oC/W$$

$$= 60^oC + 12^oC$$

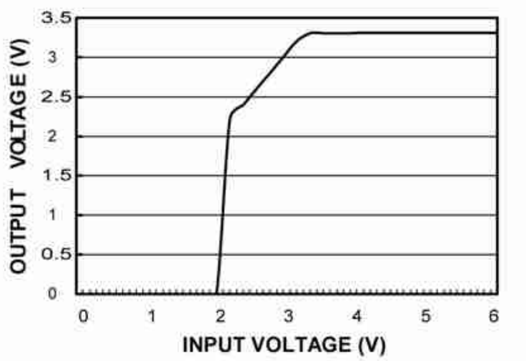
$$= 72^oC < T_{J(MAX)} = 125^oC$$

For this operation application T_J is lower than absolute maximum operation junction temperature 125°C and it's safe to use.

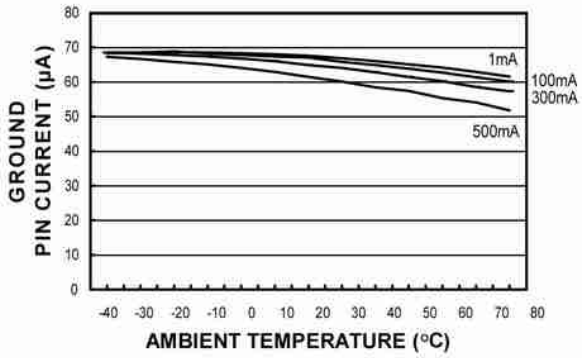
v Typical Performance Characteristics

C_{IN}=1uF, C_{OUT}=3.3uF, T_A =+25°C, unless otherwise noted.

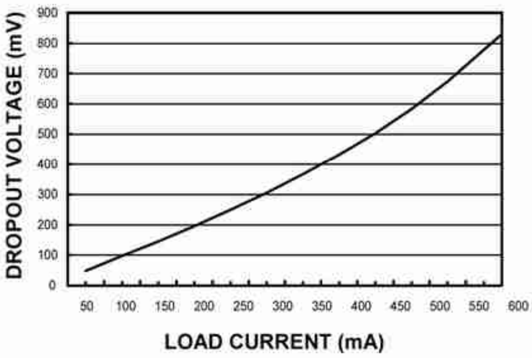
OUTPUT VOLTAGE vs. INPUT VOLTAGE



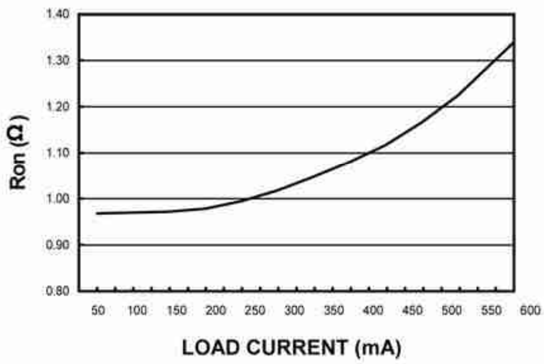
GROUND PIN CURRENT vs. AMBIENT TEMPERATURE



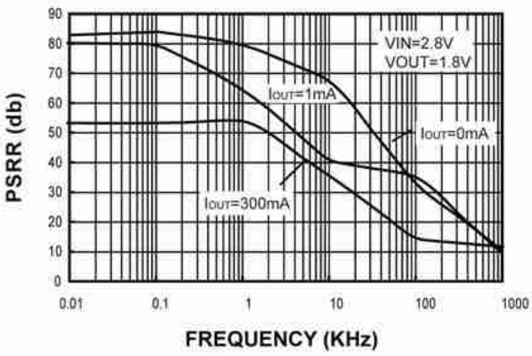
DROPOUT VOLTAGE vs. LOAD CURRENT



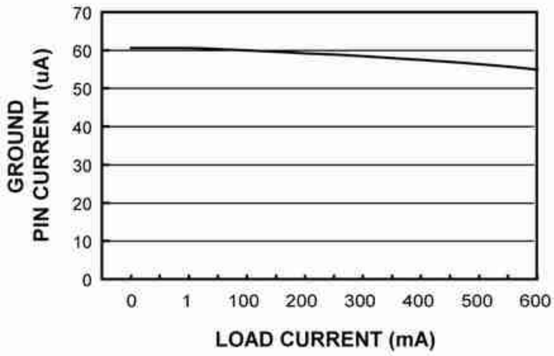
Ron vs. LOAD CURRENT



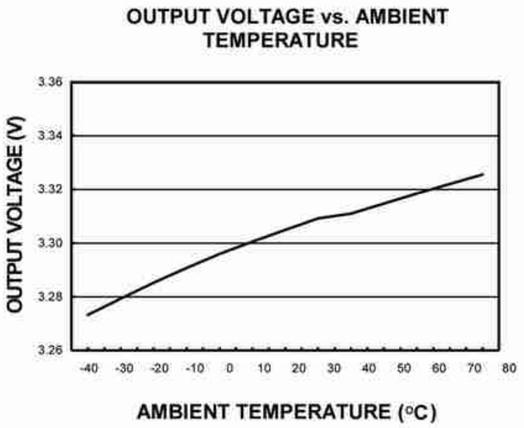
POWER SUPPLY REJECTION RATIO vs. FREQUENCY

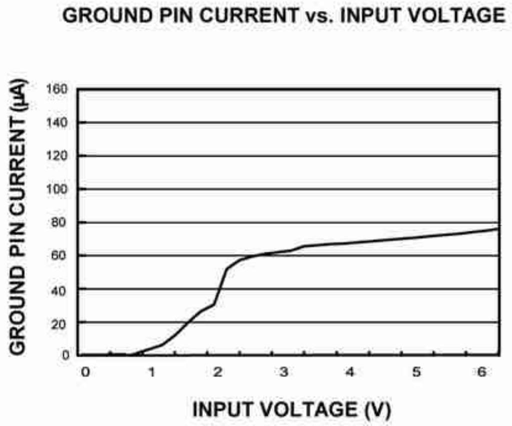


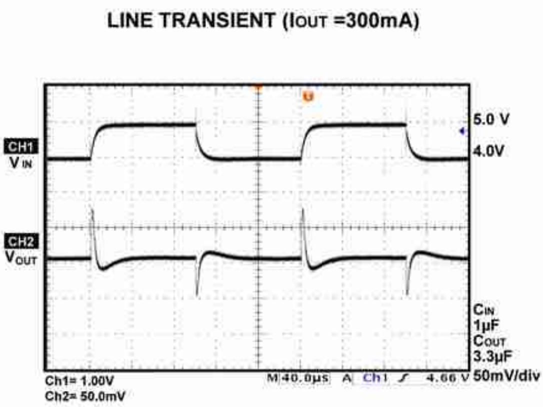
GROUND PIN CURRENT vs. LOAD CURRENT

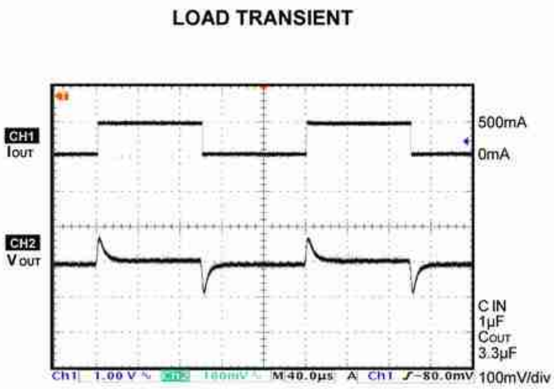


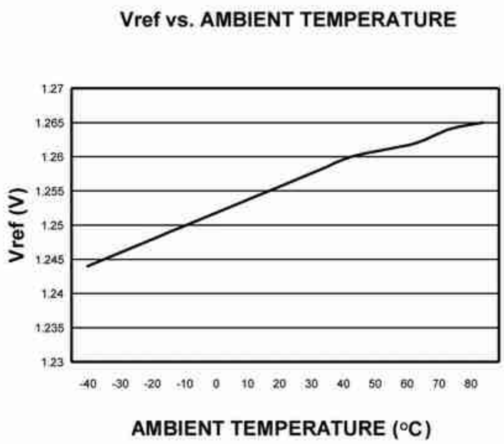
v Typical Performance Characteristics

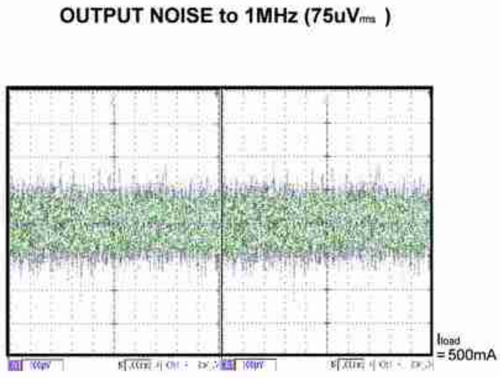






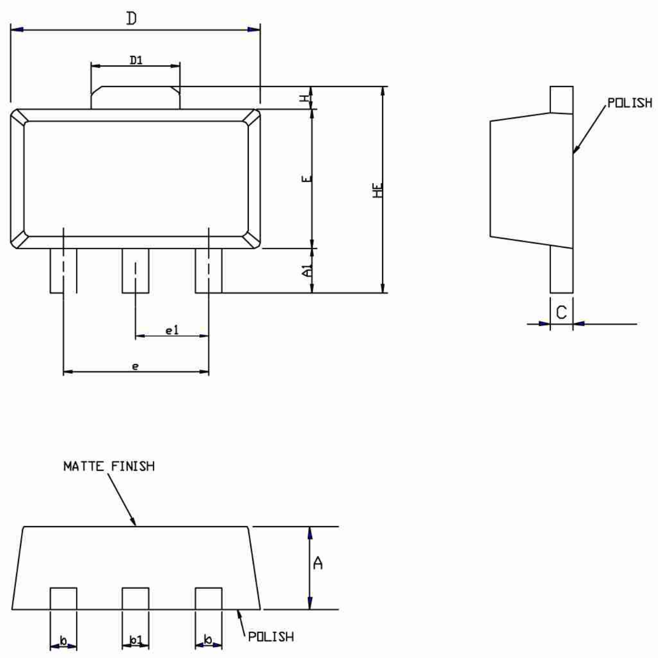






v Package Outline

SOT-89



SYMBOLS	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.40	1.50	1.60	0.055	0.059	0.063
A1	0.80	1.04	—	0.031	0.041	—
b	0.36	0.42	0.48	0.014	0.016	0.018
b1	0.41	0.47	0.53	0.016	0.018	0.020
C	0.36	0.40	0.43	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.40	1.60	1.75	0.055	0.062	0.069
HE	4.25			0.167		
E	2.40	2.50	2.60	0.094	0.098	0.102
e	2.90	3.00	3.10	0.114	0.118	0.122
H	0.35	0.40	0.45	0.014	0.016	0.018
S	0.65	0.75	0.85	0.026	0.030	0.034
e1	1.40	1.50	1.60	0.054	0.059	0.063

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