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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



# Audio Accessory IC Series

## Ground Isolation Amplifier


**BA3121F, BA3123F**

No.09092EAT01

### ●Description

The BA3121F/BA3123F are ground isolation amplifiers developed for use in car audio applications.

This IC efficiently eliminate problems caused by wiring resistance, and remove noise generated by the electrical devices used in automobiles. The capacitance values of the external capacitors required for the ICs are small to allow compact and reliable set design.

### ●Features

- 1) Large capacitors not required
- 2) High common-mode rejection ratio (57dB typ. at f = 1kHz).
- 3) Low noise (VNO = 3.5 $\mu$ Vrms Typ.).
- 4) Low distortion (THD = 0.002% Typ.).
- 5) Two channels.

### ●Applications

Car audio systems

### ●Line up matrix

	BA3121F	BA3123F
Operation temperature	-30~+85°C	-40~+85°C

### ●Absolute maximum ratings (Ta = 25°C)

Parameter		Symbol	Limits	Unit
Power supply voltage		Vcc	18	V
Power dissipation		Pd	450*	mW
Operation temperature	BA3121F	Topr	-30~+85	°C
	BA3123F		-40~+85	°C
Storage temperature		Tstg	-55~+125	°C

\* Reduced by 4.5mW in Ta of 1°C over 25°C.

### ●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	Vcc	4	12	18	V

●Electrical characteristics (unless otherwise noted, Ta = 25°C, VCC = 12V, f = 1kHz, Rg = 1.8kΩ)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Quiescent current	I <sub>Q</sub>	5.6	9.0	14.0	mA	V <sub>IN</sub> =0V <sub>rms</sub>
Output noise voltage	V <sub>NO</sub>	—	3.5	8.0	μV <sub>rms</sub>	BPF=20Hz-20kHz
Voltage gain	G <sub>V</sub>	-1.5	-0.04	1.5	dB	V <sub>O</sub> =-10dBm, R <sub>g</sub> =0Ω
Maximum output voltage	V <sub>OM</sub>	1.8	2.0	—	V <sub>rms</sub>	THD=0.1%, V <sub>CC</sub> =8V
Total harmonic distortion	THD	—	0.002	0.02	%	V <sub>O</sub> =0.7V <sub>rms</sub>
Common-mode rejection ratio	CMRR	41	57	—	dB	
Common-mode voltage	V <sub>CM</sub>	2.5	3.75	—	V <sub>rms</sub>	V <sub>CC</sub> =8V, CMRR=40dB
Ripple rejection ratio	RR	72	80	—	dB	f <sub>RR</sub> =100Hz, V <sub>RR</sub> =-10dBm, R <sub>g</sub> =0Ω
Channel separation	CS	—	82	—	dB	V <sub>IN</sub> =-10dBm, R <sub>g</sub> =1.8kΩ/OPEN
Slew rate	SR	—	2.0	—	V/μS	
Input resistance	R <sub>IN</sub>	44	55	66	kΩ	

◎Not designed for radiation resistance

●Electrical characteristics curves

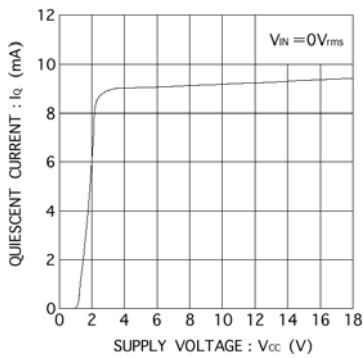


Fig.1 Quiescent current vs. power supply voltage

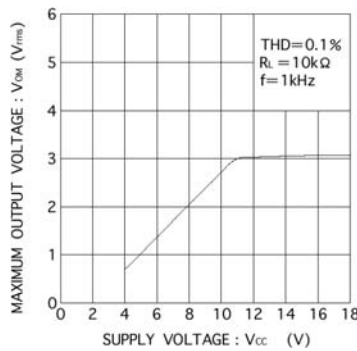


Fig.2 Maximum output voltage vs. power supply voltage

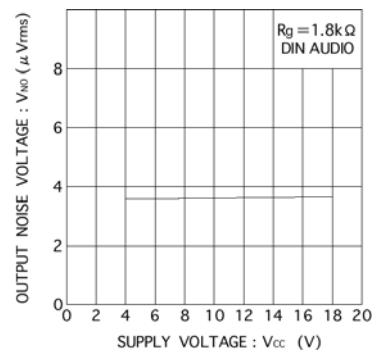


Fig.3 Output noise voltage vs. power supply voltage

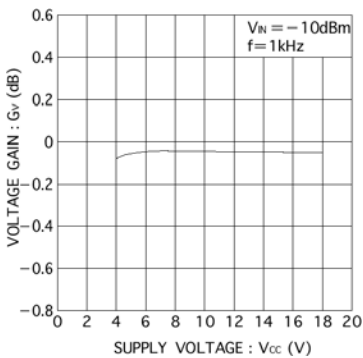


Fig.4 Voltage gain vs. power supply voltage

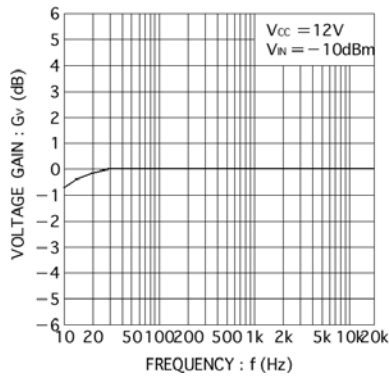


Fig.5 Voltage gain vs. frequency

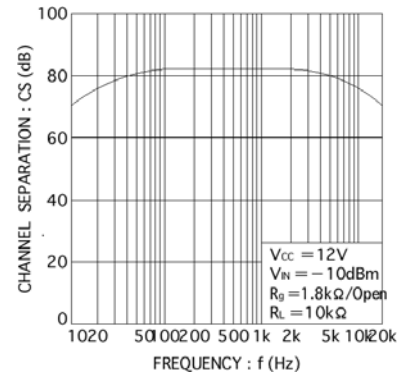


Fig.6 Channel separation

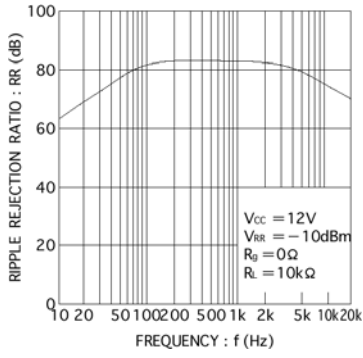


Fig.7 Ripple rejection ratio vs. frequency

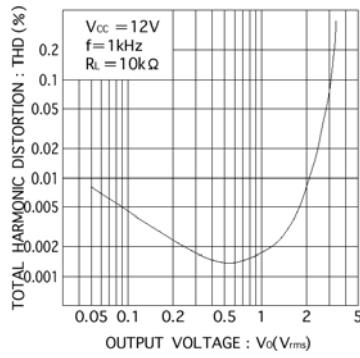


Fig.8 Total harmonic distortion vs. output voltage

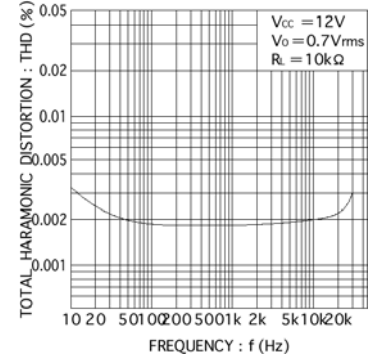


Fig.9 Total harmonic distortion vs. frequency

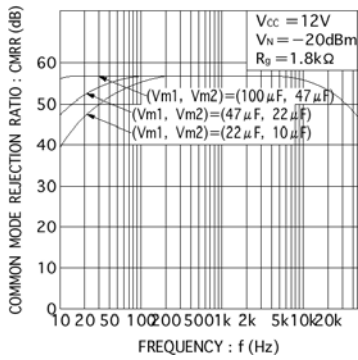


Fig.10 Common-mode rejection ratio vs. frequency

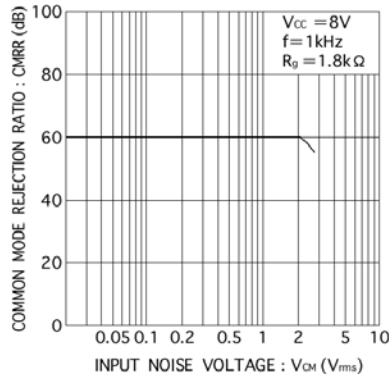


Fig.11 Common-mode rejection ratio vs. input voltage

● Measurement circuits

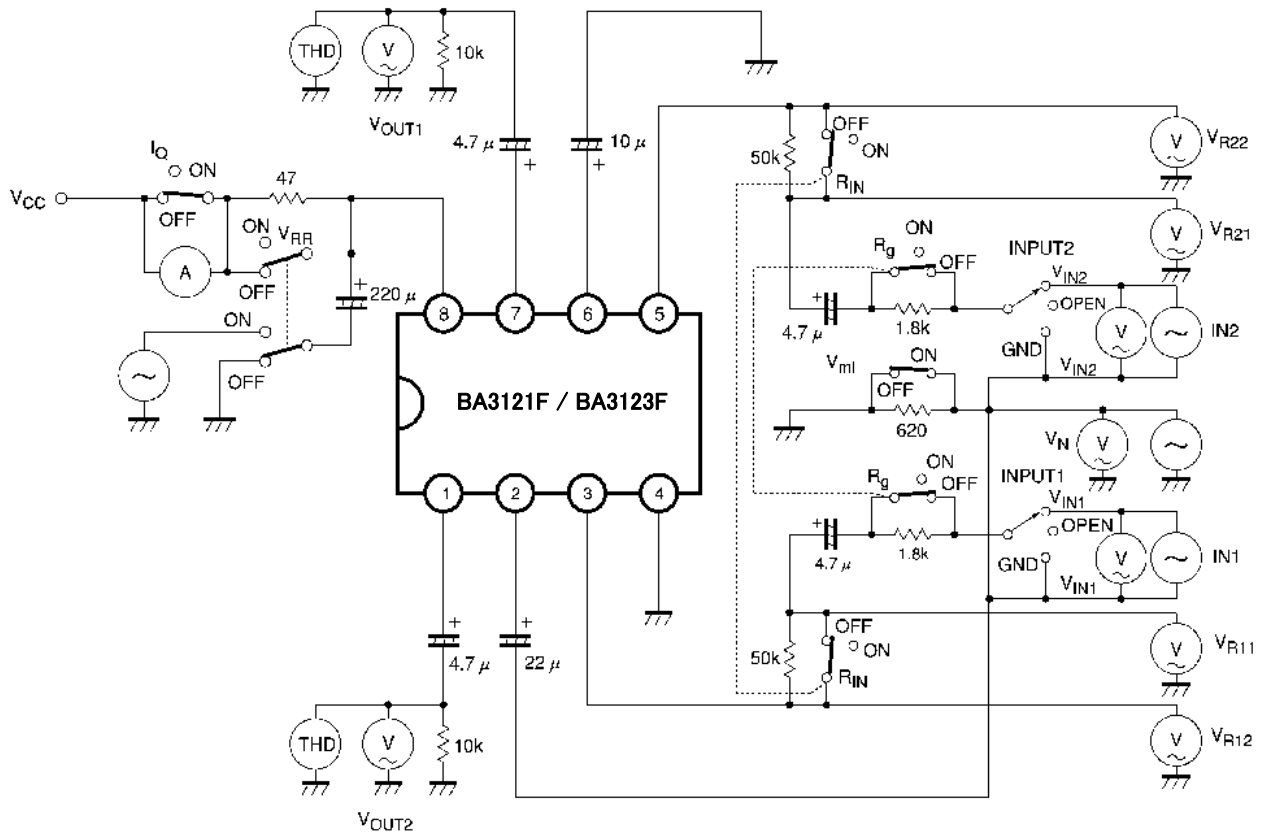


Fig.12

●Block Diagram

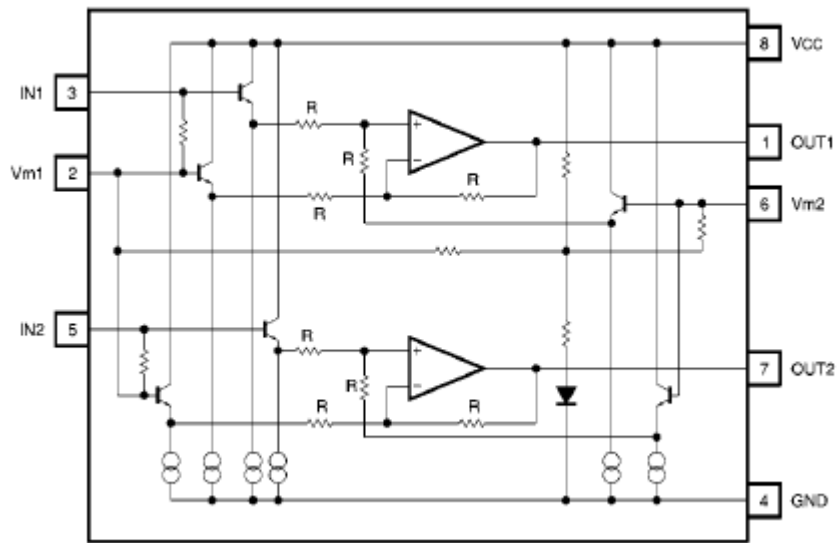


Fig.13

●Circuit operation

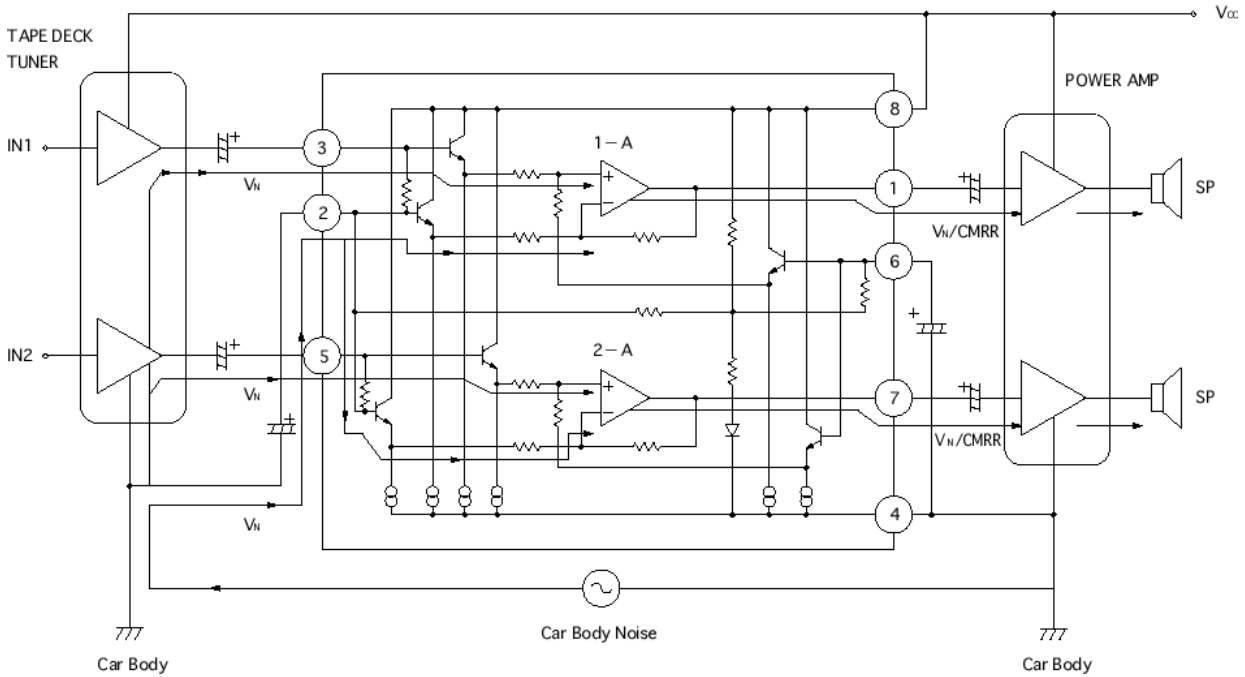


Fig.14 Flow of noise in car audio systems

Car audio systems are earthed to the car body, and for this reason, electrical noise generated by the car electrics can enter the power amplifier input via the chassis, and become audible.

The BA3121F/BA3123F makes use of the common-mode rejection characteristics of an operational amplifier to eliminate this noise. Without the BA3121F/BA3123F noise enters the power amplifier input directly, when used, the CMRR of operational amplifiers 1-A and 2-A eliminates the noise.

Principles of noise elimination:

To obtain the output voltage (e<sub>0</sub>)

$$V_i = \frac{R_4}{(R_3 + R_4)} \cdot e_2 \tag{1}$$

$$e_0 = -\frac{R_2}{R_1} e_1 + \frac{R_1 + R_2}{R_1} \cdot V_i \tag{2}$$

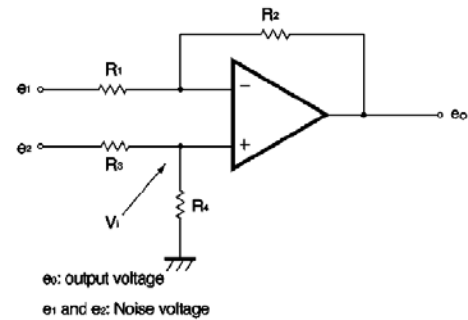


Fig.15 The principle of noise rejection

With the BA3121F/BA3123F, the elimination level of the noise is expressed

$$\text{as: CMRR} = 20 \log (e_0/e_1) (e_1 = e_2)$$

Therefore, CMRR ≥ 41dB can be guaranteed.

From ① and ②

$$\begin{aligned} e_0 &= -\frac{R_2}{R_1} e_1 + \frac{R_1 + R_2}{R_1} \cdot \frac{R_4}{(R_3 + R_4)} \cdot e_2 \\ &= -\frac{R_2}{R_1} \cdot (e_1 - e_2) + \frac{R_1 R_4 - R_2 R_3}{R_1 (R_3 + R_4)} \cdot e_2 \end{aligned}$$

Ideally, if R<sub>1</sub>R<sub>4</sub> = R<sub>2</sub>R<sub>3</sub>, and e<sub>1</sub> = e<sub>2</sub>, the noise voltage will become zero. However, due to mismatching between the resistors, difference in the noise voltages (e<sub>1</sub> and e<sub>2</sub>), and tolerances in the operational amplifier, a noise voltage does result.

## ● Applications

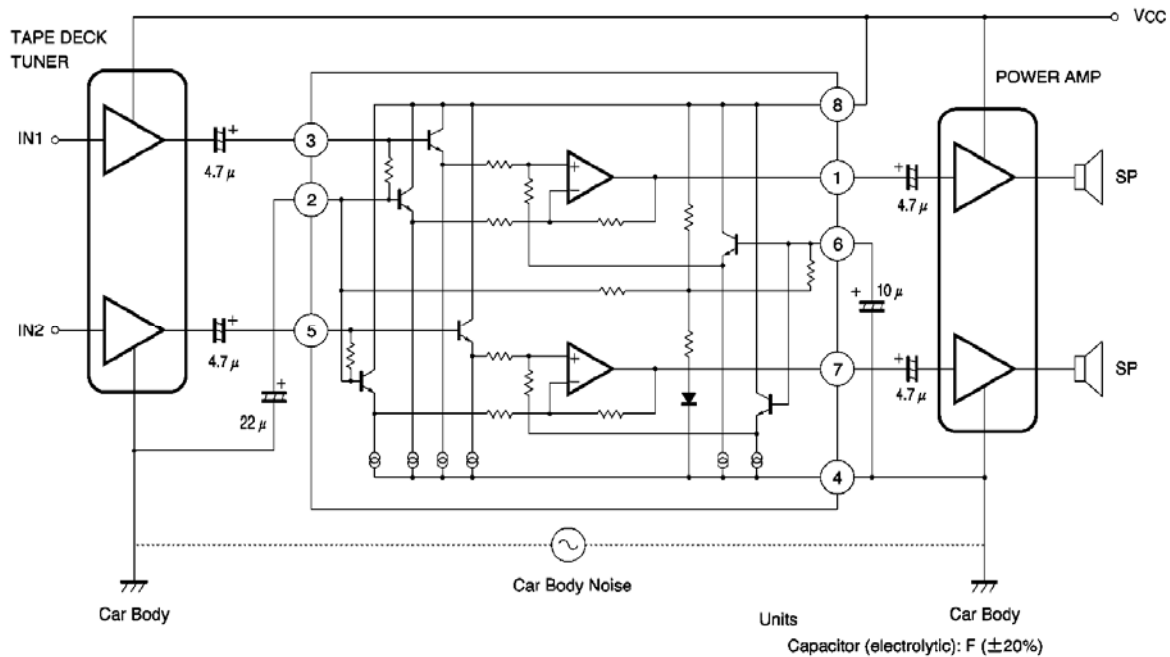


Fig.16

## ● Cautions on use

- (1) Numbers and data in entries are representative design values and are not guaranteed values of the items.
- (2) Although we are confident in recommending the sample application circuits, carefully check their characteristics further when using them. When modifying externally attached component constants before use, determine them so that they have sufficient margins by taking into account variations in externally attached components and the Rohm LSI, not only for static characteristics but also including transient characteristics.
- (3) Absolute maximum ratings  
If applied voltage, operating temperature range, or other absolute maximum ratings are exceeded, the LSI may be damaged. Do not apply voltages or temperatures that exceed the absolute maximum ratings. If you think of a case in which absolute maximum ratings are exceeded, enforce fuses or other physical safety measures and investigate how not to apply the conditions under which absolute maximum ratings are exceeded to the LSI.
- (4) GND potential  
Make the GND pin voltage such that it is the lowest voltage even when operating below it. Actually confirm that the voltage of each pin does not become a lower voltage than the GND pin, including transient phenomena.
- (5) Thermal design  
Perform thermal design in which there are adequate margins by taking into account the allowable power dissipation in actual states of use.
- (6) Shorts between pins and misinstallation  
When mounting the LSI on a board, pay adequate attention to orientation and placement discrepancies of the LSI. If it is misinstalled and the power is turned on, the LSI may be damaged. It also may be damaged if it is shorted by a foreign substance coming between pins of the LSI or between a pin and a power supply or a pin and a GND.
- (7) Operation in strong magnetic fields  
Adequately evaluate use in a strong magnetic field, since there is a possibility of malfunction.
- (8) The capacitors of 2pin ( $V_{m1}$ ), and 6pin ( $V_{m2}$ ) should maintain the ratio of 2:1 for ripple removal characteristics. Maintaining this ratio will not cause ripple removal rate to reduce significantly even if the capacitance reduces to a half.
- (9) Setting the capacitor to the double or half will make the CMRR in the low range to +6dB or -6dB respectively (Fig. 10)



●Ordering part number

B	A
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Part No.

3	1	2	1
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Part No.  
 3121:  
 Operation temperature  
 -30~85°C  
 3123:  
 Operation temperature  
 -40~85°C

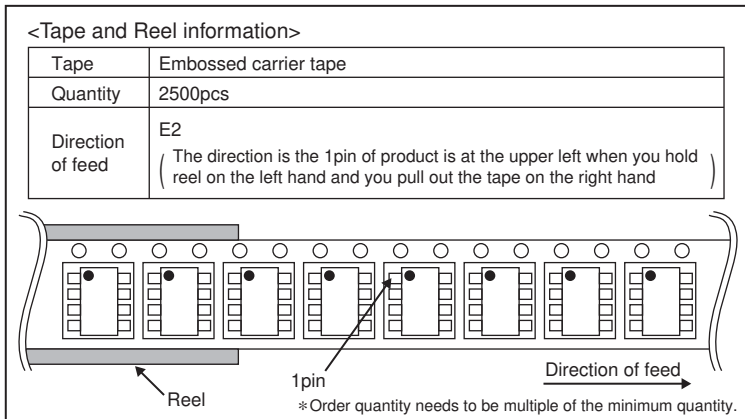
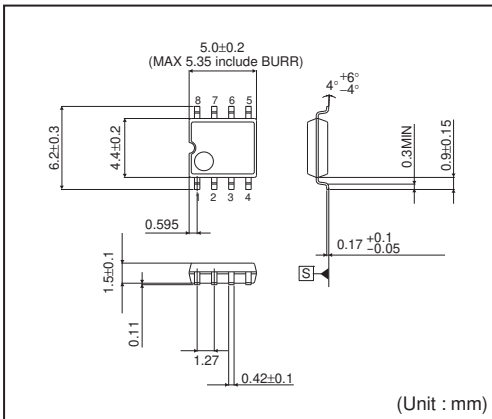
F
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Package  
 F: SOP8

E	2
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Packaging and forming specification  
 E2: Embossed tape and reel

SOP8



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