MC14470

Advance Information

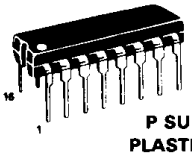
Ionization Smoke Detector with I/O
For Line-Powered Applications

The CMOS MC14470 is a smoke detector component containing both analog and digital circuitry. The IC is used with an ionization chamber. When detection occurs, a pulsating alarm is sounded via on-chip push-pull drivers and an external piezoelectric transducer.

An on-chip driver causes an external LED lamp to be illuminated when the MC14470 is receiving power in the standby mode. The lamp remains illuminated if a remote smoke condition is sensed at the I/O pin. During a local smoke condition, the lamp is extinguished.

The I/O pin, in combination with V_{SS}, can be used to interconnect up to 40 units for common signaling. An on-chip current sink provides noise immunity when the I/O is an input. A local-smoke condition activates the short-circuit-protected I/O driver, thereby signaling remote smoke to the interconnected units. Additionally, the I/O pin can be used to activate escape lights, enable auxiliary or remote alarms, and/or initiate auto-dialers.

- Complies with the UL217 and UL268 Specifications
- Operating Voltage Range: 6 to 12 V
- Direct Interface to Ionization Chamber
- Electrostatic Discharge (ESD) and Latch Up Protection Circuitry on All Pins
- Detect Threshold is Internally Set
- Power-On Reset (POR) Prevents False Alarms on Power Up

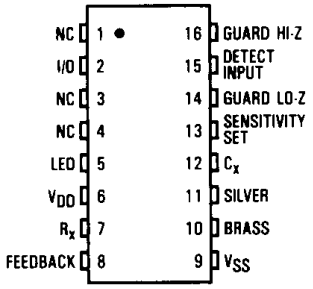


P SUFFIX
PLASTIC DIP
CASE 648

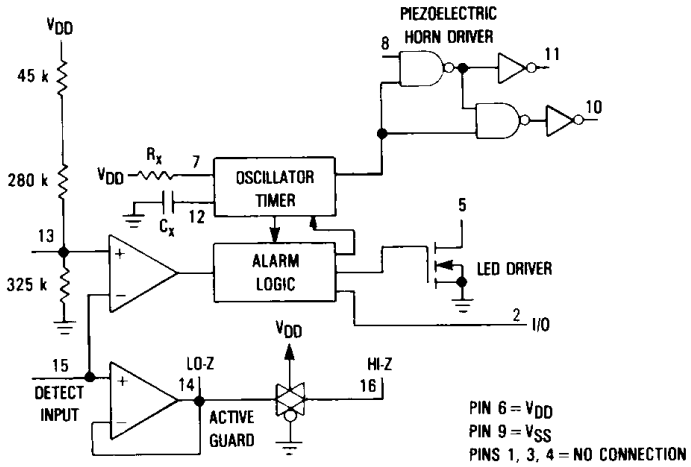
ORDERING INFORMATION

MC14470P	Plastic DIP

PIN ASSIGNMENT



BLOCK DIAGRAM



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This document contains information on a new product. Specifications and information herein are subject to change without notice.

MAXIMUM RATINGS* (Voltages Referenced to V_{SS})

Symbol	Parameter	Value	Unit
V_{DD}	DC Supply Voltage	−0.5 to +15	V
V_{in}	DC Input Voltage, All Inputs Except Pin 8	−0.25 to V_{DD} + 0.25	V
I_{in}	DC Input Current, per Pin, Except Pin 15 = 1 mA	±10	mA
I_{out}	DC Output Current, per Pin	±30	mA
T_{stg}	Storage Temperature	−55 to +125	°C
T_L	Lead Temperature, 1 mm from Case for 10 Seconds	260	°C

*Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the limits in the Electrical Characteristics tables.

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range $V_{SS} \le (V_{in}$ or $V_{out}) \le V_{DD}$ except for pin 8, which can exceed V_{DD}.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.

RECOMMENDED OPERATING CONDITIONS (Voltages Referenced to V_{SS})

Symbol	Parameter	Value	Unit
V_{DD}	DC Supply Voltage	7.2 to 12	V
C_x	Timing Capacitor (Can Use Up to ±20% Tolerance)	0.1	μF
R_x	Timing Resistor (Can Use Up to ±20% Tolerance)	8.2	MΩ
T_A	Operating Temperature	−10 to +60	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C, Voltages Referenced to V_{SS})

Symbol	Parameter		Test Condition	V_{DD} V	Min	Max	Unit
V_{DD}	Power Supply Voltage Range			–	6.0	12	V
I_{DD}	Average Operating Supply Current		R_x = 8.20 MΩ	9.0 12.0	– –	9.0 12.0	μA
V_{in}	Input Voltage Range	Feedback		–	−10	V_{DD} + 10	V
V_{ref}	Smoke Comparator Reference Voltage			–	47	53	%V_{DD}
V_{hys}	Hysteresis Voltage		Alarm Condition, Pin 13	9.0	75	150	mV
V_{CM}	Common Mode Voltage Range	Detect Input		–	0.6	V_{DD} − 2	V
V_{OS}	Offset Voltage	Active Guard Detect Comparator	$V_{in} = V_{DD}/2$	9.0 9.0	– –	±100 ±50	mV
I_{in}	Input Leakage Current	Feedback	$V_{in} = V_{DD}$ or V_{SS}	9.0	–	±0.1	μA
		Detect Input Detect Input @ 50°C	$V_{in} = V_{DD}$ or V_{SS}	9.0	– –	±1 ±5	pA
C_{in}	Input Capacitance			–	–	TBD	pF
V_{IL}	Input Voltage	I/O	No Remote Smoke	–	–	1.5	V
V_{IH}			Remote Smoke		3.0	–	
I_{IH}	Pull-Down Current	I/O	No Local Smoke $V_{in} = V_{DD} - 2$ V	–	25	100	μA
I_{OH}	Output Current	I/O	Local Smoke $V_{out} = V_{DD} - 2$ V	–	−4.0	−16	mA
V_{OH}	High-Level Output Voltage	Piezoelectric Horn Drivers	I_{out} = −16 mA	7.2	6.3	–	V
V_{OL}	Low-Level Output Voltage	Piezoelectric Horn Drivers	I_{out} = 16 mA	7.2	–	0.9	V
V_{OL}	Low-Level Output Voltage	LED Driver	I_{out} = 10 mA	7.2	–	3.0	V
Z_{out}	Output Impedance, Active Guard	Lo-Z, Pin 14 Hi-Z, Pin 16		9.0 9.0	– –	10 1000	kΩ

AC ELECTRICAL CHARACTERISTICS ($T_A = 25°C$, $V_{DD} = 9.0$ V, $C_X = 0.10$ μF, $R_X = 8.20$ MΩ, See Figure 4)

Symbol	Parameter	Test Condition		Min	Max	Unit
$1/f_{osc}$	Oscillator Period	Free-Running Sawtooth Measured at Pin 12	No Alarm	1.34	2.0	s
			Alarm	32	48	ms
t_r	Oscillator Rise Time			8	12	ms
$t_{w(Horn)}$	Horn Pulse Width	During Alarm Condition	On	120	208	ms
			Off	60	104	

DEVICE OPERATION

TIMING

The internal oscillator of the MC14470 operates with a nominal period of 1.67 seconds during non-alarm conditions. Each 1.67 seconds, internal power is applied to the entire IC and a check is made for an alarm state, except during horn modulation (in alarm condition).

The oscillator capacitor should be of a low-leakage type because of the low-current oscillator employed. Lastly, the tolerance of the external timing components must be no greater than ±20%.

DETECT CIRCUITRY

If smoke is detected, the oscillator period becomes approximately 40 ms and the piezoelectric horn oscillator circuit is enabled. The horn output is modulated approximately 160 ms on, 80 ms off. During the off time, the smoke condition is again checked and further horn output is inhibited if a smoke condition is not sensed.

The LED tied to pin 5 is normally on to indicate that the device is receiving power. When a remote smoke condition is sensed by the I/O pin, the LED remains lit. During a local smoke condition, the LED is extinguished.

An active guard is provided on both pins adjacent to the detect input. The voltage at these pins is within 100 mV of the input signal. This keeps surface leakage currents to a minimum and provides a method of measuring the input voltage without loading the detect input pin. The active guard op amp is not power strobed and thus gives constant protection from surface leakage currents. The Detect Input has internal diode protection against static damage.

SENSITIVITY THRESHOLD

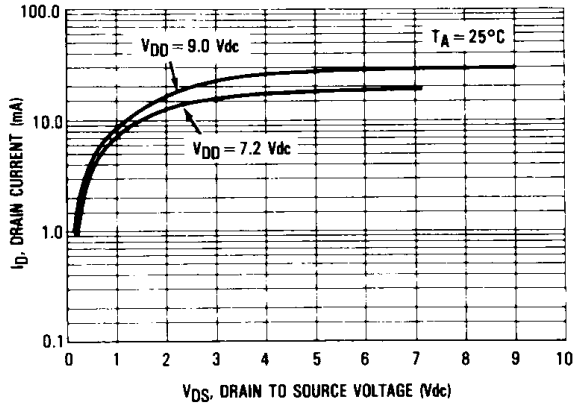
The sensitivity threshold is set internally by a voltage divider connected between V_{DD} and V_{SS}. The voltage can be altered by an external resistor connected from pin 13 to either V_{DD} or V_{SS}. The sensitivity threshold can also be set by adjusting the smoke chamber ionization source.

INTERCONNECT

The I/O (Pin 2), in combination with V_{SS}, is used to interconnect up to 40 remote units for common signaling. A Local Smoke condition activates a current limited output driver, thereby signaling Remote Smoke to interconnected units. A small current sink improves noise immunity during non-smoke conditions. Remote units at lower voltages do not draw excessive current from a sending unit at a higher voltage. The I/O is disabled for three oscillator cycles after power up, to eliminate false alarming of remote units.

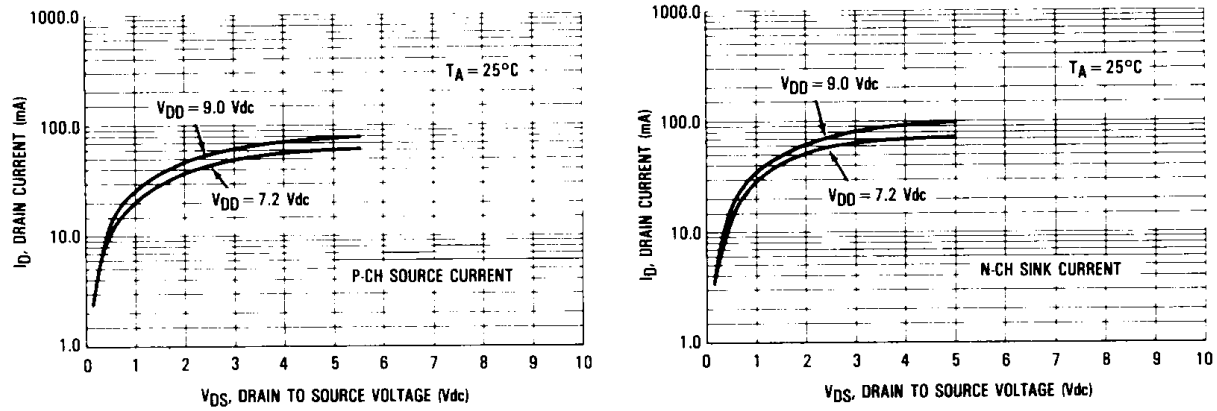
HYSTERESIS

When an alarm is detected, the resistor/divider network that sets sensitivity is altered to increase sensitivity. This yields approximately 100 mV of hysteresis and reduces intermittent triggering.



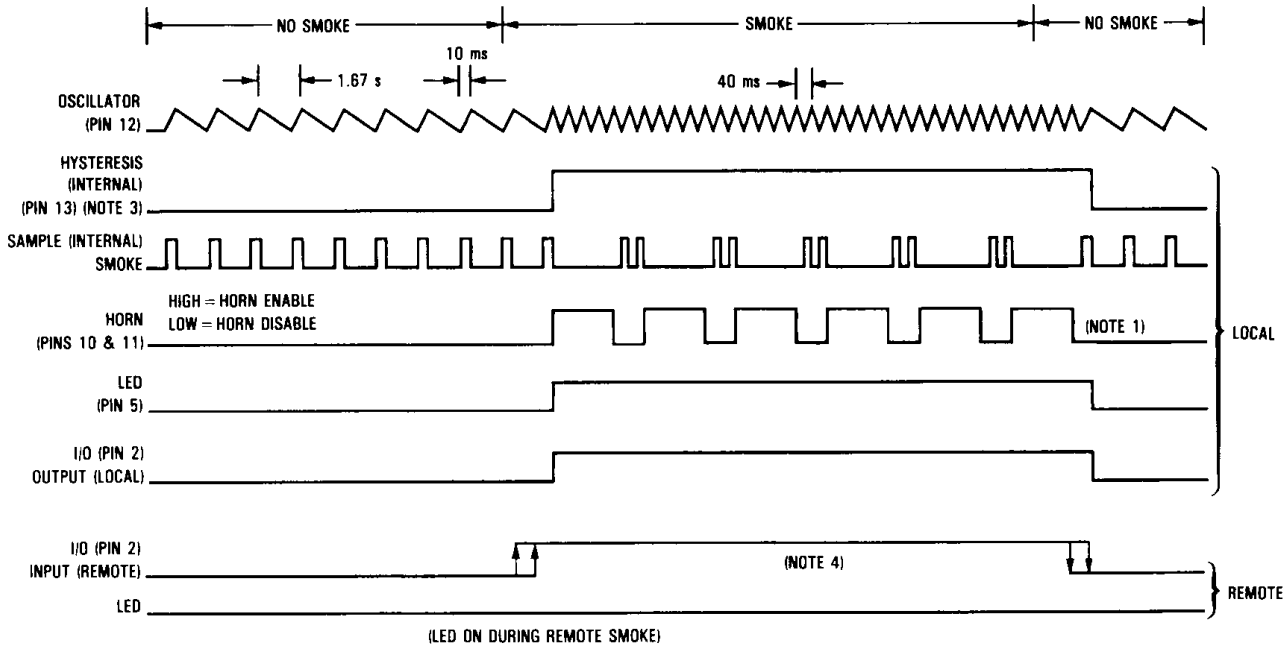
NOTE: This "typical" graph is not to be used for design purposes but is intended as an indication of the IC's potential performance.

Figure 1. Typical LED Output I-V Characteristic



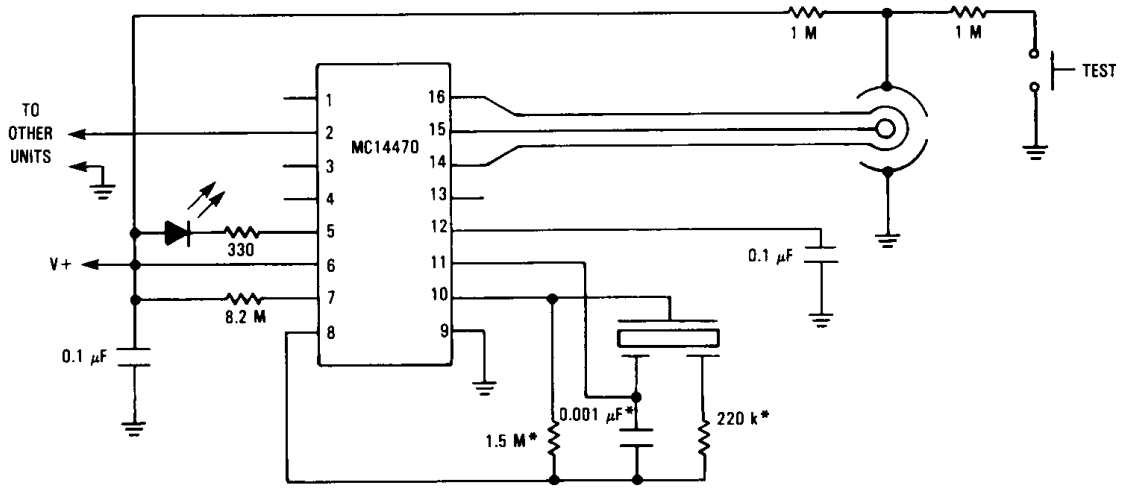
NOTE: These "typical" graphs are not to be used for design purposes but are intended as indications of the IC's potential performance.

Figure 2. Typical P Horn Driver Output I-V Characteristic



NOTES:
1. Horn modulation is self-completing. When going from smoke to no smoke, the alarm condition will terminate only when horn is off.
2. Comparators are strobed on once per clock cycle (1.67 s for no smoke, 40 ms for smoke).
3. ~ 100 mVp-p swing.
4. Horn modulation is not self-completing when going from remote smoke to no smoke.

Figure 3. Timing Diagram



*NOTE: Component values may change depending on type of piezoelectric horn used.

Figure 4. Typical Application as Ionization Smoke Detector

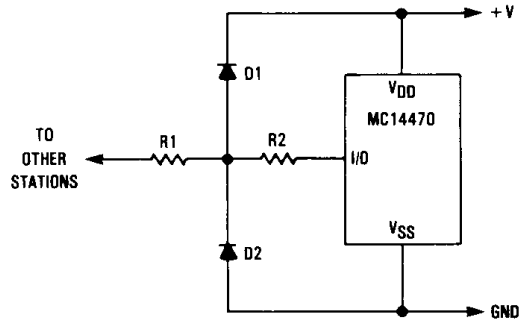


Figure 5. Protection Circuit

LINE-POWERED MC14470 PROTECTION CIRCUIT

During system installation of stations powered from the ac line, the MC14470 can be damaged if the live hot conductor and I/O conductor come in contact before the neutral conductor. The circuit of Figure 5 prevents such damage, while enhancing the ESD (electrostatic discharge) immunity of the system.

The following values may be used for the components:

D1 = D2 = 1N5393 (1.5 A, 200 V)

R1 = 1000 ohms ± 10% = 900 to 1100 ohms

R2 = 47 ohms ± 10% = 42.3 to 51.7 ohms

Assuming a 9.0 V supply, the supporting calculations (all worst case) are:

AC line voltage = 130 V_{rms} = 184 V_{peak}

Therefore,

$I_{diode} = V_{peak}/R1 = 184/900 = 204$ mA

$I_{latchup} = (V_{diode} - V_{IC})/R2 = (1.0 - 0.55)/42.3 = 11$ mA

Fanout:

$V_{remote} = IR = 100\ \mu A \times (51.7 + 1100) = 0.12$ V

Therefore,

Logic High = 3.0 + 0.12 = 3.12 V minimum

At 4 mA drive, MC14470 provides $V_{DD} - 2 = 7$ V output

Max drop allowable = $V_{R\ local} = 7 - 3.12 = 3.88$ V

Under ideal conditions,

Fanout = 3.88 V/[(1100 + 51.7) 100 μA] = 33 stations

NOTE: Interconnect wiring losses and noise reduces fanout.

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