RE46C165/6/7/8

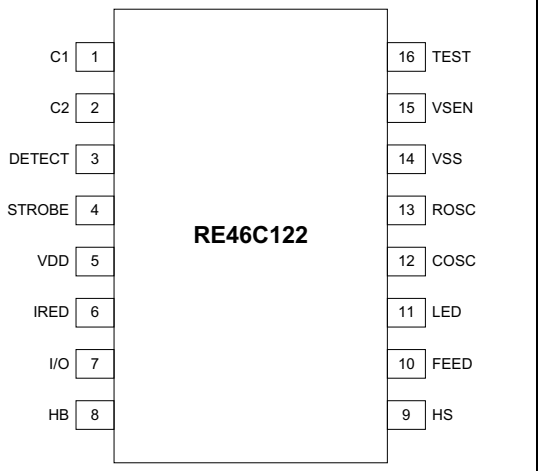
CMOS Photoelectric Smoke Detector ASIC with Interconnect, Timer Mode and Alarm Memory

Features

- Temporal Horn Pattern or Continuous Tone
- Alarm Memory
- Sensitivity Control Times:
  - 9 minutes (RE46C165/6)
  - 1.2 minutes (RE46C167/8)
- I/O Filter and Charge Dump
- Interconnect up to 40 Detectors
- Internal Power-on Reset (POR)
- > 2000V ESD Protection (HBM) on All Pins
- Low Quiescent Current Consumption (< 8 µA)
- Internal Low-battery Detection and Chamber Test
- Available in RoHS Compliant Lead-free Packaging
- Packaging:
  - 300 mil. 16-Lead PDIP
  - 3.9 mm 16-Lead SOIC

Package Types

RE46C165/6/7/8
300 mil. 16-Lead PDIP
3.9 mm 16-Lead SOIC



Description

The RE46C165/6/7/8 family of devices are low power, CMOS photoelectric smoke detector ICs. With minimal external components, these circuits provide all required features for a photoelectric smoke detector.

Each design incorporates a gain-selectable photo amplifier for use with an infrared emitter/detector pair.

An internal oscillator strobes power to the smoke detection circuitry for 100 µs every 10s to keep standby current to a minimum. If smoke is sensed, the detection rate is increased to verify an alarm condition. A High-Gain mode is available for push button chamber testing.

When the smoke detector is in standby, low-battery condition and chamber integrity checks are performed every 43s. The temporal horn pattern supports the NFPA 72 emergency evacuation signal.

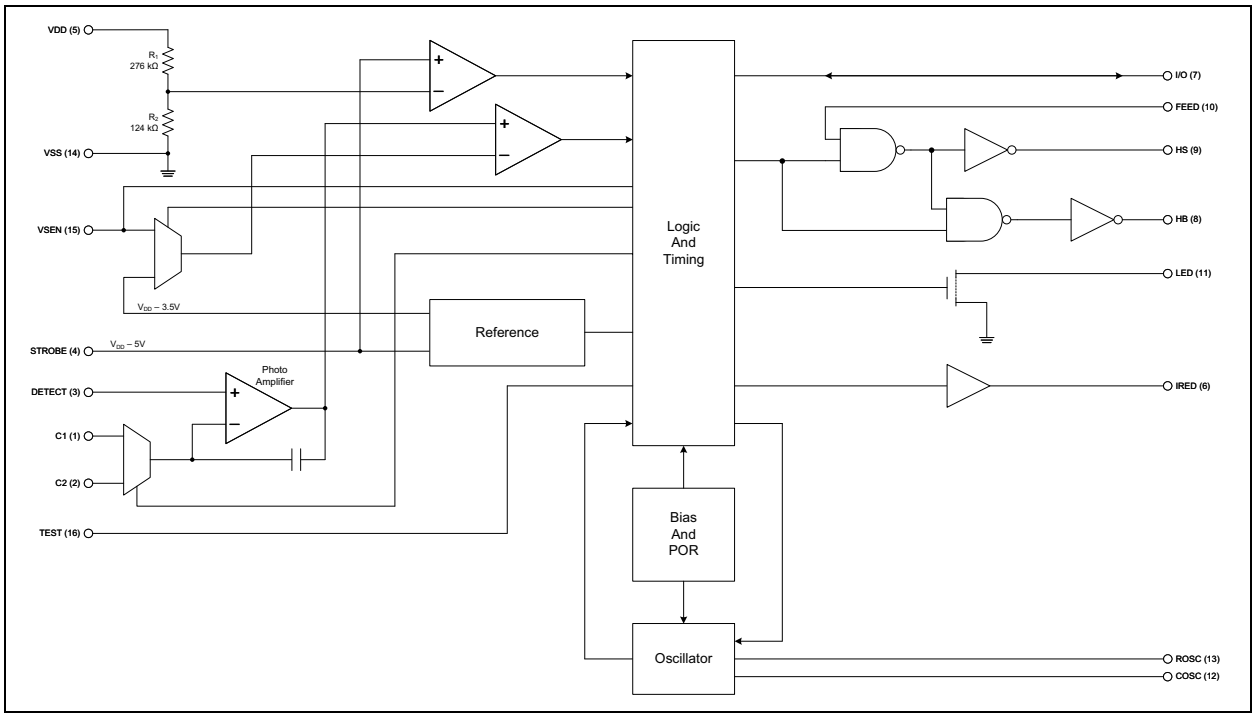
The interconnect pin (I/O) enables the connection of multiple detectors so that when one unit alarms, all units sound together. A charge dump feature quickly discharges the interconnect line when exiting a local alarm. The I/O pin is also digitally filtered.

An internal timer allows the use of a single push-to-test button to enter Reduced Sensitivity mode.

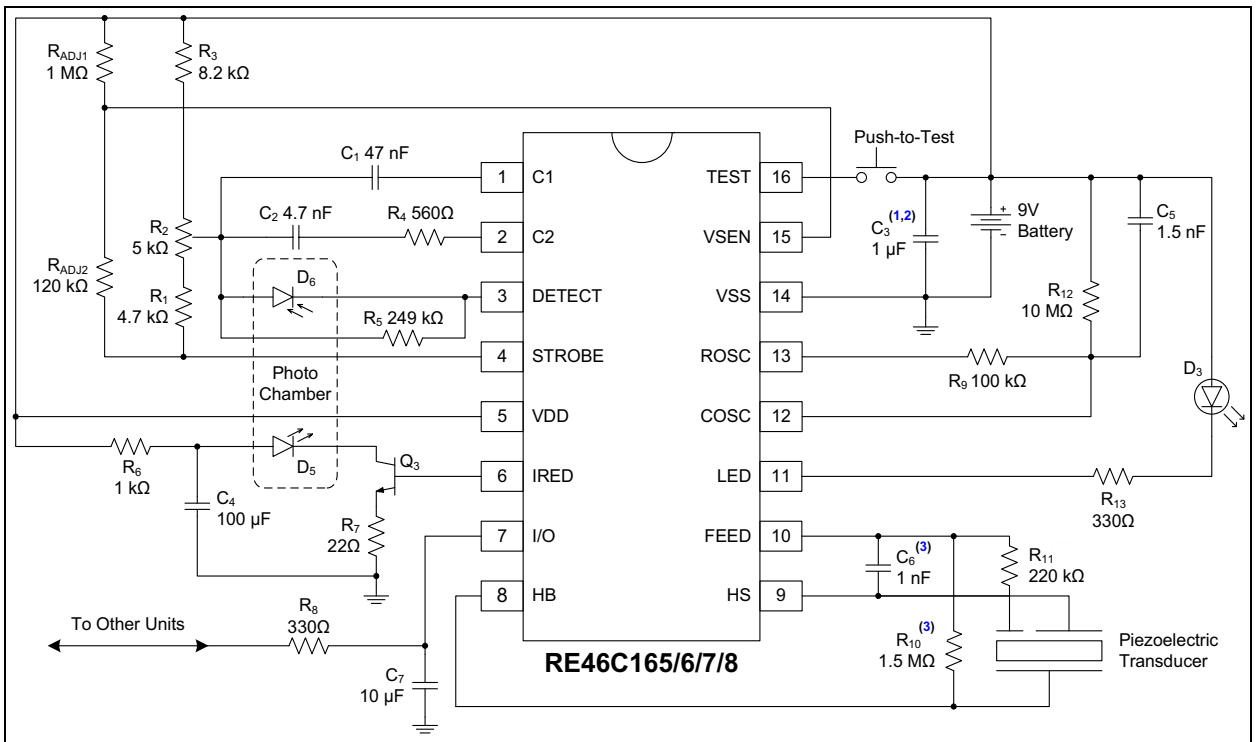
An alarm memory feature allows to determine if the RE46C165/6/7/8 smoke detector previously entered a local alarm condition.

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Functional Block Diagram



Typical Application



NOTES:

1. Place C_3 as close as possible to the power pins of RE46C165/6/7/8.
2. C_3 is typical value for an alkaline battery. Increase the capacitance to 4.7 µF or more for a carbon battery.
3. R_{10}, R_{11} and C_6 are typical values and can be adjusted to maximize sound pressure.

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1.0 ELECTRICAL CHARACTERISTICS

1.1 Absolute Maximum Ratings†

V_{DD} 12.5V
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
I/O Input Voltage Range . . . . . $V_{I/O1}$= -0.3V to +15V
Input Current except FEED, TEST, VSEN . . . . . I_{IN} = 10 mA
Input Current for FEED, VSEN . . . . . I_{IN} = 500 µA
Operating Temperature . . . . . T_A = -25°C to +75°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. This is a stress rating only and functional operation of the device at these, or any other conditions above those indicated in the operation listings of this specification, is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

1.2 Electrical Specifications

TABLE 1-1: DC ELECTRICAL CHARACTERISTICS(1)

DC Electrical Characteristics: Unless otherwise indicated, all parameters apply at T_A = -25°C to +75°C, V_{DD} = 9V, V_{SS} = 0V. Typical Application (unless otherwise noted).

Parameter	Symbol	Pin	Min.	Typical	Max.	Units	Conditions
Power Supply							
Supply Voltage	V_{DD}	VDD	6	—	12	V	Operating
Supply Current	I_{DD1}	VDD	—	4	6	µA	COSC = V_{SS}, LED Off
	I_{DD2}	VDD	—	5.5	8	µA	COSC = V_{SS}, LED Off, V_{DD} = 12V
	I_{DD3}	VDD	—	—	2	mA	COSC = V_{SS}, STROBE On, IRED Off
	I_{DD4}	VDD	—	—	3	mA	COSC = V_{SS}, STROBE On, IRED On (Note 2)
Input Voltage High	V_{IH1}	FEED	6.2	4.5	—	V	—
	V_{IH2}	I/O	3.2	—	—	V	No Local Alarm, I/O as Input
	V_{IH3}	VSEN	1.6	—	—	V	—
	V_{IH4}	TEST	8.5	—	—	V	—
Input Voltage Low	V_{IL1}	FEED	—	4.5	2.7	V	—
	V_{IL2}	I/O	—	—	1.5	V	No Local Alarm, I/O as Input
	V_{IL3}	VSEN	—	—	0.5	V	—
	V_{IL4}	TEST	—	—	7	V	—

Note 1: Production tested at room temperature with guardbanded limits.
2: Does not include Q3 emitter current.
3: Not production tested

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TABLE 1-1: DC ELECTRICAL CHARACTERISTICS[(1)] (CONTINUED)

DC Electrical Characteristics: Unless otherwise indicated, all parameters apply at T_A = -25°C to +75°C, V_{DD} = 9V, V_{SS} = 0V. Typical Application (unless otherwise noted).							
Parameter	**Symbol**	**Pin**	**Min.**	**Typical**	**Max.**	**Units**	**Conditions**
Input Leakage Low	I_{IL1}	C1, C2, DETECT	—	—	-100	nA	V_{DD} = 12V, COSC = 12V, STROBE Active
	I_{IL2}	FEED, COSC	—	—	-100	nA	V_{DD} = 12V, V_{IN} = V_{SS}
	I_{IL3}	VSEN, TEST	—	—	-1	µA	V_{DD} = 12V, V_{IN} = V_{SS}
	I_{LFD}	FEED	—	—	-50	µA	FEED = -10V
Input Leakage High	I_{IH1}	C1, C2	—	—	100	nA	V_{DD} = 12V, V_{IN} = V_{DD}, STROBE Active
	I_{IH2}	DETECT, FEED, COSC	—	—	100	nA	V_{DD} = 12V, V_{IN} = V_{DD}
	I_{HFD}	FEED	—	—	50	µA	FEED = 22V
Input Pull-down Current	I_{PD1}	TEST	0.25	—	10	µA	V_{IN} = V_{DD}
	I_{PD2}	VSEN	0.1	0.25	0.5	µA	V_{IN} = V_{DD}
	I_{PDIO1}	I/O	20	—	80	µA	V_{IN} = V_{DD}
	I_{PDIO2}	I/O	—	—	140	µA	V_{IN} = 15V, V_{DD} = 12V
Output Off Leakage Low	I_{OZL1}	LED, ROSC	—	—	-1	µA	Outputs Off, Output = V_{SS}
Output Off Leakage High	I_{OZH1}	LED, ROSC	—	—	1	µA	Outputs Off, Output = V_{DD}
Output High Voltage	V_{OH1}	HB, HS	5.5	—	—	V	I_{OH} = -16 mA, V_{DD} = 6.5V
Output Low Voltage	V_{OL1}	HB, HS	—	—	1	V	I_{OL} = 16 mA, V_{DD} = 6.5V
	V_{OL2}	ROSC	—	0.5	—	V	I_{OL} = 5 mA, V_{DD} = 6.5V
	V_{OL3}	LED	—	—	0.6	V	I_{OL} = 10 mA, V_{DD} = 6.5V
Output Current	I_{IOH1}	I/O	-4	—	-16	mA	Alarm, V_{IO} = V_{DD} – 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	6.9	7.2	7.5	V	—

Note 1: Production tested at room temperature with guardbanded limits.

2: Does not include Q3 emitter current.

3: Not production tested

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TABLE 1-1: DC ELECTRICAL CHARACTERISTICS(1) (CONTINUED)

DC Electrical Characteristics: Unless otherwise indicated, all parameters apply at T_A = -25°C to +75°C, V_{DD} = 9V, V_{SS} = 0V. Typical Application (unless otherwise noted).

Parameter	Symbol	Pin	Min.	Typical	Max.	Units	Conditions
Output Voltage	V_{STOF}	STROBE	V_{DD} – 0.1	—	—	V	STROBE Off, V_{DD} = 12V, I_{OUT} = -1 µA
	V_{STON}	STROBE	V_{DD} – 5.25	V_{DD} – 5	V_{DD} – 4.75	V	STROBE On, V_{DD} = 9V, I_{OUT} = 100 µA to 500 µA
	V_{IREDOF}	IRED	—	—	0.1	V	IRED Off, V_{DD} = 12V, I_{OUT} = 1 µA
	V_{IREDON}	IRED	2.85	3.1	3.35	V	IRED On, V_{DD} = 9V, I_{OUT} = 0 to -6 mA, T_A = +25°C
Common-mode Voltage	V_{CM1}	C1, C2, DETECT	0.5	—	V_{DD} – 2	V	Local Smoke, Push-to-Test or Chamber Test (Note 3)
Smoke Comparator Reference	V_{REF}	—	V_{DD} – 3.7	V_{DD} – 3.5	V_{DD} – 3.3	V	Internal Reference (Note 3)
Temperature Coefficient	TC_{ST}	STROBE	—	0.01	—	%/°C	STROBE Output Voltage, V_{DD} = 6V to 12V
	TC_{IRED}	IRED	—	0.3	—	%/°C	IRED Output Voltage, V_{DD} = 6V to 12V
Line Regulation	ΔV_{STON}	STROBE, VDD	—	-50	—	dB	STROBE Output (vs. V_{DD}), V_{DD} = 6V to 12V
	ΔV_{IREDON}	VDD, IRED	—	-30	—	dB	IRED Output Voltage, V_{DD} = 6V to 12V

Note 1: Production tested at room temperature with guardbanded limits.

2: Does not include Q3 emitter current.

3: Not production tested

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TABLE 1-2: AC ELECTRICAL CHARACTERISTICS

AC Electrical Characteristics: Unless otherwise indicated, all parameters apply at T_A = -25°C to +75°C, V_{DD} = 9V, V_{SS} = 0V. Typical Application (unless otherwise noted).								
Parameter	**Symbol**	**Pin**	**Min.**	**Typical**	**Max.**	**Units**	**Clocks**	**Conditions**
Oscillator Time Base (COSC, ROSC)								
Oscillator Period	t_{POSC}	HS	9.38	10.42	11.46	ms	1	Operating (Note 1)
Oscillator Tolerance	t_{TOLOSC}	HS	-10	0	10	%	1	Operating
LED Indication (LED)								
LED On Time	t_{ON1}	LED	9.4	10.4	11.5	ms	1	Operating
LED Period	t_{PLED0}	LED	LED IS NOT ON			s	—	Remote Alarm Only
	t_{PLED1}	LED	38	43	47	s	4096	Standby, No Alarm
	t_{PLED2}	LED	450	500	550	ms	48	Local Alarm Condition
	t_{PLED3}	LED	9.6	10.7	11.7	s	1024	Timer mode, No Local Alarm (Note 2)
	t_{PLED4}	LED	225	250	275	ms	24	Timer mode, No Local Alarm (Note 2)
Alarm Memory LED Pulse Train (3x) Off Time	t_{OFLED}	LED	1.2	1.3	1.5	s	127	Alarm Memory Set, LED Enabled
Alarm Memory LED Timer Period	t_{LALED}	LED	21.5	23.9	26.3	h	8257536	Alarm Memory Set
Hush Timer Operation								
Hush Timer Period	t_{TPER}	—	8.1	9.0	9.9	min	51712	RE46C165/6 Only No Alarm Condition
		—	1.1	1.2	1.4	min	7232	RE46C167/8 Only No Alarm Condition

Note 1: t_{POSC} and t_{IRON} are 100% production tested. All other timing is verified by functional testing.

2: During Timer mode, the LED period is 10.5s. The LED period returns to 43s at the conclusion of Timer mode.

3: See the timing diagram for Temporal Horn Pattern in Figure 3-2.

4: See the timing diagram for Continuous Horn Pattern in Figure 3-3.

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TABLE 1-2: AC ELECTRICAL CHARACTERISTICS (CONTINUED)

AC Electrical Characteristics: Unless otherwise indicated, all parameters apply at T_A = -25°C to +75°C, V_{DD} = 9V, V_{SS} = 0V. Typical Application (unless otherwise noted).								
Parameter	**Symbol**	**Pin**	**Min.**	**Typical**	**Max.**	**Units**	**Clocks**	**Conditions**
Detection (STROBE, IRED)								
STROBE On Time	t_{STON}	STROBE	9.4	10.4	11.5	ms	1	Smoke Test, Chamber Test
IRED On Time	t_{IRON}	IRED	94	104	114	µs	0.01	Operating/Diagnostic Mode (Note 1)
Smoke Test Period (IRED and STROBE)	t_{PER0}	STROBE, IRED	9.6	10.7	11.7	s	1024	Standby, No Alarm
	t_{PER1}	STROBE, IRED	1.8	2.0	2.2	s	192	RE46C165/7 Only Standby, after One Valid Smoke Sample
		STROBE, IRED	2.4	2.7	2.9	s	256	RE46C166/8 Only Standby, after One Valid Smoke Sample
	t_{PER2}	STROBE, IRED	0.9	1.0	1.1	s	96	RE46C165/7 Only Standby, after Two Consecutive Valid Smoke Samples
		STROBE, IRED	1.2	1.3	1.5	s	128	RE46C166/8 Only Standby, after Two Consecutive Valid Smoke Samples
	t_{PER3}	STROBE, IRED	0.9	1.0	1.1	s	96	RE46C165/7 Only Local Alarm, after Three Consecutive Valid Smoke Samples
		STROBE, IRED	1.2	1.3	1.5	s	128	RE46C166/8 Only Local Alarm, after Three Consecutive Valid Smoke Samples
	t_{PER4}	STROBE, IRED	300	333	367	ms	32	Push Button Test
	t_{PER5}	STROBE, IRED	7.2	8.0	8.8	s	768	RE46C165/7 Only In Remote Alarm
		STROBE, IRED	9.6	10.7	11.7	s	1024	RE46C166/8 Only In Remote Alarm
	t_{PER6}	STROBE, IRED	38	43	47	s	4096	Chamber Test or Low-battery Test, No Alarm

Note 1: t_{POSC} and t_{IRON} are 100% production tested. All other timing is verified by functional testing.

2: During Timer mode, the LED period is 10.5s. The LED period returns to 43s at the conclusion of Timer mode.

3: See the timing diagram for Temporal Horn Pattern in Figure 3-2.

4: See the timing diagram for Continuous Horn Pattern in Figure 3-3.

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TABLE 1-2: AC ELECTRICAL CHARACTERISTICS (CONTINUED)

AC Electrical Characteristics: Unless otherwise indicated, all parameters apply at T_A = -25°C to +75°C, V_{DD} = 9V, V_{SS} = 0V. Typical Application (unless otherwise noted).								
Parameter	**Symbol**	**Pin**	**Min.**	**Typical**	**Max.**	**Units**	**Clocks**	**Conditions**
Horn Operation (HORNB, HORNS, FEED)								
Alarm On Time	t_{HON1}	HB, HS	450	500	550	ms	48	RE46C165/7 only Local or Remote Alarm (Note 3)
		HB, HS	225	250	275	ms	24	RE46C166/8 Only Local or Remote Alarm (Note 4)
Alarm Off Time	t_{HOF1}	HB, HS	450	500	550	ms	48	RE46C165/7 Only Local or Remote Alarm (Note 3)
		HB, HS	75	83	92	ms	8	RE46C166/8 only Local or Remote Alarm (Note 4)
	t_{HOF2}	HB, HS	1.35	1.50	1.65	s	144	RE46C165/7 only Local or Remote Alarm (Note 3)
Alarm Period	t_{HPER1}	HB, HS	3.60	4.00	4.40	s	384	RE46C165/7 only Local or Remote Alarm (Note 3)
		HB, HS	0.30	0.33	0.37	s	32	RE46C166/8 only Local or Remote Alarm (Note 4)
Low-battery or Chamber Fail Horn On Time	t_{HON2}	HB, HS	9.4	10.4	11.5	ms	1	Low-battery or Fail Chamber Test, No Alarm
Low-battery Horn Off Time	t_{HOF3}	HB, HS	38	43	47	s	4095	Low Battery, No Alarm
Low-battery or Chamber Fail Period	t_{HPER2}	HB, HS	38	43	47	s	4096	Low Battery, No Alarm
Chamber Fail Horn Off Time	t_{HOF4}	HB, HS	291	323	355	ms	31	Failed Chamber, No Alarm
Chamber Fail Pause Off Time	t_{HOF5}	HB, HS	38	42	46	s	4031	Failed Chamber, No Alarm
Push-to-Test Alarm Memory Off Time	t_{HOF6}	HB, HS	216	240	264	ms	23	Alarm Memory Active, Push-to-Test
Push-to-Test Alarm Memory Period	t_{HPER3}	HB, HS	225	250	275	ms	24	Alarm Memory Active, Push-to-test

Note 1: t_{POSC} and t_{IRON} are 100% production tested. All other timing is verified by functional testing.

2: During Timer mode, the LED period is 10.5s. The LED period returns to 43s at the conclusion of Timer mode.

3: See the timing diagram for Temporal Horn Pattern in Figure 3-2.

4: See the timing diagram for Continuous Horn Pattern in Figure 3-3.

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TABLE 1-2: AC ELECTRICAL CHARACTERISTICS (CONTINUED)

AC Electrical Characteristics: Unless otherwise indicated, all parameters apply at T_A = -25°C to +75°C, V_{DD} = 9V, V_{SS} = 0V. Typical Application (unless otherwise noted).

Parameter	Symbol	Pin	Min.	Typical	Max.	Units	Clocks	Conditions
Interconnect Signal Operation (I/O)								
I/O Active Delay	t_{IODLY1}	I/O	0.0	0.0	0.0	s	0	Local Alarm Start to I/O Active
Remote Alarm Delay	t_{IODLY2}	I/O	0.74	0.99	1.27	s	95	RE46C165/7 only No Local Alarm, I/O Active to Alarm
		I/O	0.37	0.57	0.81	s	55	RE46C166/8 only No Local Alarm, I/O Active to Alarm
I/O Charge Dump Duration	t_{IODMP}	I/O	0.89	0.99	1.09	s	95	RE46C165/7 only At Conclusion of Local Alarm or Test
		I/O	1.19	1.32	1.46	s	127	RE46C166/8 only At Conclusion of Local Alarm or Test
I/O Filter	t_{IOFILT}	I/O	—	—	0.30	s	32	Maximum I/O Pulse Width Filtered

Note 1: t_{POSC} and t_{IRON} are 100% production tested. All other timing is verified by functional testing.

2: During Timer mode, the LED period is 10.5s. The LED period returns to 43s at the conclusion of Timer mode.

3: See the timing diagram for Temporal Horn Pattern in Figure 3-2.

4: See the timing diagram for Continuous Horn Pattern in Figure 3-3.

TABLE 1-3: TEMPERATURE CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, V_{DD} = 9V and V_{SS} = 0V. Typical Application (unless otherwise noted).

Parameters	Symbol	Min.	Typical	Max.	Units	Conditions
Temperature Ranges						
Specified Temperature Range	T_A	-25	—	+75	°C	—
Operating Temperature Range	T_A	-25	—	+75	°C	—
Storage Temperature Range	T_{STG}	-55	—	+125	°C	—
Thermal Package Resistances						
Thermal Resistance, 16-Lead PDIP	θ_{JA}	—	70	—	°C/W	—
Thermal Resistance, 16-Lead SOIC	θ_{JA}	—	86.1	—	°C/W	—

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NOTES:

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2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Symbol	Function
1	C1	High-gain Capacitor Pin
2	C2	Normal-gain Capacitor Pin
3	DETECT	Photo Diode Input Pin
4	STROBE	Strobed Detection Negative Supply Pin
5	VDD	Positive Power Supply Pin
6	IRED	Infrared Emitting Diode Pin
7	I/O	Interconnect Pin
8	HB	Horn Brass Inverted Output Pin
9	HS	Horn Silver Output Pin
10	FEED	Horn Feedback Pin
11	LED	LED Driver Pin
12	COSC	Oscillator Capacitor Input Pin
13	ROSC	Oscillator Resistor Drive Low Pin
14	VSS	Negative Power Supply Pin
15	VSEN	Hush Timer Sensitivity Pin
16	TEST	Test Pin

2.1 High Gain Capacitor Pin (C1)

The capacitor connected to pin C1 sets the photo amplifier gain (high) for the push-to-test and chamber sensitivity test. The size of this capacitor depends on the chamber background reflections. The gain (high) is calculated using Equation 2-1 and must be < 10,000.

EQUATION 2-1:

$$Gain(A) = 1 + \frac{C_1}{10}$$

Where:

$Gain\ (A)$ = Amplifier Gain (dB)

C_1 = Gain Capacitor connected to C1 (pF)

2.2 Normal Gain Capacitor Pin (C2)

The capacitor connected to pin C2 sets the photo amplifier gain (normal) during standby. The value of this capacitor depends on the smoke sensitivity required. The gain (normal) is calculated using Equation 2-2.

EQUATION 2-2:

$$Gain(A) = 1 + \frac{C_2}{10}$$

Where:

$Gain\ (A)$ = Amplifier Gain (dB)

C_2 = Gain Capacitor connected to C2 (pF)

2.3 Photo Diode Input (DETECT)

This pin is normally connected to the cathode of an external photo diode operated at zero bias.

2.4 Strobed Detection Negative Supply Pin (STROBE)

This pin is the regulated output voltage of V_{DD} – 5, which is active during a test for smoke. The pin is the negative side of the photo amplifier reference circuitry.

2.5 Positive Power Supply Pin (VDD)

This pin is the positive power supply input of the smoke detector.

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2.6 Infrared Emitting Diode Pin (IRED)

This pin provides a regulated pulsed output voltage pre-driver for the infrared emitter. The pin usually drives the base of an NPN transistor.

2.7 Interconnect Pin (I/O)

Use this bidirectional pin to connect many detectors in a single system. If one unit goes into alarm, the I/O pin is driven high causing all the interconnected detectors to alarm.

This pin has an internal pull-down device.

2.8 Horn Brass, Inverted Output (HB)

This pin connects to the metal electrode of a piezoelectric transducer.

2.9 Horn Silver Output Pin (HS)

This pin is a complementary output to the HB pin and connects to the ceramic electrode of the piezoelectric transducer.

2.10 Horn Feedback Pin (FEED)

This pin connects to the feedback electrode through a current limiting resistor.

When the horn is enabled, the pin drives the buffered output HS pin and the complementary output HB pin.

If not used, ensure this pin connects to V_{DD} or V_{SS}.

2.11 LED Driver Pin (LED)

This pin is an open-drain NMOS output used to drive a visible LED.

2.12 Oscillator Capacitor Input (COSC)

A capacitor connected to this pin, with a parallel resistor, sets the internal clock low time, which is approximately the clock period.

2.13 Oscillator Resistor Drive Low (ROSC)

A resistor between this pin and the COSC pin sets the internal clock high time. This also sets the IRED pulse width.

2.14 Negative Power Supply Pin (VSS)

This pin is the negative power supply input of the smoke detector.

2.15 Hush Timer Sensitivity Pin (VSEN)

In Timer mode, use this input to set an external smoke comparator reference.

2.16 Test Pin (TEST)

Use this input to enter two Test modes (push-to-test and chamber test) and the Timer mode.

This input has an internal pull-down.

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3.0 DEVICE DESCRIPTION

3.1 Introduction

The RE46C165/6/7/8 family of devices are low-power, CMOS photoelectric smoke detector ICs. With minimal external components, these circuits provide all required features for a photoelectric smoke detector.

Each design incorporates a gain-selectable photo amplifier for use with an infrared emitter/detector pair.

3.2 Internal Timing

With the external components specified under Typical Application for pins ROSC and COSC, the internal oscillator has a nominal period of 10 ms. The analog circuitry is powered down to minimize standby current (typically 4 µA at 9V). Once every 10s, the detection circuitry (normal amplifier gain) is powered up for 10 ms. Prior to the completion of the 10 ms period, the IRED pulse is active for 100 µs. At the conclusion of the 10 ms period, the photo amplifier is compared to an internal reference to determine the chamber status, which is then latched. If a smoke condition is present, the device decreases the period to the next detection and makes two more photo chamber checks. Three consecutive smoke detections cause RE46C165/6/7/8 to alarm and its horn circuit and interconnect to activate.

Once every 43s, the following tests occur:

- Low-battery Test – the status of the battery voltage is checked and latched at the conclusion of the 10 ms LED pulse. For details, see **LED Pulse**.
- Photo Chamber Test – the photo chamber is activated and checked by amplifying background reflections using High-Gain mode (capacitor C_1).

If either the low-battery test or the photo chamber test fails, the horn chirps for 10 ms every 43s.

The oscillator period is determined by the values of R_9, R_{12} and C_5 (see Typical Application). The oscillator period is as shown in Equation 3-1.

EQUATION 3-1:

$$t_{POSC} = t_R + t_F$$

$$t_R = 0.693 \cdot R_{12} \cdot C_5$$

$$t_F = 0.693 \cdot R_9 \cdot C_5$$

Where:

t_{POSC} = Oscillator Period (ms)
R_{12} = Oscillator Resistor (MΩ)
C_5 = Oscillator Capacitor (nF)
R_9 = Oscillator Resistor (kΩ)

3.3 Smoke Detection Circuit

A comparator takes the value of the photo amplifier output voltage and compares it to an internal reference voltage. If three consecutive smoke detections are made, RE46C165/6/7/8 goes into local alarm and the horn activates. In local alarm, the normal amplifier gain (capacitor C_2) internally increases by approximately ten percent to provide alarm hysteresis.

3.4 Push-to-Test Operation

If the TEST pin is activated (V_{IH4}), smoke detection is sampled at a high rate. RE46C166/8 samples at a period of 330 ms. RE46C165/7 has a first sample delay of up to 330 ms. After one sample, the smoke detection rate increases to once every 250 ms. In this mode, the high-gain capacitor C_1 is selected and background reflections are used to simulate a smoke condition. After the required three consecutive smoke detections, the device goes into a local alarm condition.

When the TEST pin is deactivated (V_{IL4}) and one clock cycle passes, the normal gain capacitor C_2 is selected. The detection rate continues, once every 330 ms for RE46C166/8 and every 250 ms while the horn is not sounding for RE46C165/7. When three consecutive 'no smoke' conditions are detected, the detector returns to standby timing.

Push-to-test does not work while the alarm memory is set. The alarm memory notification is activated instead.

3.5 LED Pulse

While in standby, the LED pulses on for 10 ms once every 43s. In a local alarm or push-to-test alarm condition, the LED pulse frequency increases once every 0.5s. In the case of a remote alarm, the LED is not active. While operating in Timer mode, the LED pulses on for 10 ms every 10s.

3.6 Low-Battery Detection

While in standby, an internal reference is compared to the voltage divided V_{DD} supply. A low-battery status is latched at the conclusion of the LED pulse. The horn chirps once for 10 ms every 43s until the low-battery condition no longer exists. The low-battery chirp occurs at the same time as the LED pulse.

The low-battery notification does not sound in a local or remote alarm condition.

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3.7 Interconnect

The bidirectional I/O pin allows the interconnection of multiple detectors. In a local alarm condition, this pin is driven high immediately through a constant-current source. Shorting this output to ground does not cause excessive current. The I/O pin is ignored as an input during a local alarm.

The I/O pin has a 280 kΩ nominal pull-down resistor, so the pin can be left unconnected.

The I/O pin also has an NMOS discharge device that is active for 1s after the conclusion of any type of local alarm. This device helps to quickly discharge any capacitance associated with the interconnect line.

If a remote active-high signal is detected, the detector goes into remote alarm and the horn activates. Internal protection circuitry allows for the signaling unit to have a higher supply voltage than the signaled unit without excessive current draw.

The I/O pin has a digital filter that ensures pulses of up to 300 ms are filtered out. Filtered pulses are ignored and do not affect internal timing of the part. This allows RE46C165/6/7/8 to interconnect with other types of detectors (for example, carbon monoxide) that have a pulsed interconnect signal.

The remote alarm delay (370 ms to 1.27s) specifies the time from the interconnect going active to sounding the piezoelectric horn alarm.

3.8 Chamber Fail Detection

In standby, a chamber test is also performed every 43s by switching to the high-gain capacitor C_1 and sensing the photo chamber background reflections. Two consecutive chamber test failures cause the horn to chirp three times for 10 ms, spaced 323 ms apart. This repeats every 42s, as long as a photo chamber test fail exists. The failed chamber test chirps occur ~21s after the LED pulse in Standby mode (not hush).

The chamber fail notification does not sound in a local or remote alarm condition.

3.9 Timer Mode

If resistors R_{ADJ1} and R_{ADJ2} (see Typical Application) are in place and a high-to-low transition occurs on the TEST pin, the detector enters Timer mode (10 minutes maximum for RE46C165/6 or one-minute maximum for RE46C167/8). In this mode, the smoke comparator reference is switched from the internal V_{DD} – 3.5V reference to the voltage that appears on the VSEN pin. This allows to modify the sensitivity for the duration of the Timer mode. High-gain operations (push-to-test and chamber test) always use the internal V_{DD} – 3.5V reference. The chamber test is performed in Timer mode.

If the VSEN pin floats or connects to V_{SS}, Hush Timer mode operation is inhibited.

If the smoke level exceeds the reduced sensitivity set point during Timer mode, the detector goes into a local alarm condition, the horn sounds and Timer mode is cancelled. If an external only alarm occurs during Timer mode, the mode is cancelled.

Pushing the test button in Standby Reduced Sensitivity mode, the detector is tested normally. Upon release of the test button, the 10-minute maximum Timer mode counter is reset and restarted.

3.10 Alarm Memory

If a detector entered a local alarm, the alarm memory latch is set when exiting the local alarm. Initially, the LED can be used to visually identify any detector that previously was in a local alarm condition. The LED flashes three times, spaced 1.3s apart. This pattern repeats every 43s. The duration of the flash is 10 ms. In order to conserve battery power, this visual indication stops after a period of 24 hours.

To identify a detector with an active alarm memory, press the push-to-test button. When this button is active, the horn chirps and the LED pulses on for 10 ms every 250 ms. The push-to-test alarm does not activate until the alarm memory is reset.

If the alarm memory condition is set, any time the push-to-test button is pressed and then released, the alarm memory latch is reset.

The initial 24-hour visual indication is not displayed if a low-battery condition exits.

3.11 Diagnostic Mode

In addition to the normal function of the TEST pin, a special Diagnostic mode is available to calibrate and test the smoke detector. Enable Diagnostic mode by taking the TEST pin below V_{SS} and sourcing ~200 µA out of the pin for one clock cycle. In Diagnostic mode, some of the pin functions are redefined. Refer to Table 3-1 for the redefined pin functions in Diagnostic mode. In addition, in this mode, the STROBE pin is always enabled and the IRED is pulsed at the clock rate of 10 ms nominal.

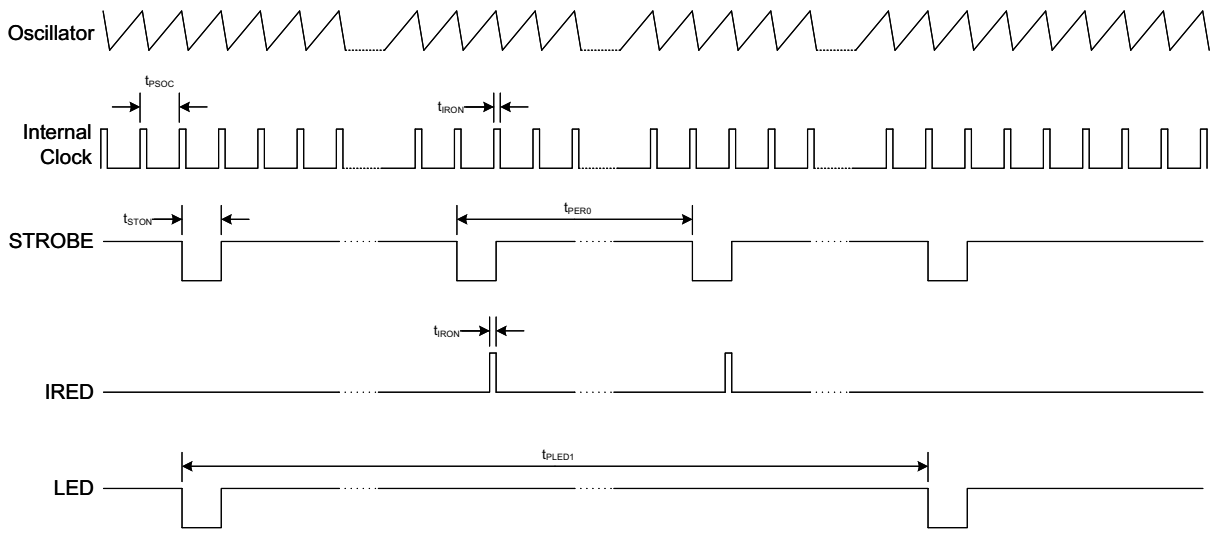
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TABLE 3-1: DIAGNOSTIC MODE PIN FUNCTION

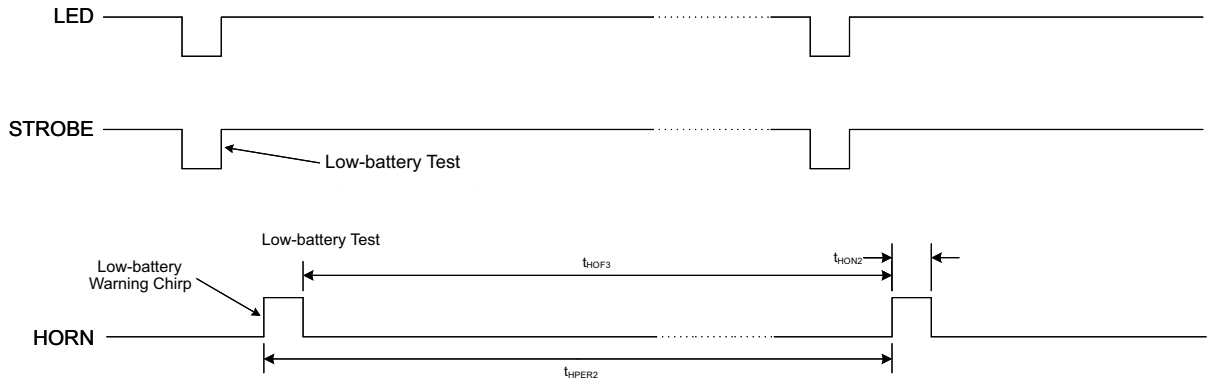
Pin Name	Pin Number	Function
I/O	7	This pin is disabled as output. A high signal on the I/O pin directs the photo amplifier output to pin C1 or C2, determined by the level on the VSEN pin. Amplification occurs during the IRED active time.
VSEN	15	If the I/O pin is driven high, then the VSEN pin controls what gain capacitor is used. If the VSEN pin is driven low, normal gain is selected and the photo amplifier output appears on the C1 pin. If the VSEN pin is driven high, high gain is selected and the photo amplifier output is on the C2 pin.
FEED	10	If the VSEN pin is driven low, then taking the FEED pin high enables hysteresis, which is a nominal 10% gain increase in Normal Gain mode.
COSC	12	If desired, the COSC pin can be driven by an external clock.
HB	8	This pin becomes the smoke integrator output. A high level on this pin indicates that an alarm condition was detected.
LED	11	The LED pin is used as a low-battery indicator. When V_{DD} is above the low-battery threshold, the open-drain NMOS is off. When V_{DD} falls below the threshold, the NMOS turns on.

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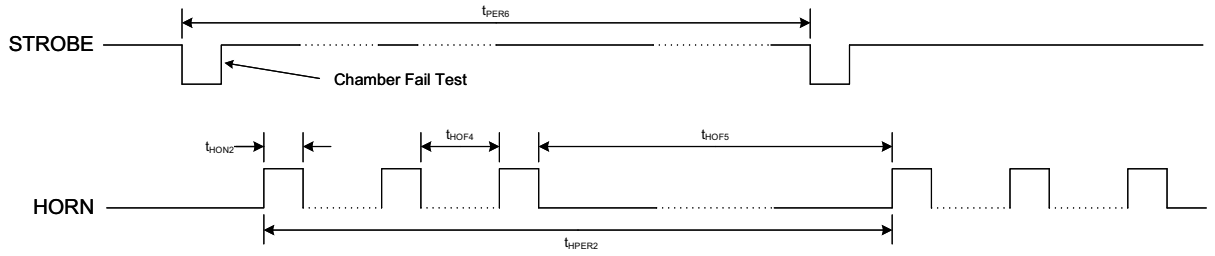
Standby, No Alarm (Not to Scale)



Low Supply Test Failure



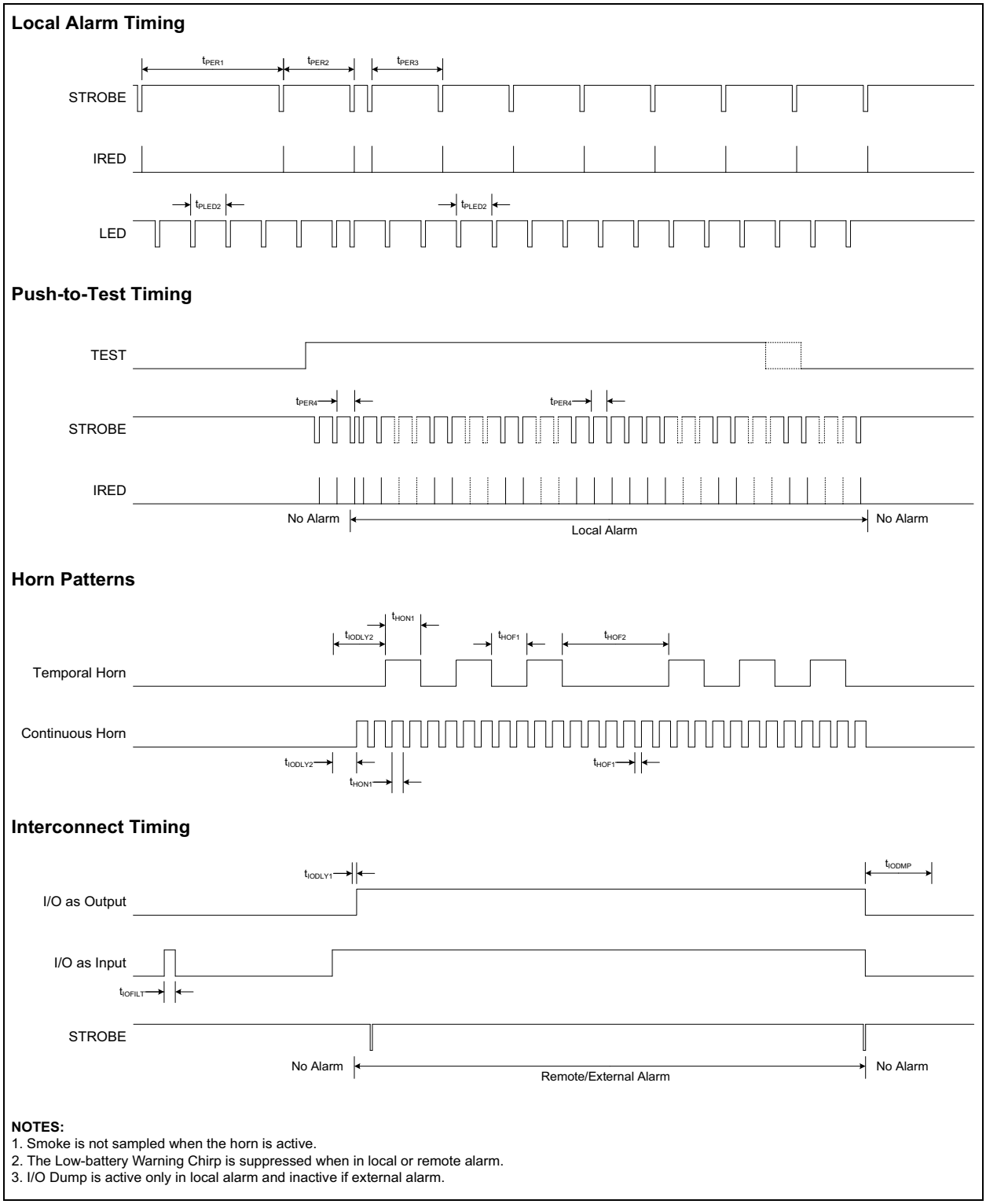
Chamber Fail Test Failure



NOTE:
The Chamber Test and Warning are offset from a Low-battery Test and Warning by 21.3s.

FIGURE 3-1: *RE46C165/6/7/8 Timing Diagram – Standby, Low Battery, Chamber Fail.*

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NOTES:
1. Smoke is not sampled when the horn is active.
2. The Low-battery Warning Chirp is suppressed when in local or remote alarm.
3. I/O Dump is active only in local alarm and inactive if external alarm.

FIGURE 3-2: *RE46C165/6/7/8 Timing Diagram – Local and Remote Alarm.*

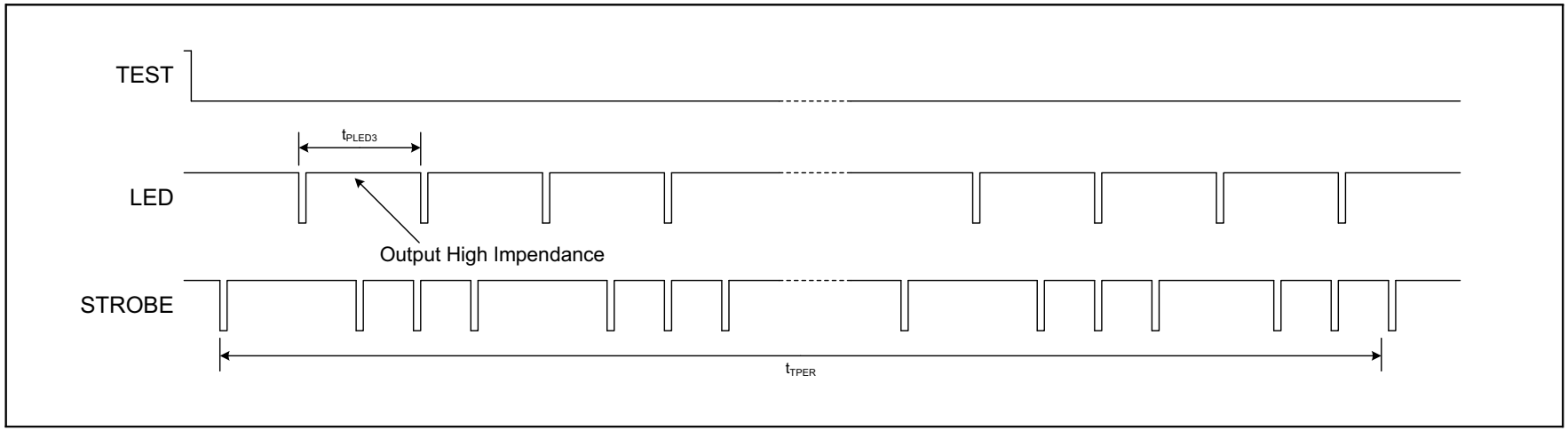


FIGURE 3-3: *RE46C165/6/7/8 Timing Diagram – Timer Mode.*

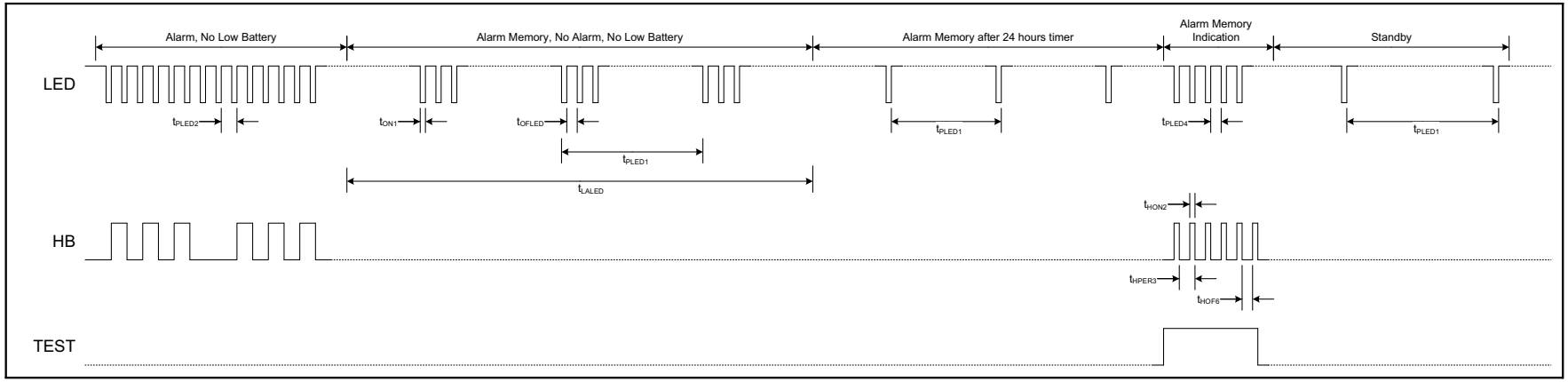


FIGURE 3-4: *RE46C165/7 Timer Diagram – Alarm Memory Mode, Temporal Horn Pattern.*

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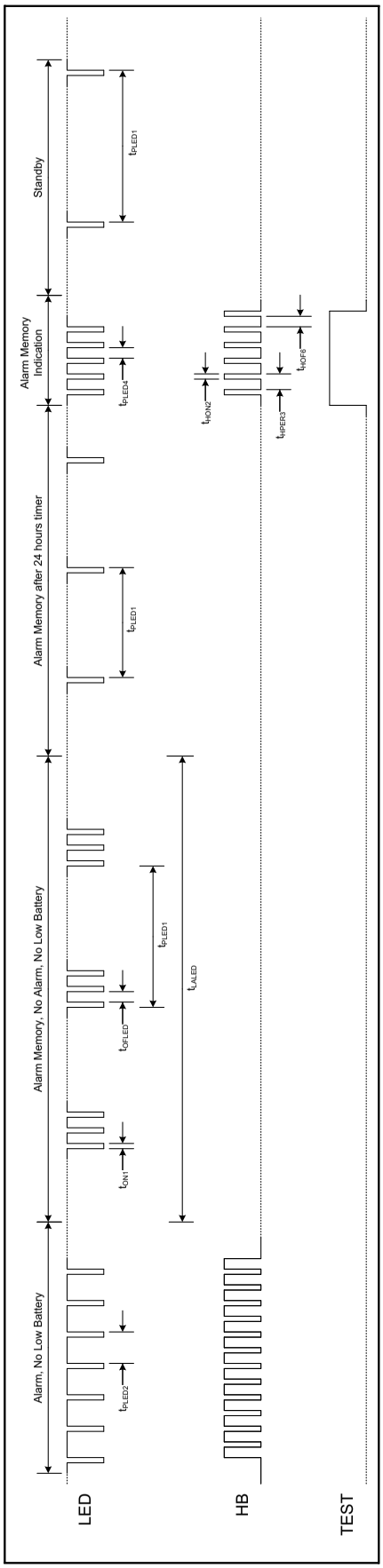


FIGURE 3-5: *RE46C166/8 Timer Diagram – Alarm Memory Mode, Continuous Horn Pattern.*

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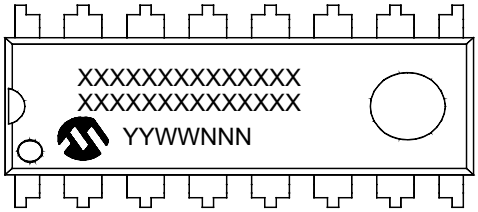
NOTES:

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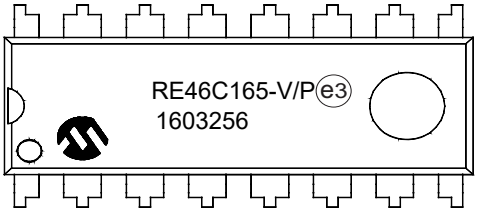
4.0 PACKAGING INFORMATION

4.1 Package Marking Information and Package Drawings

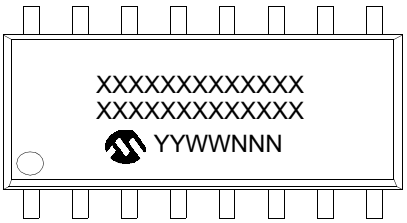
16-Lead PDIP (300 mil.)



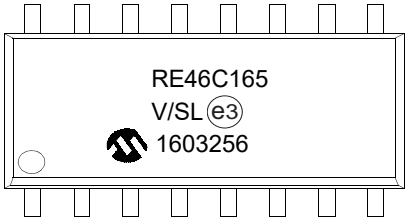
Example:



16-Lead SOIC (3.9 mm)



Example:

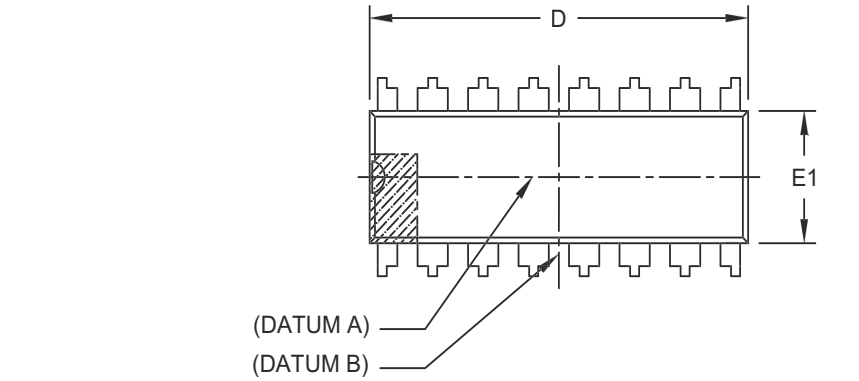


Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free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

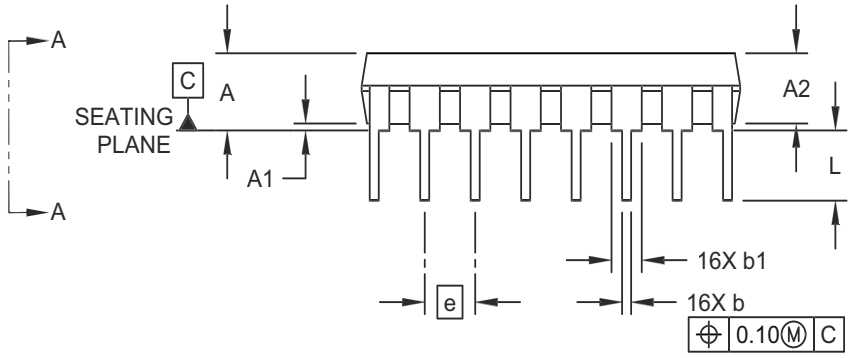
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

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

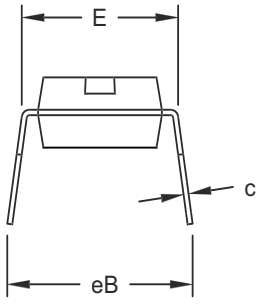
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



TOP VIEW



SIDE VIEW



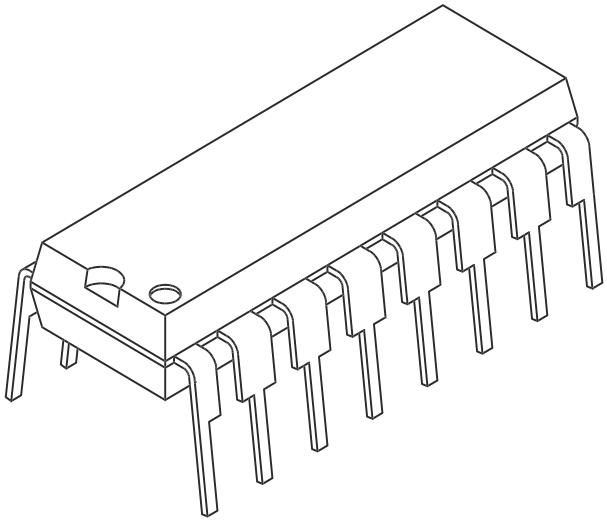
VIEW A-A

Microchip Technology Drawing C04-00017 Rev C (P) Sheet 1 of 2

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

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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	.750	.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 E do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" per side.
4. Dimensioning and tolerancing per ASME Y14.5M

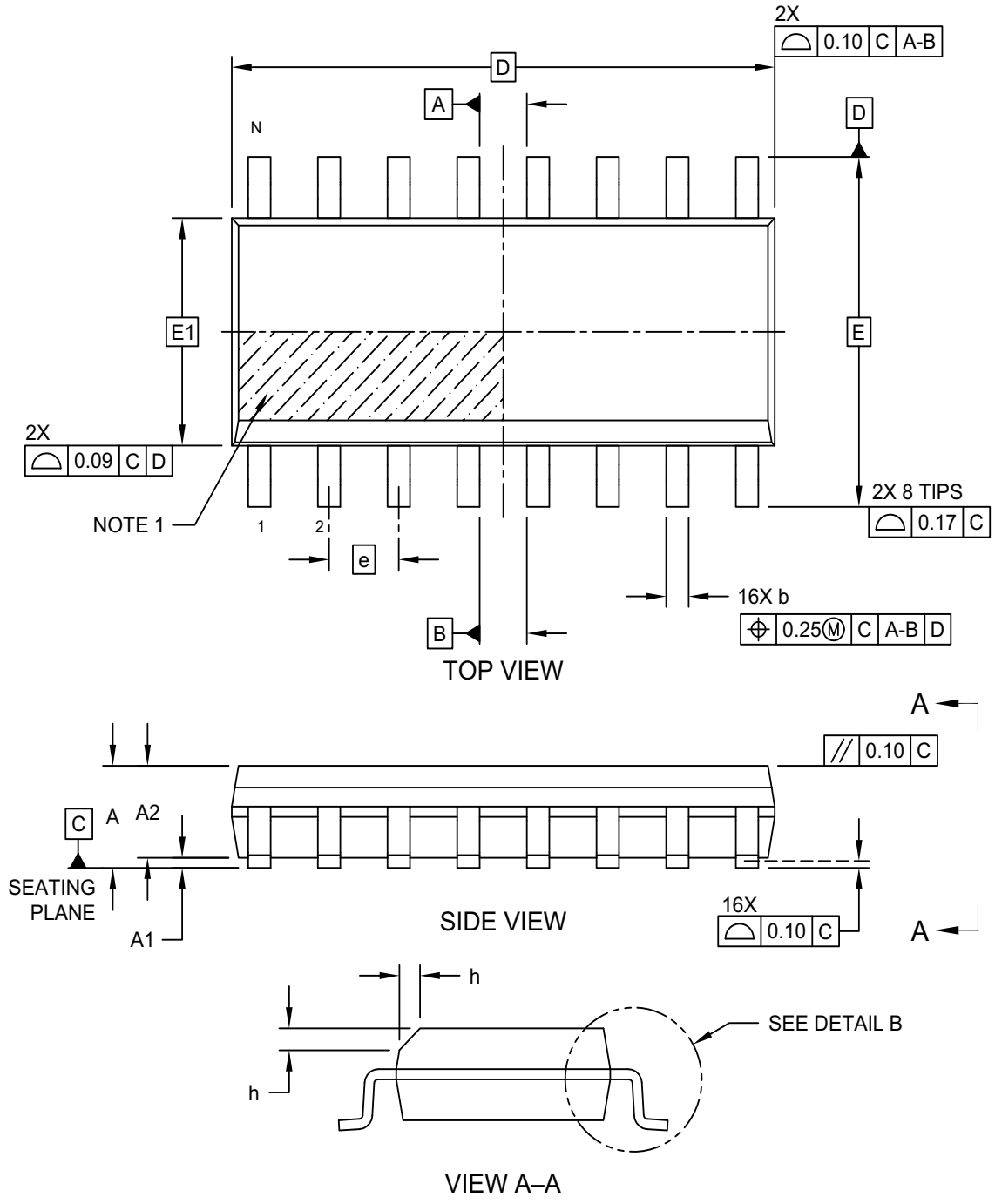
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-00017 Rev C (P) Sheet 2 of 2

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16-Lead Plastic Small Outline (D7X) - Narrow, 3.90 mm Body [SOIC]

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

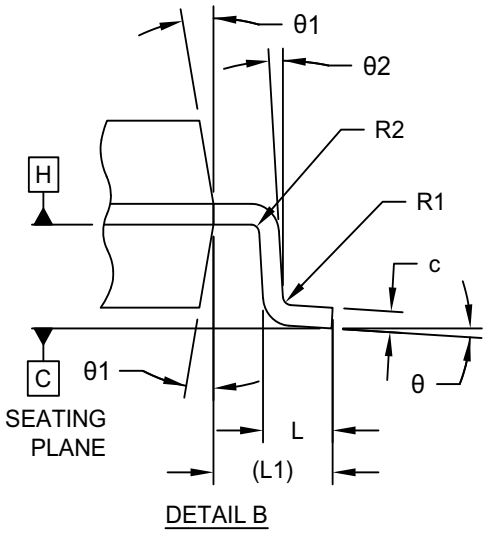


Microchip Technology Drawing C04-108-D7X Rev E Sheet 1 of 2

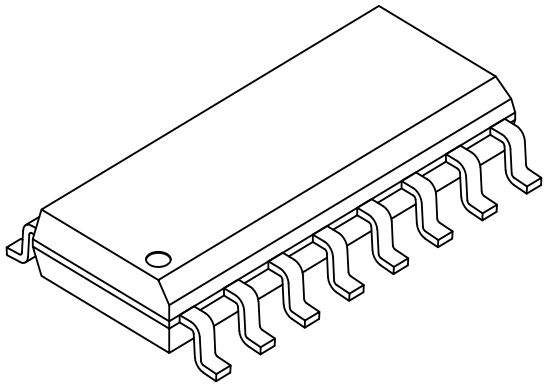
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16-Lead Plastic Small Outline (D7X) - Narrow, 3.90 mm Body [SOIC]

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



DETAIL B



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N		16	
Pitch	e		1.27 BSC	
Overall Height	A	-	-	1.75
Standoff §	A1	0.10	-	0.25
Molded Package Thickness	A2	1.25	-	–
Overall Length	D		9.90 BSC	
Overall Width	E		6.00 BSC	
Molded Package Width	E1		3.90 BSC	
Terminal Width	b	0.31	-	0.51
Terminal Thickness	c	0.10	-	0.25
Corner Chamfer	h	0.25	-	0.50
Terminal Length	L	0.40	-	1.27
Footprint	L1		1.04 REF	
Lead Bend Radius	R1	0.07	-	-
Lead Bend Radius	R2	0.07	-	-
Foot Angle	θ	0°	-	8°
Mold Draft Angle	θ1	0°	-	15°
Lead Angle	θ2	0°	-	-

Notes:

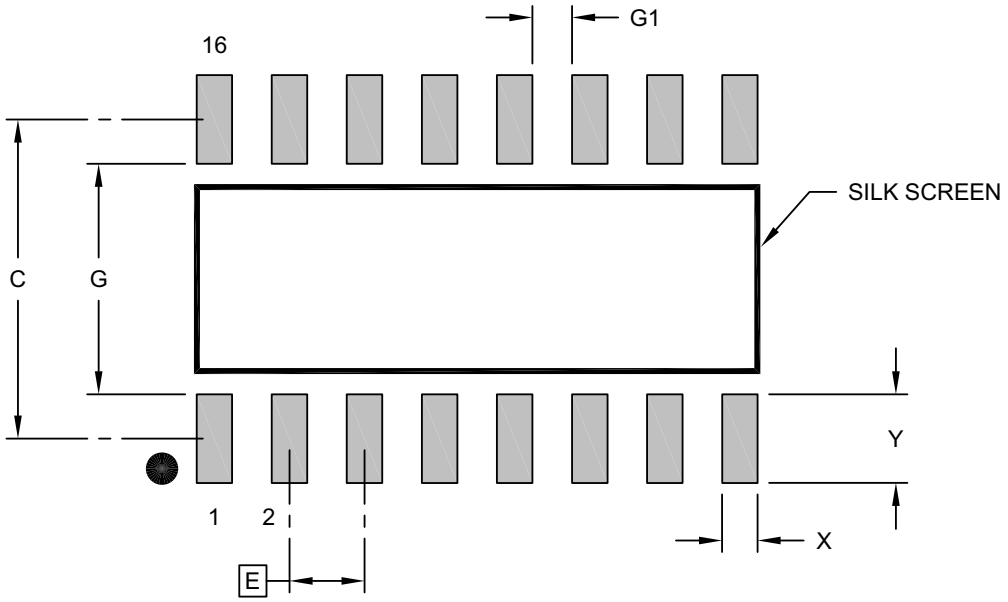
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimension D does not include mold flash, protrusions or gate burrs, which shall not exceed 0.15 mm per end. Dimension E1 does not include interlead flash or protrusion, which shall not exceed 0.25 mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.
5. Datums A & B to be determined at Datum H.

Microchip Technology Drawing C04-108-D7X Rev E Sheet 2 of 2

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16-Lead Plastic Small Outline (D7X) - Narrow, 3.90 mm Body [SOIC]

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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		1.27 BSC	
Contact Pad Spacing	C		5.40	
Contact Pad Width (X16)	X			0.60
Contact Pad Length (X16)	Y			1.50
Contact Pad to Contact Pad (X8)	G	3.90		
Contact Pad to Contact Pad (X14)	G1	0.67		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-2108-D7X Rev E

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APPENDIX A: REVISION HISTORY

Revision C (February 2025)

- Removed mentions of Underwriters Laboratory Specifications UL217 and UL268.
- Updated Functional Block Diagram and Typical Application.
- Updated Figure 3-1 through Figure 3-5.
- Updated **Section 4.1, "Package Marking Information and Package Drawings"**.
- Updated **Product Identification System** section.

Revision B (March 2016)

- Removed the 16-Lead SOIC (300 mil.) package reference from Temperature Characteristics table, **Section 4.1, "Package Marking Information and Package Drawings"** and **Product Identification System** section.
- Updated Package Drawings for 16-Lead SOIC (150 mil.) package in **Section 4.0, "Packaging Information"**.

Revision A (May 2010)

- Original release of this document.

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NOTES:

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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](1)	X
Device	Package	Number of Pins	Tape and Reel Option	Lead Free

Device:	RE46C165	= CMOS Photoelectric Smoke Detector ASIC
	RE46C166	= CMOS Photoelectric Smoke Detector ASIC
	RE46C167	= CMOS Photoelectric Smoke Detector ASIC
	RE46C168	= CMOS Photoelectric Smoke Detector ASIC
Package:	E	= Plastic Dual In-Line – 300 mil. Body, PDIP
	S	= Plastic Small Outline – Narrow, 3.9 mm Body, SOIC
Number of Pins:	16	= 16-Lead
Tape and Reel Option:	Blank	= Standard packaging (tube or tray)
	T	= Tape and Reel(1)
Lead Free:	F	= Lead Free

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

Examples:

a) RE46C165E16F = CMOS Photoelectric Smoke Detector ASIC, PDIP, 16-Lead, Lead Free

b) RE46C165S16F = CMOS Photoelectric Smoke Detector ASIC, SOIC, 16-Lead, Lead Free

c) RE46C165S16TF = CMOS Photoelectric Smoke Detector ASIC, SOIC, 16-Lead, Tape and Reel, Lead Free

d) RE46C166E16F = CMOS Photoelectric Smoke Detector ASIC, PDIP, 16-Lead, Lead Free

e) RE46C166S16F = CMOS Photoelectric Smoke Detector ASIC, SOIC, 16-Lead, Lead Free

f) RE46C166S16TF = CMOS Photoelectric Smoke Detector ASIC, SOIC, 16-Lead, Tape and Reel, Lead Free

g) RE46C167E16F = CMOS Photoelectric Smoke Detector ASIC, PDIP, 16-Lead, Lead Free

h) RE46C167S16F = CMOS Photoelectric Smoke Detector ASIC, SOIC, 16-Lead, Lead Free

i) RE46C167S16TF = CMOS Photoelectric Smoke Detector ASIC, SOIC, 16-Lead, Tape and Reel, Lead Free

j) RE46C168E16F = CMOS Photoelectric Smoke Detector ASIC, PDIP, 16-Lead, Lead Free

k) RE46C168S16F = CMOS Photoelectric Smoke Detector ASIC, SOIC, 16-Lead, Lead Free

l) RE46C168S16TF = CMOS Photoelectric Smoke Detector ASIC, SOIC, 16-Lead, Tape and Reel, Lead Free

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- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip product is strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is “unbreakable”. Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.