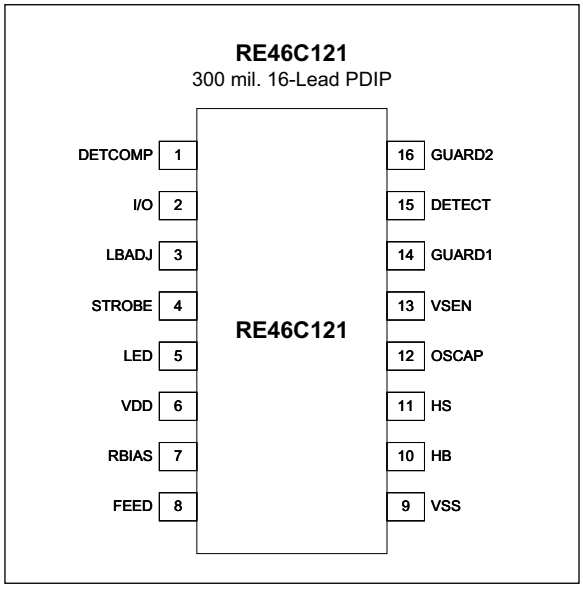
RE46C121

CMOS Ionization Smoke Detector ASIC with Interconnect

Features

- Guard Outputs for Ion Detector Input
- ±0.75 pA Detect Input Current
- Internal Reverse Battery Protection
- Internal Low Battery Detection
- Low Quiescent Current Consumption (< 6.5 µA)
- Available in 16-Lead PDIP
- Electrostatic Discharge (ESD) Protection on all Pins
- Interconnect up to 40 Detectors
- Compatible with MC145018
- Packaging:
  - Available in Standard Packaging or RoHS Compliant Pb-Free Packaging
  - 300 mil. 16-Lead PDIP

Pin Configuration



General Description

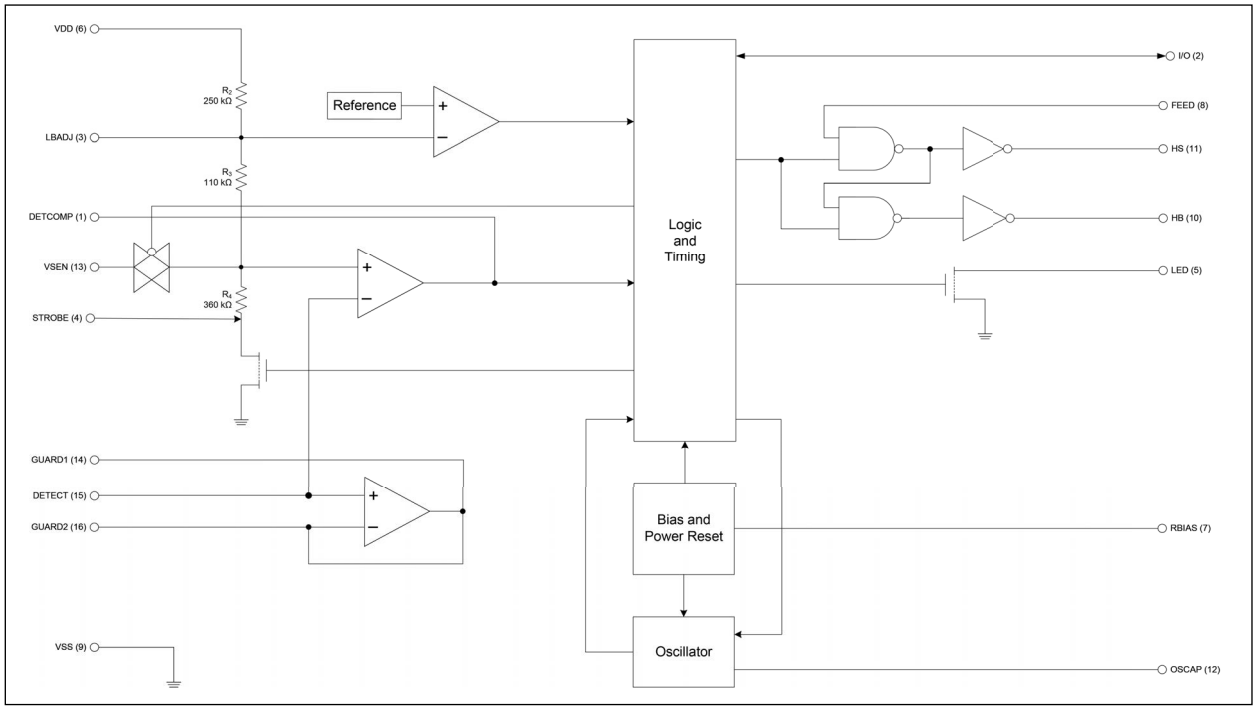
RE46C121 is a low-power CMOS ionization type smoke detector integrated circuit (IC). Together with few external components, this circuit will provide all the required features for an ionization type smoke detector.

An internal oscillator strobes power to the smoke detector circuitry for 10.5 ms every 1.66 seconds to keep standby current to a minimum. A check for a low battery condition is performed every 40 seconds when in standby. The temporal horn pattern supports the NFPA 72 emergency evacuation signal.

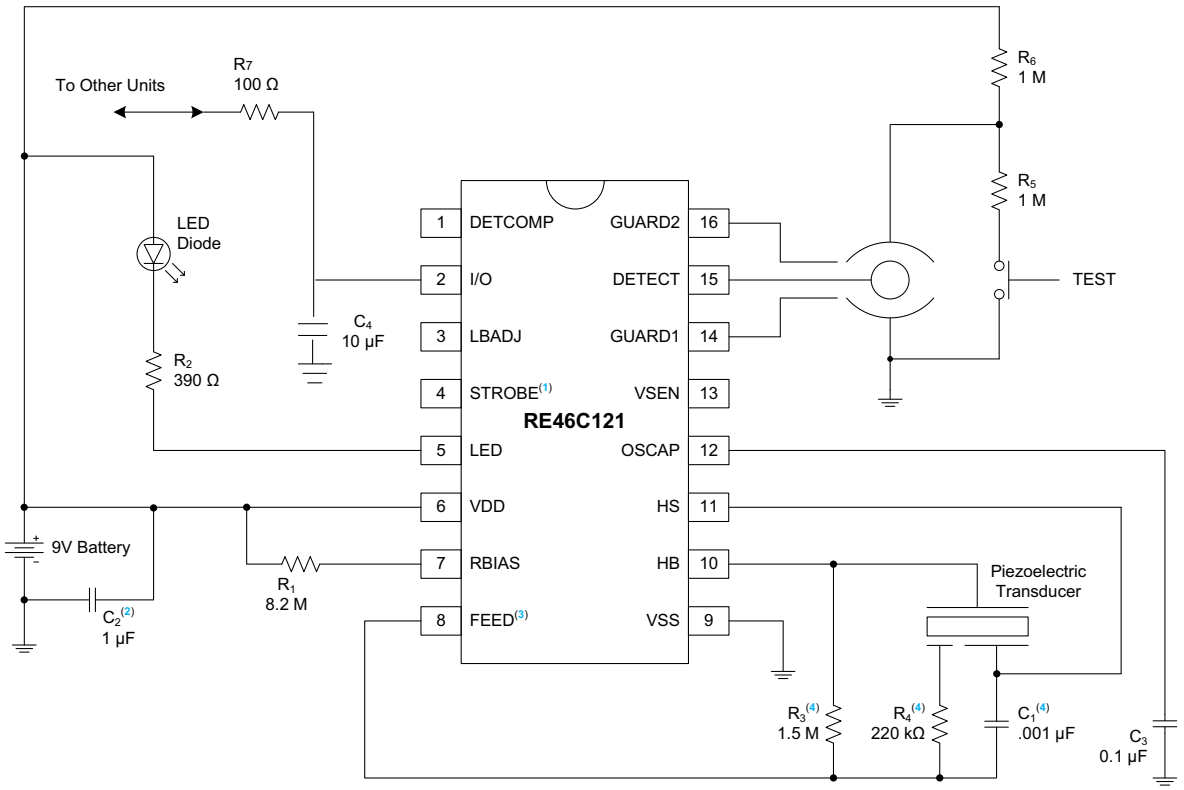
An interconnect pin allows multiple detectors to be connected such that when one unit alarms all units will sound.

Although the RE46C121 is designed for smoke detection using an ionization chamber, it can be used in the a variety of security applications.

Functional Block Diagram



Typical Application



NOTES:

1. For NFPA72 temporal horn pattern, float or connect the STROBE pin to V_{DD} through a resistor ≥ 1.5 M. For 2/3 duty cycle continuous tone, connect the STROBE pin to V_{SS}.
2. C_2 must be placed as close as possible to the RE46C121 power pins.
3. Route the PCB trace of the FEED pin away from the RBIAS pin to avoid coupling.
4. R_3, R_4 and C_1 are typical values and can be adjusted to maximize sound pressure.

NOTES:

1.0 ELECTRICAL CHARACTERISTICS

1.1 Absolute Maximum Ratings†

Supply Voltage (V_{DD}) 15V
Input Voltage Range except FEED, I/O (V_{IN}) . . . . . -0.3V to V_{DD} + 0.3V
FEED Input Voltage Range (V_{INFD}) . . . . . -10V to + 22V
IO Input Voltage Range (Vio1) . . . . . -0.3 to 17 V
Reverse Battery Time (t_{RB}) 5s
Input Current except FEED (I_{IN}) . . . . . 10 mA
Operating Temperature (T_A) . . . . . --10°C to +60°C
Storage Temperature (T_{STG}) . . . . . -55°C to +125°C
Maximum Junction Temperature (T_J) . . . . . +150°C

† **Notice:** Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only and operation at these conditions for extended periods may affect device reliability. Although this product uses CMOS technology with static protection, proper ESD prevention procedures must be used when handling this product. Damage can occur when exposed to extremely high static electric charge.

1.2 Electrical Specifications

TABLE 1-1: DC ELECTRICAL SPECIFICATIONS

DC Electrical Characteristics: Unless otherwise specified, all parameters apply at T_A = +25°C, V_{DD} = 9V, OSCAP = 0.1 µF, R_{BIAS} = 8.2 MΩ and V_{SS} = 0V.

Parameter	Symbol	Test Pin	Min.	Typical	Max.	Units	Conditions
Power Supply							
Supply Voltage	V_{DD}	VDD	6	—	12	V	Operating
Supply Current	I_{DD1}	VDD	—	4.5	6.5	µA	OSCAP = 0.1 µF, R_{BIAS} = 8.2 MΩ
	I_{DD2}	VDD	—	—	9	µA	OSCAP = 0.1 µF, R_{BIAS} = 8.2 MΩ, V_{DD} = 12V
Input							
Input Voltage High	V_{IH1}	FEED	6.2	4.5	—	V	
	V_{IH2}	I/O	3	—	—	V	No Local Alarm, I/O as an Input
Input Voltage Low	V_{IL1}	FEED	—	4.5	2.7	V	
	V_{IL2}	I/O	3	—	—	V	No Local Alarm, I/O as an Input
Input Leakage Low	IL_{DET1}	DETECT	—	—	-0.75	pA	V_{DD} = 9V, DETECT = V_{SS}, 0 - 40% RH
	IL_{DET2}	DETECT	—	—	-1.50	pA	V_{DD} = 9V, DETECT = V_{SS}, 85% RH (Note 1)
	IL_{FD}	FEED	—	—	-50	µA	FEED = -10V

Note 1: Sample test only.
2: Production tested at room temperature with guardbanded limits.
3: Not 100% production tested.

DC Electrical Characteristics: Unless otherwise specified, all parameters apply at T_A = +25°C, V_{DD} = 9V, OSCAP = 0.1 µF, R_{BIAS} = 8.2 MΩ and V_{SS} = 0V.

Parameter	Symbol	Test Pin	Min.	Typical	Max.	Units	Conditions
Input Leakage High	IH_{DET1}	DETECT	—	—	0.75	pA	V_{DD} = 9V, DETECT = V_{DD}, 0-40% RH
	IH_{DET2}	DETECT	—	—	1.50	pA	V_{DD} = 9V, DETECT = V_{DD}, 85% RH (Note 1)
	IH_{FD}	FEED	—	—	50	µA	FEED = 22V
	I_{IOL1}	IO	25	—	100	µA	No Alarm, V_{IO}=Vdd-2V
	I_{IOL2}	IO	—	—	150	µA	No Alarm, V_{IO}=17V
Output							
Output Off Leakage High	I_{OHZ}	STROBE, LED	—	—	1	µA	Output Off
Output Voltage High	V_{OH1}	HB, HS	6.3	—	—	V	I_{OH} = -16 mA, V_{DD} = 7.2V
	V_{OH2}	DETCOMP	8.5	—	—	V	I_{OH} = -30 ua
Output Voltage Low	V_{OL1}	HB, HS	—	—	0.9	V	I_{OL} = 16 mA, V_{DD} = 7.2V
	V_{OL2}	DETCOMP, STROBE	—	—	0.5	V	I_{OL} = 30 mA
	V_{OL3}	LED	—	—	3	V	I_{OL} = 10 mA, V_{DD} = 7.2V
Output Current	I_{IOH1}	I/O	-4	—	-16	mA	Alarm, V_{IO}-Vdd-2V or V_{IO}-0V
	I_{IODMP}	I/O	5	—	—	mA	At Conclusion of Local Alarm or Test, V_{IO}=1V
Low Battery Voltage	V_{LB}	VDD	7.2	7.5	7.8	V	T_A = -10°C to +60°C, Note 2
Internal Sensitivity Set Voltage	V_{SET1}	VSEN	47	50	53	%V_{DD}	
	V_{SET2}	LBADJ	—	65.5	—	%V_{DD}	
Offset Voltage	VG_{OS1}	GUARD1, DETECT	-50	—	50	mV	Guard Amplifier
	VG_{OS2}	DETECT, GUARD2	-50	—	50	mV	Guard Amplifier
	VG_{OS3}	VSEN, DETECT	-50	—	50	mV	Smoke Comparator
Common Mode Voltage	V_{CM1}	GUARD1, DETECT	2	—	V_{DD} – 0.5	V	Guard Amplifier, Note 3
	V_{CM2}	VSEN, DETECT	0.5	—	V_{DD} – 2	V	Smoke Comparator, Note 3
Output Impedance	Z_{OUT}	GUARD1, GUARD2	—	10	—	kΩ	Guard Amplifier Outputs, Note 3
Hysteresis	V_{HYS}	VSEN	90	130	170	mV	No Alarm to Alarm Condition

Note 1: Sample test only.

2: Production tested at room temperature with guardbanded limits.

3: Not 100% production tested.

TABLE 1-2: AC ELECTRICAL SPECIFICATIONS

AC Electrical Characteristics: Unless otherwise specified, all parameters apply at T_A = +25°C, V_{DD} = 9V, OSCAP = 0.1 µF, RBIAS = 8.2 MΩ and V_{SS} = 0V.
All timing except oscillator period (t_{PER}) and oscillator pulse width (t_{PW}) are guaranteed by functional tests.

Parameter	Symbol	Test Pin	Min.	Typical	Max.	Units	Conditions
Oscillator Time Base							
Oscillator Period	t_{PER1}	OSCAP	1.34	1.67	2	s	No Alarm Condition
	t_{PER2}	OSCAP	37.5	41.5	45.8	ms	Alarm Condition
Oscillator Pulse Width	t_{PW}	LED	9.1	10.5	12.9	ms	Operating
LED Indication							
LED On Time	t_{LON}	LED	9.1	10.5	12.9	ms	Operating
LED Off Time	t_{LOF1}	LED	32	40	48	s	Standby, No Alarm
	t_{LOF2}	LED	0.9	1	1.1	s	Alarm Condition
Horn Indication							
Horn On Time	t_{HON1}	HB, HS	450	500	550	ms	Operating, Alarm Condition, Note 1, TONE = V_{DD} or Float
	t_{HON2}	HB, HS	9.1	10.5	12.9	ms	Low Battery, No Alarm
Horn Off Time	t_{HOF1}	HB, HS	450	500	550	ms	Operating, Alarm Condition, Note 1, TONE = V_{DD} or Float
	t_{HOF2}	HB, HS	1.35	1.5	1.65	s	Operating, Alarm Condition, Note 1, TONE = V_{DD} or Float
	t_{HOF3}	HB, HS	32	40	48	ms	Low Battery, No Alarm
I/O Charge Dump Duration	t_{IODMP}	I/O	1.34	1.67	2.0	s	At Conclusion of Local Alarm or Test
I/O Delay	t_{IODLY1}	I/O	—	0	—	s	From Start of Local Alarm to I/O Active
I/O Filter	t_{IOFILT}	I/O	—	—	450	ms	I/O pulse width guaranteed to be filtered. I/O as Input, No Local Alarm
Remote Alarm Delay	t_{IODLY2}	I/O	0.450	—	2.2	s	No Local Alarm, I/O as input, From I/O active to Horn Active

Note 1: See timing diagram for HFPA72 Temporal Horn Pattern in Figure 3-1.

TABLE 1-3: TEMPERATURE CHARACTERISTICS

DC Electrical Characteristics: Unless otherwise specified, all parameters apply at V_{DD} = 9V and V_{SS} = 0V (typical application).						
Parameter	**Symbol**	**Min.**	**Typical**	**Max.**	**Units**	**Conditions**
Temperature Ranges						
Specified Temperature Range	T_A	-10	—	+60	°C	
Operating Temperature Range	T_A	-10	—	+60	°C	
Storage Temperature Range	T_{STG}	-55	—	+125	°C	
Thermal Package Resistances						
Thermal Resistance, 16-Lead PDIP	θ_{JA}	—	70	—	°C/W	

2.0 PIN DESCRIPTION

Table 2-1 describes the pins of RE46C121.

TABLE 2-1: RE46C121 PIN FUNCTION

Pin Number	Symbol	Description
1	DETCOMP	Use this pin to check for smoke, while holding the OSCAP pin low.
2	I/O	This bidirectional pin provides the capability to interconnect many detectors in a single system. This pin has an internal pull-down resistor.
3	LBADJ	Use this pin to modify the low battery set point by connecting a resistor between the pin and V_{DD} or V_{SS}.
4	STROBE	This pin pulls low during smoke and low battery checks
5	LED	LED Driver Pin. Open-drain NMOS output used to drive a visible LED.
6	VDD	This pin connects to the positive power supply.
7	RBIAS	Set the internal bias current by connecting a resistor between this pin and V_{DD}.
8	FEED	This pin connects to the feedback electrode through a current limiting resistor. If not used, ensure this pin connects to V_{DD} or V_{SS}.
9	VSS	This pin connects to the negative power supply.
10	HB	Horn Brass, Inverted Output. This pin connects to the metal electrode of a piezoelectric transducer.
11	HS	Horn Silver Output. This pin is a complementary output to the HB pin and connects to the ceramic electrode of the piezoelectric transducer
12	OSCAP	Set the oscillator period (t_{PER}) by connecting a capacitor between this pin and V_{SS}.
13	VSEN	Use this pin to set an external smoke comparator reference by connecting external resistors to V_{DD} or V_{SS}.
14	GUARD1	Guard amplifier output 1. This allows for measurement of the DETECT pin without loading the ionization chamber.
15	DETECT	This pin connects to the collector electrode of the ion smoke chamber.
16	GUARD2	Guard amplifier output 2. This allows for measurement of the DETECT pin without loading the ionization chamber.

NOTES:

3.0 DEVICE DESCRIPTION

3.1 Introduction

RE46C121 is a low-power CMOS ionization smoke detector integrated circuit (IC). Together with a few external components, this circuit provides all the required features for an ionization type smoke detector.

Note: All timing references are nominal values. Refer to Table 1-1 and Table 1-2 for limits.

3.2 Internal Timing

With external components as indicated in the Typical Application diagram, the oscillator period becomes t_{PER1} = 1.67 seconds while in standby. The detection circuitry is powered up for 10.5 ms every 1.66 seconds and the status of the smoke comparator is latched. Additionally, every 40 seconds, the LED driver is turned on for 10.5 ms and the status of the low battery comparator is latched. The smoke comparator status is not checked during the low battery test or low battery horn warning chirp or when the horn is active due to an alarm condition.

If RE46C121 detects an alarm condition, the oscillator period increases to t_{PER2} = 41.5 ms.

Due to the low currents used in the oscillator, ensure that the OSCAP pin connects to a low leakage type capacitor. Oscillator accuracy depends mainly on the tolerance of the RBIAS resistor and OSCAP capacitor.

3.3 Smoke Detection Circuitry

The smoke comparator takes the value of the ionization chamber voltage and compares it to a voltage derived from a resistor divider across V_{DD}. This divider voltage is available externally on the VSEN pin. When smoke is detected, the divider voltage is internally increased by 130 mV nominal to provide hysteresis and make the detector less sensitive to false triggering.

Use the VSEN pin to modify the internal set point for the smoke comparator by connecting external resistors to V_{DD} or V_{SS}. Nominal values for the internal resistor divider are indicated on the Functional Block Diagram. While these internal resistor values can vary up to ±20%, the resistor matching is typically less than 2% on any single device. A transmission switch on the VSEN pin isolates the pin during low battery tests to prevent the low battery set point from being affected when using external resistors to modify the smoke sensitivity set point.

To reduce surface leakage, the guard amplifier and outputs are always active and within 50 mV of the DETECT pin voltage. The guard outputs also allow for the measurement of the DETECT input without loading the ionization chamber.

3.4 Low Battery Detection

An internal reference is compared to the voltage divided V_{DD} power supply. The battery is checked under load using the LED low side driver output since a low battery status is latched at the conclusion of the 11 ms LED pulse. Use the LBADJ pin to modify the low battery set point by connecting a resistor to V_{DD} or V_{SS}.

Note 1: The internal resistor string is common to both LBADJ and VSEN pins. This results in some interaction between the two pins.

2: Modifying the low battery set point can affect the smoke sensitivity setting.

3.5 LED Pulse

The LED pulses on for 10.5 ms every 40 seconds while in standby. When an alarm condition is detected, the LED pulses on for 10.5 ms every second. For a remote alarm condition the LED is always off.

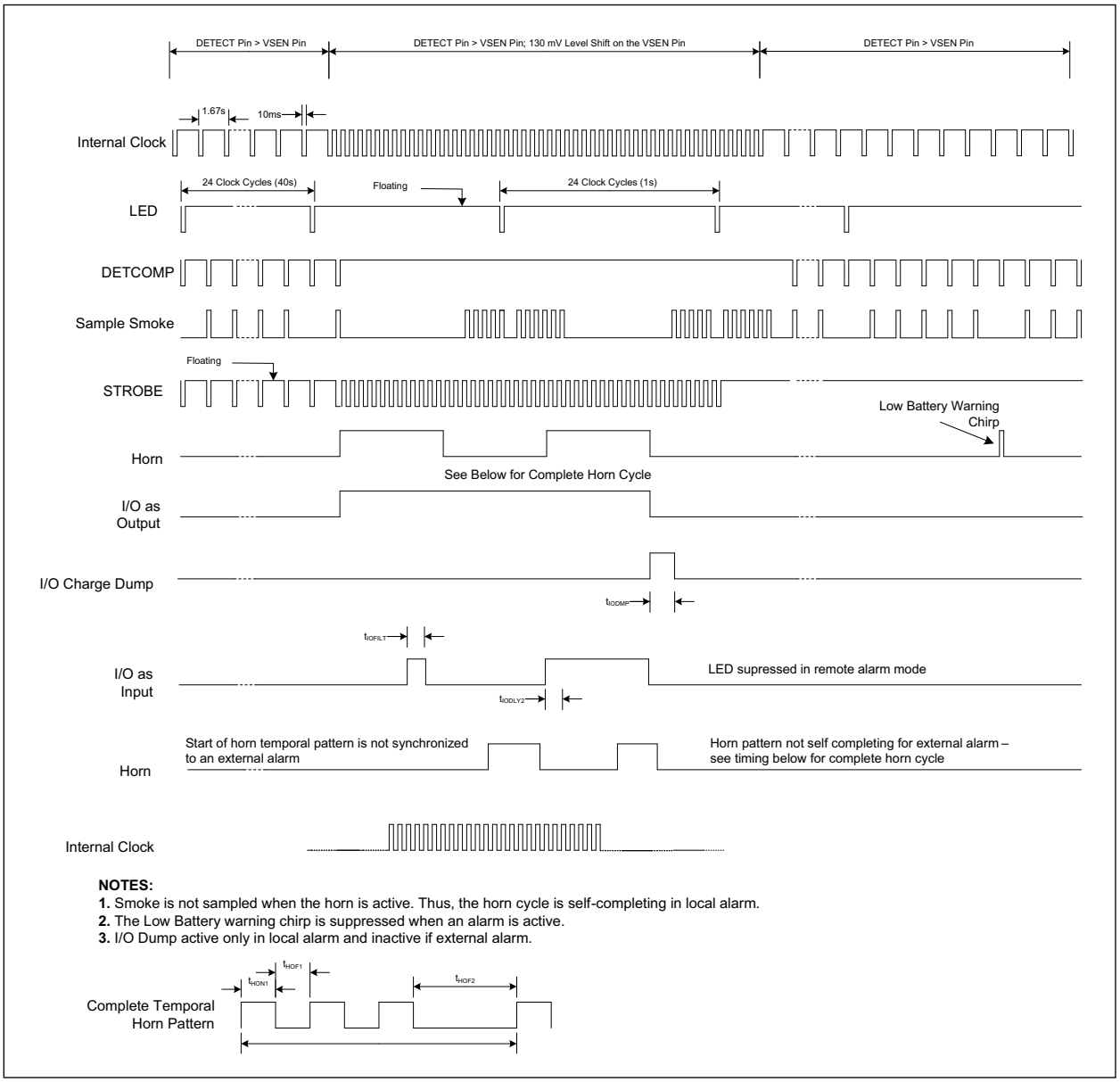
3.6 Interconnect

The I/O pin provides the capability to common many detectors in a single system. If a single unit goes into alarm the I/O pin is driven high. This high signal causes the interconnected units to alarm. The LED flashes every 1s for 10.5 ms on the signaling unit and is inhibited on the units that are in alarm due to the I/O signal. An internal sink device on the I/O pin helps to discharge the interconnect line. This dump device is active for 1 clock cycle after the unit exits the alarm condition (1.67s).

The interconnect input has a 500 ms nominal digital filter. This allows for interconnection to other types of alarms (carbon monoxide for example) that may have a pulsed interconnect signal.

3.7 Testing

By holding the OSCAP pin low the internal power strobe is active and the DETCOMP pin can be used to check for smoke. Refer to the timing diagrams in Figure 3-1.



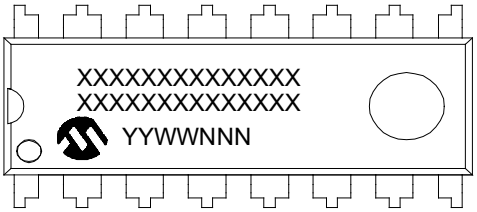
NOTES:
1. Smoke is not sampled when the horn is active. Thus, the horn cycle is self-completing in local alarm.
2. The Low Battery warning chirp is suppressed when an alarm is active.
3. I/O Dump active only in local alarm and inactive if external alarm.

FIGURE 3-1: *RE46C121 Timing Diagram.*

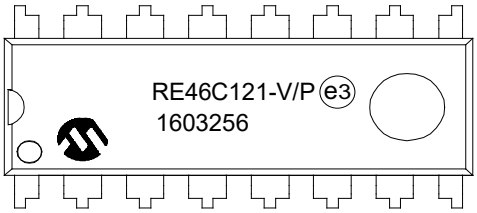
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

16-Lead PDIP (300 mil.)



Example:



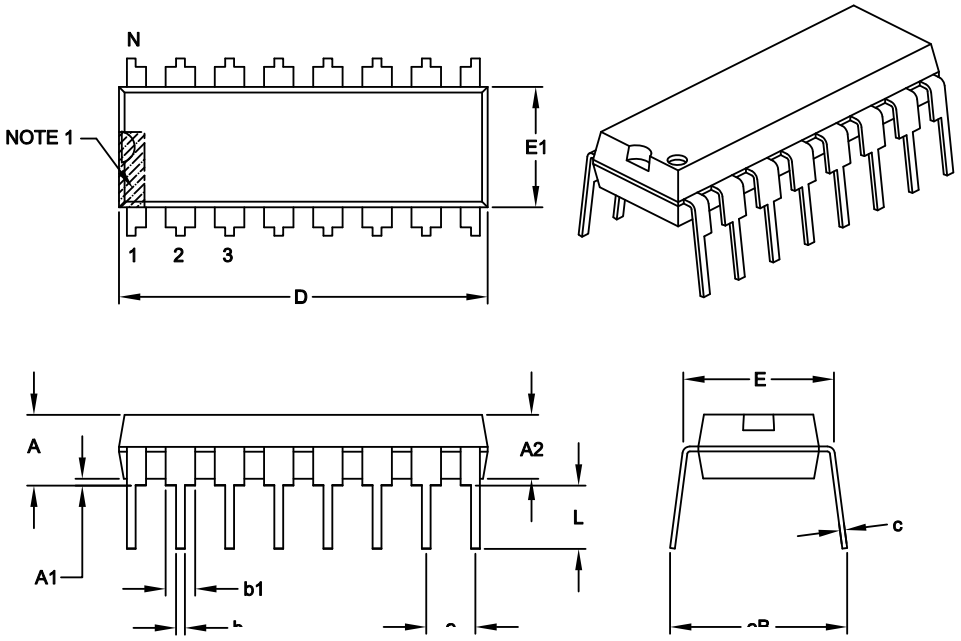
Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

4.2 Package Drawings

16-Lead Plastic Dual In-Line (P) - .300 In. Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		16	
Pitch	e		.100 BSC	
Top to Seating Plane	A	-	-	.210
Molded Package Thickness	A2	.115	.130	.195
Base to Seating Plane	A1	.015	-	-
Shoulder to Shoulder Width	E	.290	.310	.325
Molded Package Width	E1	.240	.250	.280
Overall Length	D	.735	.755	.775
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.045	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	-	-	.430

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-017C

APPENDIX A: REVISION HISTORY

Revision C (June 2025)

- Removed mentions of Underwriters Laboratory Specifications UL217 and UL268.
- Updated Functional Block Diagram and Typical Application.
- Updated Figure 3-1.
- Added **Section 2.0, "Pin Description"**.
- Updated **Section 3.0, "Device Description"**.
- Added **Section 4.0, "Packaging Information"**.
- Added **Product Identification System** section.

Revision B (June 2009)

- Undocumented changes.

Revision A (May 2009)

- Initial release of this document.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	X	XX	X
Device	Package	Number of Pins	Lead Free

Device:	RE46C121	= CMOS Ionization Smoke Detector ASIC
Package:	E	= Plastic Dual In-Line (P), 300 mil. Body (PDIP)
Number of Pins:	16	= 16-Lead
Lead Free:	F	= Lead Free Packaging

Examples:

a) RE46C121E16F: CMOS Ionization Smoke Detector ASIC, Plastic Dual In-Line PDIP, 16-Lead, Lead Free

NOTES:

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