

## Ionization Smoke Detector with Interconnect and Timer

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### Discontinued Product

These parts are no longer in production. The device should not be purchased for new design applications. Samples are no longer available.

Date of status change: May 17, 2023

#### **Recommended Substitutions:**

*For existing customer transition, and for new customers or new applications, contact factory.*

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NOTE: For detailed information on purchasing options, contact your local Allegro field applications engineer or sales representative.

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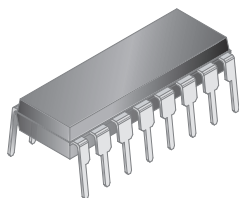
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# Ionization Smoke Detector with Interconnect and Timer

## FEATURES AND BENEFITS

- Low average standby current for long battery life
- Interconnect up to 125 detectors
- Piezoelectric horn driver
- Guard outputs for detector input
- Pulse testing for low battery
- Power-on reset (POR)
- Internal reverse battery protection
- Timer (Hush) mode for enabling reduced sensitivity period
- Built-in hysteresis reduces false triggering

## PACKAGE: 16-pin DIP (suffix A):



Not to scale

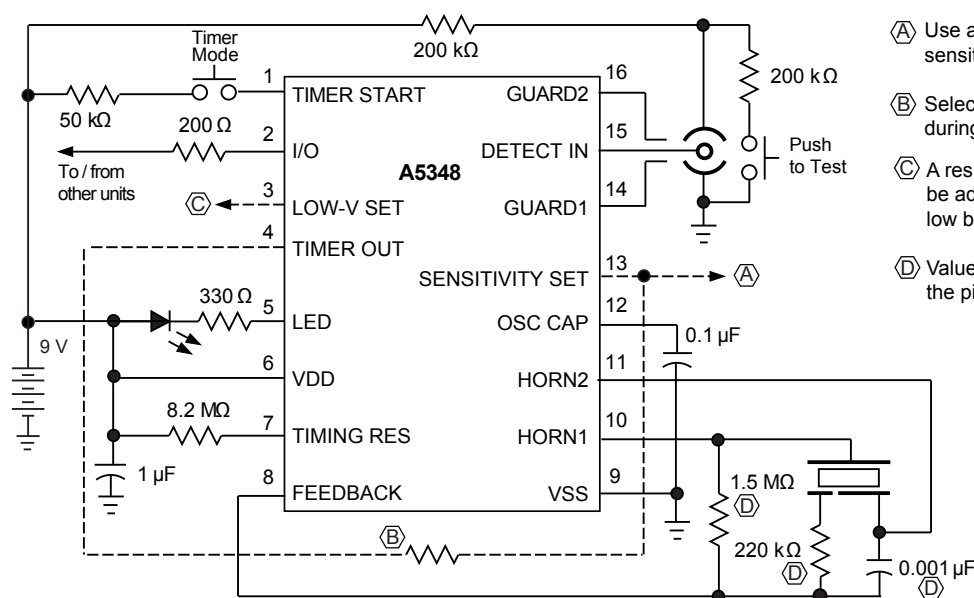
## DESCRIPTION

The A5348 is a low-current, BiCMOS circuit providing all of the required features for an ionization-type smoke detector. A networking capability allows as many as 125 units to be interconnected so that if any unit senses smoke all units will sound their alarm. In addition, special features are incorporated to facilitate alignment and test of the finished smoke detector.

The internal oscillator and timing circuitry keep standby power to a minimum by powering down the device for 1.66 seconds and sensing for smoke for only 10 ms. Every 24 on-off cycles, a check is made for a low battery condition. By substituting other types of sensors or a switch for the ionization detector, this very-low-power device can be used in numerous other battery-operated safety/security applications.

The A5348 is supplied in a low-cost 16-pin dual in-line plastic package (DIP). It is rated for continuous operation over the temperature range of  $-10^{\circ}\text{C}$  to  $60^{\circ}\text{C}$ . The Pb (lead) free version (suffix -T) has 100% matte tin leadframe plating.

## Typical Application



- Ⓐ Use an external resistor to adjust sensitivity for a particular smoke chamber.
- Ⓑ Select resistor to reduce sensitivity during Timer mode.
- Ⓒ A resistor to VSS or VDD may be added to this pin to modify low battery voltage threshold.
- Ⓓ Value of component will vary, based on the piezoelectric horn used.

## Selection Guide

| Part Number | Pb-Free | Packing            |
|-------------|---------|--------------------|
| A5348CA-T   | Yes     | 25 pieces per tube |
| A5348CA     | —       |                    |

## Absolute Maximum Ratings\*

| Characteristic                     | Symbol     | Notes                  | Rating                 | Units |
|------------------------------------|------------|------------------------|------------------------|-------|
| Supply Voltage Range               | $V_{DD}$   | Referenced to $V_{SS}$ | −0.5 to 15             | V     |
| Input Voltage Range                | $V_{IN}$   | Referenced to $V_{SS}$ | −0.3 to $V_{DD} + 0.3$ | V     |
| Reverse Battery Condition Duration | $t_{RBAT}$ | 10.5 V                 | 20                     | s     |
| Input Current                      | $I_{IN}$   |                        | 10                     | mA    |
| Operating Ambient Temperature      | $T_A$      |                        | −10 to 60              | °C    |
| Junction Temperature               | $T_J(max)$ |                        | 150                    | °C    |
| Storage Temperature Range          | $T_{stg}$  |                        | −55 to 125             | °C    |

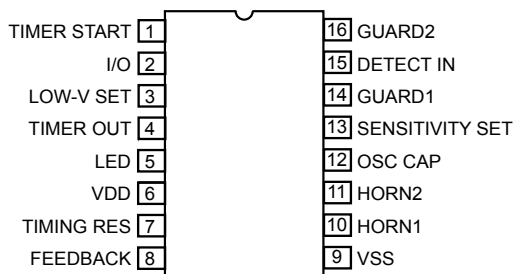
\* CAUTION: BiCMOS devices have input static protection but are susceptible to damage when exposed to extremely high static electrical charges.

## THERMAL CHARACTERISTICS

| Characteristic             | Symbol          | Test Conditions*                    | Value | Units |
|----------------------------|-----------------|-------------------------------------|-------|-------|
| Package Thermal Resistance | $R_{\theta JA}$ | 4-layer PCB based on JEDEC standard | 38    | °C/W  |

\*Additional thermal information available on Allegro website.

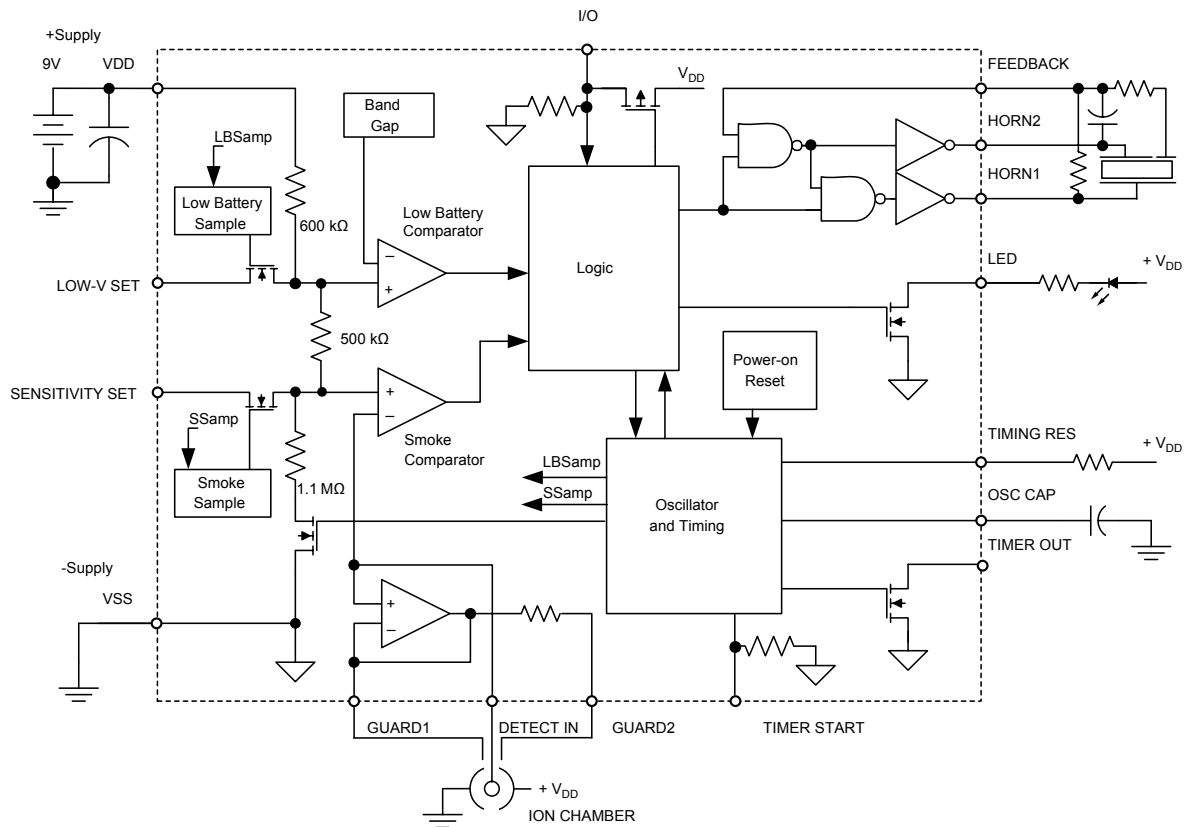
## Pinout Diagram



## Terminal List Table

| Number | Name            | Function                                                                      |
|--------|-----------------|-------------------------------------------------------------------------------|
| 1      | TIMER START     | Input to start reduced sensitivity timer mode                                 |
| 2      | I/O             | Input/output to interconnected detectors                                      |
| 3      | LOW-V SET       | Optionally used with a resistor to adjust low-battery threshold               |
| 4      | TIMER OUT       | Optionally used with a resistor to adjust sensitivity during timer mode       |
| 5      | LED             | Output to drive visible LED                                                   |
| 6      | VDD             | Positive supply voltage                                                       |
| 7      | TIMING RES      | Terminal for timing resistor, sets internal bias (affects timing)             |
| 8      | FEEDBACK        | Input for driving piezoelectric horn                                          |
| 9      | VSS             | Negative supply voltage                                                       |
| 10     | HORN1           | Output for driving piezoelectric horn                                         |
| 11     | HORN2           | Complementary output for driving piezoelectric horn                           |
| 12     | OSC CAP         | Terminal for charging/discharging an external capacitor to run the oscillator |
| 13     | SENSITIVITY SET | Optionally used with a resistor to adjust sensitivity for a specific chamber  |
| 14     | GUARD1          | Active guard 1 for detector input                                             |
| 15     | DETECT IN       | Input from detector chamber                                                   |
| 16     | GUARD2          | Active guard 2 for detector input                                             |

## Functional Block Diagram



**ELECTRICAL CHARACTERISTICS**<sup>1,2</sup> at  $T_A = 25^\circ\text{C}$ ,  $V_{DD} = 9.0\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $C_{OSSCAP} = 0.1\text{ }\mu\text{F}$ ,  
 $R_{TIMINGRES} = 8.2\text{ M}\Omega$  (unless otherwise noted)

| Characteristic             | Symbol           | Test Conditions                                                           | Test Pin | Min.  | Typ.          | Max.           | Units         |
|----------------------------|------------------|---------------------------------------------------------------------------|----------|-------|---------------|----------------|---------------|
| Supply Voltage Range       | $V_{DD}$         | Operating                                                                 | 6        | 6.0   | 9.0           | 12             | V             |
| Supply Current             | $I_{DD}$         | $V_{DD} = 9.0\text{ V}$ , no alarm, no loads                              | 6        | —     | 5.0           | 9.0            | $\mu\text{A}$ |
|                            |                  | $V_{DD} = 12\text{ V}$ , no alarm, no loads                               | 6        | —     | —             | 12             | $\mu\text{A}$ |
| Detector Input Current     | $I_{DETECTIN}$   | 0% to 40% RH, $V_{IN} = 0$ to $9.0\text{ V}$                              | 15       | —     | —             | $\pm 1.0$      | pA            |
| Input Offset Voltage       | $V_{OS(GUARD1)}$ | Active GUARD1                                                             | 14, 15   | —     | —             | $\pm 100$      | mV            |
|                            | $V_{OS(GUARD2)}$ | Active GUARD2                                                             | 16, 15   | —     | —             | $\pm 100$      | mV            |
|                            | $V_{OS}$         | Detect comparator                                                         | 15, 13   | —     | —             | $\pm 50$       | mV            |
| Hysteresis                 | $V_{HYS}$        | No alarm to alarm                                                         | 13       | 90    | 130           | 170            | mV            |
| Common Mode Range          | $V_{CM(guard)}$  | Guard amplifier                                                           | 14, 15   | 2.0   | —             | $V_{DD} - 0.5$ | V             |
|                            | $V_{CM}$         | Smoke comparator                                                          | 13, 15   | 0.5   | —             | $V_{DD} - 2.0$ | V             |
| Active Guard Impedance     | $Z_{AG1}$        | GUARD1 to VSS                                                             | 14       | —     | 10            | —              | k $\Omega$    |
|                            | $Z_{AG2}$        | GUARD2 to VSS                                                             | 16       | —     | 500           | —              | k $\Omega$    |
| Oscillator Period          | $t_{osc}$        | No alarm                                                                  | 12       | 1.34  | 1.67          | 2.00           | s             |
|                            | $t_{osc(alarm)}$ | Local or remote alarm                                                     | 12       | 37.50 | 41.67         | 45.84          | ms            |
| Oscillator Pulse Width     | $t_{w(osc)}$     |                                                                           | 12       | 8.0   | 10            | 12             | ms            |
| Timer Mode Duration        | $t_{timer}$      | After TIMER START high-to-low, no smoke                                   | 4        | 8.0   | 10            | 12             | min           |
| Low-Battery Threshold      | $V_{DD(th)}$     | $T_A = 0^\circ\text{C}$ to $50^\circ\text{C}$ ,<br>LOW-V SET open circuit | 6        | 7.2   | —             | 7.8            | V             |
| Sensitivity Adjust Voltage | $V_{SET}$        | $V_{SENSITIVITYSET} / V_{DD}$ ,<br>SENSITIVITY SET open circuit           | 13       | 48.5  | 50            | 51.5           | % $V_{DD}$    |
| Horn Output Voltage        | $V_{OL}$         | $I_{OUT} = 16\text{ mA}$ , $V_{DD} = 9.0\text{ V}$                        | 10, 11   | —     | 0.1           | 0.5            | V             |
|                            |                  | $I_{OUT} = 16\text{ mA}$ , $V_{DD} = 7.2\text{ V}$                        | 10, 11   | —     | —             | 0.9            | V             |
|                            | $V_{OH}$         | $I_{OUT} = -16\text{ mA}$ , $V_{DD} = 9.0\text{ V}$                       | 10, 11   | 8.5   | 8.8           | —              | V             |
|                            |                  | $I_{OUT} = -16\text{ mA}$ , $V_{DD} = 7.2\text{ V}$                       | 10, 11   | 6.3   | —             | —              | V             |
| Horn Output On-Time        | $t_{on(horn)}$   | Local or remote alarm                                                     | 10, 11   | 120   | 160           | 208            | ms            |
|                            | $t_{w(horn)}$    | Low battery                                                               | 10, 11   | 8     | 10            | 12             | ms            |
| Horn Output Off-Time       | $t_{off(horn)}$  | Local or remote alarm                                                     | 10, 11   | 60    | 80            | 104            | ms            |
|                            | $t_{horn}$       | Low battery                                                               | 10, 11   | 32    | 40            | 48             | s             |
| TIMER START Logic Levels   | $V_{IH}$         |                                                                           | 1        | 3.5   | —             | —              | V             |
|                            | $V_{IL}$         |                                                                           | 1        | —     | —             | 1.5            | V             |
| TIMER START Input Current  | $I_{IN}$         | $V_{TIMERSTART} = 9.0\text{ V}$                                           | 1        | 20    | —             | 80             | $\mu\text{A}$ |
| TIMER OUT Pulldown Current | $I_{PD}$         | $V_{TIMEROUT} = 0.5\text{ V}$                                             | 4        | 500   | —             | —              | $\mu\text{A}$ |
| LED Output-On Current      | $I_{LED}$        | $V_{DD} = 7.2\text{ V}$ , $V_{LED} = 1.0\text{ V}$                        | 5        | 10    | —             | —              | mA            |
| LED Output On-Time         | $t_{w(LED)}$     |                                                                           | 5        | 8.0   | 10            | 12             | ms            |
| LED Output Off-Time        | $t_{LED1}$       | No alarm, in standby                                                      | 5        | 32    | 40            | 48             | s             |
|                            | $t_{LED2}$       | No alarm, timer mode                                                      | 5        | 8.0   | 10            | 12             | s             |
|                            | $t_{LED3}$       | Local alarm or test alarm                                                 | 5        | 0.76  | 0.97          | 1.14           | s             |
|                            | $t_{LED4}$       | Remote alarm, no local smoke                                              | 5        | —     | No LED pulses | —              | s             |

Continued on the next page...

**ELECTRICAL CHARACTERISTICS**<sup>1,2</sup> (continued) at  $T_A = 25^\circ\text{C}$ ,  $V_{DD} = 9.0\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $C_{OSCCAP} = 0.1\text{ }\mu\text{F}$ ,  $R_{TIMINGRES} = 8.2\text{ M}\Omega$  (unless otherwise noted)

| Characteristic    | Symbol        | Test Conditions                                | Test Pin | Min. | Typ. | Max. | Units         |
|-------------------|---------------|------------------------------------------------|----------|------|------|------|---------------|
| I/O Current       | $I_{IOL}$     | No alarm, $V_{I/O} = V_{DD} - 2.0\text{ V}$    | 2        | 25   | —    | 60   | $\mu\text{A}$ |
|                   | $I_{IOH}$     | Local alarm, $V_{I/O} = V_{DD} - 2.0\text{ V}$ | 2        | -7.5 | —    | —    | mA            |
| I/O Alarm Voltage | $V_{IH(I/O)}$ | External “alarm” in                            | 2        | 3.0  | —    | —    | V             |
| I/O Delay         | $t_{r(I/O)}$  | Local or test alarm to I/O active              | 2        | —    | 3.0  | —    | s             |

<sup>1</sup>Negative current is defined as coming out of the specified device pin (sourcing).

<sup>2</sup>Alarm (smoke) condition is defined as  $V_{DETECTIN} < V_{SENSITIVITYSET}$ ; no alarm (no smoke) condition is defined as  $V_{DETECTIN} > V_{SENSITIVITYSET}$ .

## Circuit Description

The A5348 is a low-current, BiCMOS circuit providing all of the required features for an ionization-type smoke detector.

### Oscillator

An internal oscillator operates with a period of 1.67 seconds during no-smoke conditions. Every 1.67 seconds, internal power is applied to the entire circuit for 10 ms and a check is made for smoke. Every 24 clock cycles (approximately 40 seconds), the LED pin is pulsed, and a check is made for low battery by comparing  $V_{DD}$  to an internal reference. Because very-low currents are used in the device, the oscillator capacitor at the OSC CAP pin should be a low-leakage type (PTFE, polystyrene, or polypropylene).

### Detector Circuitry

When the voltage on the DETECT IN pin is less than the voltage on the SENSITIVITY SET pin, the A5348 evaluates this as a *smoke condition*. During a smoke condition, the resistor divider network that sets the sensitivity (also referred to as the *smoke trip point*) is altered to increase  $V_{SENSITIVITYSET}$  by 130 mV typical (with no external connections on the SENSITIVITY SET pin). This provides hysteresis and reduces false triggering.

An active guard is provided on GUARD1 and GUARD2, the two pins adjacent to the detector input, the DETECT IN pin.  $V_{GUARD1}$  and  $V_{GUARD2}$  will be within 100 mV of  $V_{DETECTIN}$ . This will keep surface leakage currents to a minimum and provide a method of measuring the input voltage without loading the ionization chamber. The active guard amplifier is not power strobed and thus provides constant protection from surface leakage

currents. The detector input has internal diode protection against electrostatic damage.

### Alarm Circuitry

If smoke is detected, the oscillator period changes to 40 ms and the horn is enabled. The horn output is typically 160 ms on, 80 ms off. During the off-time, smoke is checked, and further alarm output will be inhibited if smoke is not sensed. During a smoke condition, the low-battery alarm is inhibited, and the LED is pulsed approximately once every second.

### Sensitivity Adjust

The detector sensitivity to smoke is set internally by a voltage divider connected between VDD and VSS. The sensitivity can, however, be externally adjusted to the individual characteristics of the ionization chamber by connecting a resistor between the SENSITIVITY SET pin and either the VDD or VSS pins.

With no external connections on the SENSITIVITY SET pin, while the A5348 is checking for smoke:

$$V_{SENSITIVITYSET} = V_{DD} / 2$$

To increase sensitivity, a resistor can be connected between SENSITIVITY SET and VDD, with the value:

$$R_{SENSITIVITYSET} = 1.1\text{E}6 \times K / (1 - K)$$

where

$$K = V_{DD} / V_{SENSITIVITYSET} - 1$$

To decrease sensitivity, a resistor can be connected between

SENSITIVITY SET and VSS, with the value:

$$R_{\text{SENSITIVITYSET}} = 1.1\text{E}6 \times K / (1 - K) ,$$

where

$$K = 1 / (V_{\text{DD}} / V_{\text{SENSITIVITYSET}} - 1) .$$

### Low Battery

The low battery condition threshold is set internally by a voltage divider connected between VDD and VSS. The threshold can be externally adjusted by connecting a resistor between the LOW-V SET pin and either the VDD or VSS pins.

To increase the threshold, a resistor can be connected between LOW-V SET and VSS. Given an initial threshold,  $V_{(\text{th})\text{init}}$  (nominally 7.5 V), and a target threshold,  $V_{(\text{th})\text{set}}$ , the resistor should have the value:

$$R_{\text{LOWVSET}} = 600\text{E}3 \times K / (1 - 0.375 \times K) ,$$

where

$$K = 1 / (V_{(\text{th})\text{set}} / [0.727 \times V_{(\text{th})\text{init}}] - 1) .$$

To decrease the threshold, a resistor can be connected between LOW-V SET and VDD. Given an initial threshold,  $V_{(\text{th})\text{init}}$  (nominally 7.5 V), and a target threshold,  $V_{(\text{th})\text{set}}$ , the resistor should have the value:

$$R_{\text{LOWVSET}} = 960\text{E}3 \times K / (0.6 - 1.6 \times K) ,$$

where

$$K = V_{(\text{th})\text{set}} / (0.727 \times V_{(\text{th})\text{init}}) - 1 .$$

The battery voltage level is checked approximately every 40 seconds during the (approximately) 10 mA, 10 ms LED pulse. If an LED is not used, it should be replaced with an equivalent resistor (typically 500 to 1000  $\Omega$ ) such that the battery loading remains about 10 mA.

### Timer (Hush) Mode

An internal timer is provided that can be used in various configurations to allow a period of reduced smoke detector sensitivity, referred to as Timer (or Hush) mode.

In normal operation, when a high-to-low transition occurs at the TIMER START pin, the internal timer is reset, Timer mode is enabled, and the circuit resets to a no-alarm condition. During Timer mode, which is active for approximately 10.25 minutes (368 clock cycles), the TIMER OUT pin is pulled down to VSS every time the A5348 makes a check for smoke. A resistor connected between the TIMER OUT and the SENSITIVITY SET

pins will decrease the detector's sensitivity to smoke during this time and allow the user to hush alarms caused by nuisance smoke or steam (such as from cooking). At the end of Timer mode, the device signals its completion with two 10-ms horn chirps, 1.67 seconds apart.

While the Timer mode is active, the LED flashes once every (approximately) 10 seconds. If the level of smoke increases such that the reduced-sensitivity level is reached, the A5348 will signal an Alarm condition. If such an Alarm condition does occur, the timer will still continue to completion of its cycle. If Timer mode will not be used, the TIMER START pin can be tied to VSS or left open.

### I/O

A connection to the I/O pin allows multiple smoke detectors to be interconnected. If any single unit detects smoke, its I/O pin is driven high (after a nominal 3 s delay), and all connected units will sound their associated horns. When the I/O pin is driven high by another device, the oscillator immediately speeds up to its 41.7 ms period. The remainder of the sped-up clock cycle, and two additional consecutive clock cycles with I/O high are required to cause an alarm. If the I/O pin falls below its threshold at any time during those (approximately) 83.4 ms, an internal latch is reset and there will not be an alarm. Thus, the I/O must remain high for (approximately) 93.9 ms in order to cause an alarm. This filtering provides significant immunity to I/O noise.

The LED is suppressed when an alarm is signaled from an interconnected unit, and any local alarm condition causes the I/O pin to be ignored as an input. When in Timer mode, the device will still signal an alarm if I/O is driven high externally. This pin has an on-chip pulldown device and must be left unconnected if not used.

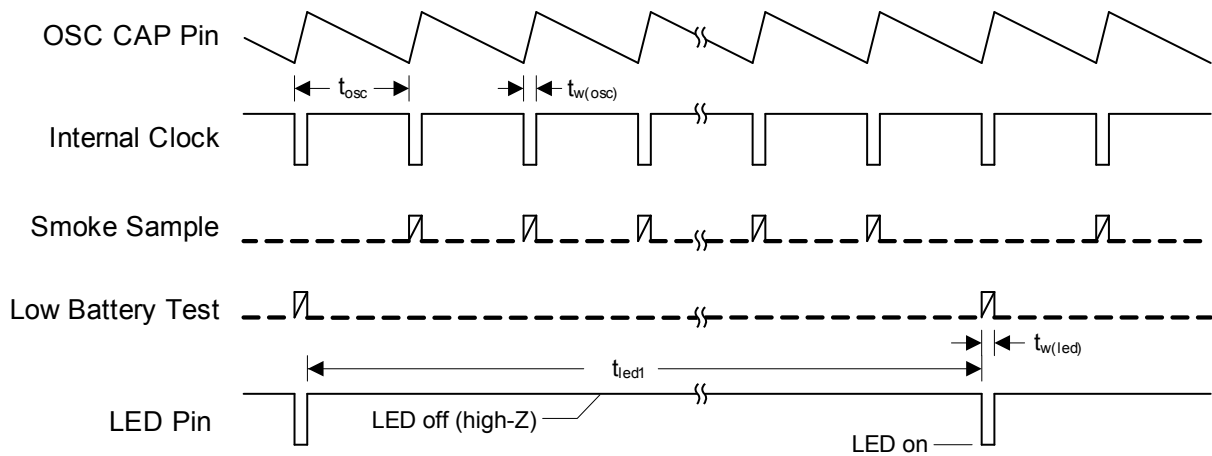
### Testing

On power-up, all internal counters are reset. Internal test circuitry allows low battery check by holding the FEEDBACK and OSC CAP pins low during power-up, then reducing  $V_{\text{DD}}$  and monitoring the HORN1 pin. HORN1 will be driven high when  $V_{\text{DD}}$  falls below the low-battery threshold. All functional tests can be accelerated by driving the OSC CAP pin with a 2 kHz square wave. The 10 ms strobe period must be maintained for proper operation of the comparator circuitry.

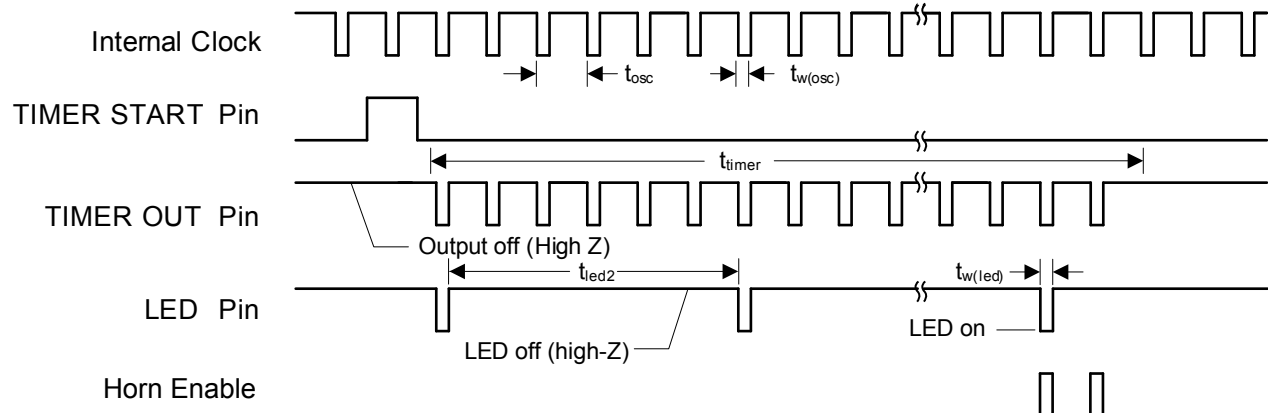
### Timing Diagrams (Not to scale)

▮ Test event

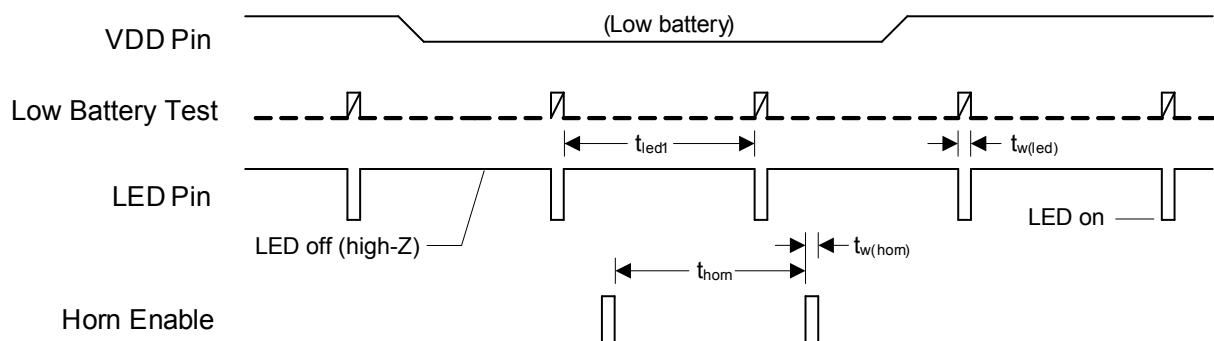
#### Standby Mode



#### Timer Mode

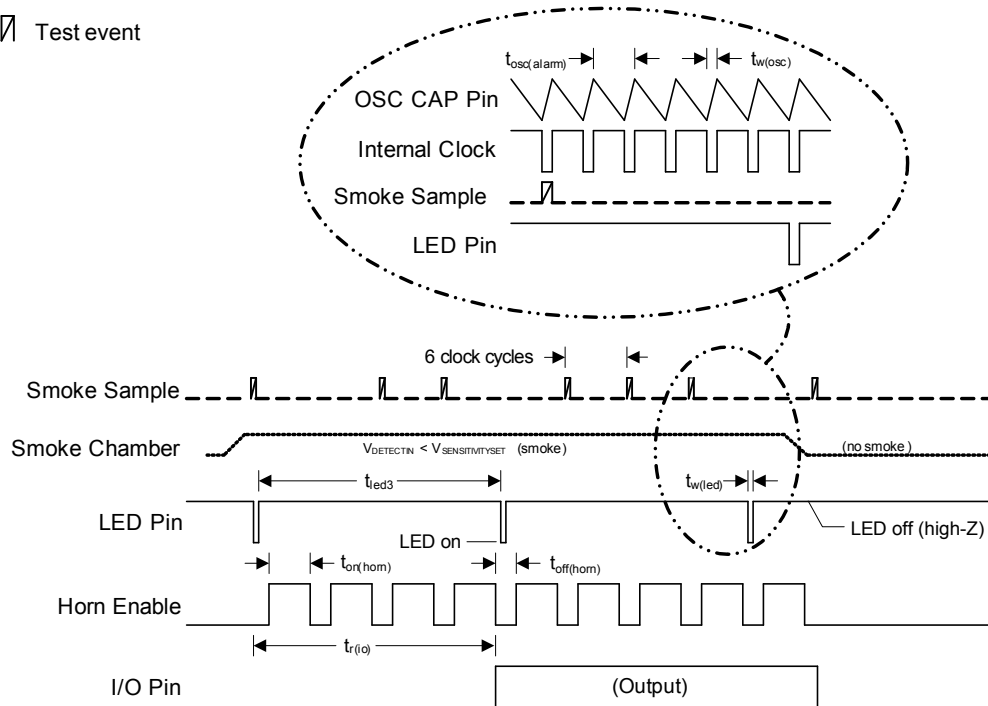


#### Low Battery Condition

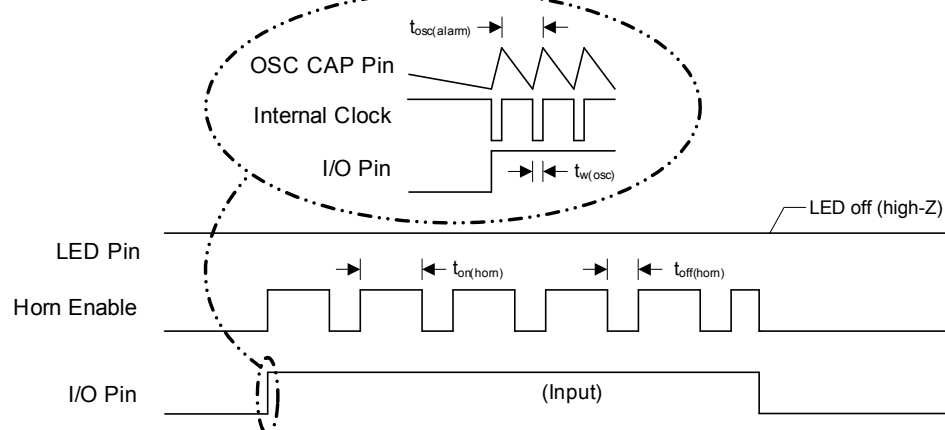


## Local Smoke Detection/Test Alarm Condition

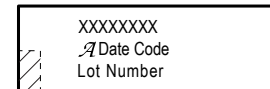
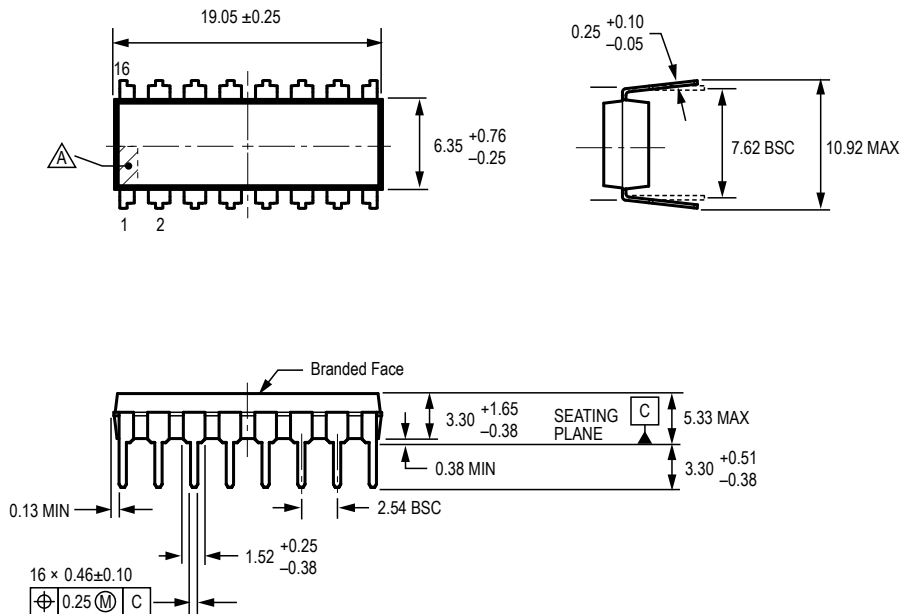
Test event



## Remote Alarm Condition

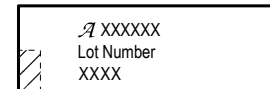


## Package A, 16-Pin DIP



**A** Standard Branding Reference View 1

Line 1: Part Number  
Line 2: Logo A, 4-Digit Date Code  
Line 3: Assembly Lot Number



**B** Standard Branding Reference View 2

Line 1: Logo A, Part Number  
Line 2: First 8 Characters of Assembly Lot Number  
Line 3: Country of Origin

**A** Terminal #1 mark area

**B** Branding scale and appearance at supplier discretion

For Reference Only; not for tooling use  
(reference Allegro DWG-0000370 or JEDEC MS-001BB)  
Dimensions in millimeters  
Dimensions exclusive of mold flash, gate burrs, and dambar protrusions  
Exact case and lead configuration at supplier discretion within limits shown

**Revision History**

| Number | Date            | Description                                |
|--------|-----------------|--------------------------------------------|
| 5      | July 10, 2020   | Minor editorial updates                    |
| 6      | July 12, 2021   | Updated Package Outline Drawing (page 9)   |
| 7      | October 1, 2022 | Changed product status: Not for new design |
| 8      | May 17, 2023    | Changed product status: Discontinued       |

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