## BL59A12 PHOTOELECTRIC SMODE DETECTOR IC

# 1. Product description

## 1.1  Basic function:

BL59A12 is a CMOS LSI used for smoke detection. Ultra-low power analog and digital circuits are contained in it. Combined with an IR photoelectric chamber, this IC is used to detect smoke through receiving light scattered by tiny smoke particles going into the chamber. When smoke is detected, a burst of alarm sounds are generated by an external piezoelectric buzzer driven by the push-pull output of this IC.

## 1.2. Applications:

Smoke detection system.

## 2. Features:

Power supply range:          6V ～ 12V
Average supply current:      8uA
Operating temperature range:    -10 ～ 60℃
Ideal for battery powered applications.

## 3. Block diagram of this IC



## 4. Pin assignment

## 5.Pin description

| Pin No. | Symbol | Input/output | | Functions |
|---|---|---|---|---|
| 1,2 | C1,C2 | | External capacitor connection | By connecting external capacitor, a voltage feedback amplifier is formed. The gain of it is determined by capacitor's value. |
| 3 | DETECT | I | Detecting input | Connect a photodiode to supply a signal to the internal comparator. |
| 4 | STROBE | O | Strobe | A strobe voltage output, referenced to $V_{DD}$. When output = $V_{DD}$ -5V, it enables other internal circuits. |
| 5,14 | $V_{DD}$,GND | | Power supply | To supply the power |
| 6 | IRED | O | Output signal | To output pulse drive signal for external NPN transistor which drives a IR photodiode. |
| 7 | I/O | | Input/output | It can be used to connect up to 40 detectors to make auxiliary alarm, remote alarm, auto-dialer… |
| 8,9 | BRASS,SILVER | O | Push-pull driver's output | Push-pull driver outputs signal to drive external buzzer to alarm, and to show various operation states. |
| 10 | FEEDBACK | I | Feedback terminal | To feed 'silver' signal back to the push-pull output driver circuit's input |
| 11 | LED | O | Output signal | It is an open drain output, can drive LED directly. The LED can tell the detector's various operation states. |
| 12 | OSC | I | Oscillator's input | Connected to external R and C, which determine the internal oscillator's frequency. |
| 13 | R1 | | External R and C connecting terminal | Connected to external R and C, which determine the output pulse period of IRED. |
| 15 | LOW-SUPPLY | I | Low voltage detecting input | It connected to external resistor divider between VDD and LED to get a low supply alarm threshold voltage |
| 16 | TEST | I | Test terminal | This pin is normally low by an internal pull-down device. When |

| | | | | it is set high, the IC enters into a simulated-smoke condition. When floating, this pin comes back to $V_{SS}$ (low) by pull-down device. |
|---|---|---|---|---|

## 6. Function of this IC:

**6.1.** The variable gain photoelectric amplifier is directly connected to IR detector (photodiode). The amplifier's gain is determined by external capacitors C1 and C2. During standby, the amplifier's gain is at minimum. Under smoke condition, the amplifier's gain is at medium. Entering into test condition, the amplifier's gain is at maximum. Additionally, under standby state, if the special supervisory circuit is activated to check the chamber's sensitivity, the amplifier's gain is also at its maximum.

**6.2.** Using $V_{SS}$ as its reference, the I/O pin can be used to connect up to 40 units together. When I/O pin is used as an input, its on-chip pull-down resistor can prevent noise from entering into the unit. Under smoke status, the unit activates I/O driver to send a signal to its interconnected units to activate remote alarm.

**6.3.** Display method: LED (connected to LED pin) flashing combined with alarm sound, indicates a LOCAL SMOKE condition. Only pulsating alarm sound without LED flashing indicates a REMOTE SMOKE condition.

6.4 Typical Timing
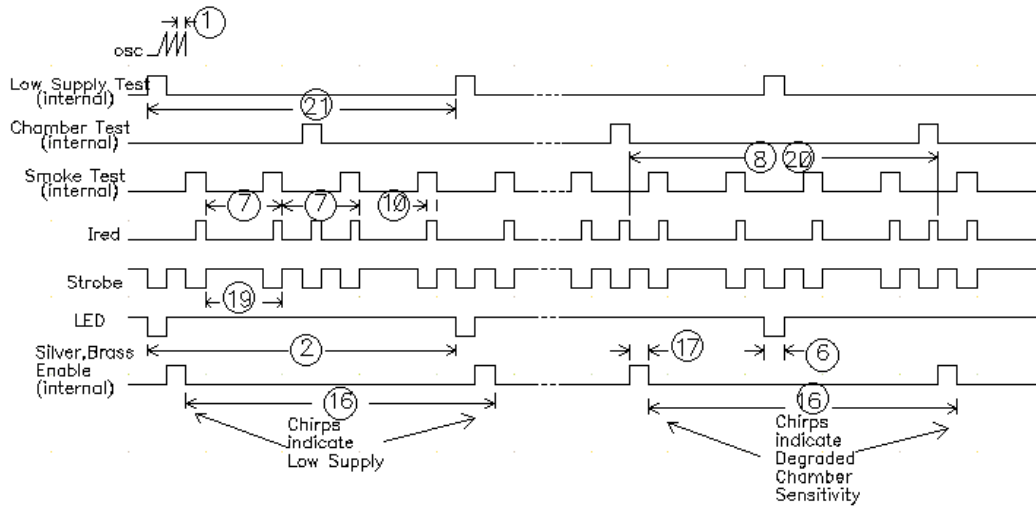


**Standby Timing Diagram**
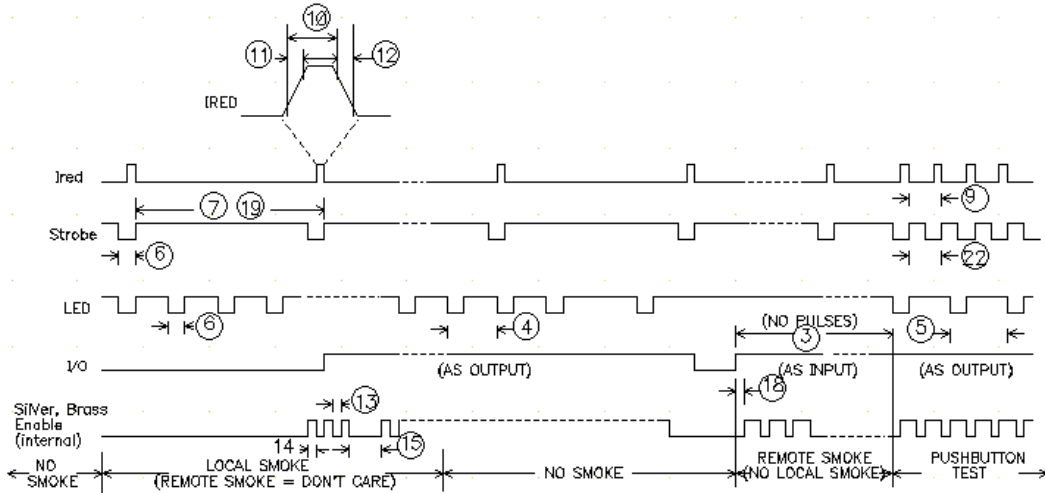
**Smoke Timing Diagram**

## 7. Specifications:

### 7.1. Absolute maximum ratings($V_{SS}$ as reference)

| Symbol | Parameter | Limits | Units |
|---|---|---|---|
| $V_{DD}$ | Supply voltage | $-0.5 \sim +12$ | |
| $V_{IN}$ DC input voltage | C1, C2, Detect | $-0.25 \sim Vdd+0.25$ | V |
| | OSC, low-supply trip | $-0.25 \sim Vdd+0.25$ | |
| | I/O | $-0.25 \sim Vdd+0.25$ | |
| | Feedback | $-15 \sim +15$ | |
| | Test | $-1.0 \sim Vdd+0.25$ | |
| $I_{IN}$ | DC input current | $\pm 10$ | mA |
| $I_{OUT}$ | DC output current | $\pm 25$ | mA |
| $I_{DD}$ | Supply current | $+25/-150$ | mA |
| PD | Power dissipation in still air, 5Sec | 1200 | mW |
| | Continuous | 350 | |
| TSTG | Storage temperature | $-55 \sim 125$ | ℃ |
| TL | Soldering temperature | 260 | ℃ |

### 7.2 Electrical characteristics(Ta = 25℃, $V_{SS}$ as reference, unless otherwise indicated)

| Symbol | Parameters | Test condition | $V_{DD}$ | Min. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Power supply voltage range | | -- | 6.0 | 12 | V |
| $V_{TH}$ | Supply threshold voltage, Low supply alarm voltage | Low supply trip voltage $V_{IN} = V_{DD}/3$ | | 6.5 | 7.8 | V |
| $I_{DD}$ | Average supply current | Standby, (See sample | 12 | -- | 8 | uA |

| Symbol | Parameter | | Test Conditions | | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | figure) | | | | |
| $i_{DD}$ | Supply peak current | | Strobe on, IRED off (See sample figure) | 12 | -- | 2.0 | mA |
| $V_{IL}$ | Low level input voltage, I/O | | | 9.0 | | 1.5 | V |
| | Feedback | | | 9.0 | | 2.7 | |
| | Test | | | 9.0 | | 7.0 | |
| $V_{IH}$ | High level input voltage I/O | | | 9.0 | 3.2 | | V |
| | Feedback | | | 9.0 | 6.3 | | |
| | Test | | | 9.0 | 8.5 | | |
| $I_{IN}$ | Input current  OSC, Detect | | $V_{IN} = V_{SS}$ or $V_{DD}$ | 12 | | ±100 | nA |
| | Low supply trip | | $V_{IN} = V_{SS}$ or $V_{DD}$ | 12 | | ±100 | |
| | Feedback | | $V_{IN} = V_{SS}$ or $V_{DD}$ | 12 | | ±100 | |
| $I_{IL}$ | Low level input current TEST | | $V_{IN} = V_{SS}$ | 12 | | −1 | uA |
| $I_{IH}$ | Pull-down current  Test I/O | | $V_{IN} = V_{DD}$ | 9.0 | 0.5 | 10 | uA |
| | | | No local smoke, $V_{IN} = V_{DD}$ | 9.0 | 25 | 100 | |
| | | | No local smoke, $V_{IN} = 17V$ | 12 | -- | 140 | |
| $V_{OL}$ | Low level output voltage, LED | | $I_{OUT} = 10mA$ | 6.5 | | 0.6 | V |
| | Silver, Brass | | $I_{OUT} = 16mA$ | 6.5 | | 1.0 | |
| $V_{OH}$ | High level output voltage Silver, Brass | | $I_{OUT} = -16mA$ | 6.5 | 5.5 | − | V |
| $V_{OUT}$ | Output voltage (See pin description) | Strobe | Inactive, $I_{OUT} = -1uA$ | − | VDD-0.1 | − | V |
| | | | Active, $I_{OUT} = 100uA$ to $500uA$ (load regulation) | 9.0 | VDD-4.4 | Vdd-5.6 | |
| | | IRED | Inactive, $I_{OUT} =-1uA$ | − | − | 0.1 | |
| | | | Active, $I_{OUT} =6uA$ (load regulation) | 9.0 | 2.25 | 3.75 | |
| $I_{OH}$ | High-level output current, I/O | | Local smoke, $V_{OUT} =4.5V$ | 6.5 | −4 | -- | mA |
| | | | Local smoke, $V_{OUT} = V_{SS}$ (short-circuit current) | 12 | -- | −16 | |
| $I_{OZ}$ | Output off-state leak current, LED | | $V_{OUT} = V_{SS}$ or $V_{DD}$ | 12 | − | ±1 | uA |

| $V_{IC}$ | Common-mode voltage range C1, C2, Detect | Local smoke, Pushbutton test or chamber sensitivity test | -- | $V_{DD}-4$ | $V_{DD}-2$ | V |
| $V_{REF}$ | Internal reference voltage of smoke comparator | Local smoke, pushbutton test or chamber sensitivity test | -- | $V_{DD}-3.08$ | $V_{DD}-3.92$ | V |

## 7.3 AC Electrical characteristics(Ta = 25℃, $V_{SS}$ as reference, unless otherwise indicated, Vdd=9V, R1=100kΩ, C3=1500pF, R2=10MΩ)

| No | Symbol | Parameter | Conditions | Clock | Min. | Typ | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| 1 | 1/fosc | OSC Period* | Free-Running Sawtooth Measured at Pin12 | 1 | 7.0 | 7.9 | 8.6 | ms |
| 2 | Tled | Led Pulse Period | No Local and Remote Smoke | 4096 | 28.8 | 32.4 | 35.2 | s |
| 3 | Tled | | Remote Smoke, But no Local Smoke Only | – | Extinguised | | | s |
| 4 | Tled | | Local Smoke | 64 | 0.45 | 0.5 | 0.55 | s |
| 5 | Tled | | Pushbutton Test | 64 | 0.45 | 0.5 | 0.55 | s |
| 6 | Tw(led,stb)) | Led and strobe Pulse Width | | 1 | 7.0 | – | 8.6 | ms |
| 7 | Tired | Ired Pulse Period | Smoke Test | 1024 | 7.2 | 8.1 | 8.8 | s |
| 8 | Tired | | Chamber sensitivity Test without Local Smoke | 4096 | 28.8 | 32.4 | 35.2 | s |
| 9 | Tired | | Pushbutton Test | 128 | 0.9 | 1 | 1.1 | s |
| 10 | Tw(ired) | Ired Pulse Width | | Tf* | 94 | | 116 | us |
| 11 | Tr(ired) | Ired Rise Time | | - | - | | 30 | us |
| 12 | Tf(ired) | Ired Fall Time | | - | - | | 200 | us |
| 13 | Ton | Sliver and Brass Temporal Modulation Polse Width | | 64 | 0.45 | 0.5 | 0.55 | s |
| 14 | Toff | | | 64 | 0.45 | 0.5 | 0.55 | s |
| 15 | Toffd | | | 192 | 1.35 | 1.52 | 1.65 | s |
| 16 | Tch | Sliver and Brass Chirp Pulse Period | Low Supply or Degraded Chamber Sensitivity | 4096 | 28.8 | 32.4 | 35.2 | s |
| 17 | Tw(ch) | Sliver and Brass Chirp Pulse Width | | 1 | 7.0 | 7.9 | 8.6 | ms |
| 18 | Trr | Rising Edge on I/O to smoke Alarm Response Time | Remote Smoke, no Local Smoke | - | - | | 2 | - | ms |
| 19 | Tstb | Strobe Out Pulse Period | Smoke Test | 1024 | 7.2 | 8.1 | 8.8 | s |
| 20 | | | Chamber sensitivity Test without Local Smoke | 4096 | 28.8 | 32.4 | 35.2 | s |
| 21 | | | Low Supply Test without Local Smoke | 4096 | 28.8 | 32.4 | 35.2 | s |
| 22 | | | Pushbutton Test | – | - | 1 | - | s |

OSC Period T (=Tr+Tf) is determined by the external R1 , R2, and C3, where Tr=(0.6931)R2*C3 and Tf=(0.6931)R1*C3

## 8. Application sample figure
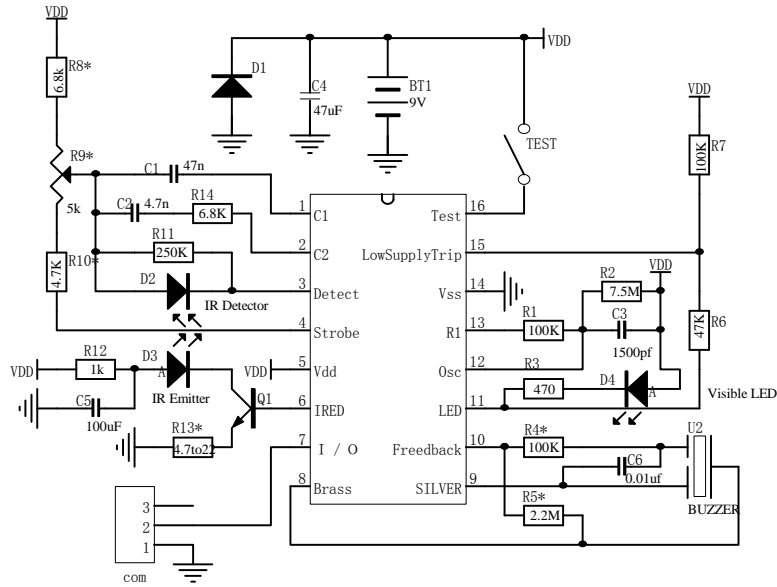
## 9. Calibration:

**To** enter calibration mode, pin16 (TEST) must be below VSS, pulling more than 100uA continuously out of the pin for at least one OSC cycle. To exit this mode, the TEST pin is floated at least one OSC cycle.

Table. Configuration of pins in the calibration mode

| Description | PIN | Comments |
|---|---|---|
| I/O | 7 | Forcing this pin = $V_{DD}$, places photo amp's output on pin2 when pin15= $V_{DD}$, or on pin1 when pin15= $V_{SS}$. |
| Low-supply | 15 | **Low:** normal gain of photo amplifier on pin1.<br>**High**: supervisory gain on pin2. |
| Feedback | 10 | When pin15=low, driving it high enables gain with a hysteresis in the photo amp. |
| OSC | 12 | It equals to internal clock. |
| Silver | 9 | This pin becomes smoke comparator's output. Positive pulses indicate that smoke has been detected. A static low level indicates no smoke. |
| Brass | 8 | This pin becomes the smoke integrator's output. Static high level means two consecutive smoke detections. Static low level means two no-detections. |

## PACKAGE
## DIP16
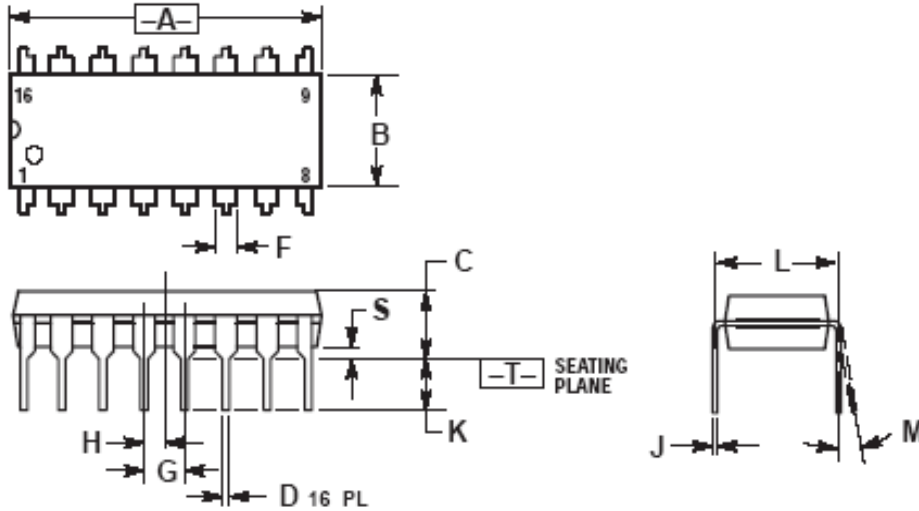


| DIM | INCHES | | MILLIMETERS | |
|-----|--------|--------|--------|--------|
| | MIN | MAX | MIN | MAX |
| A | 0.740 | 0.770 | 18.80 | 19.55 |
| B | 0.250 | 0.270 | 6.35 | 6.85 |
| C | 0.145 | 0.175 | 3.69 | 4.44 |
| D | 0.015 | 0.021 | 0.39 | 0.53 |
| F | 0.040 | 0.70 | 1.02 | 1.77 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.050 BSC | | 1.27 BSC | |
| J | 0.008 | 0.015 | 0.21 | 0.38 |
| K | 0.110 | 0.130 | 2.80 | 3.30 |
| L | 0.295 | 0.305 | 7.50 | 7.74 |
| M | 0 ° | 10 ° | 0 ° | 10 ° |
| S | 0.020 | 0.040 | 0.51 | 1.01 |

## SOP16
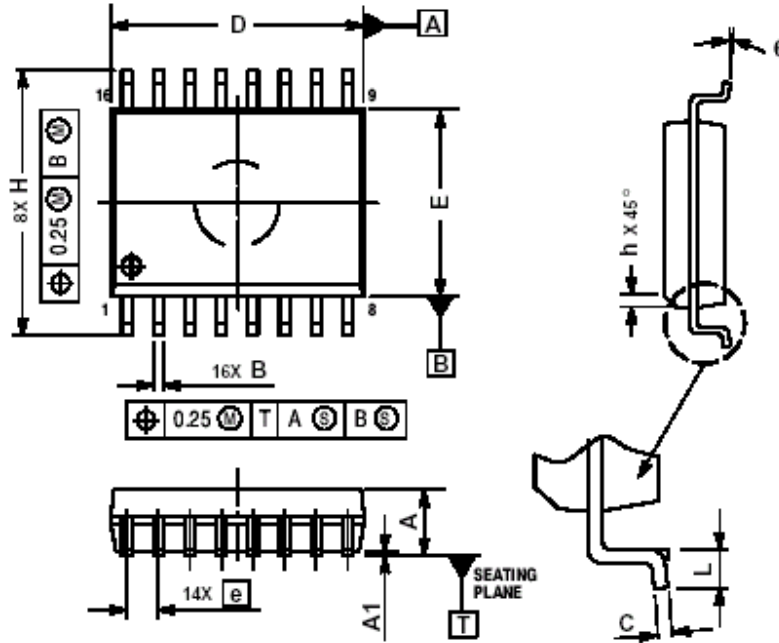


| DIM | MILLIMETERS | |
| --- | --- | --- |
| | MIN | MAX |
| A | 2.35 | 2.65 |
| A1 | 0.10 | 0.25 |
| B | 0.35 | 0.49 |
| C | 0.23 | 0.32 |
| D | 10.15 | 10.45 |
| E | 7.40 | 7.60 |
| e | 1.27 BSC | |
| H | 10.05 | 10.55 |
| h | 0.25 | 0.75 |
| L | 0.50 | 0.90 |
| θ | 0° | 7° |