# Low-Power CMOS Ionization Smoke Detector IC with Temporal Pattern Horn Driver

The MC145017, when used with an ionization chamber and a small number of external components, will detect smoke. When smoke is sensed, an alarm is sounded via an external piezoelectric transducer and internal drivers. This circuit is designed to operate in smoke detector systems that comply with UL217 and UL268 specifications.

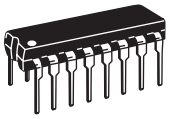
### Features

- Ionization Type with On-Chip FET Input Comparator
- Piezoelectric Horn Driver
- Guard Outputs on Both Sides of Detect Input
- Input-Production Diodes on the Detect Input
- Low-Battery Trip Point, Internally Set, can be Altered Via External Resistor
- Detect Threshold, Internally Set, can be Altered Via External Resistor
- Pulse Testing for Low Battery Uses LED for Battery Loading
- Comparator Outputs for Detect and Low Battery
- Internal Reverse Battery Protection
- Supports NFPA 72, ANSi 53.41, and ISO 8201 Audible Emergency Evacuation Signals
- Pb-Free Packaging Designated by Suffix Code ED and EG

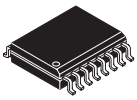
| ORDERING INFORMATION | | |
|---|---|---|
| **Device** | **Case No.** | **Package** |
| MC145017P | 648-08 | Plastic Dip |
| MC145017ED | | |
| MCZ145017EG/R2 | 751G-04 | SOICW |

**MC145017**

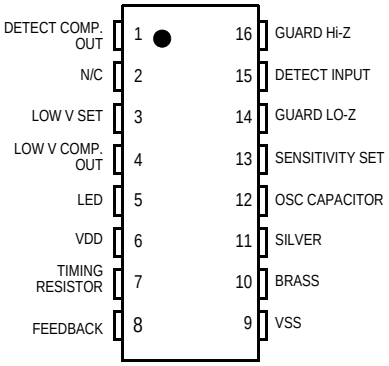
**LOW-POWER CMOS IONIZATION SMOKE DETECTOR IC WITH TEMPORAL PATTERN HORN DRIVER**



**P SUFFIX**
**ED SUFFIX**
**(PB-FREE)**
**PLASTIC DIP**
**CASE 648-08**



**EG SUFFIX**
**(PB-FREE)**
**16-LEAD**
**SOICW**
**CASE 751G-04**



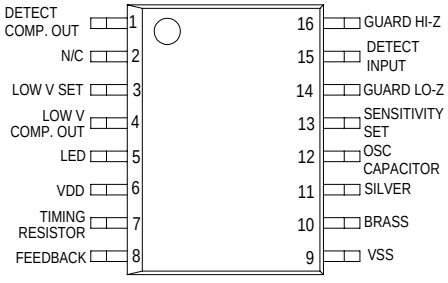




**Figure 1. . Pin Connections**

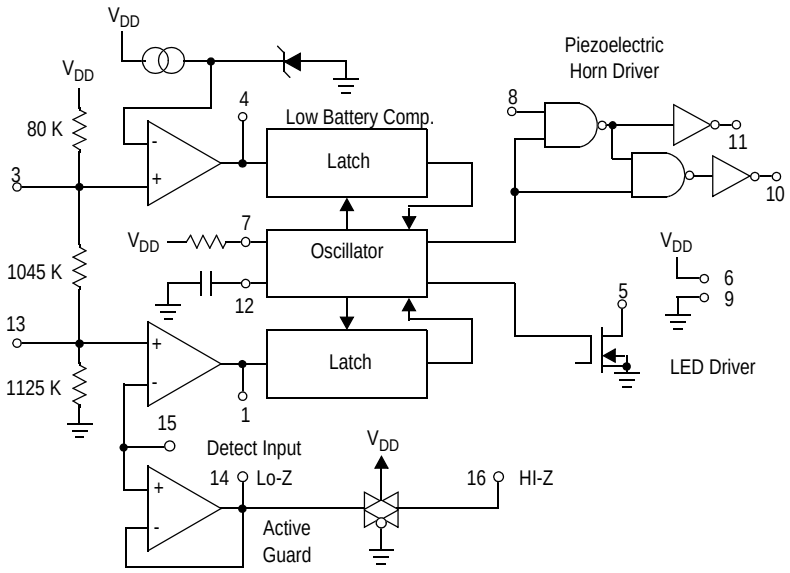



**Figure 2. Block Diagram**

**Table 1. Maximum Ratings(1)**
(Voltages referenced to $V_{SS}$)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| DC Supply Voltage | $V_{DD}$ | -0.5 to + 15 | V |
| Input Voltage, All Inputs Except Pin 8 | $V_{IN}$ | -0.25 to $V_{DD}$ +0.25 | V |
| DC Current Drain per Input Pin, Except Pin 15 = 1 mA | I | 10 | mA |
| DC Current Drain per Output Pin | I | 30 | mA |
| Operating Temperature Range | $T_A$ | -10 to +60 | °C |
| Storage Temperature Range | $T_{STG}$ | -55 to +125 | °C |
| Reverse Battery Time | $T_{RB}$ | 5.0 | s |

1. Maximum Ratings are those values beyond which damage to the device may occur.

   This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that $V_{IN}$ and $V_{OUT}$ be constrained to the range $V_{SS} \le (V_{IN}$ or $V_{OUT}) \le V_{DD}$.

**Table 2. Recommended Operating Conditions**
(Voltages referenced to $V_{SS}$)

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Supply Voltage | $V_{DD}$ | 9.0 | V |
| Timing Capacitor | — | 0.1 | μF |
| Timing Resistor | — | 8.2 | MΩ |
| Battery Load (Resistor or LED) | — | 10 | mA |

**Table 3. Electrical Characteristics[1]**
(Voltages referenced to $V_{SS}$, $T_A$ = 25°C)

| Characteristic | Symbol | $V_{DD}$ $V_{DC}$ | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Operating Voltage | $V_{DD}$ | — | 6.0 | — | 12 | V |
| Output Voltage | $V_{OH}$ | | | | | V |
| Piezoelectric Horn Drivers ($I_{OH}$ = -16 mA) | | 7.2 | 6.3 | — | — | |
| Comparators ($I_{OH}$ = -30 μA) | | 9.0 | 8.5 | 8.8 | — | |
| Piezoelectric Horn Drivers ($I_{OL}$ = +16 mA) | $V_{OL}$ | 7.2 | — | — | 0.9 | V |
| Comparators ($I_{OL}$ = +30 μA) | | 9.0 | — | 0.1 | 0.5 | |
| Output Voltage — LED Driver, $I_{OL}$ = 10 mA | $V_{OL}$ | 7.2 | — | — | 3.0 | V |
| Output Impedance, Active Guard | | | | | | kΩ |
| Pin 14 | LO-Z | 9.0 | — | — | 10 | |
| Pin 16 | HI-Z | 9.0 | — | — | 1000 | |
| Operating Current ($R_{bias}$ = 8.2 MΩ) | $I_{DD}$ | 9.0 | — | 3.2 | 7.0 | μA |
| | | 12.0 | — | — | 10.0 | |
| Input Current — Detect (40% R.H.) | $I_{IN}$ | 9.0 | — | — | ±1.0 | pA |
| Input Current, Pin 8 | $I_{IN}$ | 9.0 | — | — | ±0.1 | μA |
| Input Current @ 50°C, Pin 15 | $I_{IN}$ | — | — | — | ±6.0 | pA |
| Internal Set Voltage | | | | | | |
| Low Battery | $V_{LOW}$ | 9.0 | 7.2 | — | 7.8 | V |
| Sensitivity | $V_{SET}$ | — | 47 | 50 | 53 | %$V_{DD}$ |
| Hysteresis | $V_{HYS}$ | 9.0 | 75 | 100 | 150 | mV |
| Offset Voltage (measured at $V_{IN}$ = $V_{DD}$/2 | $V_{OS}$ | | | | | mV |
| Active Guard | | 9.0 | — | — | ±100 | |
| Detect Comparator | | 9.0 | — | — | ±50 | |
| Input Voltage Range, Pin 8 | $V_{IN}$ | — | $V_{SS}$ -10 | — | $V_{DD}$ + 10 | V |
| Input Capacitance | $C_{IN}$ | — | — | 5.0 | — | pF |
| Common Mode Voltage Range, Pin 15 | $V_{CM}$ | — | 0.6 | — | $V_{DD}$ - 2 | V |

1. Data labelled “Typ” is not to be used for design purposes but is intended as an indication of the IC’s potential performance.

**Table 4. Timing Parameters**
(C = 0.1 μF, $R_{bias}$ = 8.2 MΩ, $V_{DD}$ = 9.0 V, $T_A$ = 25°C, See Figure 7)

| Characteristics | | Symbol | Min | Max | Units |
|---|---|---|---|---|---|
| Oscillator Period | No Smoke | $t_{CI}$ | 1.46 | 1.85 | s |
| | Smoke | | 37.5 | 45.8 | ms |
| Oscillator Rise Time | | $t_R$ | 10.1 | 12.3 | ms |
| Horn Output | On Time | $PW_{ON}$ | 450 | 550 | ms |
| (During Smoke) | Off Time | $PW_{OFF}$ | 450 | 550 | ms |
| LED Output | Between Pulses | $t_{LED}$ | 35.0 | 44.5 | s |
| | On Time | $PW_{ON}$ | 10.1 | 12.3 | ms |
| Horn Output | On Time | $t_{ON}$ | 10.1 | 12.3 | ms |
| (During Low Battery) | Between Pulses | $t_{OFF}$ | 35.0 | 44.5 | s |

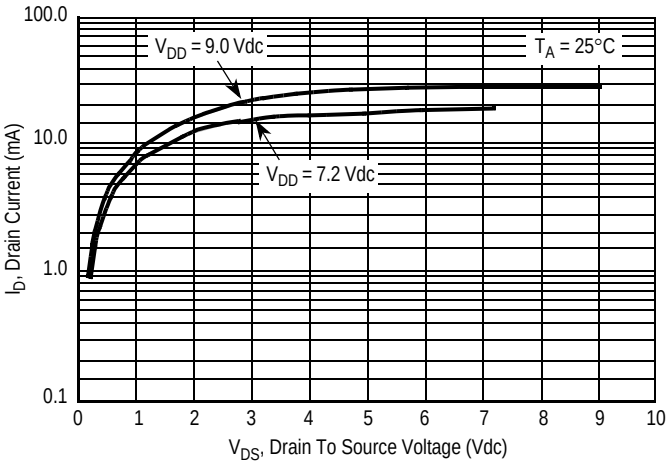



**Figure 3. Typical LED Output I–V Characteristic**

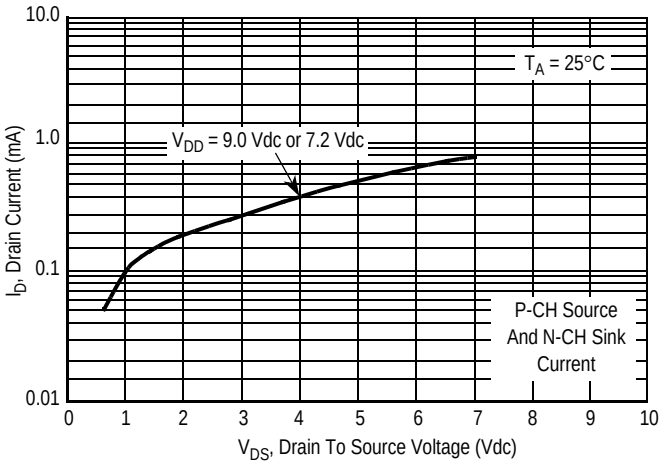



**Figure 4. Typical Comparator Output I–V Characteristic**

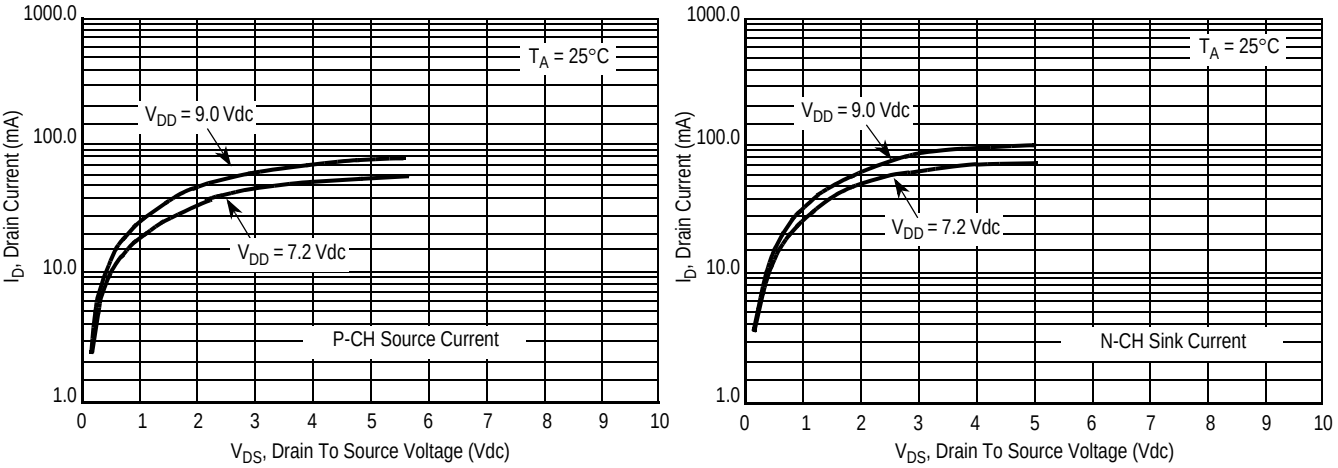



**Figure 5. Typical P Horn Driver Output I–V Characteristic**

## DEVICE OPERATION

### Timing

The internal oscillator of the MC145017 operates with a period of 1.65 seconds during no-smoke conditions. Each 1.65 seconds, internal power is applied to the entire IC and a check is made for smoke, except during LED pulse, Low Battery Alarm Chirp, or Horn Modulation (in smoke). Every 24 clock cycles a check is made for low battery by comparing $V_{DD}$ to an internal zener voltage. Since very small currents are used in the oscillator, the oscillator capacitor should be of a low leakage type.

### Detect Circuitry

If smoke is detected, the oscillator period becomes 41.67 ms and the piezoelectric horn oscillator circuit is enabled. The horn output is modulated 500 ms on, 500 ms off. During the off time, smoke is again checked and will inhibit further horn output if no smoke is sensed. During smoke conditions the low battery alarm is inhibited, but the LED pulses at a 1.0 Hz rate.

An active guard is provided on both pins adjacent to the detect input. The voltage at these pins will be within 100 mV of the input signal. This will keep surface leakage currents to a minimum and provide a method of measuring the input voltage without loading the ionization chamber. The active guard op amp is not power strobed and thus gives constant protection from surface leakage currents. Pin 15 (the Detect input) has internal diode protection against static damage.

### Sensitivity/Low Battery Thresholds

Both the sensitivity threshold and the low battery voltage levels are set internally by a common voltage divider (please see Figure 2) connected between VDD and VSS. These voltages can be altered by external resistors connected from pins 3 or 13 to either VDD or VSS. There will be a slight interaction here due to the common voltage divider network. The sensitivity threshold can also be set by adjusting the smoke chamber ionization source.

### Test Mode

Since the internal op amps and comparators are power strobed, adjustments for sensitivity or low battery level could be difficult and/or time-consuming. By forcing Pin 12 to VSS, the power strobing is bypassed and the outputs, Pins 1 and 4, constantly show smoke/no smoke and good battery/low

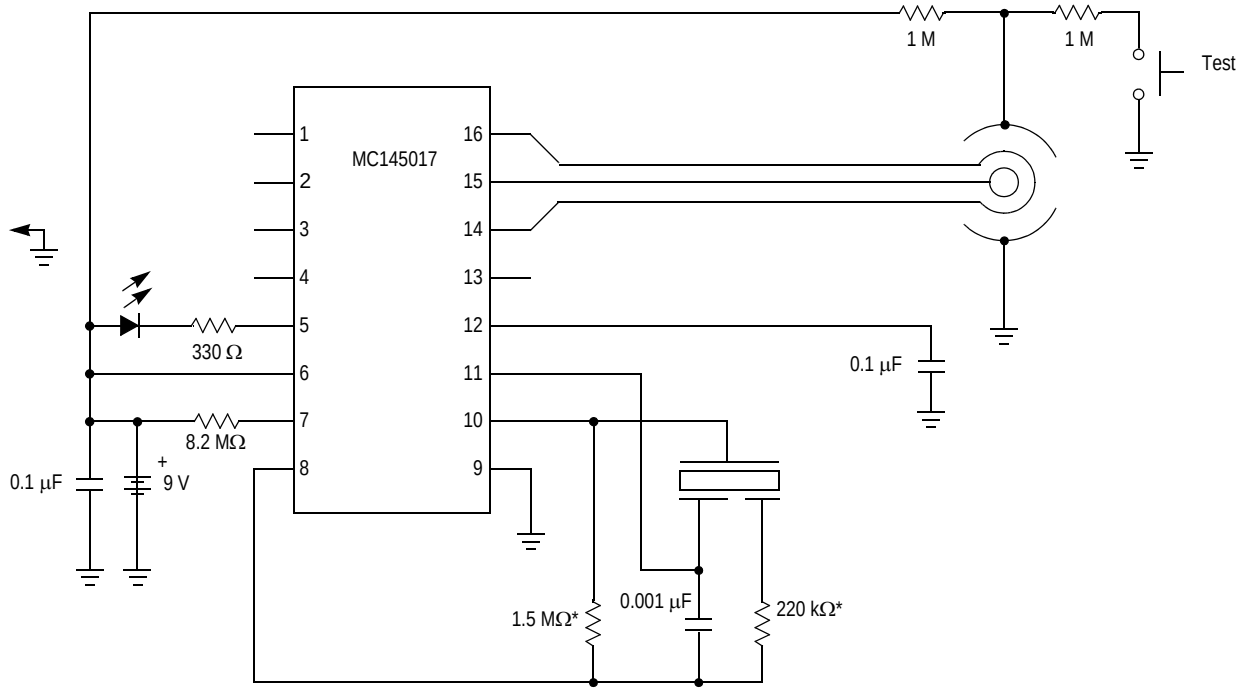
battery, respectively. Pin 1 = $V_{DD}$ for smoke and Pin 4 = VDD for low battery. In this mode and during the 10 ms power strobe, chip current rises to approximately 50 μA.

**Led Pulse**

The 9-volt battery level is checked every 40 seconds during the LED pulse. The battery is loaded via a 10 mA pulse for 11.6 ms. If the LED is not used, it should be replaced with an equivalent resistor such that the battery loading remains at 10 mA.

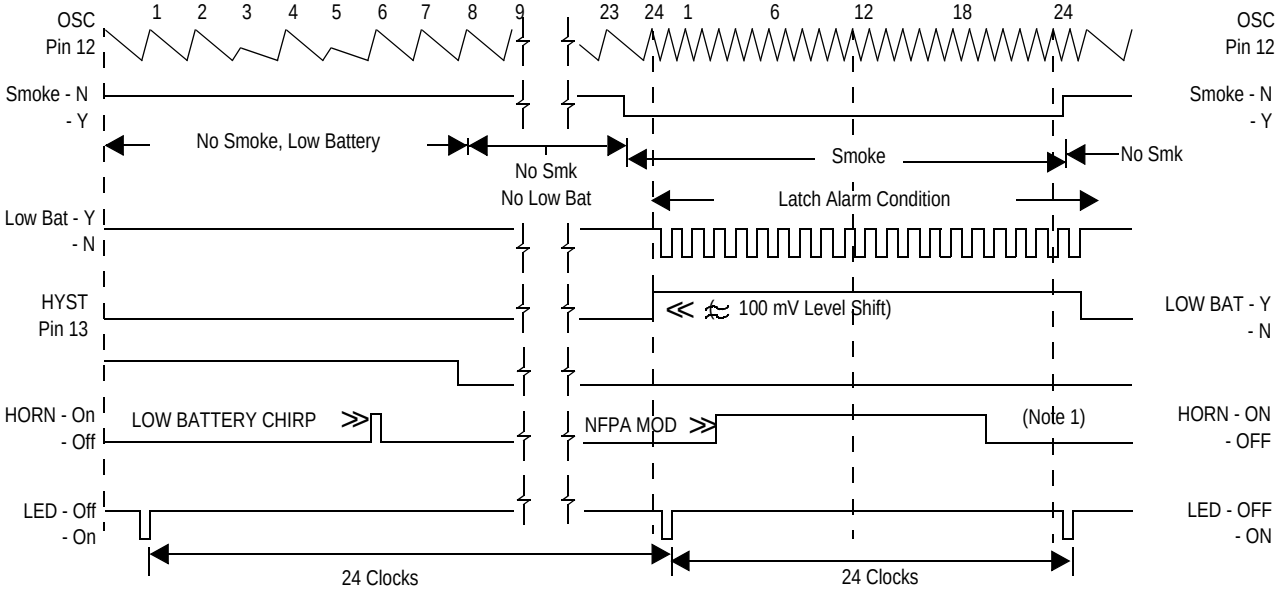
**Hysteresis**

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




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

**Figure 6. Typical Application as Ionization Smoke Detector**




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 once per cycle (1.65 sec for no smoke, 40 msec for smoke).

**Figure 7. MC145017 Timing Diagram**

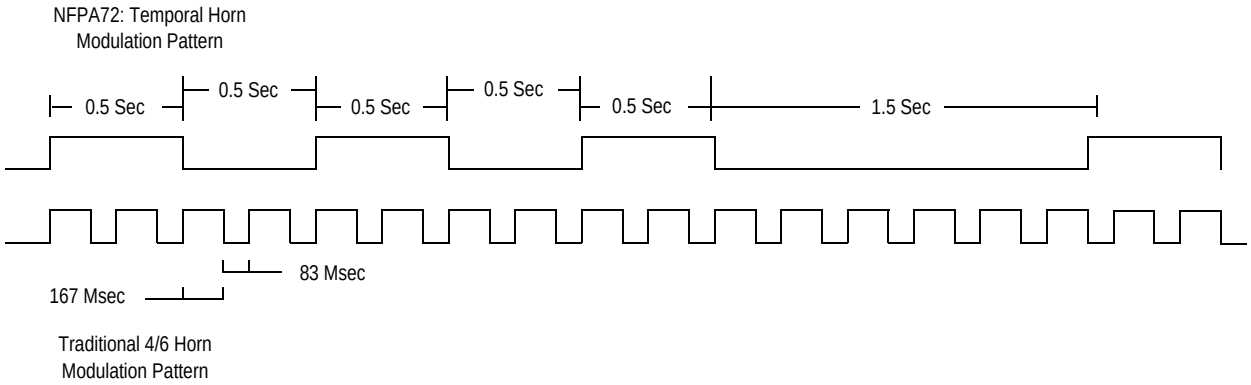
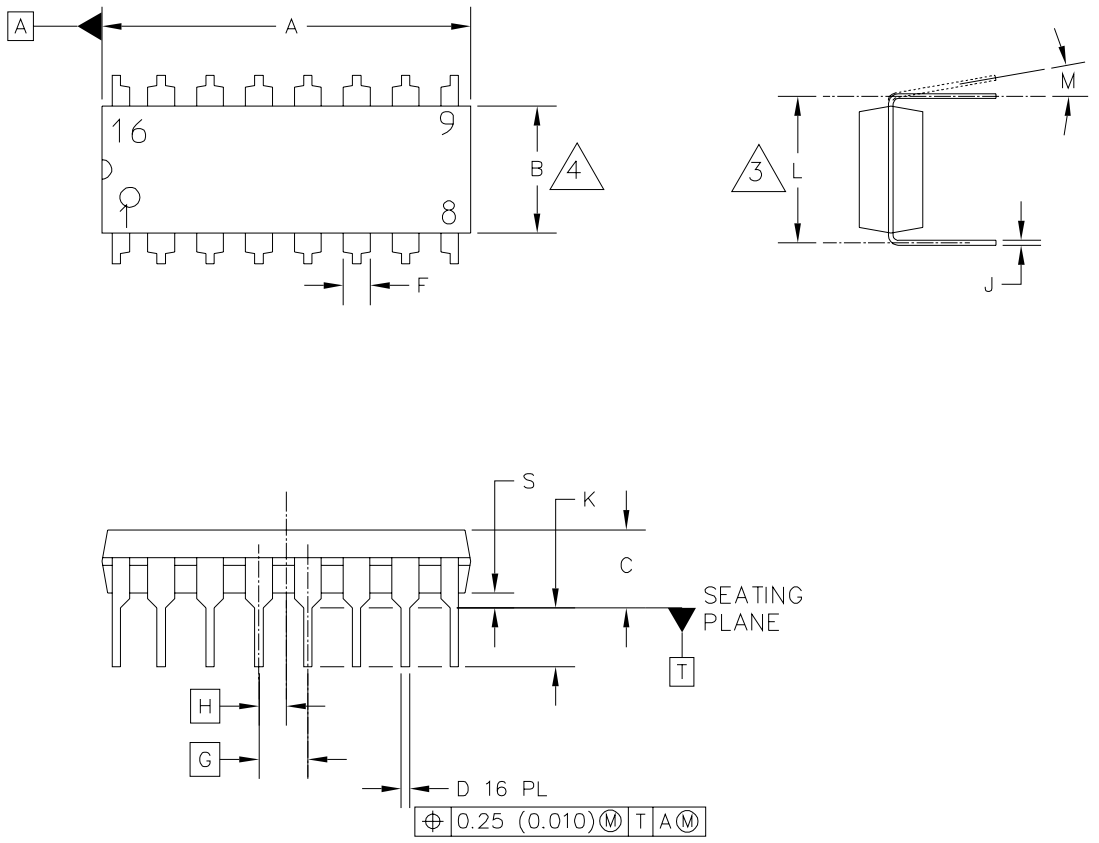



**Figure 8. Horn Modulation**

## PACKAGE DIMENSIONS

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**CASE 648-08**
**ISSUE T**
**16-LEAD PLASTIC DIP**

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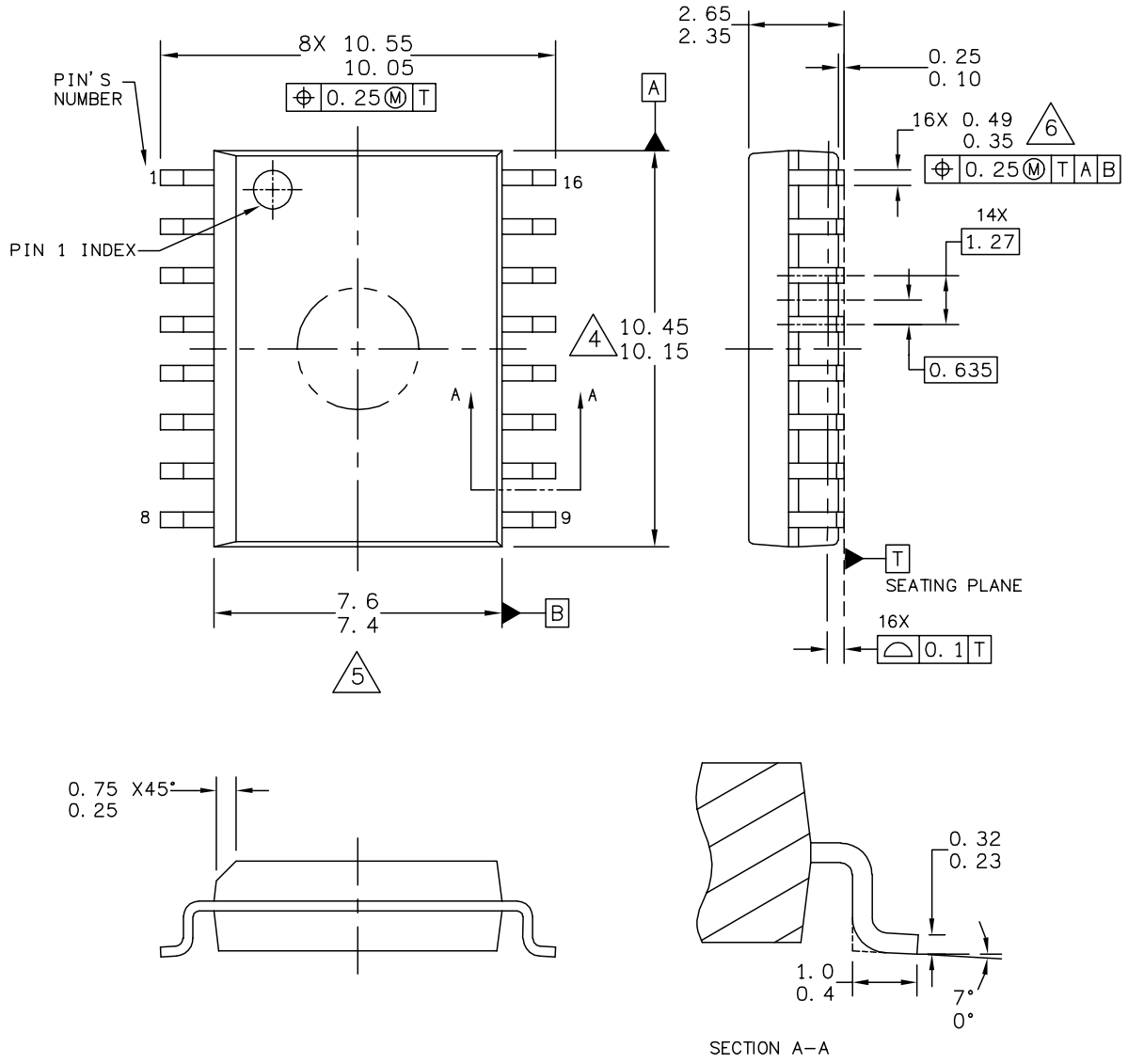





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