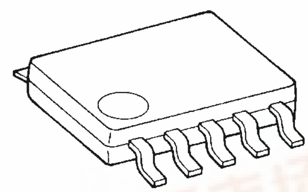
TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

# TA6009FN,TA6009FNG

## Shock Sensor IC (1 ch version)

TA6009FN/FNG detects an existence of external shock through the shock sensor and output.



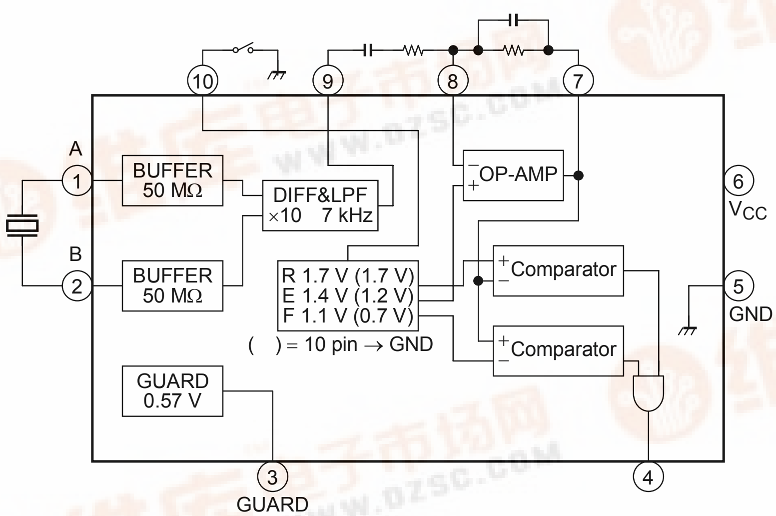
SSOP10-P-0.65A

Weight: 0.04 g (typ.)

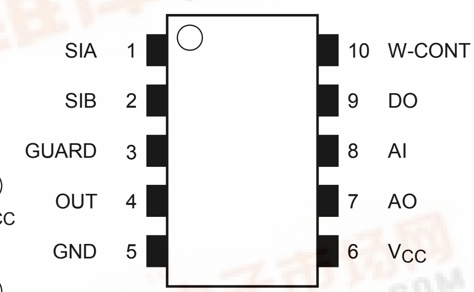
## Features

- TA6009FN/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.
- TA6009FN/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)

## Block Diagram




## Pin Connection (top view)



## Pin Function

| Pin No. | Pin Name | Function |
|---|---|---|
| 1 | SIA | Connection terminal of shock sensor |
| 2 | SIB | Connection terminal of shock sensor |
| 3 | GUARD | Input (1, 2 pin) GUARD terminal |
| 4 | OUT | Output terminal (output = “L” when shock is detected.) |
| 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 | W-CONT | WindComp. trip voltage selection terminal |

## 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 |

## Electrical Characteristics (unless otherwise specified, $V_{CC}$ = 3.3 V, Ta = 25°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 V | | 1.8 | 2.4 | mA |
| | | | $V_{CC}$ = 5.0 V | | 1.8 | 2.4 | |

### (GUARD)

| Characteristics | Symbol | Test Circuit | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Output voltage | VoGur | (2) | — | 0.52 | 0.57 | 0.62 | V |

### (DIFF-AMP)

| Characteristics | Symbol | Test Circuit | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Input impedance (Note 1) | Zin | — | — | 50 | 100 | | MΩ |
| Gain | GvBuf | (3) | — | 19.6 | 20 | 20.4 | dB |
| Output DC voltage | VoBuf | (4) | Connect C = 100 pF between 1 pin and 2 pin | 0.7 | 1 | 1.3 | V |
| Low pass filter cut-off freq. | fc | (5) | Frequency at −3dB point | 5 | 7 | 10 | kHz |
| Output source current | IBso | (6) | Voh = $V_{CC}$ − 1 V | 400 | 800 | | μA |
| Output sink current | IBsi | (7) | Vol = 0.3 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) | fT | — | — | 1.5 | 2 | | MHz |
| Openloop gain (Note 1) | Gvo | — | — | 80 | 90 | | dB |
| Input voltage 1 | Vin1 | (8) | 10 pin → OPEN (Note 2) | 1.33 | 1.4 | 1.47 | V |
| Input voltage 2 | Vin2 | (9) | 10 pin → GND (Note 2) | 1.14 | 1.2 | 1.26 | V |
| Input current | $I_{in}$ | (10) | — | | 25 | 50 | nA |
| Offset voltage (Note 1) | Voff | — | — | −5 | 0 | 5 | mV |
| Output source current | IAso | (11) | Voh = $V_{CC}$ − 1 V | 300 | 800 | | μA |
| Output sink current | IAsi | (12) | Vol = 0.3 V | 130 | 200 | | μA |

Note 1: Marked parameters are reference data.

Note 2: 10 pin must be non-connected otherwise connected to GND.

### (window-comparator)

| Characteristics | Symbol | Test Circuit | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Trip voltage 1 (Note 1) | Vtrp1 | — | 10 pin → OPEN (Note 2) | Vin1 ±0.285 | Vin1 ±0.3 | Vin1 ±0.315 | V |
| Trip voltage 2 (Note 1) | Vtrp2 | — | 10 pin → GND (Note 2) | Vin2 ±0.475 | Vin2 ±0.5 | Vin2 ±0.525 | V |
| Output source current | IWso | (13) | Voh = $V_{CC}$ − 0.5 V | 30 | 50 | | μA |
| Output sink current | IWsi | (14) | Vol = 0.3 V | 300 | 800 | | μA |

Note 1: Marked parameters are reference data.

Note 2: 10 pin must be non-connected otherwise connected to GND.

## Application Note

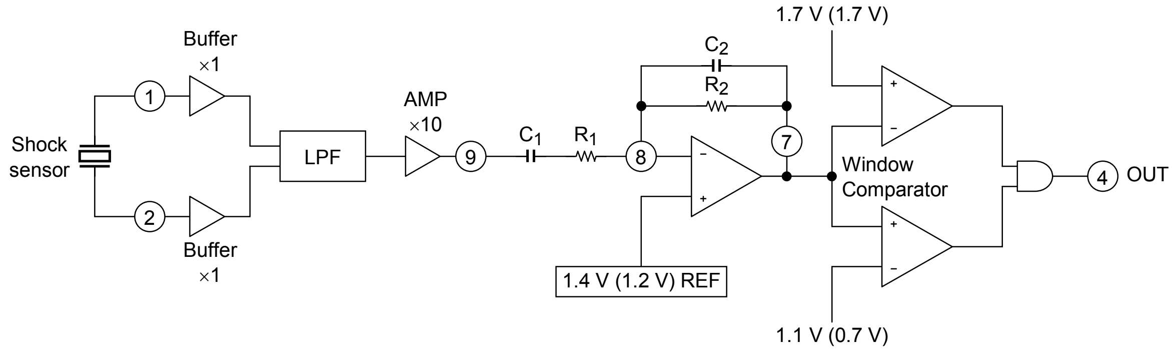



**Figure 1 The Composition of G-Force Sense Amplifier**

Figure 1 is the composition of G-Force sense amplifier.
The shock sensor is connected between 1 and 2 terminal.
When G-force Sensor (sensor sensibility = s (mV/G)) is used to detect external shock of g (G), the external parts are determined as following.

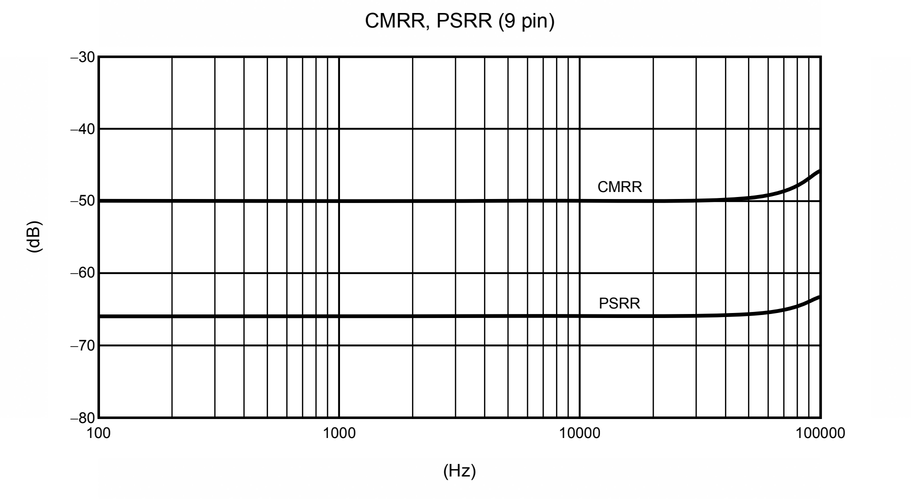
(gain setting) * 10 PIN → GND
500/(s × g) = G1
G1/10 = G (OP-AMP)

(HPF setting)
$fc = 1/(2\pi \times R_1 \times C_1)$

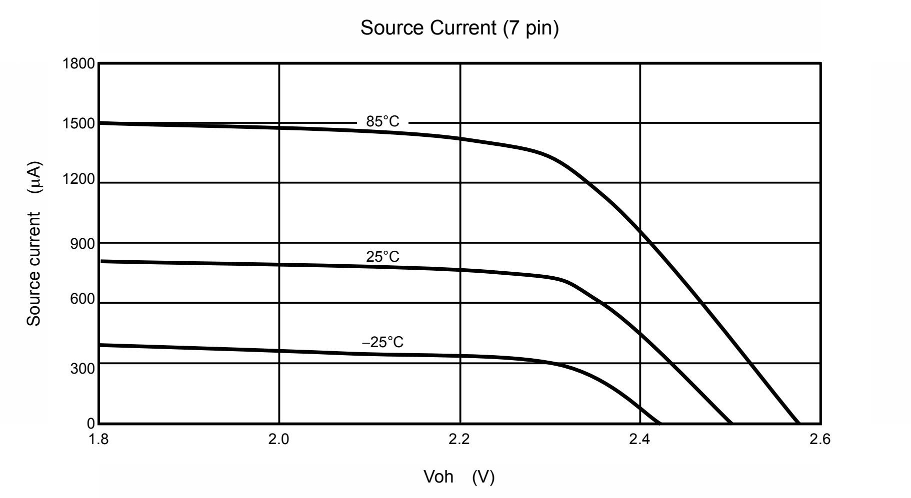
(LPF setting)
$fc = 1/(2\pi \times R_2 \times C_2)$

## Reference Data

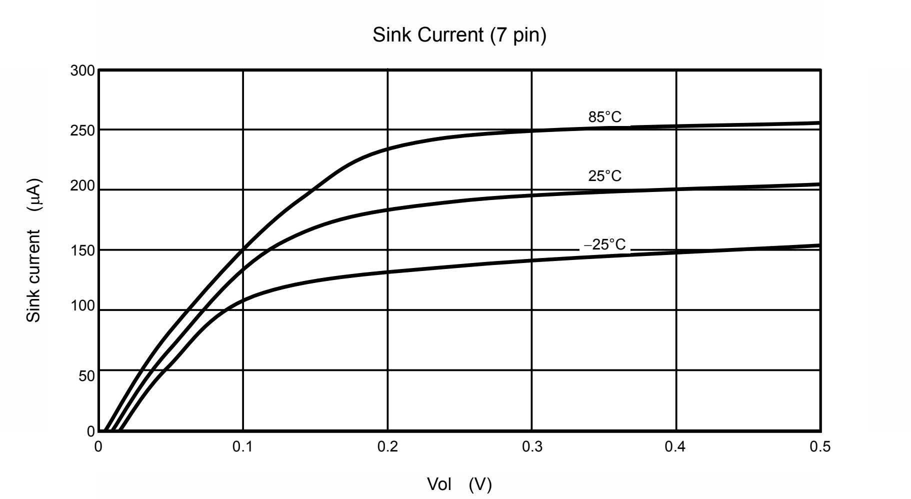
(1) 9 pin (DIFF-AMP output) CMRR, PSRR



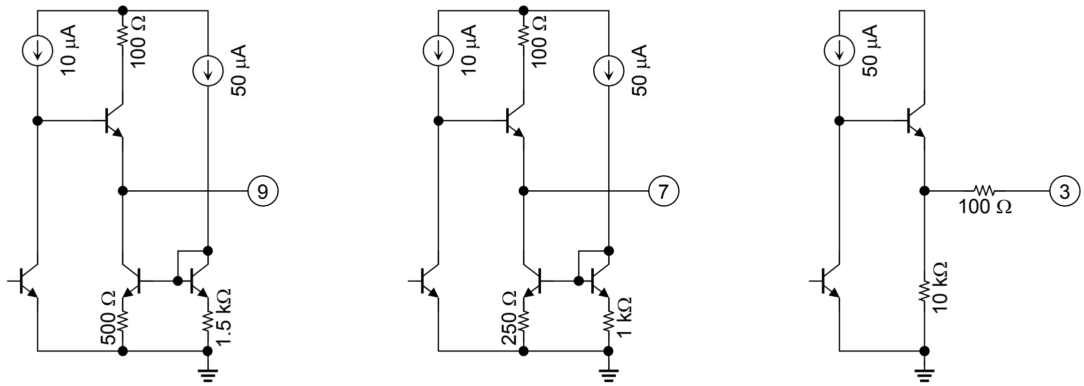

(2) 7 pin (OP-AMP output) source current

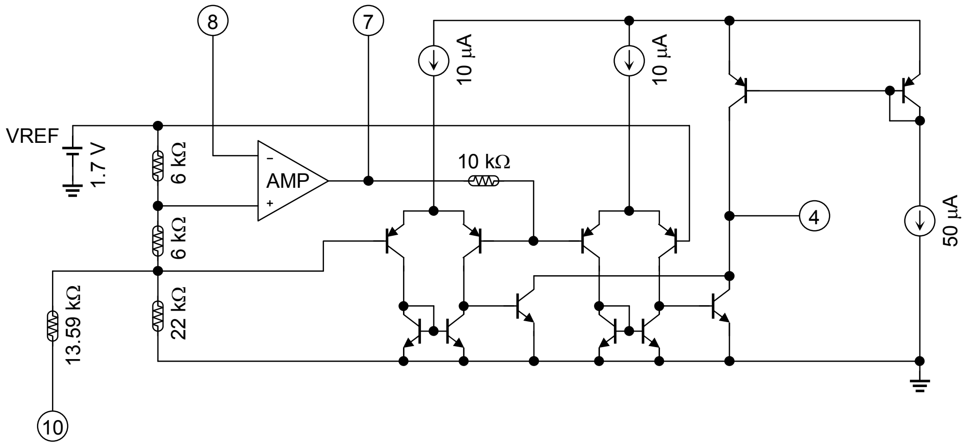



(3) 7 pin (OP-AMP output) sink current



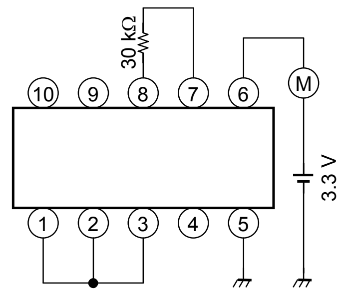
## Equivalent Circuit



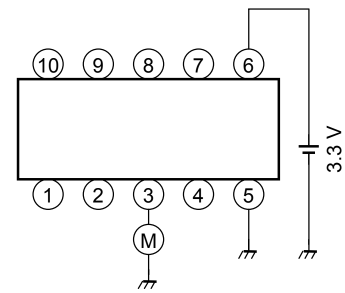



## Test Circuit

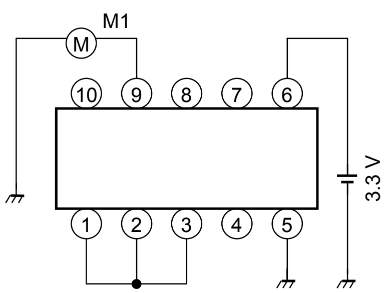
(1) Supply current $I_{CC}$



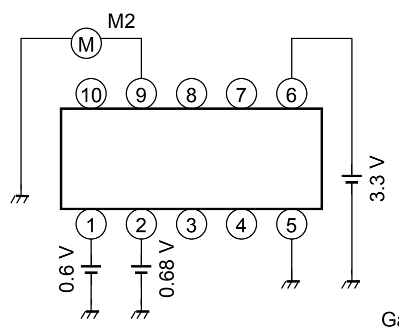

(2) GUARD
Output voltage VoGur




(3) DIFF-AMP
Gain GvBuf
Step 1

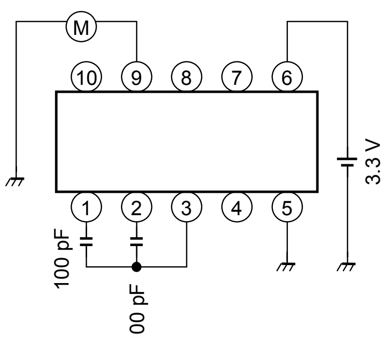



Step 2

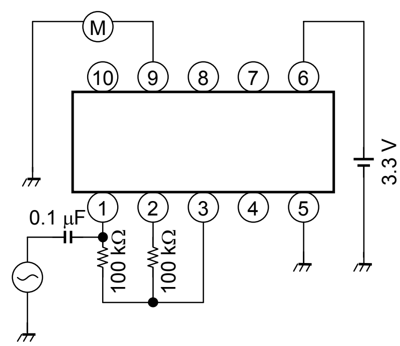



$$\text{Gain} = \frac{M2 - M1}{0.68 - 0.60}$$

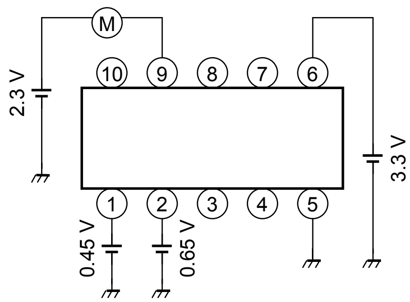
(4) DIFF-AMP
Output DC voltage VoBuf



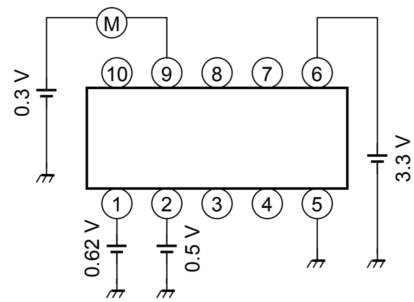

(5) DIFF-AMP
Low pass filter cut-off freq. fc



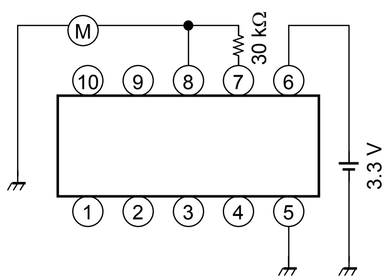
(6) DIFF-AMP
Output source current IBso



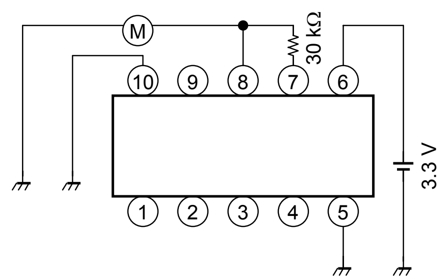

(7) DIFF-AMP
Output sink current IBsi



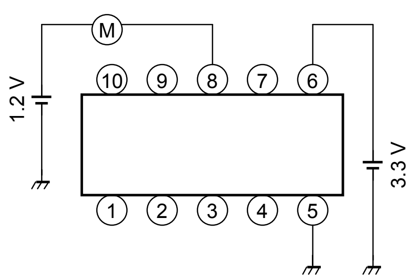

(8) OP-AMP
Input voltage 1 Vin1



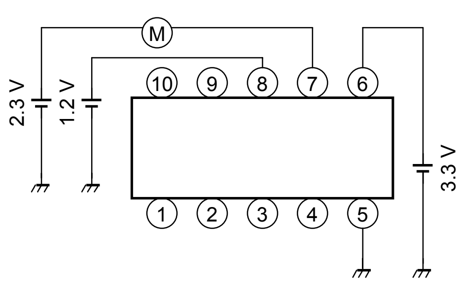

(9) OP-AMP
Input voltage 2 Vin2



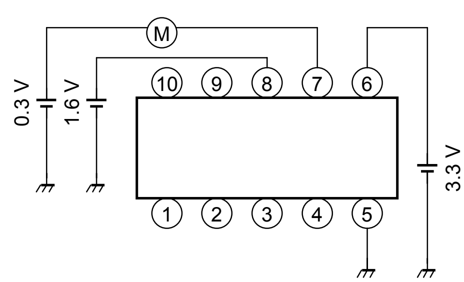

(10) OP-AMP
Input current $I_{in}$



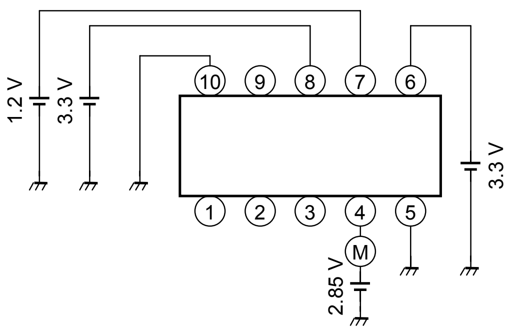

(11) OP-AMP
Output source current IAso



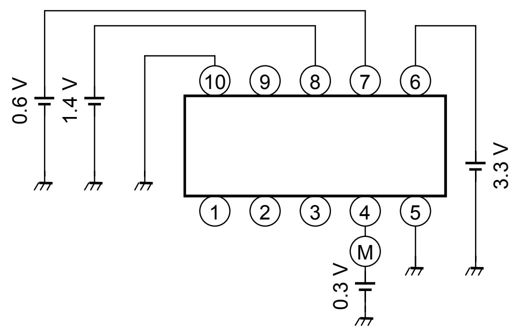

(12) OP-AMP
Output sink current IAsi



(13) Window comparator
Output source current **IWso**

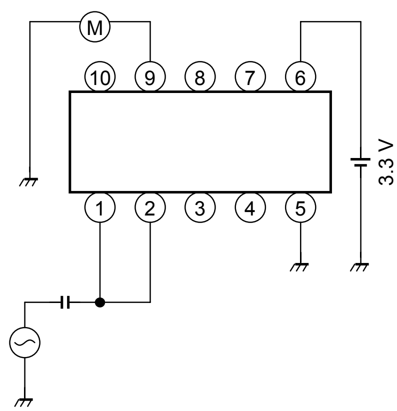



(14) Window comparator
Output sink current **IWsi**

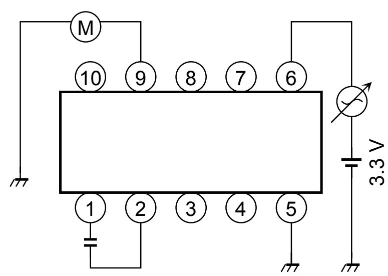



## Test Circuit (for reference)

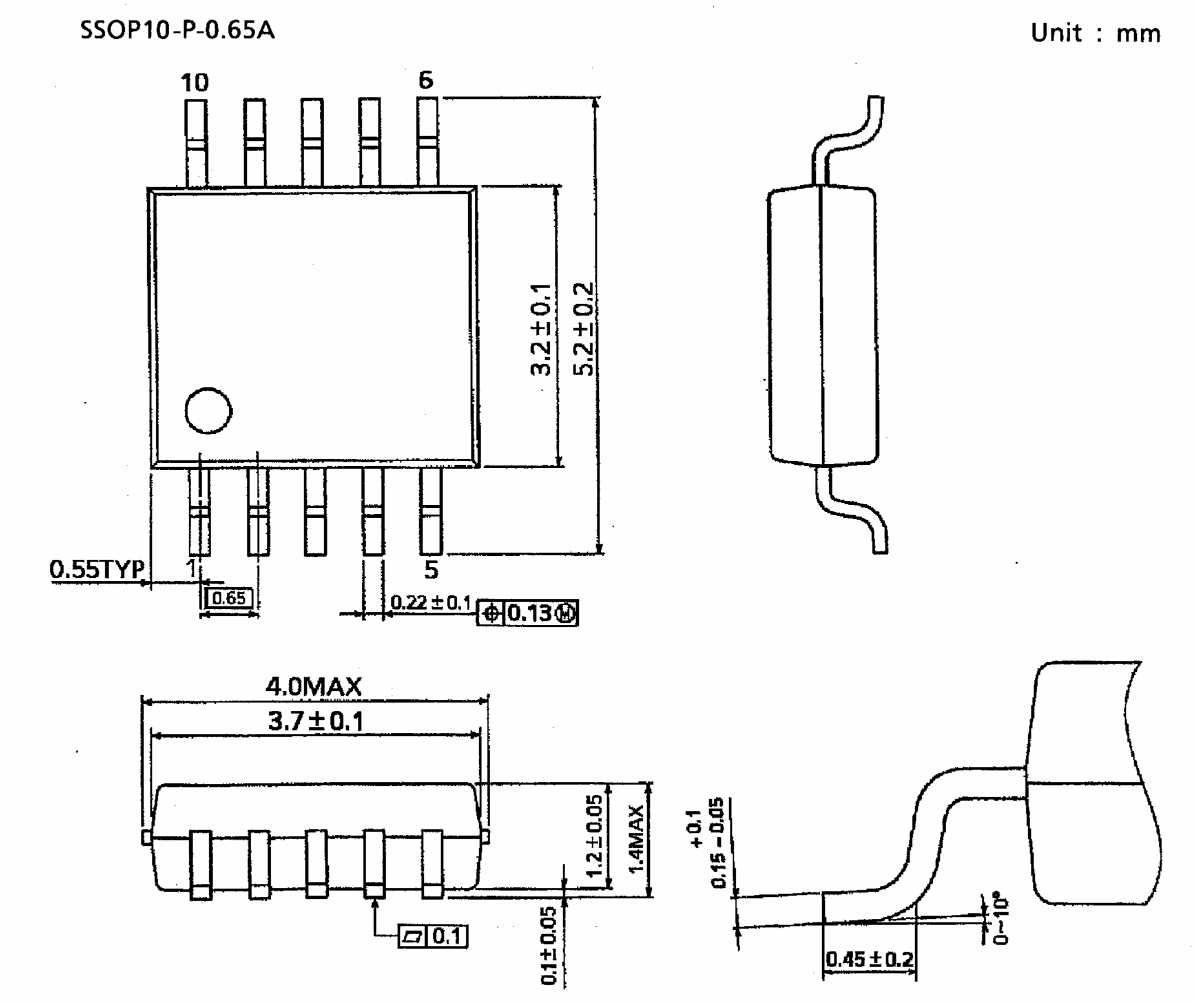
(a) DIFF-AMP
**CMRR**




(b) DIFF-AMP
**PSRR**



**Package Dimensions**




Weight: 0.04 g (typ.)

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