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MOSDESIGN SEMICONDUCTOR CORP.

SMOKE DETECTOR

PHOTOELECTRIC SMOKE DETECTOR WITH INTERCONNECT

M75010

GENERAL DESCRIPTION

The M75010 is a very low-power IC providing all of the required features for a photoelectric type smoke detector. This device can be used in conjunction with an infrared photoelectric chamber to sense scattered light from smoke particles.

A variable-gain photo amplifier can be directly interfaced to an infrared emitter / detector pair. The amplifier gain levels are determined by two external capacitors that are then internally selected depending on the operating mode. Low gain is selected during standby and timer modes. During a local alarm this low gain is increased (internally) by ~ 10% to reduce false triggering. High gain is used during the push-button test and during standby to periodically monitor the chamber sensitivity.
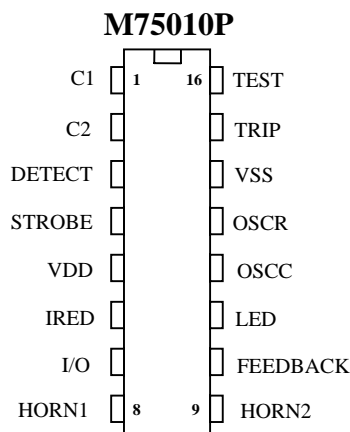
FEATURES

- Interconnect up to 50 detectors.
- Piezoelectric horn driver.
- All internal low-battery detection.
- Power-on reset.
- Built-in circuits to reduce false triggering.
- 6V to 12V operating voltage range.
- ESD-Protection circuitry on all pins.

APPLICATIONS

- Smoke detector.

PIN ASSIGNMENT

M75010P

Pin		Pin
C1	1 16	TEST
C2		TRIP
DETECT		VSS
STROBE		OSCR
VDD		OSCC
IRED		LED
I/O		FEEDBACK
HORN1	8 9	HORN2

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ABSOLUTE MAXIMUM RATING

Parameter	Sym.	Rating	Unit
Supply Voltage Range	V_{DD}	-0.5 ~ 13	V
Input Voltage Range	V_{IN}	-0.3 to V_{DD} + 0.3	V
Input Current	I_{IN}	10	mA
Operating Temperature Range	T_A	-25 ~ 75	℃
Storage Temperature Range	T_S	-55 to 125	℃

PIN AND CIRCUIT DESCRIPTION

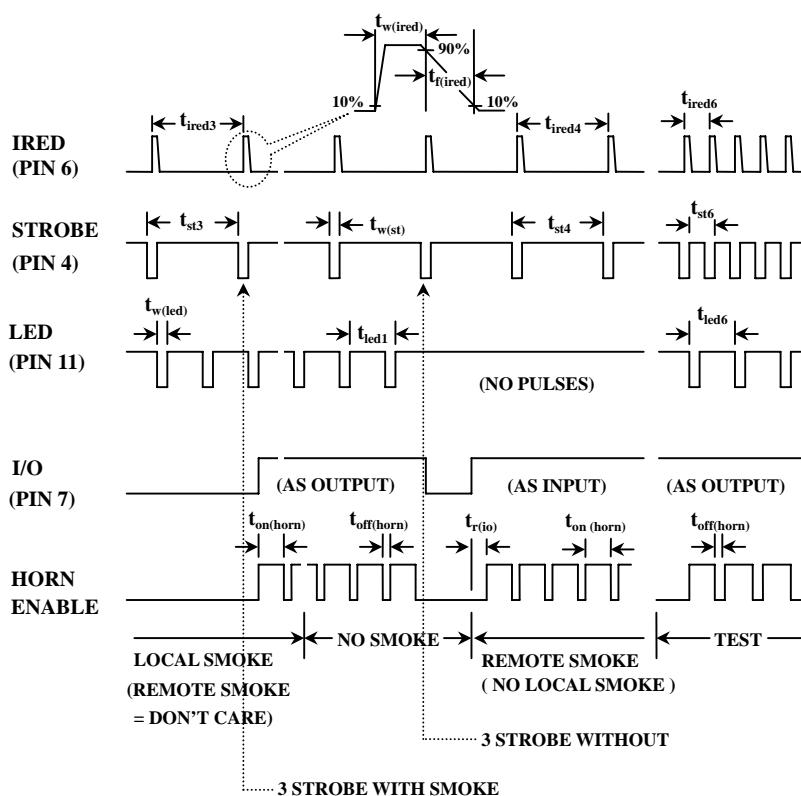| Pin No	Pin Name	Description
1	C1	A capacitor connected to this pin determines the gain of the photo amplifier during the push-to-test mode and during the chamber monitor test. A typical value for this high-gain mode is 0.047 μ F but should be selected based on the photo chamber background reflections reaching the detector and the desired level of sensitivity. Ae $\doteqdot$ 1 + (C1 / 10) where C1 is in pF. Ae should not exceed 10,000.
2	C2	A capacitor connected to this pin determines the gain of the photo amplifier during standby. A typical value for this low-gain mode is 4700 pF but should be selected based on a specific photo chamber and the desired level of sensitivity to smoke. Ae $\doteqdot$ 1 + (C2 / 10) where C2 is in pF. Ae should not exceed 10,000.
3	DETECT	This is the input to the photo amplifier and is connected to the cathode of the photo diode. The photo diode is operated at zero bias and should have low darkleakage current and low capacitance.
4	STROBE	This output provides a strobed , regulated voltage of VDD-5V. The minus side of all internal and external photo amplifier circuitry is referenced to this pin.
5	VDD	This pin is connected to the most-positive supply potential and can range from 6V to 12V with respect to VSS.
6	IRED	This output provides a pulsed base current for the external NPN transistor , which drives the IR emitter. Its beta should be greater than 100. The IRED output is not active , to minimize noise impact , when the horn and visible LED outputs are active.
7	I/O	A connection at this pin allows multiple smoke detectors to be interconnected. If a local smoke condition occurs , this pin is driven high. As an input , this pin is sampled nominally every 1.35 seconds during standby. Any local-alarm condition causes this pin to be ignored as an input. An internal NMOS device acts as a charge dump to aid in applications involving a large (distributed) capacitance. The charge dump is activated at the end of local or test alarm. This pin also has an on-chip pull-down resistor and must be left unconnected if not used. In application , there is a series current-limiting resistor to other smoke alarms.
8	HORN1	These three pins are used in conjunction with external passive components and a self-resonating piezoelectric transducer. HORN1 is connected to the piezo metal support electrode ; the complementary output , HORN2 , is connected to the ceramic electrode and the FEEDBACK input to the feedback electrode.
9	HORN2	
10	FEEDBACK	A continuous modulated tone indicates either a local or remote alarm condition. A short (10ms) chirp indicates a low-battery chirp occurs almost simultaneous with the visible LED flash. If the FEEDBACK pin is not used , it must be connected to VDD or VSS.

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11	LED	This open-drain NMOS output is used to directly drive a visible LED. The low-battery test does not occur coincident with any other test or alarm signal. The LED also indicates detector status as follows (with component values as in the typical application , all times nominal)： **Standby** — Pulses every 43 seconds. **Local Smoke** — Pulses every 0.67 seconds. **Remote Alarm** — No pulses. **Test Mode** — Pulses every 0.67 seconds.
12	OSCC	A capacitor between this pin and VDD , along with a parallel resistor , forms part of a two-terminal oscillator and sets the internal clock low time. With component values as shown , this nominal time is 11 ms and essentially the oscillator period.
13	OSCR	A resistor between this pin and OSCC (pin 12) is part of the two-terminal oscillator and sets the internal clock high time , which is also the I_{RED} pulse width. With component values as shown , this nominal time is 105 μs .
14	VSS	This pin is connected to the most negative supply potential (usually ground).
15	TRIP	This pin is connected to an external voltage which determines the low-supply alarm threshold. The trip voltage is obtained through a resistor divider connected between the VDD and LED pins. The low-supply alarm threshold voltage (in volts) $\doteqdot$ (5R15/R14) + 5 where R6 and R7are in the same units.
16	TEST	This pin has an internal pull-down device and is used to manually invoke a test mode. The Push-to-Test Mode is initiated by a high logic level on this pin (usually the depression of a normally open push-button switch to VDD). After one oscillator cycle, I_{RED} pulse every 336 ms (nominal) and amplifier gain is increased by internal selection of C1. Background reflections in the smoke chamber can be used to simulate a smoke condition. After the third I_{RED} pulse , a successful test (three consecutive simulated smoke conditions) activates the horn drivers and the I/O pin. When the push-button is released , the input returns to VSS due to the internal pull down. After one oscillator cycle , the amplifier gain returns to normal and after three additional I_{RED} pulse (less than one second) , the device exits this mode and returns to standby.

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PHOTOELECTRIC SMOKE DETECTOR
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LOCAL ALARM TIMING DIAGRAM (NOT TO SCALE)：

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**PHOTOELECTRIC SMOKE DETECTOR
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STANDBY TIMING DIAGRAM (NOT TO SCALE)：

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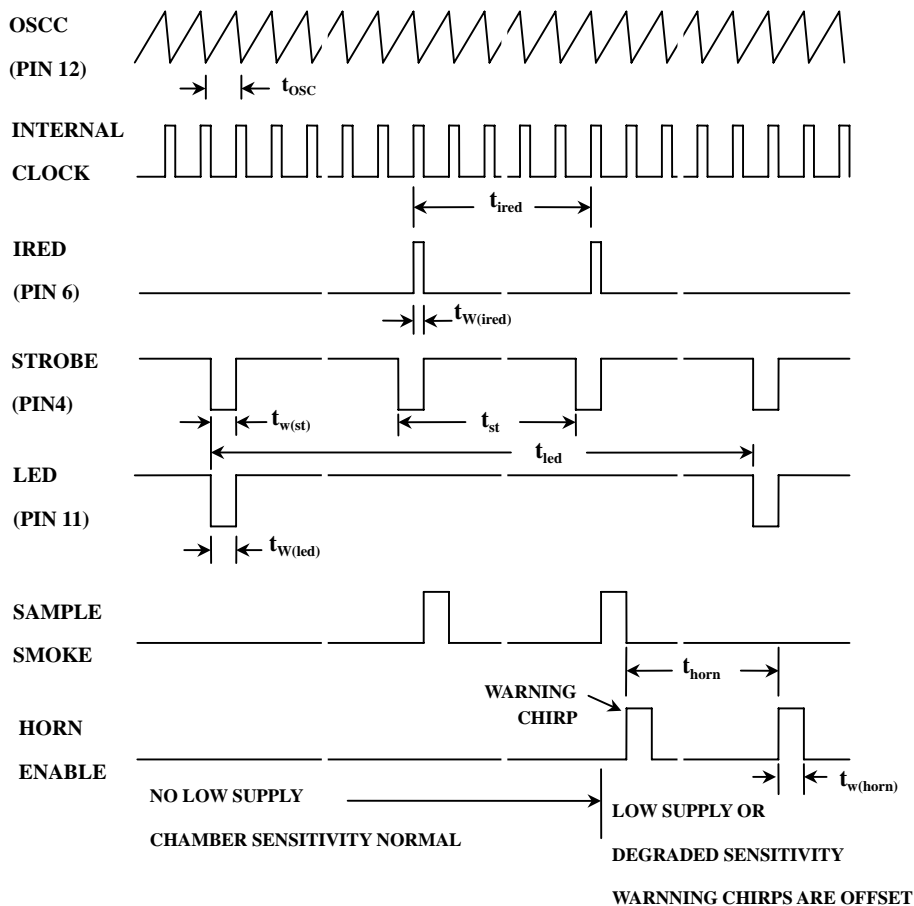
PHOTOELECTRIC SMOKE DETECTOR WITH INTERCONNECT

FUNCTIONAL BLOCK DIAGRAM

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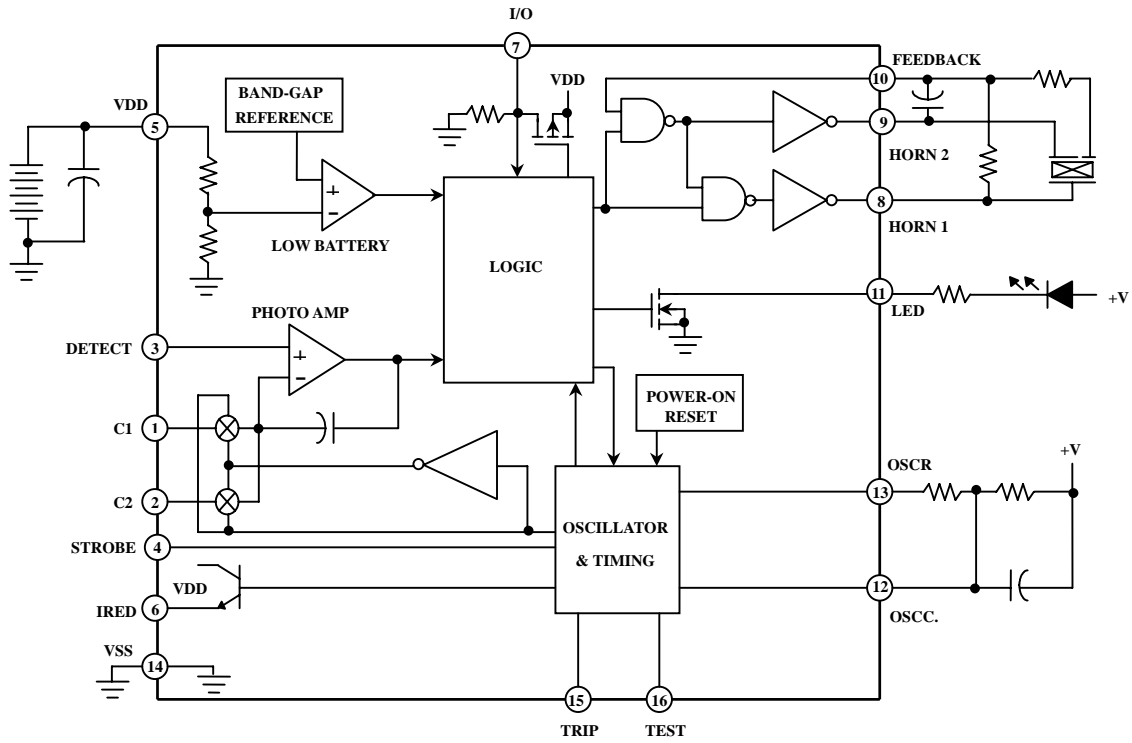
PHOTOELECTRIC SMOKE DETECTOR
WITH INTERCONNECT

DC ELECTRICAL CHARACTERISTICS

(TA=-25℃ ~ 75℃)

Characteristics	Sym.	Pin	V_{DD}	Min.	Typ.	Max.	Unit	Conditions
Supply Voltage	V_{DD}		—	6.0	—	12	V	
Operating Supply Current	I_{DD}	12		—	—	12	μA	Average Standby
		12		—	—	2.0	mA	During Strobe ON , I_{RED} OFF
		12		—	—	3.0	mA	During Strobe ON , I_{RED} ON
Low-Level Input Voltage	V_{IL}	7	9	—	—	1.5	V	
		10	9	—	—	2.7	V	
		16	9	—	—	7.0	V	
		15	9	—	—	0.5	V	
High-Level Input Voltage	V_{IH}	7	9	3.2	—	—	V	
		10	9	6.3	—	—	V	
		16	9	8.5	—	—	V	
		15	9	1.6	—	—	V	
Input Leakage High	I_{IH}	12	12	—	—	100	nA	V_{IN}=V_{DD} , Strobe Active ,Pin12 @V_{DD}
		15	12	—	—	100	nA	V_{IN}=V_{DD}
Input Leakage Low	I_{IL}	12	12	—	—	-100	nA	V_{IN}=V_{ST} , Strobe Active ,Pin12 @V_{DD}
		15	12	—	—	-100	nA	V_{IN}=V_{SS}
		16	12	—	—	-1.0	μA	
Input Pull-Down Current	I_{IN}	16	9	0.25	—	10	μA	V_{IN}=V_{DD} (@ V_{DD}=9V)
		7	9	20	—	80	μA	No Local Smoke ,V_{IN}= V_{DD} (@V_{DD}=9V)
		7	12	—	—	140	μA	No Local Smoke ,V_{IN}=17V(@V_{DD}=12V)
Low-Level Output Voltage	V_{OL}	11	6.5	—	—	0.6	V	I_O = 10mA
		8, 9	6.5	—	—	1.0	V	I_O = 16mA
		13	6.5	—	0.5	—	V	I_O = 5mA
High-Level Output Voltage	V_{OH}	8, 9	6.5	5.5	—	—	V	I_O = -16mA
Strobe Output Voltage	V_{ST}	4	12	V_{DD}-0.1	—	—	V	Inactive , I_O = -1μA
			9	V_{DD}-5.6	—	V_{DD}-4.4	V	Active , I_O = 100μA to 500μA
Line Regulation	$\Delta V_{ST(\Delta VDD)}$		—	—	-60	—	dB	Active , V_{DD}= 6V to 12V
I_{RED} Output Voltage	V_{IRED}	6	12	—	—	0.1	V	Inactive , I_O =1Ma , T_A = +25℃
			9	2.25	3.0	3.75	V	Active , I_O = -6mA , T_A = +25℃
Line Regulation	$\Delta V_{IRED(\Delta VDD)}$		—	—	-35	—	dB	Active , V_{DD}= 6V to 12V
High-Level Output Voltage	I_{OH}	7	9	-4.0	—	—	mA	V_{DD}= Alarm , I/O active , V_O= V_{DD}-2V
OFF Leakage Current High	I_{OZ}	11	12	—	—	1.0	μA	V_O= V_{DD}
OFF Leakage Current Low	I_{OZ}	11	12	—	—	-1.0	μA	V_O= V_{SS}
Low V_{DD} Alarm Threshold	$V_{DD(th)}$		—	6.5	7.2	7.8	V	
Common Mode Voltage	V_{IC}	1, 2, 3	—	V_{DD}-4	—	V_{DD}-2	V	Any Alarm Condition
Smoke Comparator Ref. Volt.	V_{REF}	Int.	—	V_{DD}-3.92	—	V_{DD}-3.08	V	Any Alarm Condition

* Limits over the operating temperature range are based on characterization data.

  Characteristics are production tested at +25℃.

  Typical values are at +25℃ and are given for circuit design information only.

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AC ELECTRICAL CHARACTERISTICS

(TA=-25℃ ~ 75℃)

Characteristics	Sym.	V_{DD}	Min.	Typ.	Max.	Unit	Conditions
Oscillator Period	T_{OSC}	9	9.4	10.5	11.5	ms	
Led Pulse Period	T_{LED1}	9	39	—	48	s	No Local or Remote Smoke
	T_{LED2}	9	None	—	—	s	Remote Smoke only
	T_{LED3}	9	0.45	0.50	0.55	s	Local Smoke or Test
Led Pulse Width	$T_{W\,(LED)}$	9	9.5	—	11.5	ms	
Strobe Pulse Period	T_{ST1}	9	9.6	—	11.9	s	No Local or Remote Smoke
	T_{ST2}	9	1.8	2.0	2.2	s	After 1 or 3 Valid Samples
	T_{ST3}	9	0.8	1.0	1.1	s	After 2 or 3 Valid Samples and During Local Alarm
	T_{ST4}	9	7.2	8.0	8.9	s	Remote Alarm
	T_{ST5}	9	38.9	—	47.1	s	Chamber Test or Low Supply Test , No Local Alarm
	T_{ST6}	9	300	336	370	ms	Pushbutton Test , No Alarm
Strobe Pulse Width	$T_{W\,(ST)}$	9	9.5	—	11.5	ms	
I_{RED} Pulse Period	T_{IRED1}	9	9.6	—	11.9	s	No Local or Remote Smoke
	T_{IRED2}	9	1.8	2.0	2.2	s	After 1 or 3 Valid Samples
	T_{IRED3}	9	0.8	1.0	1.1	s	After 2 or 3 Valid Samples and During Local Alarm
	T_{IRED4}	9	7.2	8.0	8.9	s	Remote Alarm
	T_{IRED5}	9	38.9	—	47.1	s	Chamber Test , No Local Alarm
	T_{IRED6}	9	300	336	370	ms	Pushbutton Test , No Alarm
I_{RED} Pulse Width	$T_{W\,(IRED)}$	9	94	—	116	μs	
I_{RED} Rise Time	$T_{r(IRED)}$		—	—	30	μs	10% to 90%
I_{RED} Fall Time	$T_{f\,(IRED)}$		—	—	200	μs	90% to 10%
I/O to Active Delay	$T_{d\,(IO)}$	9	—	0	—	s	Local Alarm
I/O Charge Dump Duration	T_{dump}	9	0.9	1.0	1.1	s	End of Local Alarm or Test
Rising Edge on I/O to Alarm	$T_{r\,(IO)}$	9	—	—	1.34	s	No Local Alarm
Horn Warning Pulse Period	T_{HORN}	9	38.9	—	47.1	s	Low Supply and Degraded Chamber Sensitivity
Horn Warning Pulse Width	$T_{W\,(HORN)}$	9	9.5	—	11.5	ms	Low Supply and Degraded Chamber Sensitivity
Horn ON Time	$T_{ON\,(HORN)}$	9	—	216	280	ms	Local or Remote Alarm
Horn OFF Time	$T_{OFF\,(HORN)}$	9	—	80	83	ms	Local or Remote Alarm

* Limits over the operating temperature range are based on characterization data.
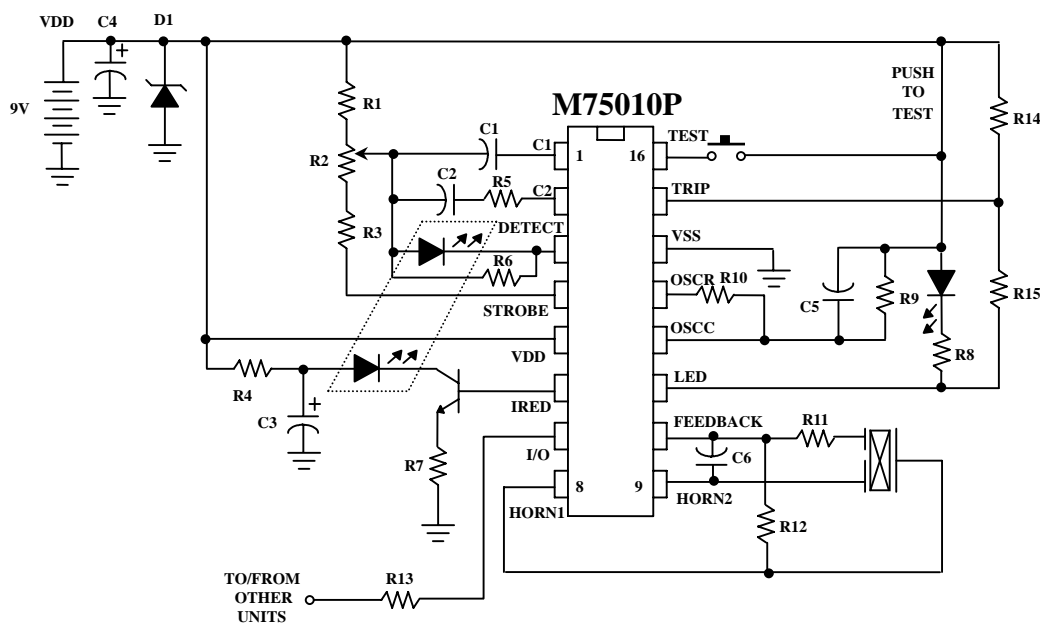
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ELECTRICAL CHARACTERISTICS

（ 一 ）**STAND-ALONE：**

C1	0.047 μ F	R1	5.6K Ω
C2	4700pF	R2	5K Ω
C3	100 μ F	R3	8.2K Ω
C4	22 μ F	R4	1K Ω
C5	1500pF	R5	560 Ω
C6	1000pF	R6	200K Ω
		R7	4.7 Ω ~22 Ω
		R8	330 Ω
		R9	7.5M Ω
		R10	100K Ω
		R11	200K Ω
		R12	2M Ω
		R13	220 Ω
		R14	100K Ω
		R15	47K Ω

1. Value for R11、R12 and C6 may differ depending on type of piezoelectric horn used.
2. C2 and R7 are used for coarse sensitivity adjustment. Typical values are shown.
3. C4 should be 22 μ F if B1 is a carbon battery. C4 could be reduced to 1 μ F when an alkaline battery is used.

（ 二 ）NETWORK：

C1	0.047 μ F
C2	4700pF
C3	100 μ F
C4	22 μ F
C5	1500pF

R1	5.6KΩ
R2	5KΩ
R3	8.2KΩ
R4	1KΩ
R5	560Ω
R6	200KΩ
R7	4.7Ω~22Ω
R8	7.5MΩ
R9	100KΩ
R10	220Ω

1. C2 and R7 are used for coarse sensitivity adjustment. Typical values are shown.
2. C4 should be 22 μ F if B1 is a carbon battery. C4 could be reduced to 1 μ F when an alkaline battery is used.
3. FEEDBACK (PIN10)、TRIP (PIN15) and TEST (PIN16) must connect to ground.

* All specs and applications shown above subject to change without prior notice.
  (以上電路及規格僅供參考,本公司得逕行修正)