

TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

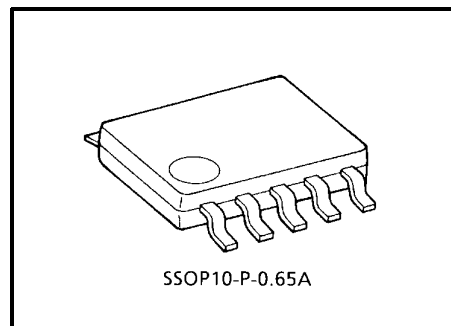
TA6038FN, TA6038FNG

Shock Sensor IC

TA6038FN/FNG detects an existence of external shock through the shock sensor and output.

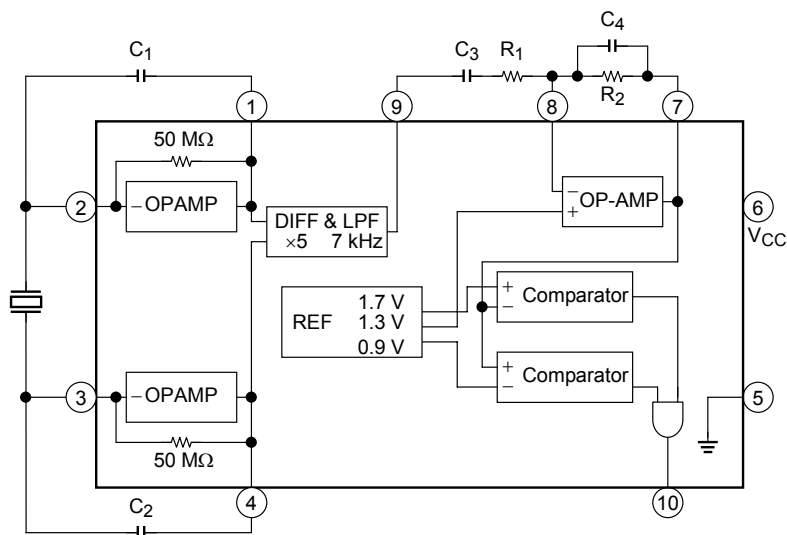
Features

- TA6038FN/FNG operates from 2.7 to 5.5 V DC single power supply voltage.
- Signal from the shock sensor is amplified according to setting gain, and is detected through the internal window comparator.
- TA6038FN/FNG incorporates 1-ch shock detecting circuitry.
- Input terminal of sensor signal is designed high impedance.
Differential input impedance = 100 MΩ (typ.)
- LPF (low pass filter) circuitry is incorporated.
Cut-off frequency of LPF = 7 kHz
- Sensitivity of shock detection can be adjusted by external devices.
- Small package
SSOP10-P-0.65A (0.65 mm pitch)

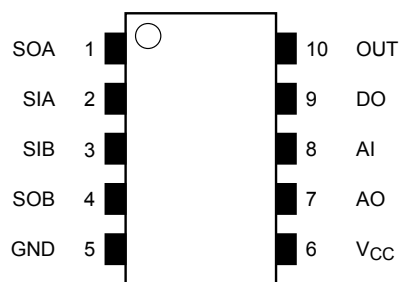


Weight: 0.04 g (typ.)

Block Diagram



Pin Connection (top view)



Pin Function

Pin No.	Pin Name	Function
1	SOA	Amp (A) output terminal
2	SIA	Connection terminal of shock sensor
3	SIB	Connection terminal of shock sensor
4	SOB	Amp (B) output terminal
5	GND	Ground terminal
6	V _{CC}	Power supply voltage
7	AO	Op-Amp output terminal
8	AI	Op-Amp input terminal
9	DO	Differential-Amp output terminal
10	OUT	Output terminal (output = "L" when shock is detected.)

Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V _{CC}	7	V
Power dissipation	P _D	300	mW
Storage temperature	T _{stg}	-55 to 150	°C

Recommend Operating Condition

Characteristics	Symbol	Rating	Unit
Power supply voltage	V _{CC}	2.7 to 5.5	V
Operating temperature	T _{opr}	-25 to 85	°C

Note: The IC may be destroyed due to short circuit between adjacent pins, incorrect orientation of device's mounting, connecting positive and negative power supply pins wrong way round, air contamination fault, or fault by improper grounding.

Electrical Characteristics (unless otherwise specified, $V_{CC} = 3.3\text{ V}$, $T_a = 25^\circ\text{C}$)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Supply voltage	V_{CC}	—	—	2.7	3.3	5.5	V
Supply current	I_{CC}	(1)	$V_{CC} = 3.3\text{ V}$	—	1.8	2.5	mA
			$V_{CC} = 5.0\text{ V}$	—	1.8	2.5	

(DIFF-AMP)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input impedance (Note 1)	Z_{in}	—	—	30	100	—	$M\Omega$
Gain	G_{vBuf}	(2)	—	13.6	14	14.4	dB
Output DC voltage	V_{oBuf}	(3)	Connect C = 1000 pF between 1 pin and 2 pin, 3 pin and 4 pin	0.7	1	1.3	V
Low pass filter cut-off freq.	f_c	(4)	Frequency at -3dB point	5	7	11	kHz
Output source current	I_{Bso}	(5)	$V_{oh} = V_{CC} - 1\text{ V}$	300	800	—	μA
Output sink current	I_{Bsi}	(6)	$V_{ol} = 0.3\text{ V}$	75	130	—	μA

Note 1: Marked parameters are reference data.

(OP-AMP)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Cut-off frequency (Note 1)	f_T	—	—	1.5	2	—	MHz
Openloop gain (Note 1)	G_{vo}	—	—	80	90	—	dB
Input voltage 1	V_{in1}	(7)	—	1.235	1.3	1.365	V
Input current	I_{in}	(8)	—	—	25	50	nA
Offset voltage (Note 1)	V_{off}	—	—	-5	0	5	mV
Output source current	I_{Aso}	(9)	$V_{oh} = V_{CC} - 1\text{ V}$	250	800	—	μA
Output sink current	I_{Asi}	(10)	$V_{ol} = 0.3\text{ V}$	130	200	—	μA

Note 1: Marked parameters are reference data.

(window-comparator)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Trip voltage 1 (Note 1)	V_{trp1}	—	—	$V_{in1} \pm 0.38$	$V_{in1} \pm 0.4$	$V_{in1} \pm 0.42$	V
Output source current	I_{Wso}	(11)	$V_{oh} = V_{CC} - 0.5\text{ V}$	30	50	—	μA
Output sink current	I_{Wsi}	(12)	$V_{ol} = 0.3\text{ V}$	300	800	—	μA

Note 1: Marked parameters are reference data.

Application Note

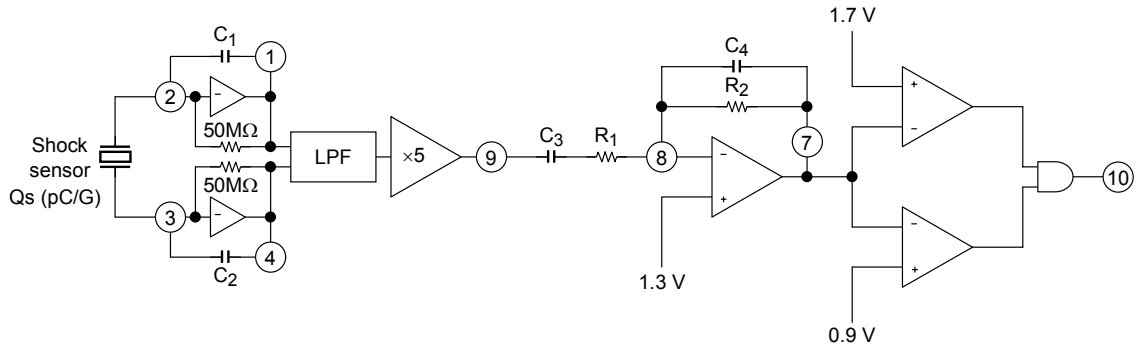


Figure 1 The Configuration of G-Force Sensor Amplifier

Figure 1 shows the configuration of G-Force sensor amplifier. The shock sensor is connected between the pins 2 and 3.

< How to output 0 or 1 from the pin 10 to detect whether there is a shock or not. >
 – Using a sensor with the sensitivity Q_s (pC/G) to detect the shock g (G). –

a. Setting gain: $C_1 = C_2$ (pF), R_1 (kΩ), R_2 (kΩ)

$$\frac{Q_s \times g}{C_1} \times 2 \times 5 \times \frac{R_2}{R_1} = 0.4 \text{ (V)}$$

$$C_1 = C_2 = \frac{Q_s \times g}{0.04} \times \frac{R_2}{R_1}$$

Example: Detecting 5 (G)-shock using a sensor with $Q_s = 0.34$ (pC/G), $R_1 = 10$ (kΩ), $R_2 = 100$ (kΩ).

$$C_1 = C_2 = \frac{0.34 \times 5}{0.04} \times \frac{100}{10} = 425 \text{ (pF)}$$

b. Setting the frequency (Hz) of HPF: Setting C_3 (μF), R_1 (kΩ)

$$f_c \text{ (Hz)} = \frac{1}{2 \times \pi \times R_1 \times C_3} \times 10^3$$

Example: Setting the frequency to 20 Hz with $R_1 = 10$ (kΩ).

$$C_3 = \frac{1}{2 \times \pi \times 10 \times 20} \times 10^3 = 0.8 \text{ (}\mu\text{F)}$$

c. Setting the frequency (kHz) of LPF: Setting C_4 (pF), R_2 (kΩ)

$$f_c \text{ (kHz)} = \frac{1}{2 \times \pi \times R_2 \times C_4} \times 10^6$$

Example: Setting the frequency to 5 kHz with $R_2 = 100$ (kΩ).

$$C_4 = \frac{1}{2 \times \pi \times 100 \times 5} \times 10^6 = 318 \text{ (pF)}$$

< How to output the voltage according to the shock through the pin 7. >

– Using a sensor with the sensitivity Q_s (pC/G), and assuming the shock sensitivity of the system is V_{system} (mV/G). –

a. Setting gain: $C_1 = C_2$ (pF), R_1 (kΩ), R_2 (kΩ)

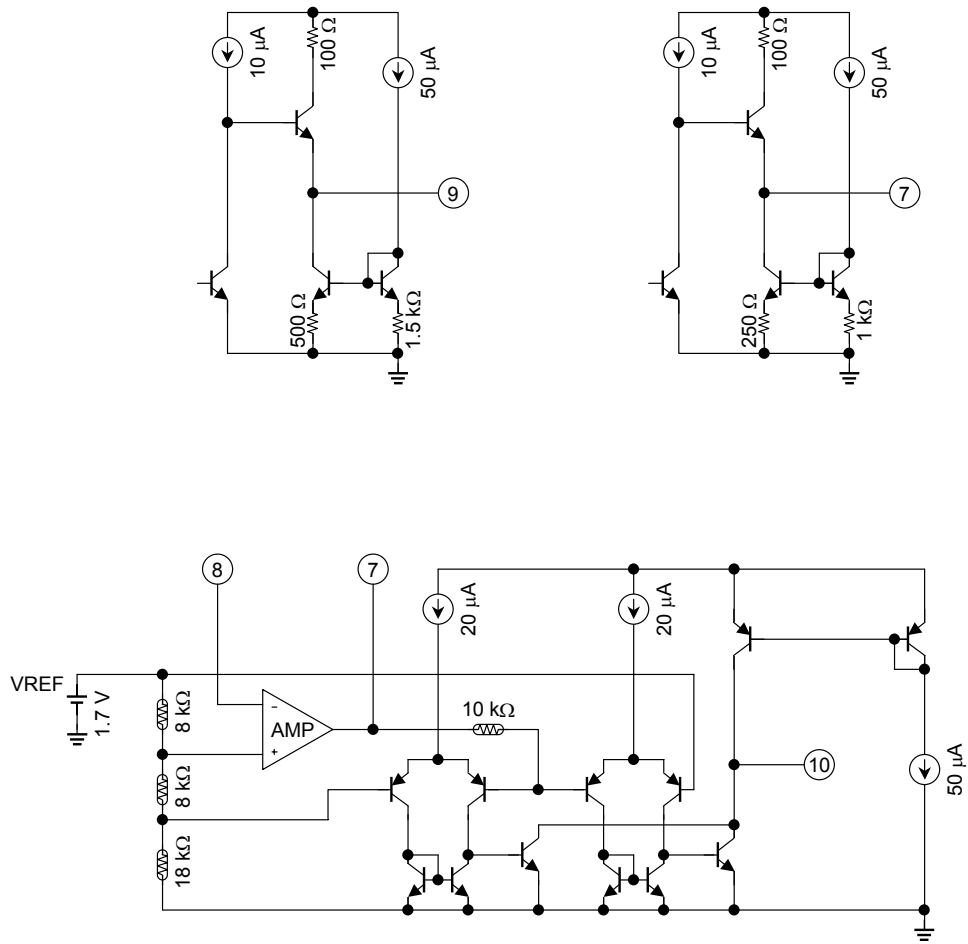
$$\frac{Q_s}{C_1} \times 2 \times 5 \times \frac{R_2}{R_1} = V_{\text{system}} \times 10^3 \text{ (mV/G)}$$

$$C_1 = C_2 = \frac{Q_s}{V_{\text{system}}} \times \frac{R_2}{R_1} \times 10^4 \text{ (pF)}$$

Example: Designing the system with 200 (mV/G) by using a sensor that $Q_s = 0.34$ (pC/G), $R_1 = 10$ (kΩ), $R_2 = 100$ (kΩ).

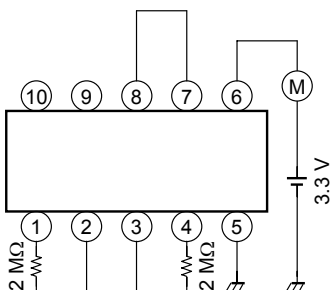
$$C_1 = C_2 = \frac{0.34}{200} \times \frac{100}{10} \times 10^4 = 170 \text{ (pF)}$$

Equivalent Circuit

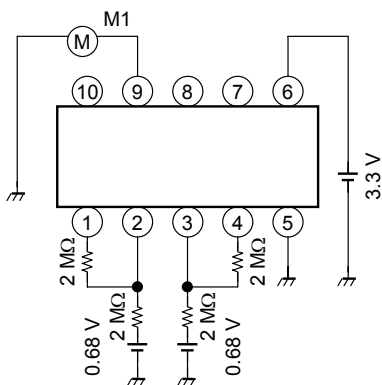


Test Circuit

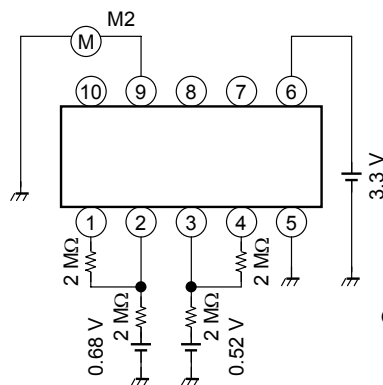
- (1) Supply current **ICC**



- (2) DIFF-AMP
Gain **GvBuf**
Step 1

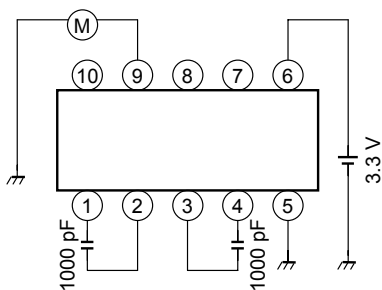


- Step 2

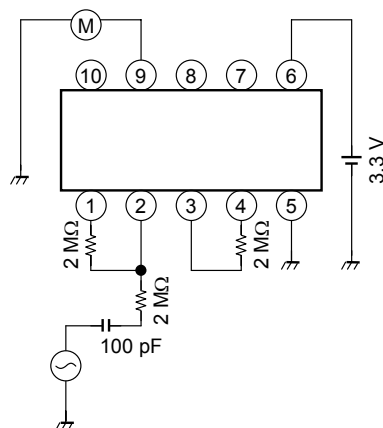


$$\text{Gain} = \frac{M2 - M1}{0.68 - 0.52}$$

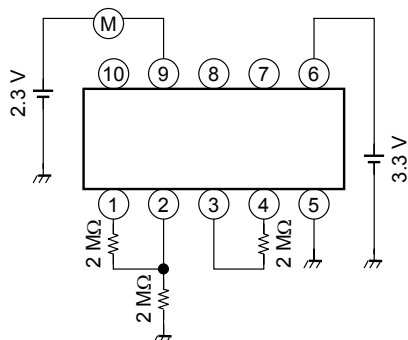
- (3) DIFF-AMP
Output DC voltage **VoBuf**



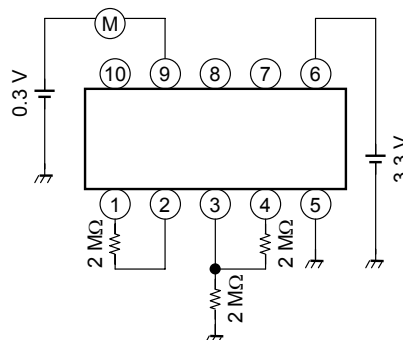
- (4) DIFF-AMP
Low pass filter cut-off freq. **fc**



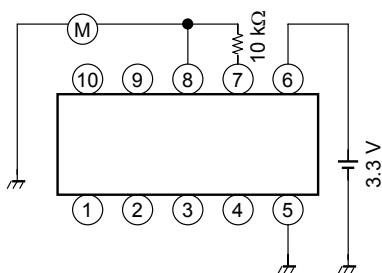
(5) DIFF-AMP
Output source current I_{Bso}



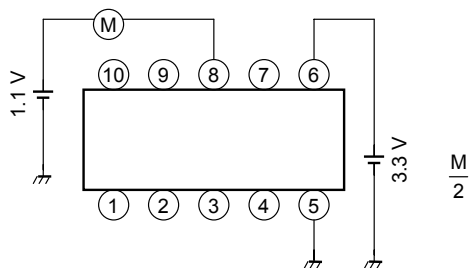
(6) DIFF-AMP
Output sink current I_{Bsi}



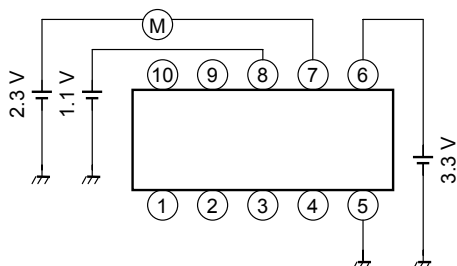
(7) OP-AMP
Input voltage 1 V_{in1}



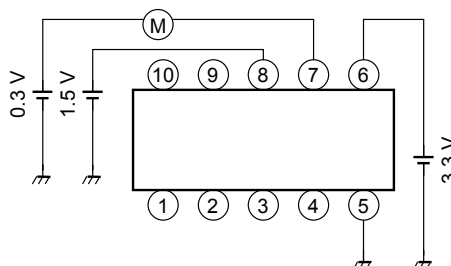
(8) OP-AMP
Input current I_{in}



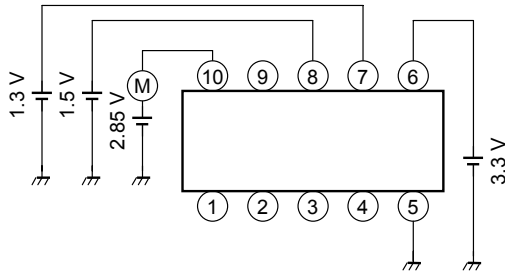
(9) OP-AMP
Output source current I_{Aso}



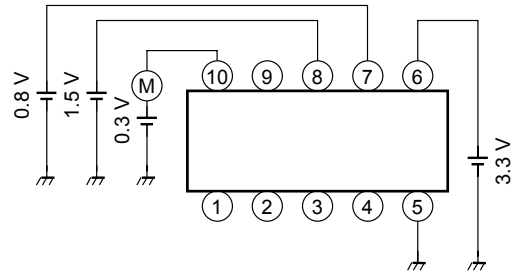
(10) OP-AMP
Output sink current I_{Asi}



(11) Window comparator
Output source current I_{Wso}

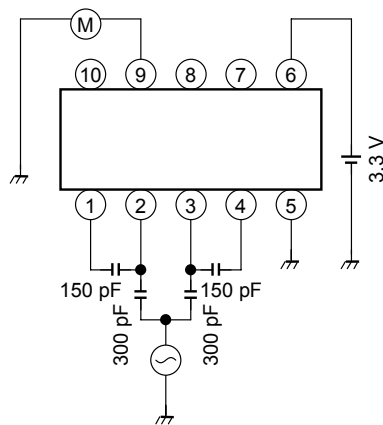


(12) Window comparator
Output sink current I_{Wsi}

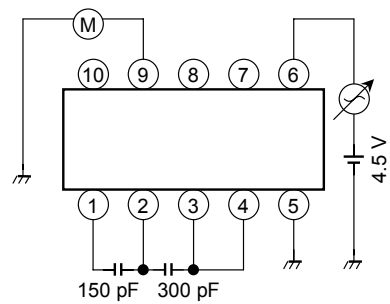


Test Circuit (for reference)

(a) DIFF-AMP
CMRR



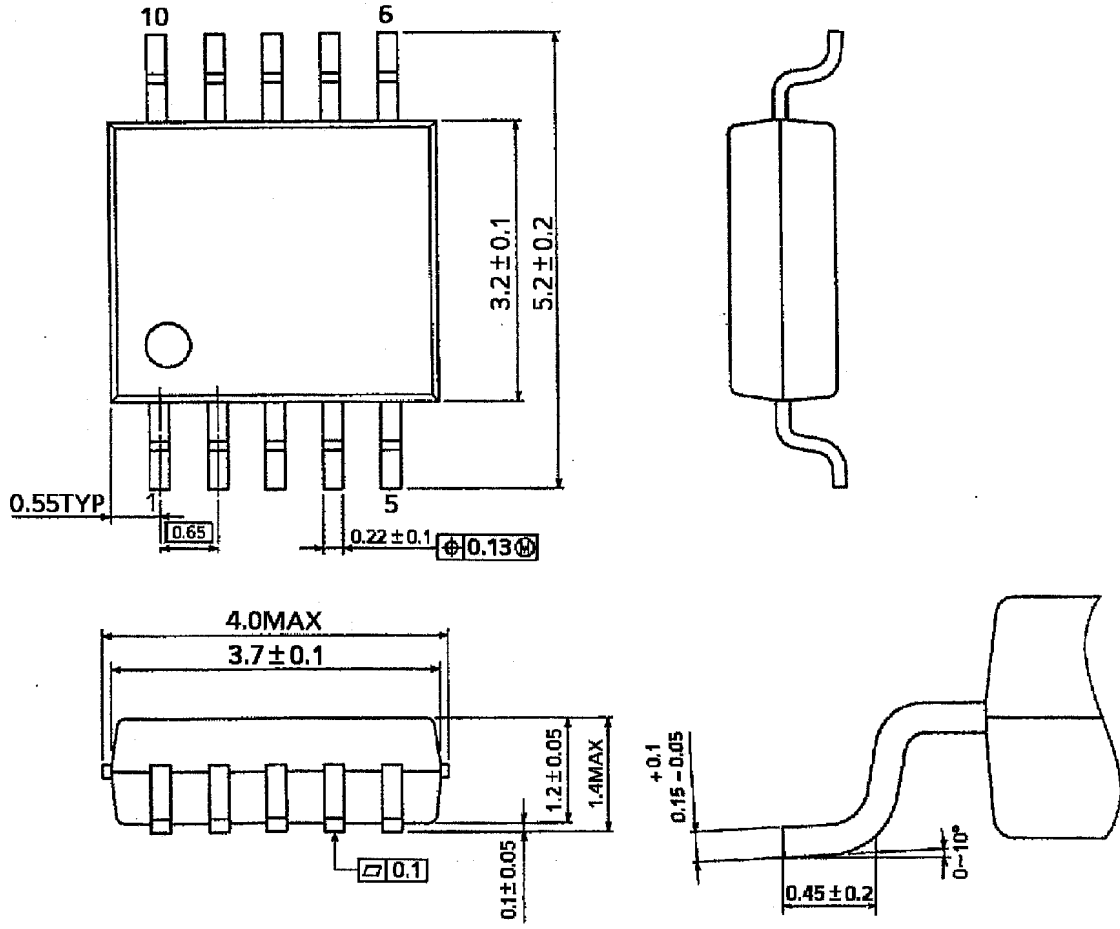
(b) DIFF-AMP
PSRR



Package Dimensions

SSOP10-P-0.65A

Unit : mm



Weight: 0.04 g (typ.)

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