A5358

Photoelectric Smoke Detector With Interconnect and Timer

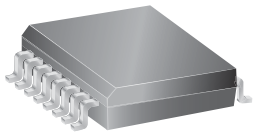
Features and Benefits

- Interconnect up to 50 detectors
- Piezoelectric horn driver
- All internal low-battery detection
- Power-on reset (POR)
- Internal timer and control for reduced sensitivity
- Built-in circuits to reduce false triggering
- 6 to 12 V operating voltage range
- ESD-protection circuitry on all pins

Packages:

Package A 16-pin DIP

Package LW 16-pin SOICW



Not to scale

Description

The A5358 is a low-current BiCMOS circuit 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. Special features are incorporated in the design to facilitate calibration and testing of the finished detector. The device is designed for applications that comply with European Standard EN 14604 and British Standard BS 5446, Part 1.

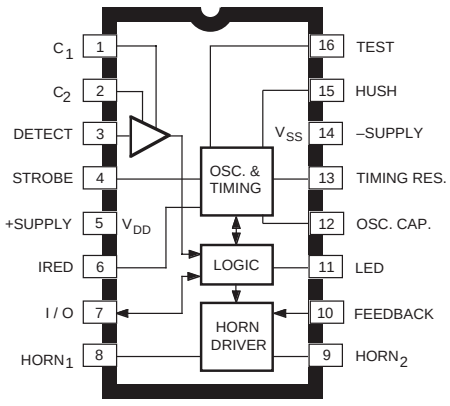
A variable-gain photoamplifier can be directly interfaced to an infrared emitter-detector pair. The amplifier gain levels are determined by two external capacitors that are then internally selected depending on the operating mode. Low gain is selected during standby and timer modes. During a local alarm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

The internal oscillator and timing circuitry keeps standby power to a minimum by sensing for smoke every 10 seconds in a 10 µs window. A special three-stage speedup sensing scheme is incorporated to minimize the time to an audible alarm and also to reduce false triggering. Also, two consecutive cycles of degraded chamber sensitivity are required for a warning signal to occur.

The A5358 is supplied in a low-cost 16-pin dual in-line plastic package (suffix A), and for surface mount, a 16-pin SOICW (suffix LW). The lead (Pb) free versions (suffix –T), have 100 % matte-tin leadframe plating. The devices are rated for continuous operation over the temperature range of –25°C to 75°C.

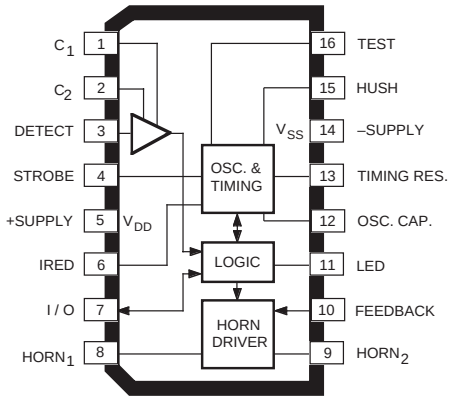
Pin-out Diagrams

Package A



Dwg. PC-007

Package LW



SELECTION GUIDE

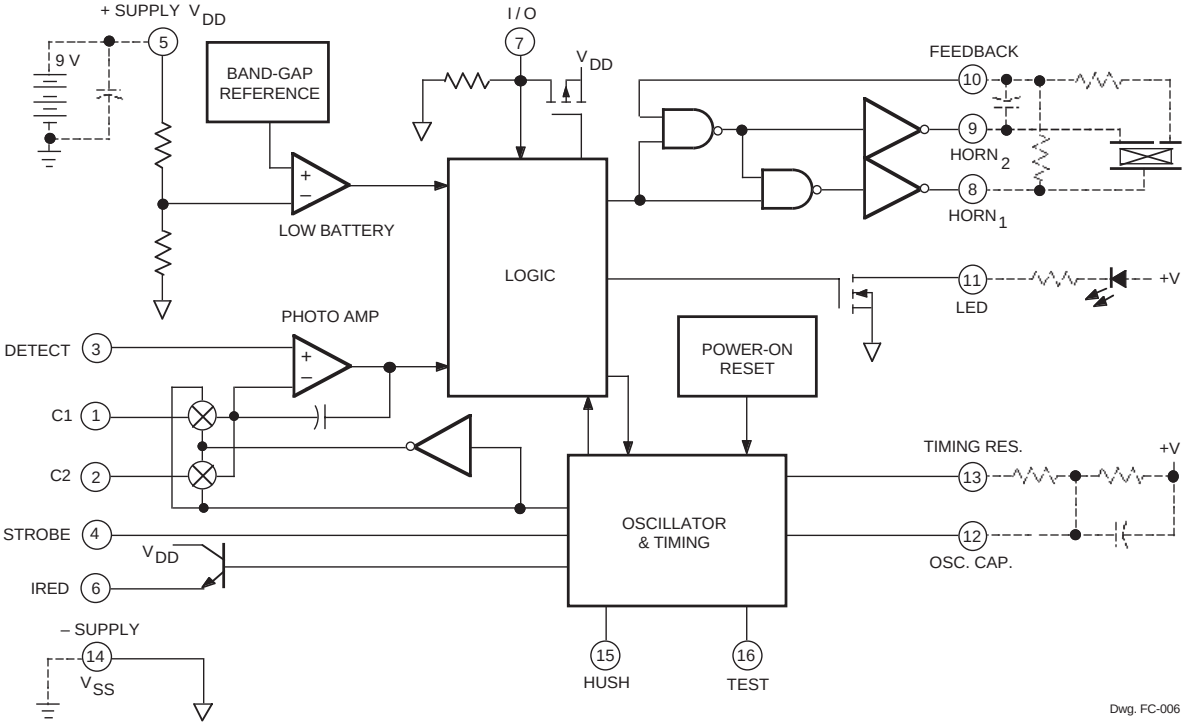
Part Number	Pb-free	Package	Packing
A5358CA	–	16-pin DIP through hole	25 pieces / tube
A5358CA-T	Yes	16-pin DIP through hole	25 pieces / tube
A5358CLWTR-T	Yes	16-pin SOICW surface mount	1000 pieces / reel

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
Input Current	I_{IN}		10	mA
Operating Ambient Temperature Range	T_A	Range C	–25 to 75	ºC
Maximum 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 if exposed to extremely high static electrical charges.

FUNCTIONAL BLOCK DIAGRAM



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DC ELECTRICAL CHARACTERISTICS at T_A = -25°C to +75°C*, V_{SS} = 0 V, in typical application (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Test Pin	V_{DD}	Limits			
					Min.	Typ.	Max.	Units
Supply Voltage Range	V_{DD}		5	–	6.0	–	12	V
Operating Supply Current	I_{DD}	Average Standby Configured per Figure 1	5	12	–	–	12	µA
		During Strobe ON, I_{RED} OFF, Configured per Figure 1	5	12	–	–	2.0	mA
		During Strobe ON, I_{RED} ON, Configured per Figure 1	5	12	–	–	3.0	mA
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}	$V_{IN} = V_{DD}$, Strobe Active, Pin 12 @ V_{DD}	1, 2	12	–	–	100	nA
		$V_{IN} = V_{DD}$	3, 10, 12	12	–	–	100	nA
Input Leakage Low	I_{IL}	$V_{IN} = V_{ST}$, Strobe Active, Pin 12 @ V_{DD}	1, 2, 3	12	–	–	-100	nA
		$V_{IN} = V_{SS}$	10, 12	12	–	–	-100	nA
			15, 16	12	–	–	-1.0	µA
Input Pull-Down Current	I_{IN}	$V_{IN} = V_{DD}$	16, 15	9	0.25	–	10	µA
		No Local Smoke, $V_{IN} = V_{DD}$	7	9	20	–	80	µA
		No Local Smoke, V_{IN} = 17 V	7	12	–	–	140	µA
Low-Level Output Voltage	V_{OL}	I_O = 10 mA	11	6.5	–	–	0.6	V
		I_O = 16 mA	8, 9	6.5	–	–	1.0	V
		I_O = 5 mA	13	6.5	–	0.5	–	V
High-Level Output Voltage	V_{OH}	I_O= -16 mA	8, 9	6.5	5.5	–	–	V
Strobe Output Voltage	V_{ST}	Inactive I_O = -1 µA	4	12	V_{DD} - 0.1	–	–	V
		Active, I_O = 100 µA to 500 µA	4	9	V_{DD} - 5.25	–	V_{DD} - 4.75	V

Continued...

DC ELECTRICAL CHARACTERISTICS (continued) at T_A = -25°C to +75°C*, V_{SS} = 0 V, in typical application (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Test Pin	V_{DD}	Limits			
					Min.	Typ.	Max.	Units
Line Regulation	$\Delta V_{ST(\Delta VDD)}$	Active, V_{DD} = 6 V to 12 V	4	–	–	-60	–	dB
Strobe Temperature Coeff.	α_{ST}	V_{DD} = 6 V to 12 V	4	–	–	0.01	–	%/°C
I_{RED} Output Voltage	V_{IRED}	Inactive I_O = 1 µA, T_A = +25°C	6	12	–	–	0.1	V
		Active I_O = -6 mA, T_A = +25°C	6	9	2.85	3.1	3.35	V
Line Regulation	$\Delta V_{IRED(\Delta VDD)}$	Active, V_{DD} = 6 V to 12 V	6		–	-35	–	dB
I_{RED} Temperature Coefficient	α_{IRED}	V_{DD} = 6 V to 12 V	6	–	–	+0.40	–	%/°C
High-Level Output Current	I_{OH}	V_{DD} = Alarm, I/O active, $V_O = V_{DD}$ - 2 V	7	9	-4.0	–	–	mA
OFF Leakage Current High	I_{OZ}	$V_O = V_{DD}$	11, 13	12	–	–	1.0	µA
OFF Leakage Current Low	I_{OZ}	$V_O = V_{SS}$	11, 13	12	–	–	-1.0	µA
Low V_{DD} Alarm Threshold	$V_{DD(th)}$		5	-	6.9	7.2	7.5	V
Common Mode Voltage	V_{IC}	Any Alarm Condition	1, 2, 3	-	V_{DD} - 4	–	V_{DD} - 2	V
Smoke Comparator Ref. Volt.	V_{REF}	Any Alarm Condition	Internal	-	V_{DD} - 3.7	–	V_{DD} - 3.3	V

* Limits over the operating temperature range are based on characterization data.
Characteristics are production tested at +25°C only.
Typical values are at +25°C and are given for circuit design information only.

AC ELECTRICAL CHARACTERISTICS at T_A = -25°C to +75°C*, V_{SS} = 0 V, in typical application (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Test Pin	V_{DD}	Limits			
					Min.	Typ.	Max.	Units
Oscillator Period	t_{osc}		12	9	9.4	10.5	11.5	ms
Led Pulse Period	t_{led1}	No Local or Remote Smoke	11	9	39	–	48	s
	t_{led4}	Remote Smoke Only	11	9	None	–	–	–
	t_{led6}	Local Smoke or Test	11	9	0.60	0.67	0.74	s
	t_{led7}	Timer Mode, No Alarm	11	9	9.67	10.8	11.8	s
Led Pulse Width	$t_{w(led)}$		11	9	9.5	–	11.5	ms

Continued...

AC ELECTRICAL CHARACTERISTICS (continued) at T_A = -25°C to +75°C*, V_{SS} = 0 V, in typical application (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Test Pin	V_{DD}	Limits			
					Min.	Typ.	Max.	Units
Strobe Pulse Period	t_{st1}	No Local or Remote Smoke	4	9	9.6	–	11.9	s
	t_{st2}	After 1 of 3 Valid Samples	4	9	2.42	2.70	2.96	s
	t_{st3}	After 2 of 3 Valid Samples and During Local Alarm	4	9	1.21	1.34	1.47	s
	t_{st4}	Remote Alarm	4	9	9.67	10.8	11.8	s
	t_{st5}	Chamber Test or Low Supply Test, No Local Alarm	4	9	38.9	–	47.1	s
	t_{st6}	Pushbutton Test, No Alarm	4	9	300	336	370	ms
Strobe Pulse Width	$t_{w(st)}$		4	9	9.5	–	11.5	ms
I_{RED} Pulse Period	t_{ired1}	No Local or Remote Smoke	6	9	9.6	–	11.9	s
	t_{ired2}	After 1 of 3 Valid Samples	6	9	2.42	2.70	2.96	s
	t_{ired3}	After 2 of 3 Valid Samples and During Local Alarm	6	9	1.21	1.34	1.47	s
	t_{ired4}	Remote Alarm	6	9	9.67	10.8	11.8	s
	t_{ired5}	Chamber Test, No Local Alarm	6	9	38.9	–	47.1	s
	t_{ired6}	Pushbutton Test, No Alarm	6	9	300	336	370	ms
I_{RED} Pulse Width	$t_{w(ired)}$		6	9	94	–	116	µs
I_{RED} Rise Time	$t_{r(ired)}$	10% to 90%	6		–	–	30	µs
I_{RED} Fall Time	$t_{f(ired)}$	90% to 10%	6		–	–	200	µs
I/O to Active Delay	$t_{d(io)}$	Local Alarm	7	9	–	0	–	s
Rising Edge on I/O to Alarm	$t_{r(io)}$	No Local Alarm	7	9	–	–	1.34	s
Horn Warning Pulse Period	t_{horn}	Low Supply and Degraded Chamber Sensitivity	8, 9	9	38.9	–	47.1	s
Horn Warning Pulse Width	$t_{w(horn)}$	Low Supply and Degraded Chamber Sensitivity	8, 9	9	9.5	–	11.5	ms
Horn ON Time	$t_{on(horn)}$	Local or Remote Alarm	8, 9	9	–	252	–	ms
Horn OFF Time	$t_{off(horn)}$	Local or Remote Alarm	8, 9	9	–	84	–	ms

* Limits over the operating temperature range are based on characterization data.
Characteristics are production tested at +25°C only.
Typical values are at +25°C and are given for circuit design information only.

PIN AND CIRCUIT DESCRIPTION
(In Typical Application)

PIN 1 (C_1)

A capacitor connected to this pin determines the gain of the photoamplifier during the push-to-test mode and during the chamber monitor test. A typical value for this high-gain mode is 0.047 µF, but should be selected based on the photo chamber background reflections reaching the detector and the desired level of sensitivity. A_e^3 1+(C1/10) where C_1 is in pF. A_e should not exceed 10 000.

PIN 2 (C_2)

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. A_e^3 1+(C2/10) where C2 is in pF. A_e should not exceed 10 000. This gain increases by a nominal 10% after a local alarm is detected (three consecutive detections). Coupling of other signals to C2 (C1 and the DETECT inputs also) must be minimized.

A resistor must be installed in series with C2.

PIN 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 dark-leakage current and low capacitance.

PIN 4 (STROBE)

This output provides a strobed, regulated voltage of V_{DD} – 5 V. The minus side of all internal and external photo amplifier circuitry is referenced to this pin.

PIN 5 (V_{DD})

This pin is connected to the most-positive supply potential and can range from 6 V to 12 V with respect to V_{SS}.

PIN 6 (I_{RED})

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 I_{RED} output is not active, to minimize noise impact, when the horn and visible LED outputs are active.

PIN 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.

This pin 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.

PIN 8 ($HORN_1$), PIN 9 ($HORN_2$), and PIN 10 (FEEDBACK)

These three pins are used in conjunction with external passive components and a self-resonating piezoelectric transducer. $HORN_1$ is connected to the piezo metal support electrode; the complementary output, $HORN_2$, is connected to the ceramic electrode and the FEEDBACK input to the feedback electrode.

A continuous modulated tone indicates either a local or remote alarm condition. A short (10 ms) chirp indicates a low-battery condition or degraded chamber sensitivity. The low-battery chirp occurs almost simultaneous with the visible LED flash. If the FEEDBACK pin is not used, it must be connected to V_{DD} or V_{SS}.

PIN 11 (LED)

This open-drain NMOS output is used to directly drive a visible LED. The load for the low-battery test is applied to this output. 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 second.
Remote Alarm	No pulses.
Test Mode	Pulses every 0.67 second.
Timer Mode	Pulses every 10 seconds

PIN 12 (OSC. CAP.)

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.

Continued...

PIN AND CIRCUIT DESCRIPTION, continued

PIN 13 (TIMING RES.)

A resistor between this pin and OSC. CAP. (pin 12) is part of the two-terminal oscillator and sets the internal clock high time, which is also the IRED pulse width. With component values as shown, this nominal time is 105 µs.

PIN 14 (V_{SS})

This pin is connected to the most negative supply potential (usually ground).

PIN 15 (HUSH)

This input pin serves two purposes in normal operation. It serves as an enable for the internal 10-minute (nominal) timer and also as the reference for the smoke comparator during the timer mode. This reference is established by a resistive divider between VDD and STROBE (RX1 and RX2). This allows the detector to have a different sensitivity set point during the timer mode. If the timer mode is not used, this pin can be left open or connected to VSS, which disables this mode.

PIN 16 (TEST)

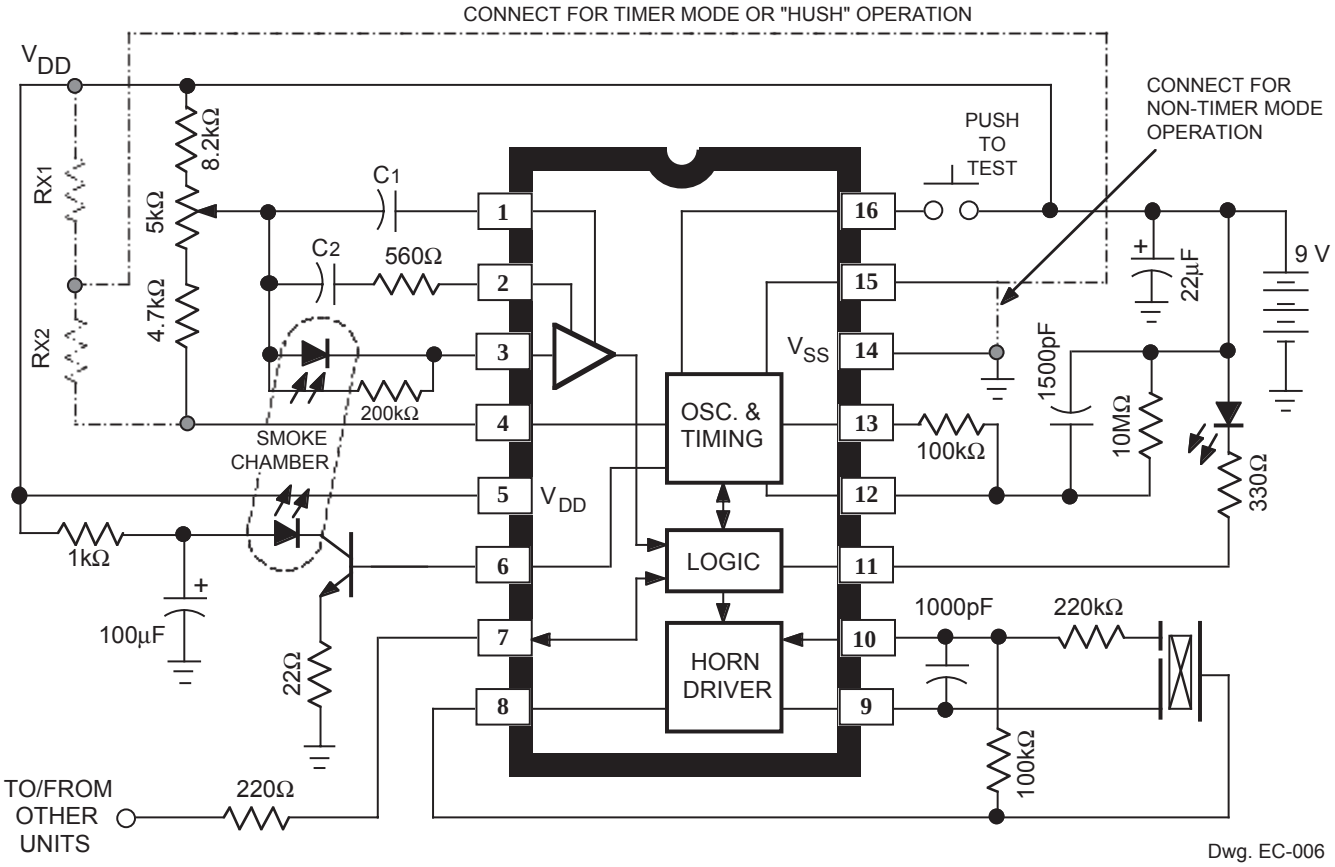
This pin has an internal pull-down device and is used to manually invoke two test modes and a Timer Mode.

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, IRED pulses 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 IRED 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 IRED pulses (less than one second), the device exits this mode and returns to standby. This high-to-low transition on pin 16 also resets and starts the 10 minute hush timer (timer mode).

The Diagnostic Test Mode is initiated by pulling this pin below VSS and continuously sourcing 400 µA from the pin for at least one clock cycle on the OSC. CAP. pin. This mode is used to facilitate calibration and test of the IC and the assembled detector. In this mode, certain device pins are reconfigured as described below. In this mode, the IRED pulse rate is increased to one every OSC. CAP. cycle and the STROBE pin is always active. To exit this mode, the test pin is floated for at least one OSC. CAP. cycle.

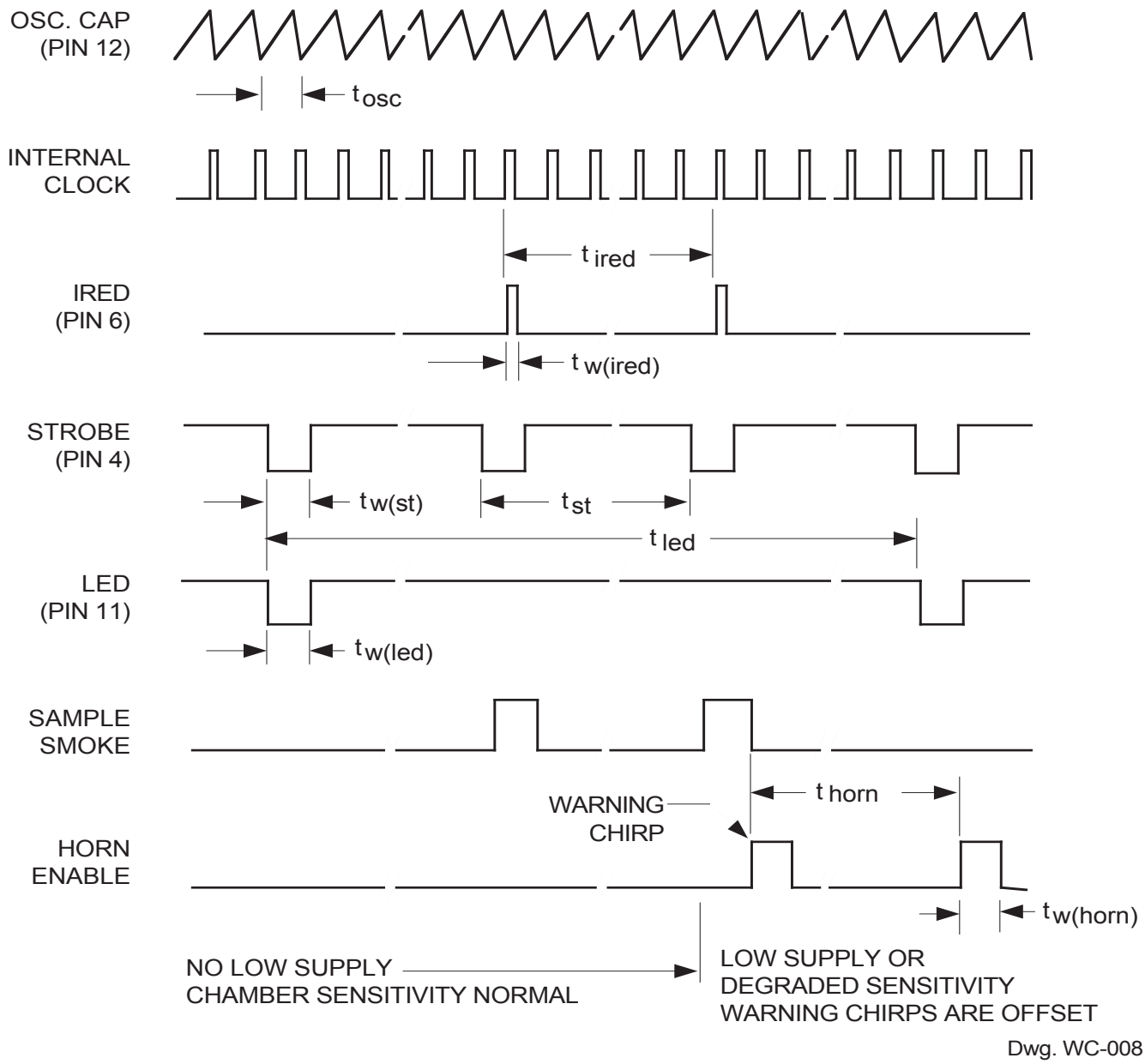
Pin Name	Pin No.	Configuration
I/O	7	Disabled as an output. A logic high on this pin places the photoamplifier output on pin 1 or pin 2 as determined by pin 15. The amplifier output appears as pulses.
HUSH	15	If the I/O pin is high, this pin controls the amplifier gain capacitor. If pin 15 is low, normal gain is selected and the amplifier output is on pin 1. If pin 15 is high, supervisory gain is selected and the amplifier output is on pin 2.
FEEDBACK	10	If pin 7 is high and pin 15 is low (normal gain), taking this pin to a high logic level increases the amplifier gain by ≈10% (hysteresis).
OSC. CAP.	12	This pin may be driven by an external clock source. Driving this pin low and high drives the internal clock low and high. The external RC network may remain intact.
HORN1	8	This pin is reconfigured as the smoke integrator output. Three consecutive smoke detections will cause this pin to go high and three consecutive no-smoke detections cause this pin to go low.
LED	11	This pin becomes a low-battery indicator. The open-drain NMOS output is normally OFF. If V_{DD} falls below the low-battery threshold, the output turns on.

TYPICAL APPLICATION



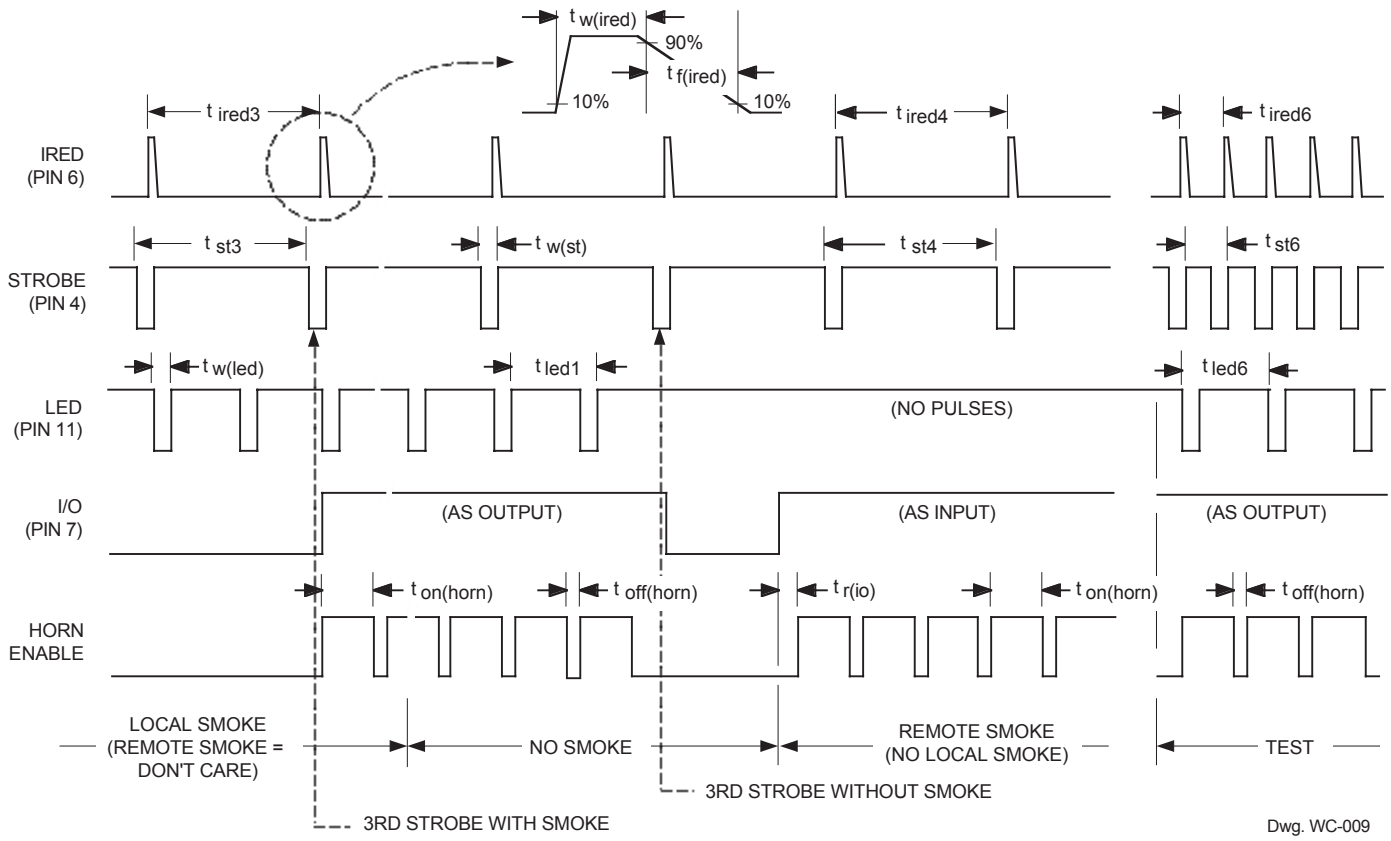
Dwg. EC-006

STANDBY TIMING DIAGRAM
(not to scale)

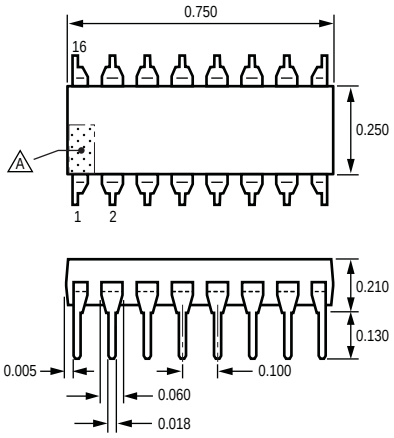


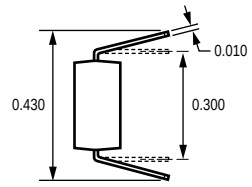
Dwg. WC-008

LOCAL ALARM TIMING DIAGRAM
(not to scale)



Package A, 16-Pin DIP



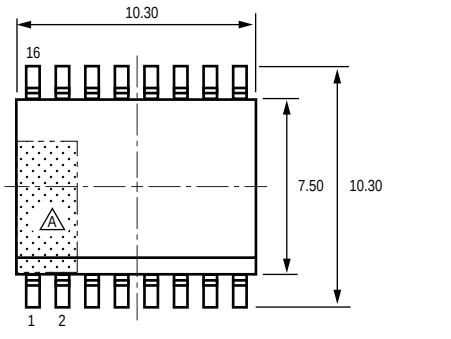


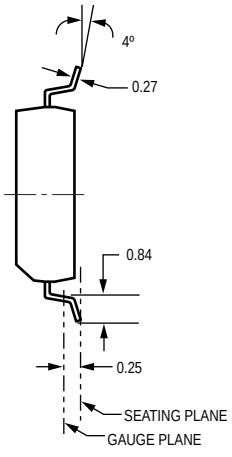
All dimensions nominal, not for tooling use
(reference JEDEC MS-001 BB)
Dimensions in inches
Dimensions exclusive of mold flash, gate burrs, and dambar protrusions
Exact case and lead configuration at supplier discretion within limits shown
A Terminal #1 mark area

Package LW, 16-Pin SOIC

All dimensions nominal, not for tooling use
Dimensions in millimeters
(reference JEDEC MS-013 AA)
Dimensions exclusive of mold flash, gate burrs, and dambar protrusions
Exact case and lead configuration at supplier discretion within limits shown

A Terminal #1 mark area





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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The selectable Hush feature may be covered by U.S. patent number Re. 33,920. Any sale or use of the Hush feature in a smoke alarm in the U.S. would be a possible infringement of this patent.

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