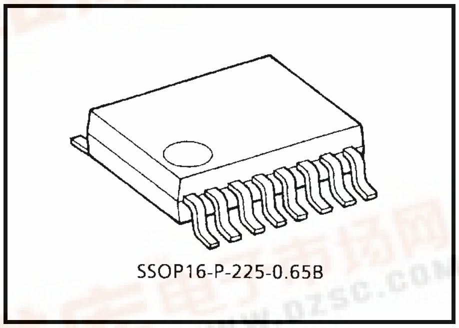
TOSHIBA BiCMOS Linear Integrated Circuit Silicon Monolithic

TB6066FNG

Shock Sensor IC

TB6066FNG detects an existence of external shock through the shock sensor and output Low-level signal at 7 pin.

It has so excellent characteristic in S/N ratio that user can use Analog signal for mechanical control systems, like servo control.



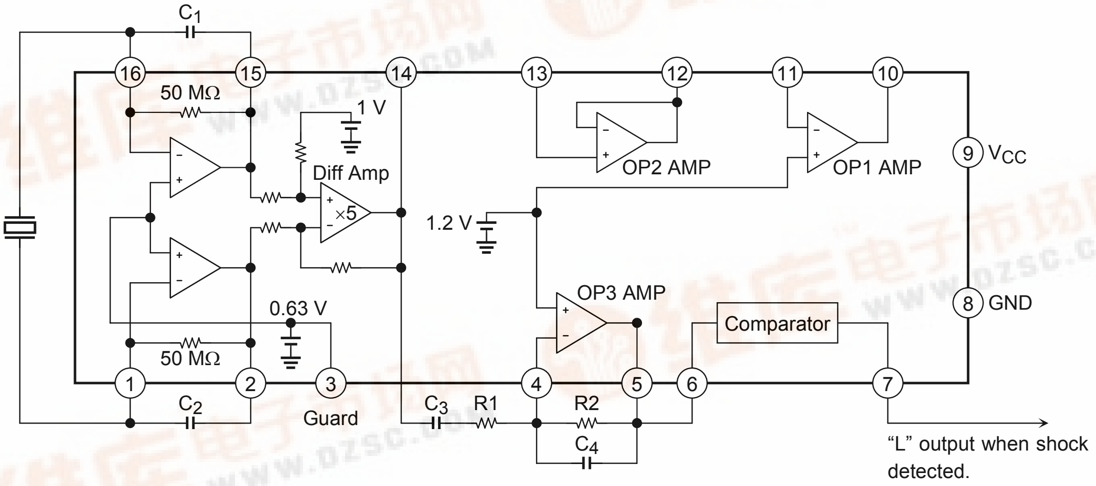
Weight: 0.07 g (typ.)

Features

- TB6066FNG 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.
- Input terminal of sensor signal is designed high impedance.
  Differential input impedance = 100 MΩ (typ.)
- Three Operatinal-Amplifier is built in for design flexibility. (*Note 1)
- Sensitivity of shock detection can be adjusted by external devices.
- Small package: SSOP16-P-225-0.65B (0.65 mm pitch)
- Excellent S/N ratio: Improved 10dB compared with our TA6038FN/FNG

*Note 1: LPF (low pass filter) circuitry is not bulit in. User needs to make some filter with one operational-amplifier to cancel the signal of resonant frequency of piezo sensor

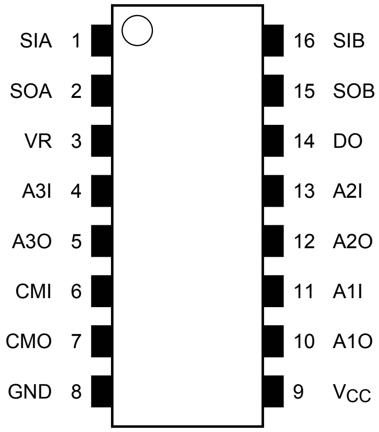
Block Diagram



Pin Function

Pin No.	Pin Name	Function
1	SIA	Connection terminal of shock sensor
2	SOA	Amp (A) output terminal
3	VR	Guard terminal. Reference voltage to protect (1, 16 pin)
4	A3I	OP-AMP (3) input terminal
5	A3O	OP-AMP (3) output terminal
6	CMI	Comparator Input terminal
7	CMO	Comparator Output terminal (output = “L” when shock is detected.)
8	GND	Ground terminal
9	V_{CC}	Power supply voltage
10	A1O	OP-AMP (1) output terminal
11	A1I	OP-AMP (1) input terminal
12	A2O	OP-AMP (2) output terminal
13	A2I	OP-AMP (2) input terminal
14	DO	Differential-Amp output terminal
15	SOB	Amp (B) output terminal
16	SIB	Connection terminal of shock sensor

Pin Connection (top view)



Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	6	V
Input voltage	V_{IN}	-0.3 to $V_{CC} + 0.3$	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 (1) --- Guaranteed data
(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	—	3.5	5	mA
			V_{CC} = 5.0 V	—	3.6	5	

(DIFF-AMP)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Gain	GvBuf	2	—	13.6	14	14.4	dB
Output DC voltage	VoBuf	3	Connect C = 1000 pF between 1 pin and 2 pin, 15 pin and 16 pin,	0.7	1	1.3	V
Output source current	IB_{so}	4	Voh = V_{CC} − 1 V	0.6	1.9	—	mA
Output sink current	IB_{si}	5	Vol = 0.3 V	70	150	—	μA

(OP-AMP1)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input voltage 1	Vin1	6	—	1.135	1.2	1.265	V
Input current	Iin	7	—	—	40	100	nA
Output voltage range (Low side)	Vol	—	—	0.3	—	—	V
Output voltage range (High side)	Voh	—	—	—	—	V_{CC} − 1	V
Output source current	IA_{so}	8	Voh = V_{CC} − 1 V	200	800	—	μA
Output sink current	IA_{si}	9	Vol = 0.3 V	100	200	—	μA

(OP-AMP2)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input voltage range (Low side)	Vil	—	—	0	—	—	V
Input voltage range (High side)	Vih	—	—	—	—	V_{CC} − 1	V
Input current	Iin	10	Input voltage 1.0 V	−100	—	100	nA
Output voltage range (Low side)	Vol	—	—	0.3	—	—	V
Output voltage range (High side)	Voh	—	—	—	—	V_{CC} − 1	V
Output source current	IA_{so}	11	Voh = V_{CC} − 1 V	200	800	—	μA
Output sink current	IA_{si}	12	Vol = 0.3 V	100	200	—	μA

(OP-AMP3)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input voltage 1	Vin1	13	—	1.135	1.2	1.265	V
Input current	Iin	14	—	—	40	100	nA
Output voltage range (Low side)	Vol	—	—	0.3	—	—	V
Output voltage range (High side)	Voh	—	—	—	—	$V_{CC} - 1$	V
Output source current	IA_{so}	15	Voh = $V_{CC} - 1$ V	200	800	—	μA
Output sink current	IA_{si}	16	Vol = 0.3 V	100	200	—	μA

(Window-Comparator)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Output pull-up resistance	RW_u	17	—	21	27	33	kΩ
Output sink current	IW_{si}	18	Vol = 0.3 V	1.0	3.0	—	mA

(Guard Terminal)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Reference Voltage	V_{ref}	—	—	0.50	0.63	0.80	V

Note: This terminal should be used to make guard ring for (1, 16 pin). Please don’t use for any other usage.

Electrical Characteristics (2) --- Reference data for application (Note)

(DIFF-AMP)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input impedance	Zin	—	—	30	100	—	MΩ

(OP-AMP1/2/3)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Cut-off frequency	fT	—	—	500	—	—	kHz
Openloop gain	Gvo	—	—	80	90	—	dB
Offset voltage (OP-AMP1/3)	Voff	—	—	−5	0	5	mV
Offset voltage (OP-AMP2)	Voff	—	—	−15	0	15	mV

(Window-Comparator)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Trip voltage 1	Vtrp1	—	—	Vin1 ±0.37	Vin1 ±0.4	Vin1 ±0.43	V

Note: Toshiba can not test these tables of characteristics for all samples. Therefore Toshiba does not guarantee the data. Please use the data as reference data for customer’s application.

Application Note

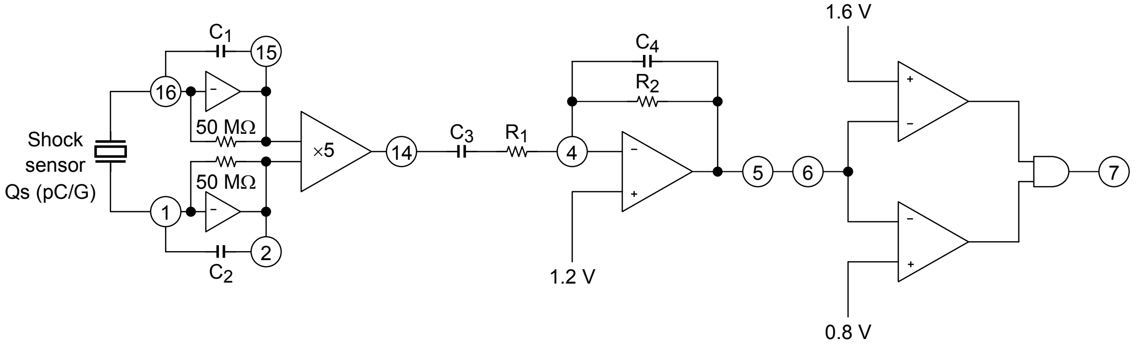


Figure 1 The Configuration of G-Force Sensor Amplifier

Figure 1 shows the configuration of G-Force sensor amplifier.
The shock sensor is connected between the pins 1 and 16.

< How to output 0 or 1 from the pin 7 to detect whether there is a shock or not. >
– Using a sensor with the sensitivity Qs (pC/G) to detect the shock g (G). –

a. Setting gain: C1 = C2 (pF), R1 (kΩ), R2 (kΩ)

$$\frac{\mathrm{Qs} \times \mathrm{g}}{\mathrm{C1}} \times 2 \times 5 \times \frac{\mathrm{R2}}{\mathrm{R1}} = 0.4\ (\mathrm{V})$$

Example: Detecting 5 (G)-shock using a sensor with Qs = 0.34 (pC/G), R1 = 10 (kΩ), R2 = 100 (kΩ).

$$\mathrm{C1} = \mathrm{C2} = \frac{\mathrm{Qs} \times \mathrm{g}}{0.04} \times \frac{\mathrm{R2}}{\mathrm{R1}}$$

$$\mathrm{C1} = \mathrm{C2} = \frac{0.34 \times 5}{0.04} \times \frac{100}{10} = 425\ (\mathrm{pF})$$

b. Setting the frequency (Hz) of HPF: Setting C3 (μF), R1 (kΩ)

$$\mathrm{fc\ (Hz)} = \frac{1}{2 \times \pi \times \mathrm{R1} \times \mathrm{C3}} \times 10^3$$

Example: Setting the frequency to 20 Hz with R1 = 10 (kΩ).

$$\mathrm{C3} = \frac{1}{2 \times \pi \times 10 \times 20} \times 10^3 = 0.8\ (\mu\mathrm{F})$$

c. Setting the frequency (kHz) of LPF: Setting C4 (pF), R2 (kΩ)

$$\mathrm{fc\ (kHz)} = \frac{1}{2 \times \pi \times \mathrm{R2} \times \mathrm{C4}} \times 10^6$$

Example: Setting the frequency to 5 kHz with R2 = 100 (kΩ).

$$\mathrm{C4} = \frac{1}{2 \times \pi \times 100 \times 5} \times 10^6 = 318\ (\mathrm{pF})$$

< How to output the voltage according to the shock through the pin 5. >
– Using a sensor with the sensitivity Qs (pC/G), and assuming the shock sensitivity of the system is Vsystem (mV/G). –

a. Setting gain: C1 = C2 (pF), R1 (kΩ), R2 (kΩ)

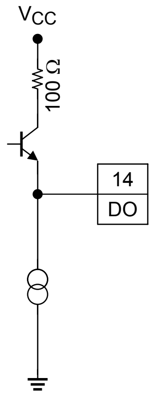
Example: Designing the system with 200 (mV/G) by using a sensor that Qs = 0.34 (pC/G), R1 = 10 (kΩ), R2 = 100 (kΩ).

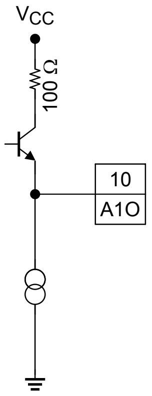
$$\frac{\mathrm{Qs}}{\mathrm{C1}} \times 2 \times 5 \times \frac{\mathrm{R2}}{\mathrm{R1}} = \mathrm{Vsystem} \times 10^3\ (\mathrm{mV/G})$$

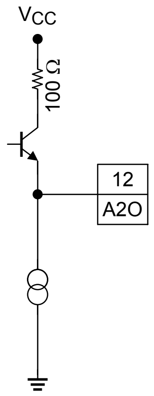
$$\mathrm{C1} = \mathrm{C2} = \frac{\mathrm{Qs}}{\mathrm{Vsystem}} \times \frac{\mathrm{R2}}{\mathrm{R1}} \times 10^4\ (\mathrm{pF})$$

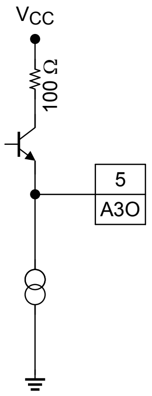
$$\mathrm{C1} = \mathrm{C2} = \frac{0.34}{200} \times \frac{100}{10} \times 10^4 = 170\ (\mathrm{pF})$$

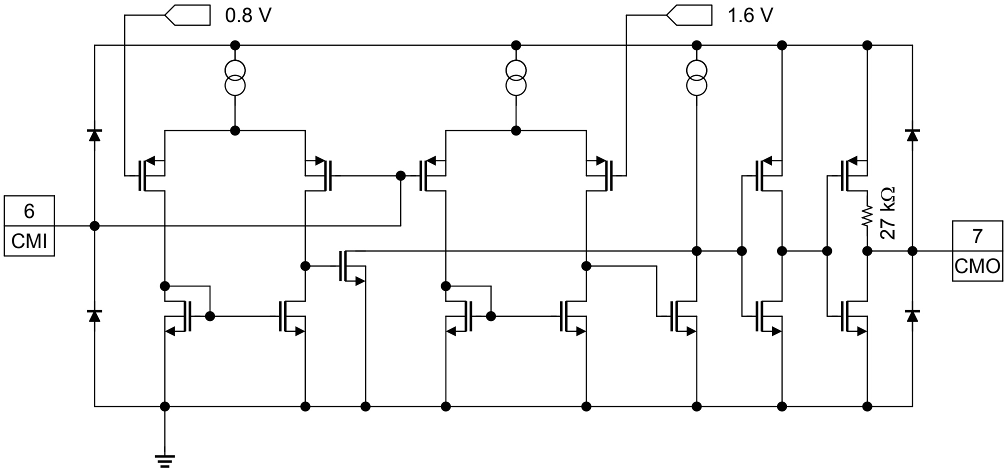
Equivalent Circuit





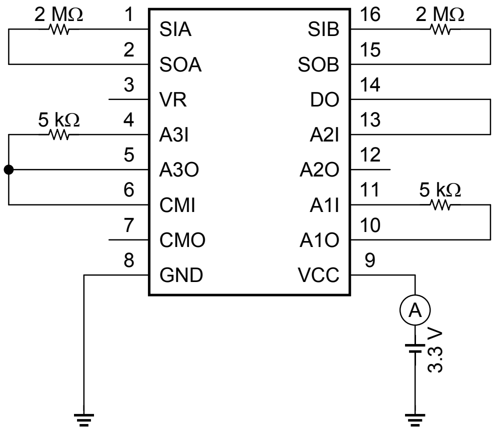




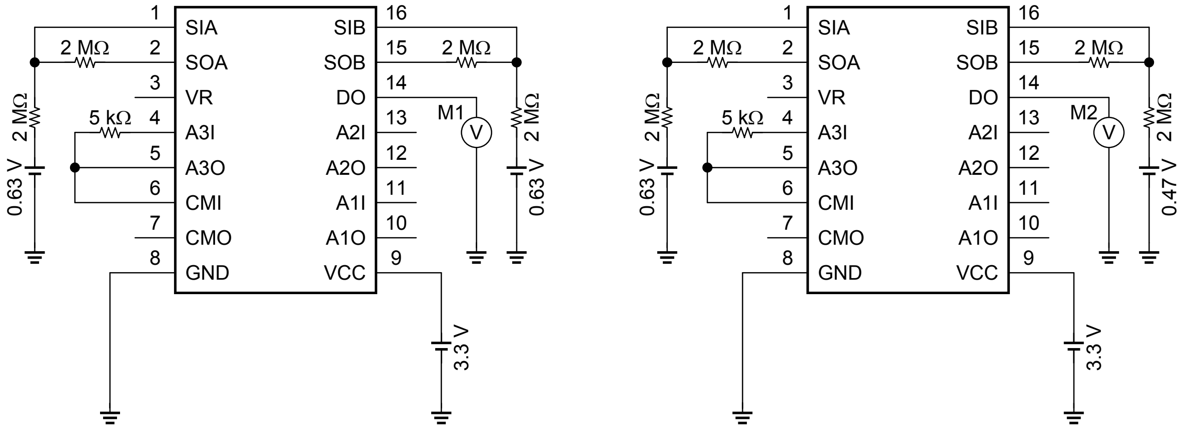


Test Circuit

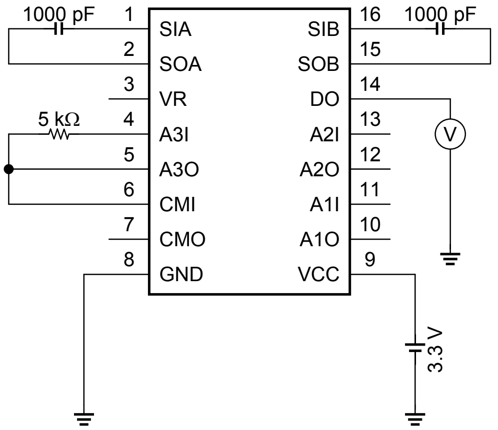
(1) Supply current: I_{CC}



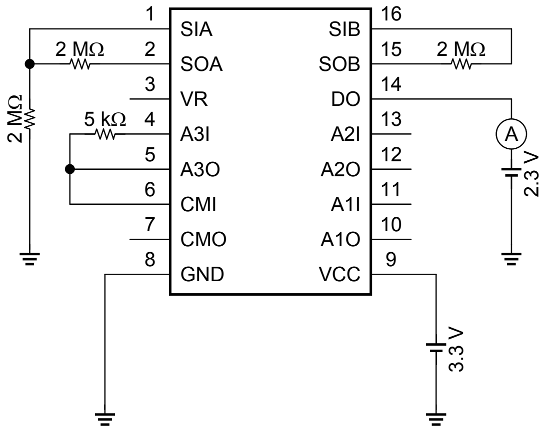
(2) DIFF-AMP
Gain: **GvBuf** Gain = (M2-M1)/(0.63-0.47)



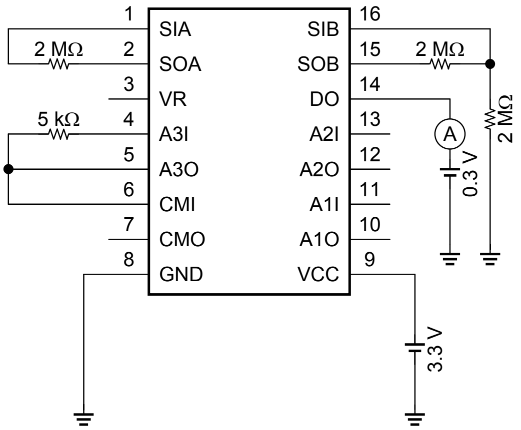
(3) DIFF-AMP
Output DC voltage: **VoBuf**



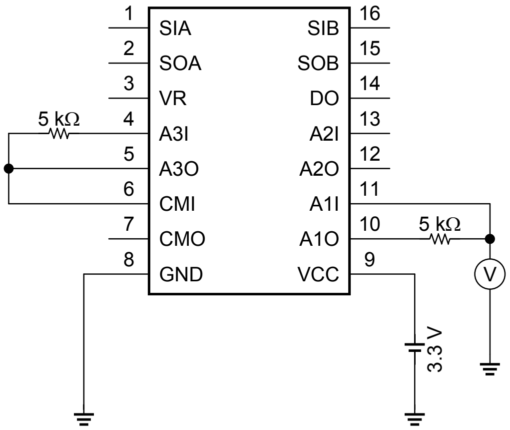
(4) DIFF-AMP
Output source current: **IBso**



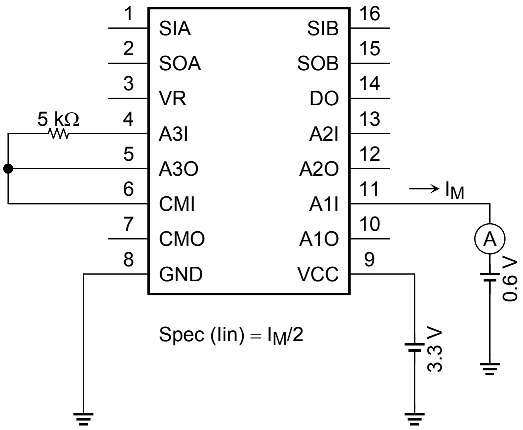
(5) DIFF-AMP
Output sink current: **IBsi**



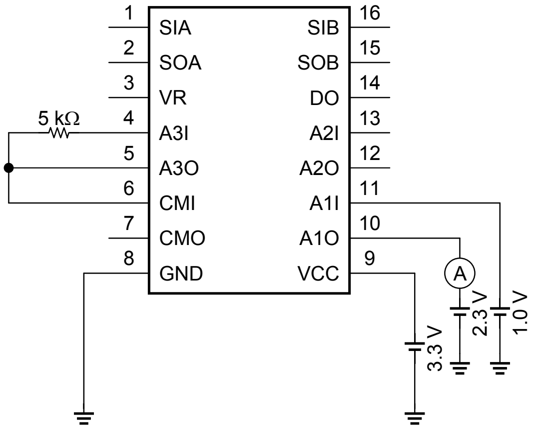
(6) OP-AMP1
Input voltage 1: **Vin1**



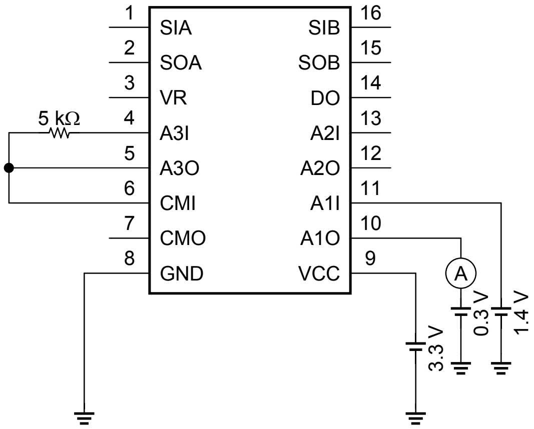
(7) OP-AMP1
Input current: **Iin**



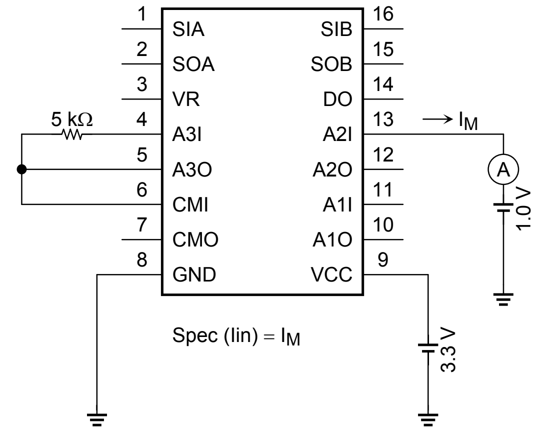
(8) OP-AMP1
Output source current: **IAso**



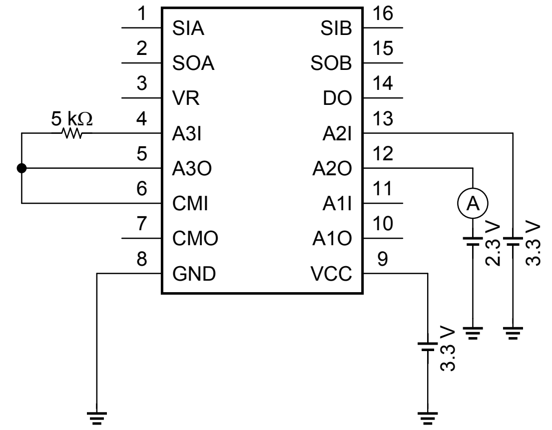
(9) OP-AMP1
Output sink current: **IAsi**



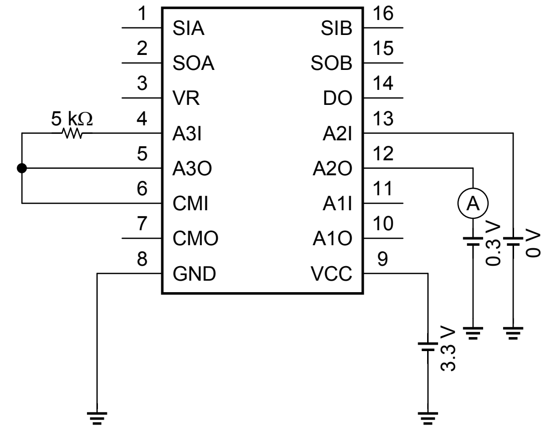
(10) OP-AMP2
Input current: **Iin**



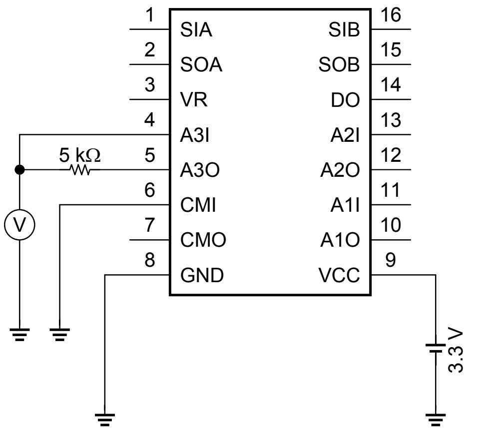
(11) OP-AMP2
Output source current: **IAso**



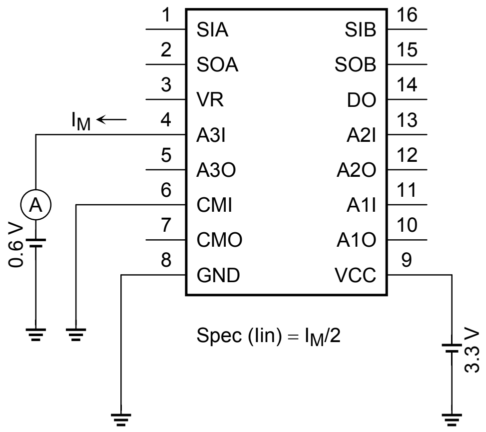
(12) OP-AMP2
Output sink current: **IAsi**



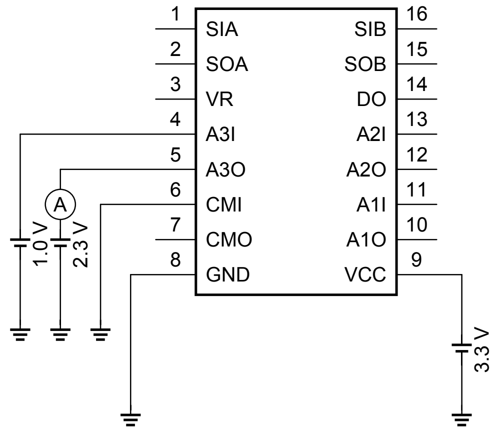
(13) OP-AMP3
Input voltage 1: **Vin1**



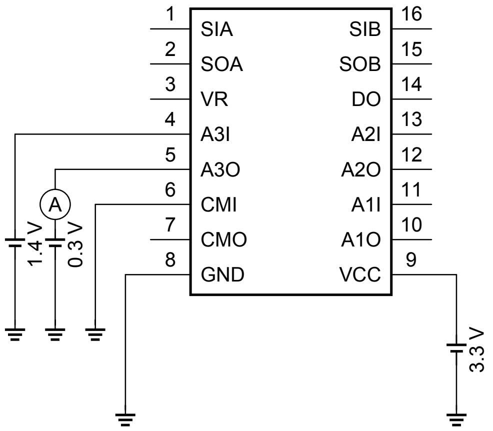
(14) OP-AMP3
Input current: **Iin**



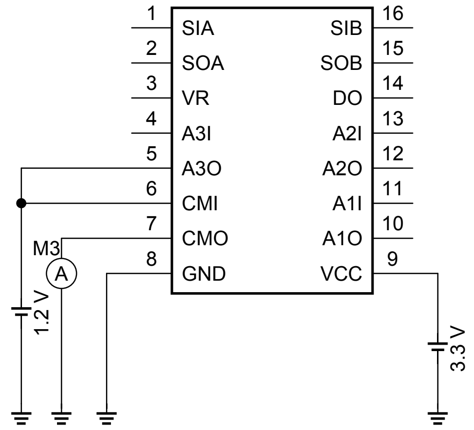
(15) OP-AMP3
Output source current: **IAso**



(16) OP-AMP3
Output sink current: **IAsi**

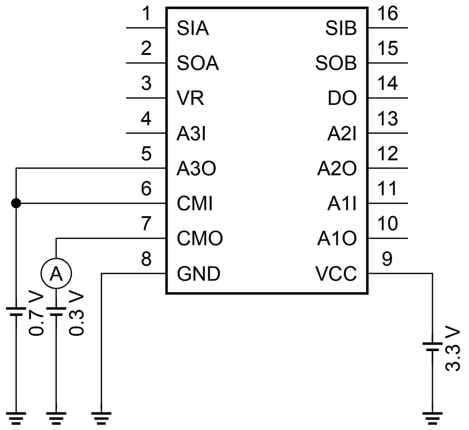


(17) Window comparator
Output pull-up resistance: **RWu**



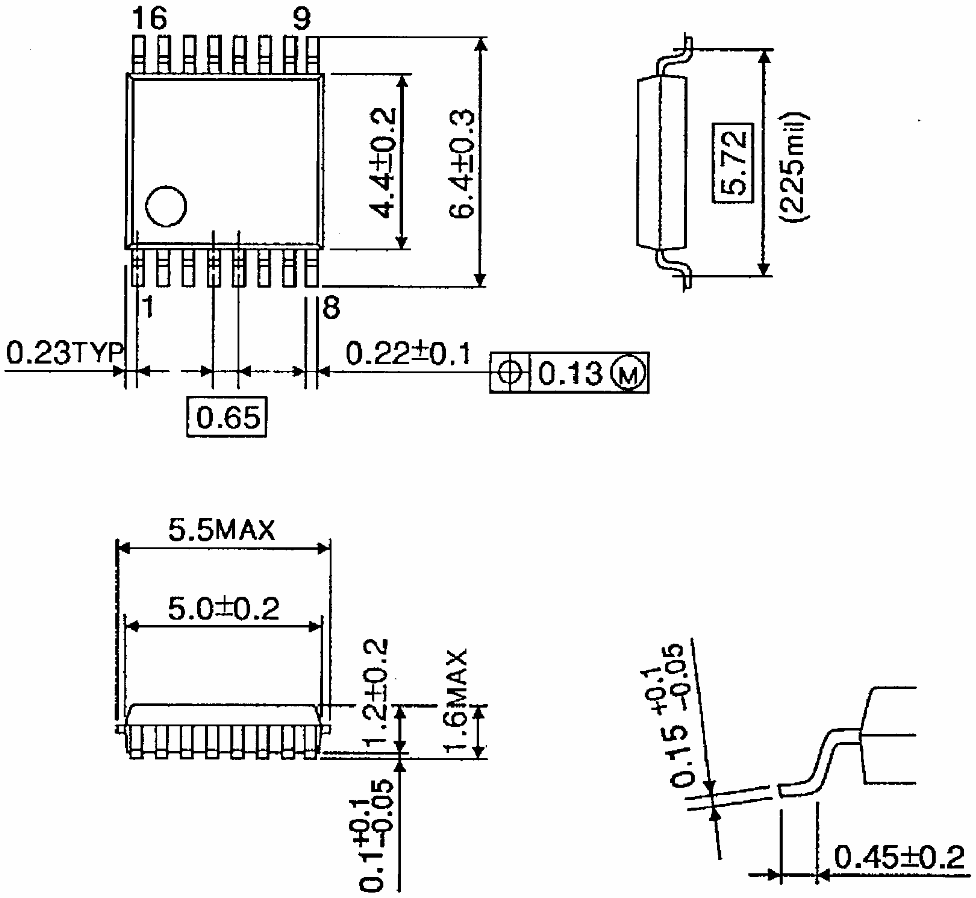
RWu = 3.3/M3

(18) Window comparator
Output sink current: **Iwsi**



Package Dimensions

SSOP16-P-225-0.65B Unit : mm



Weight: 0.07 g (typ.)

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