# A5364

# *Ionization Smoke Detector with Interconnect*

## 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
- Built-in hysteresis reduces false triggering
- Temporal horn pattern, per UL217, NFPA72, and ISO8201
- UL Recognized for UL217 applications, per file # S2113

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



*Not to scale*

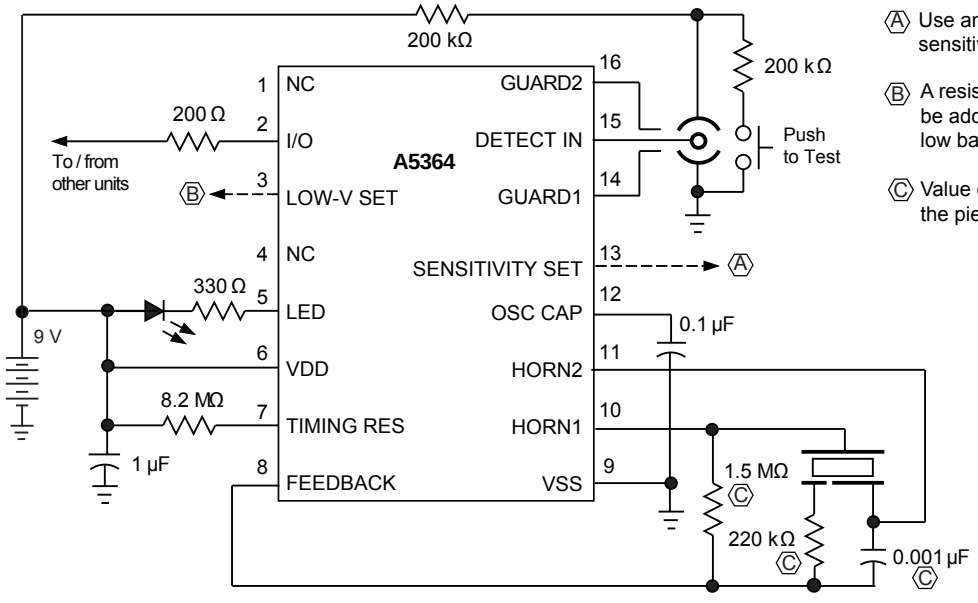
## Description

The A5364 is a low-current, CMOS 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 device is Recognized by Underwriters Laboratories for use in smoke alarms that comply with Standard UL217.

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 A5364 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 0°C to 50°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.

Ⓑ 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 |
|---|---|---|
| A5364CA-T | Yes | 25 pieces per tube |
| A5364CA | – | |

### 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 | $T_A$ | | 0 to 50 | ºC |
| Junction Temperature | $T_J$(max) | | 150 | ºC |
| Storage Temperature Range | $T_{stg}$ | | –55 to 125 | ºC |

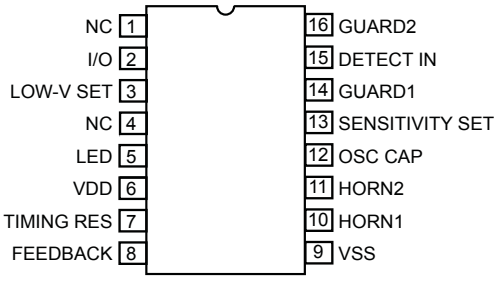
* CAUTION: CMOS devices have input static protection but are susceptible to damage when exposed to extremely high static electrical charges.

### THERMAL CHARACTERISTICS

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

*Additional thermal information available on Allegro website.

### Pin-out Diagram




### Terminal List Table

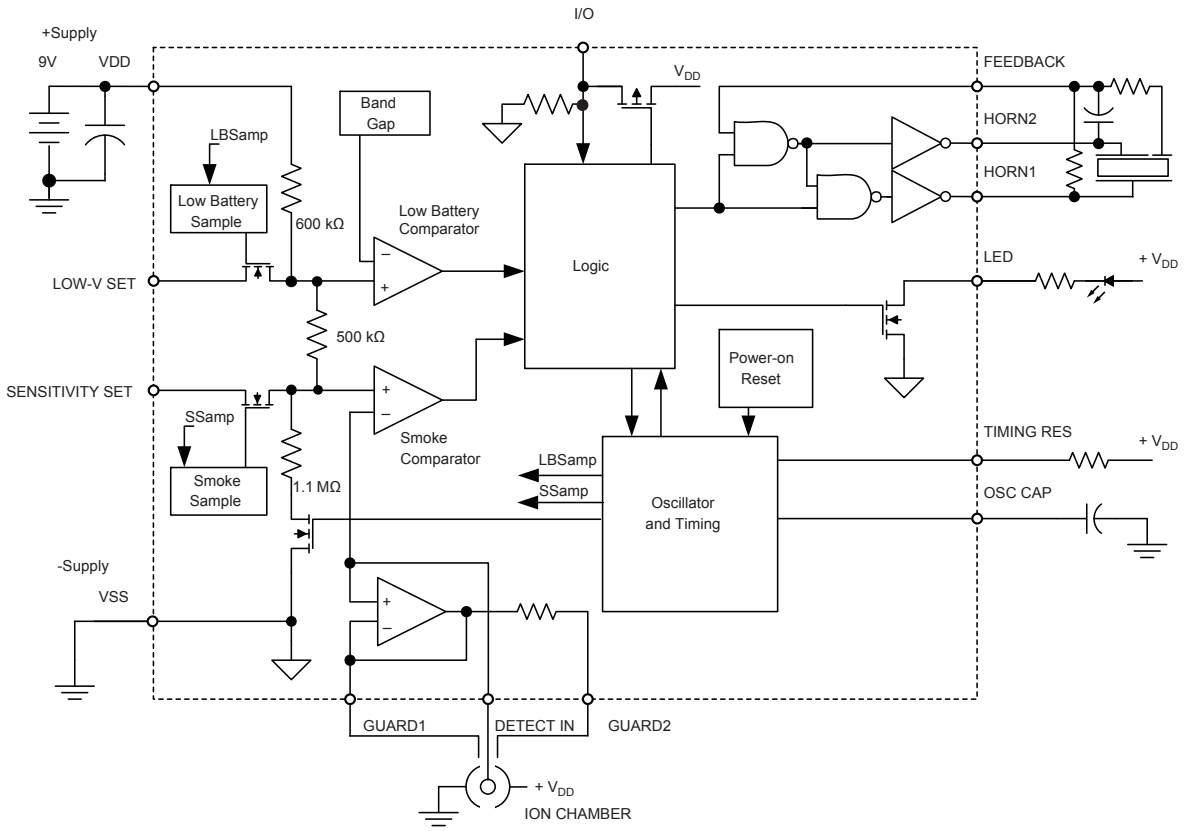
| Number | Name | Function |
|---|---|---|
| 1 | NC | No connection |
| 2 | I/O | Input/output to interconnected detectors |
| 3 | LOW-V SET | Optionally used with a resistor to adjust low-battery threshold |
| 4 | NC | No connection |
| 5 | LED | Output to drive visible LED |
| 6 | VDD | Positive supply 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 |



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## Functional Block Diagram



**ELECTRICAL CHARACTERISTICS**[1,2] at $T_A$ = 25°C, $V_{DD}$ = 9.0 V, $V_{SS}$ = 0 V, $C_{OSCCAP}$ = 0.1 µF, $R_{TIMINGRES}$ = 8.2 MΩ (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 V, no alarm, no loads | 6 | — | 5.0 | 9.0 | µA |
| | | $V_{DD}$ = 12 V, no alarm, no loads | 6 | — | — | 12 | µA |
| Detector Input Current | $I_{DETECTIN}$ | 0% to 40% RH, $V_{IN}$ = 0 to 9.0 V | 15 | — | — | ±1.0 | pA |
| Input Offset Voltage | $V_{OS(GUARD1)}$ | Active GUARD1 | 14, 15 | — | — | ±100 | mV |
| | $V_{OS(GUARD2)}$ | Active GUARD2 | 16, 15 | — | — | ±100 | mV |
| | $V_{OS}$ | Detect comparator | 15, 13 | — | — | ±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 | — | kΩ |
| | $Z_{AG2}$ | GUARD2 to VSS | 16 | — | 500 | — | kΩ |
| Oscillator Period | $t_{osc}$ | No alarm | 12 | 1.34 | 1.67 | 2.00 | s |
| | $t_{osc(alarm)}$ | Local or remote alarm | 12 | 32 | 40 | 48 | ms |
| Oscillator Pulse Width | $t_{w(osc)}$ | | 12 | 8.0 | 10 | 12 | ms |
| Low-Battery Threshold | $V_{DD(th)}$ | $T_A$ = 0°C to 50°C, LOW-V SET open circuit | 6 | 7.2 | — | 7.8 | V |
| Sensitivity Adjust Voltage | $V_{SET}$ | $V_{SENSITIVITYSET}$ / $V_{DD}$, SENSITIVITY SET open circuit | 13 | 48.5 | 50 | 51.5 | %$V_{DD}$ |
| Horn Output Voltage | $V_{OL}$ | $I_{OUT}$ = 16 mA, $V_{DD}$ = 9.0 V | 10, 11 | — | 0.1 | 0.5 | V |
| | | $I_{OUT}$ = 16 mA, $V_{DD}$ = 7.2 V | 10, 11 | — | — | 0.9 | V |
| | $V_{OH}$ | $I_{OUT}$ = –16 mA, $V_{DD}$ = 9.0 V | 10, 11 | 8.5 | 8.8 | — | V |
| | | $I_{OUT}$ = –16 mA, $V_{DD}$ = 7.2 V | 10, 11 | 6.3 | — | — | V |
| Horn Output On-Time | $t_{on(horn)}$ | Local or remote alarm | 10,11 | 450 | 500 | 550 | ms |
| | $t_{w(horn)}$ | Low battery | 10, 11 | 8.0 | 10 | 12 | ms |
| Horn Output Off-Time | $t_{off1(horn)}$ | Local or remote alarm (see Timing Diagrams section) | 10, 11 | 450 | 500 | 550 | ms |
| | $t_{off2(horn)}$ | Local or remote alarm (see Timing Diagrams section) | 10, 11 | 1350 | 1500 | 1650 | ms |
| | $t_{horn}$ | Low battery | 10, 11 | 32 | 40 | 48 | s |
| LED Output-On Current | $I_{LED}$ | $V_{DD}$ = 7.2 V, $V_{LED}$ = 1.0 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 |
| | $t_{LED3}$ | 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**[1,2] (continued) at $T_A$ = 25°C, $V_{DD}$ = 9.0 V, $V_{SS}$ = 0 V, $C_{OSCCAP}$ = 0.1 µF, $R_{TIMINGRES}$ = 8.2 MΩ (unless otherwise noted)

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

[1]Negative current is defined as coming out of the specified device pin (sourcing).
[2]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 A5364 is a low-current, CMOS 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 A5364 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 follows a temporal horn pattern of nominally: 0.5 s on, 0.5 s off, 0.5 s on, 0.5 s, 0.5 s on, 1.5 s 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 A5364 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:

$$R_{SENSITIVITYSET} = 1.1E6 \times K / (1 - K) \ ,$$

where

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

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

$$R_{SENSITIVITYSET} = 1.1E6 \times K / (1 - K) \ ,$$

where

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

### 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, $V_{(th)init}$ (nominally 7.5 V), and a target threshold, $V_{(th)set}$, the resistor should have the value:

$$R_{LOWVSET} = 600E3 \times K / (1 - 0.375 \times K) \ ,$$

where

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

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

$$R_{LOWVSET} = 960E3 \times K / (0.6 - 1.6 \times K) \ ,$$

where

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

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 Ω) such that the battery loading remains about 10 mA.

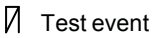
### I/O

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. 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. This pin has an on-chip pulldown device and must be left unconnected if not used.

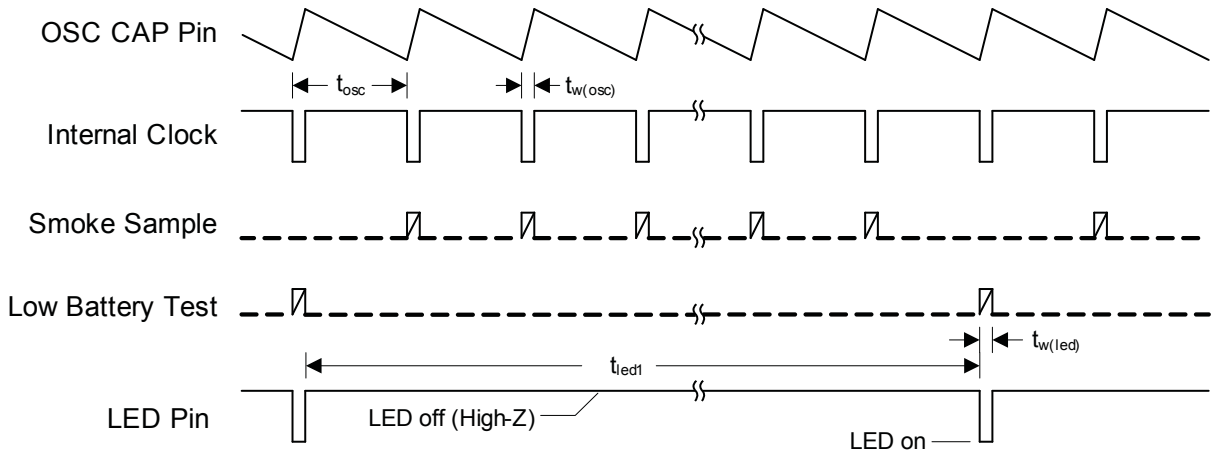
### Testing

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 $V_{DD}$ and monitoring the HORN1 pin. HORN1 will be driven high when $V_{DD}$ 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.

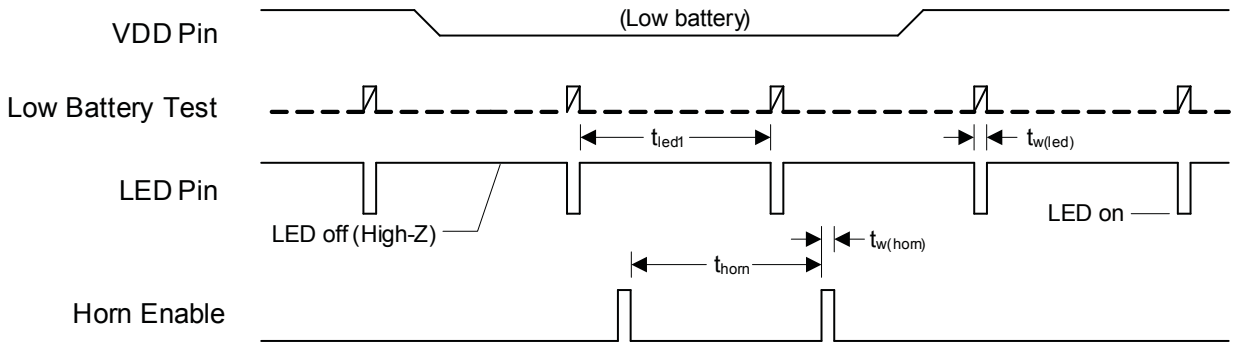
## Timing Diagrams
**(Not to scale)**



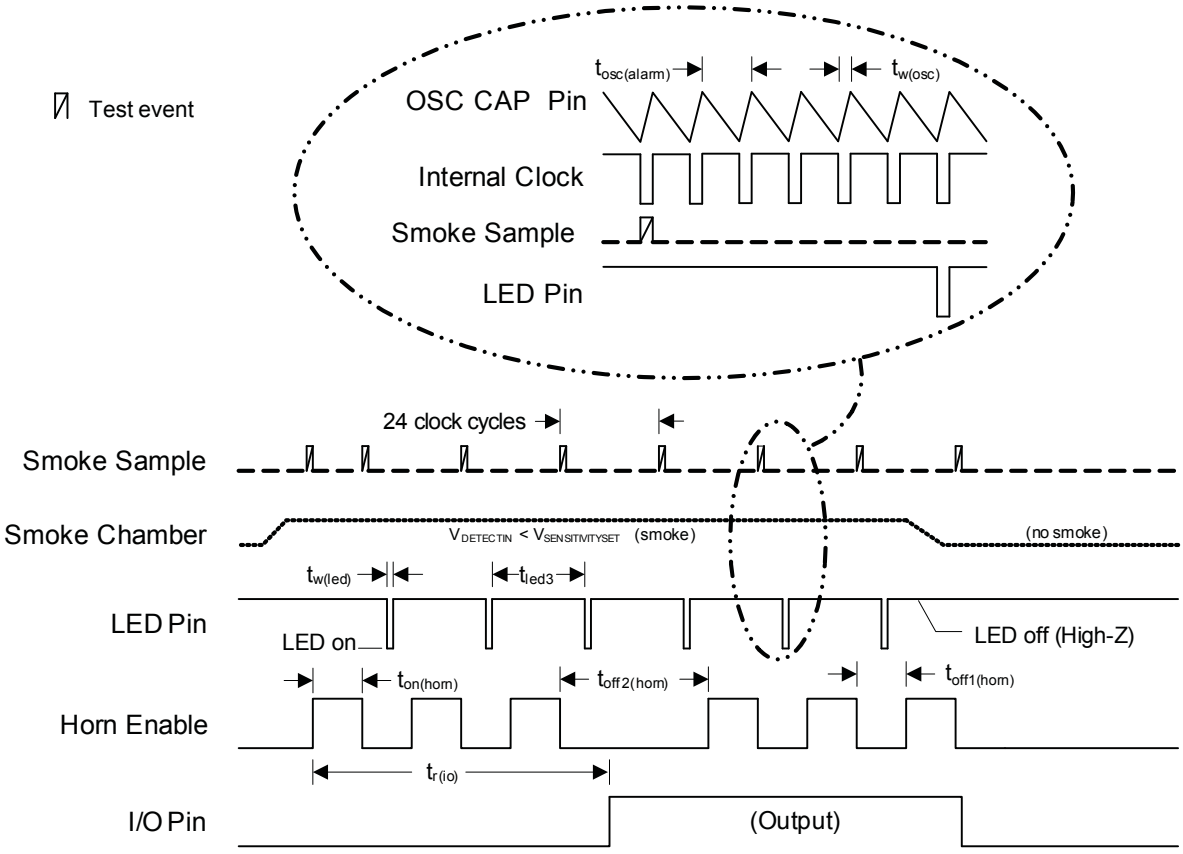

### Standby Mode



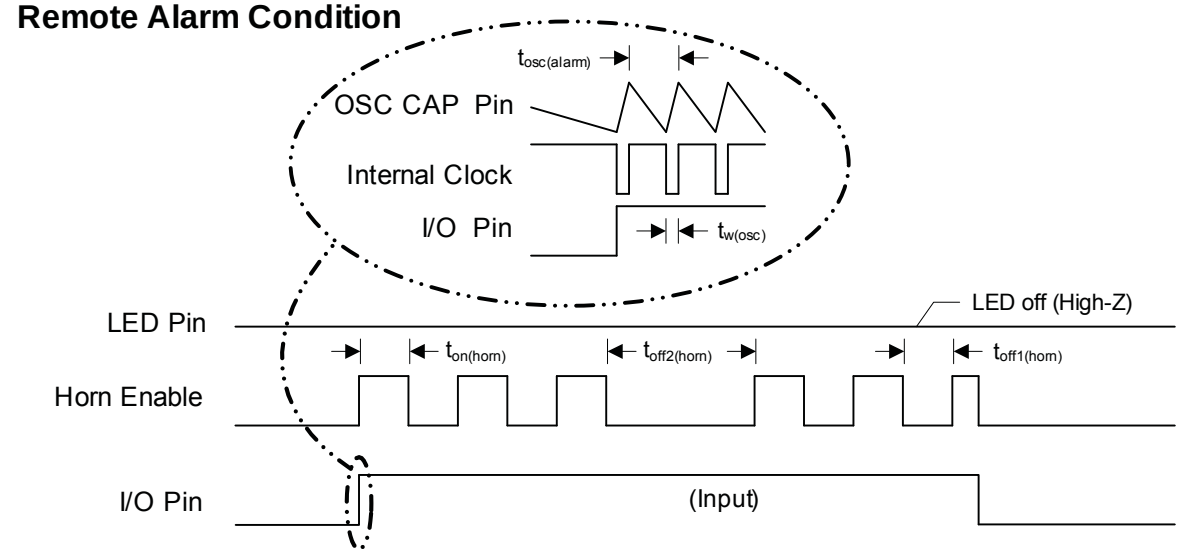

### Low Battery Condition



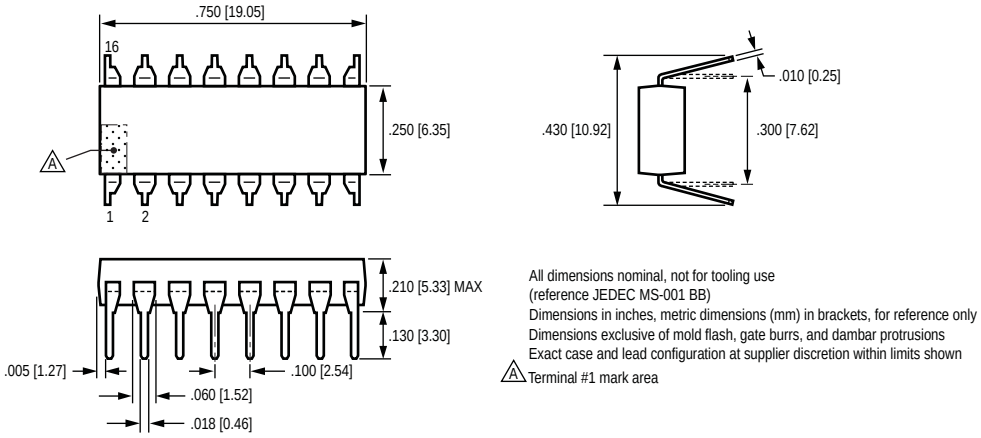
## Local Smoke Detection/Test Alarm Condition




## Remote Alarm Condition



## Package A, 16-Pin DIP




Allegro MicroSystems offers an industry-leading range of ionization and photoelectric smoke detector ICs. For a current listing, please visit our website at:

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