# RE46C180

## CMOS Programmable Ionization Smoke Detector ASIC with Interconnect, Timer Mode and Alarm Memory

### Features

- 6 – 12V Operation
- Low Quiescent Current Consumption
- Programmable Standby Sensitivity
- Programmable HUSH Sensitivity
- Programmable Hysteresis
- Programmable Chamber Voltage for Push-to-Test (PTT) and Chamber Test
- Programmable ±150 mV Low Battery Set Point
- Internal Ionization Chamber Test
- Internal Low Battery Test
- Internal Power-On Reset and Power-up Low Battery Test
- Alarm Memory
- Auto Alarm Locate
- Horn Synchronization
- IO Filter and Charge Dump
- Smart Interconnect
- Interconnect up to 40 Detectors
- ±5% All Internal Oscillator
- 9 Minute or 80 Second Timer for Sensitivity Control
- Temporal or Continuous Horn Pattern
- Guard Outputs for Ion Detector Input
- ±0.75 pA Detect Input Current
- 10-year End-of-Life Indication

### Description

The RE46C180 is a next generation low power, CMOS ionization-type, smoke detector IC. With minimal external components, this circuit will provide all the required features for an ionization-type smoke detector.

An on-chip oscillator strobes power to the smoke detection circuitry for 5 ms every 10 seconds to keep the standby current to a minimum.

A check for a Low Battery condition is performed every 80s and an ionization chamber test is performed once every 320s when in Standby. The temporal horn pattern complies with the National Fire Protection Association NFPA 72® National Fire Alarm and Signaling Code® for emergency evacuation signals.

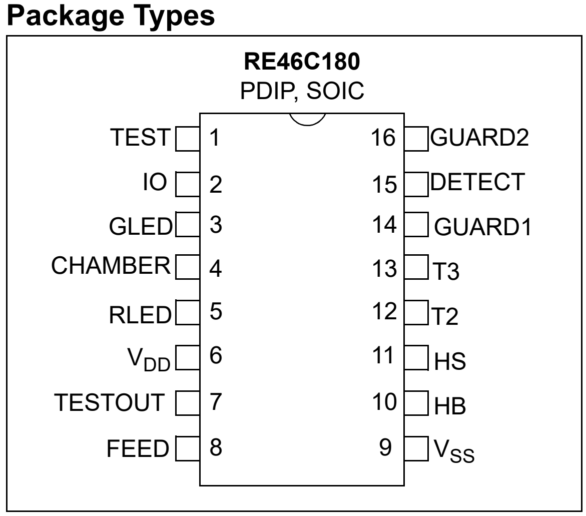
An interconnect pin allows multiple detectors to be connected, such that when one unit alarms, all units will sound. A charge dump feature quickly discharges the interconnect line when exiting a Local Alarm condition. The interconnect input is also digitally filtered.

An internal 9 minute or 80s timer can be used for a Reduced Sensitivity mode.

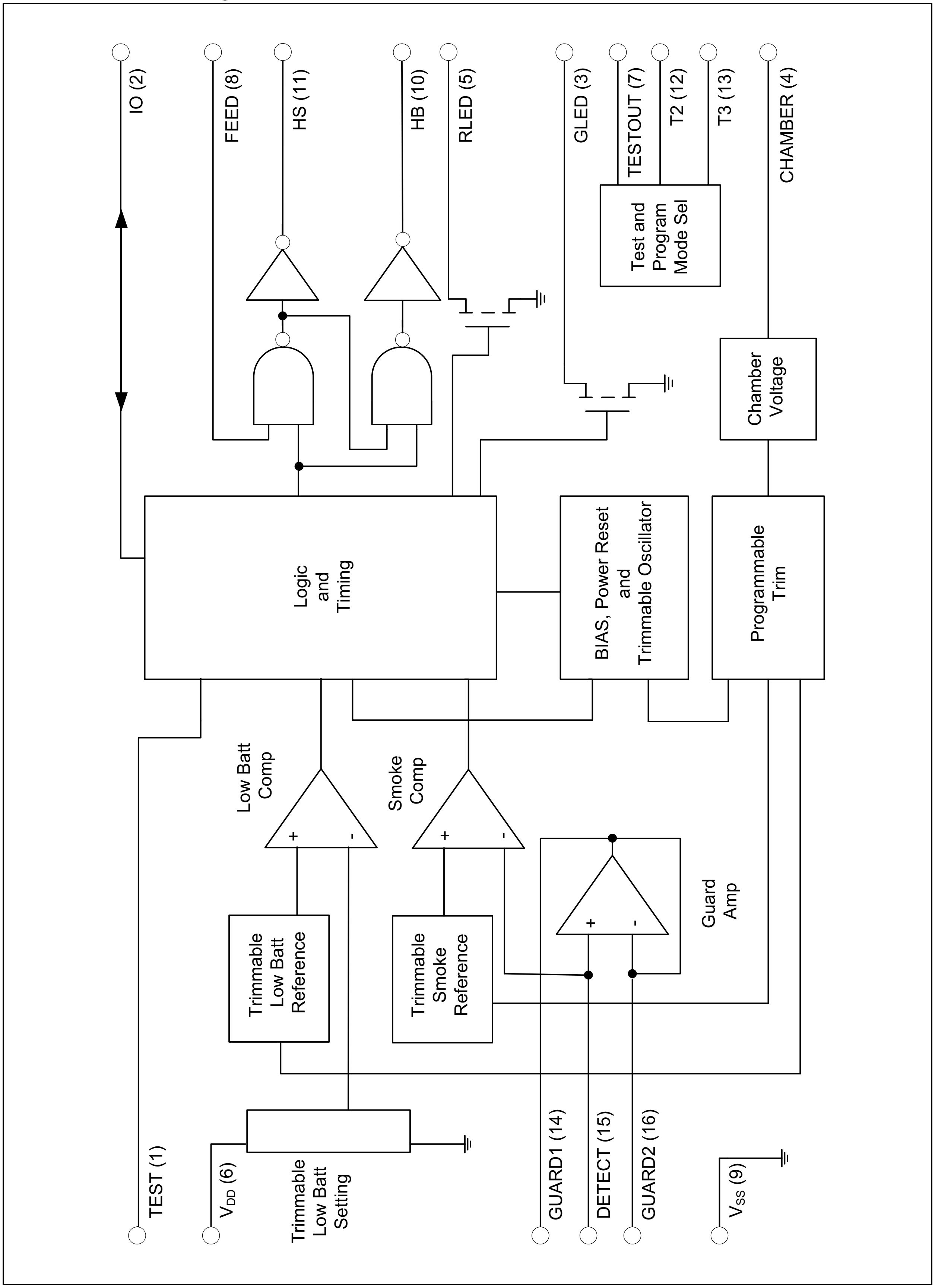
An alarm memory feature allows the user to determine whether the unit has previously entered a Local Alarm condition.

Utilizing low-power CMOS technology, the RE46C180 is designed for use in smoke detectors that comply with the Standard for Single and Multiple Station Smoke Alarms, UL217 and the Standard for Smoke Detectors for Fire Alarm Systems, UL268.

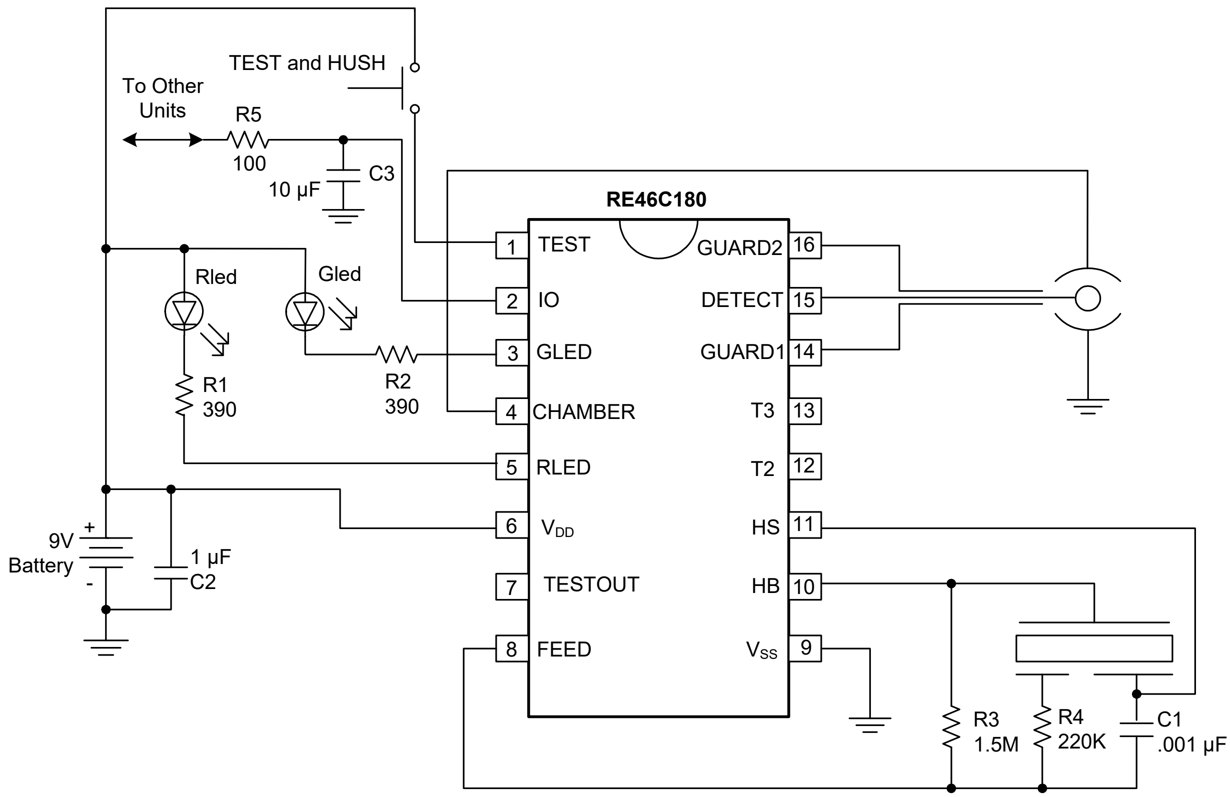
### Package Types



## Functional Block Diagram



## Typical Application




**Note 1:** R3, R4 and C1 are typical values, and may be adjusted to maximize sound pressure.

**2:** C2 should be located as close as possible to the device power pins.

**3:** Route the pin 8 PC board trace away from pin 4 to avoid coupling.

**4:** No internal reverse battery protection. External reverse battery protection circuitry required.

## 1.0 ELECTRICAL CHARACTERISTICS

### 1.1 Absolute Maximum Ratings†

$V_{DD}$ ........................................................................ 12.5V
Input Voltage Range Except FEED, IO ......... $V_{IN}$ = -.3V to $V_{DD}$ +.3V
FEED Input Voltage Range .................... $V_{INFD}$ =-10 to +22V
IO Input Voltage Range ................................ $V_{IO1}$= -.3 to 15V
Input Current except FEED .................................. $I_{IN}$ = 10 mA
Operating Temperature ................................ $T_{A}$ = -10 to +60°C
Storage Temperature .......................... $T_{STG}$ = -55 to +125°C
Maximum Junction Temperature ........................... $T_{J}$ = +150°

**† Notice:** Stresses above those listed under "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.

## DC ELECTRICAL CHARACTERISTICS

**DC Electrical Characteristics:** Unless otherwise indicated, all parameters apply at $T_A$ = -10°C to +60°C, $V_{DD}$ = 9V, $V_{SS}$ = 0V (Note 1)

| Parameter | Symbol | Test Pin | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | 6 | 6 | — | 12 | V | Operating |
| Supply Current | $I_{DD1}$ | 6 | — | 3.8 | 5.3 | µA | Operating, RLED off, GLED off |
| | $I_{DD2}$ | 6 | — | — | 6 | µA | Operating, $V_{DD}$ = 12V, RLED off, GLED off |
| | $I_{DD3}$ | 6 | — | 9.6 | 13.9 | µA | Operating, RLED off, GLED off, Smoke check |
| | $I_{DD4}$ | 6 | — | 21.4 | 30 | µA | Operating, RLED off, GLED off, Low Battery check |
| Input Voltage High | $V_{IH1}$ | 8 | 6 | — | — | V | |
| | $V_{IH2}$ | 2 | 3 | — | — | V | No Local Alarm, IO as an input |
| | $V_{IH3}$ | 1 | 5.6 | — | — | V | |
| | $V_{IH4}$ | 12 | 5.6 | — | — | V | |
| Input Voltage Low | $V_{IL1}$ | 8 | — | — | 2.8 | V | |
| | $V_{IL2}$ | 2 | — | — | 1 | V | No Local Alarm, IO as an input |
| | $V_{IL3}$ | 1 | — | — | 3.4 | V | |
| | $V_{IL4}$ | 12 | — | — | 3.4 | | |
| Input Leakage Low | $IL_{DET1}$ | 15 | — | — | -0.75 | pA | $V_{DD}$ = 9V, DETECT = $V_{SS}$, 0-40% RH, $T_A$ = +25°C |
| | $IL_{DET2}$ | 15 | — | — | -1.5 | pA | $V_{DD}$ = 9V, DETECT = $V_{SS}$, 85% RH, $T_A$ = +25°C (Note 2) |
| | $IL_{FD1}$ | 8 | — | — | -50 | µA | FEED = -10V |
| | $IL_{FD2}$ | 8 | — | — | -100 | nA | FEED = $V_{SS}$ |

**Note 1:** Production tested at room temperature with temperature guard banded limits.
**2:** Sample test only.
**3:** Not 100% production tested.
**4:** Same limit range at each programmable step, see Table 4-1.

## DC ELECTRICAL CHARACTERISTICS (CONTINUED)

**DC Electrical Characteristics:** Unless otherwise indicated, all parameters apply at $T_A$ = -10°C to +60°C, $V_{DD}$ = 9V, $V_{SS}$ = 0V (Note 1)

| Parameter | Symbol | Test Pin | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|---|
| Input Leakage High | $IH_{DET1}$ | 15 | — | — | 0.75 | pA | $V_{DD}$ = 9V, DETECT = $V_{DD}$, 0–40% RH, $T_A$ = +25°C |
| | $IH_{DET2}$ | 15 | — | — | 1.5 | pA | $V_{DD}$ = 9V, DETECT = $V_{DD}$, 85% RH, $T_A$ = +25°C (Note 2) |
| | $IH_{FD1}$ | 8 | — | — | 50 | µA | FEED = 22V |
| | $IH_{FD2}$ | 8 | — | — | 100 | nA | FEED = $V_{DD}$ |
| | $I_{IOL2}$ | 2 | — | — | 150 | µA | No Alarm, $V_{IO}$ = 15V |
| Output Off Leakage High | $I_{IOHZ}$ | 3, 5 | — | — | 1 | µA | Outputs Off, $V_{RLED}$ = 9V, $V_{GLED}$ = 9V |
| Input Pull Down Current | $I_{PD1}$ | 1 | 20 | 50 | 80 | µA | TEST = 9V |
| | $I_{PD2}$ | 12 | 0.4 | 0.8 | 1.3 | mA | T2 = 9V |
| Output High Voltage | $V_{OH1}$ | 10,11 | 6.3 | — | — | V | $I_{OH}$ = -16 mA, $V_{DD}$ = 7.2V |
| Output Low Voltage | $V_{OL1}$ | 10,11 | — | — | 0.9 | V | $I_{OL}$ = 16 mA, $V_{DD}$ = 7.2V |
| | $V_{OL3}$ | 3, 5 | — | — | 1 | V | $I_{OL}$ = 10 mA, $V_{DD}$ = 7.2V |
| Output Current | $I_{IOL1}$ | 2 | 25 | — | 60 | µA | No Alarm, $V_{IO}$ = $V_{DD}$ -2V |
| | $I_{IOH1}$ | 2 | -4 | — | -16 | mA | Alarm, $V_{IO}$ = 4V or $V_{IO}$ = 0V |
| | $I_{IODMP}$ | 2 | 5 | — | — | mA | At conclusion of Local Alarm or PTT, $V_{IO}$ = 1V |
| Low Battery Voltage | $V_{LB}$ | 6 | 6.75 | 6.9 | 7.05 | V | LBTR[2:1] = 1 0 |
| | | | 7.05 | 7.2 | 7.35 | V | LBTR[2:1] = 1 1 |
| | | | 7.35 | 7.5 | 7.65 | V | LBTR[2:1] = 0 0 |
| | | | 7.65 | 7.8 | 7.95 | V | LBTR[2:1] = 0 1 |
| Offset Voltage | $V_{GOS1}$ | 14,15 | -50 | — | 50 | mV | Guard amplifier |
| | $V_{GOS2}$ | 15,16 | -50 | — | 50 | mV | Guard amplifier |
| | $V_{GOS3}$ | 15 | -50 | — | 50 | mV | Smoke comparator |
| Common Mode Voltage | $V_{CM1}$ | 14,15 | 2 | — | $V_{DD}$–.5 | V | Guard amplifier (Note 3) |
| | $V_{CM2}$ | 15 | 0.5 | — | $V_{DD}$–2 | V | Smoke comparator (Note 3) |
| Output Impedance | $Z_{OUT}$ | 14,16 | — | 10 | — | kΩ | Guard amplifier outputs (Note 3) |
| Chamber Voltage in PTT/Chamber Test | $V_{CHAMBER}$ | 4 | 4.49 | 4.5 | 4.51 | V | User programmable (2.1V to 6.75V) (Note 4) |
| Hysteresis | $V_{HYS}$ | 13 | 140 | 150 | 160 | mV | No Alarm to Alarm condition, user programmable (50 to 225 mV) (Note 4) |

**Note 1:** Production tested at room temperature with temperature guard banded limits.

**2:** Sample test only.

**3:** Not 100% production tested.

**4:** Same limit range at each programmable step, see Table 4-1.

## AC ELECTRICAL CHARACTERISTICS

| **AC Electrical Characteristics:** Unless otherwise indicated, all parameters apply at $T_A$ = -10°C to +60°C, $V_{DD}$ = 9V, $V_{SS}$ = 0V. | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Test Pin** | **Min** | **Typ** | **Max** | **Units** | **Conditions** |
| **Time Base** | | | | | | | |
| Internal Oscillator Period | $T_{POSC}$ | 7 | 593 | 625 | 657 | µs | Test mode (Note 1) |
| Internal Clock Period | $T_{PCLK}$ | | 9.5 | 10 | 10.5 | ms | Operating |
| **RLED Indicator** | | | | | | | |
| On Time | $T_{ON1}$ | 5 | 9.5 | 10 | 10.5 | ms | Operating |
| Period | $T_{PLED1}$ | 5 | 304 | 320 | 336 | s | Standby |
| | $T_{PLED2}$ | 5 | 0.95 | 1 | 1.05 | s | Local alarm |
| | $T_{PLED3}$ | 5 | 9.5 | 10 | 10.5 | s | HUSH mode, No Local Alarm |
| **GLED Indicator** | | | | | | | |
| Period | $T_{PLED4}$ | 3 | 38 | 40 | 42 | s | Alarm Memory Indication GLED period, No Alarm, no PTT |
| | $T_{PLED5}$ | 3 | 237 | 250 | 263 | ms | Alarm Memory Indication GLED period upon PTT, AMLEDEn = 1 |
| Off Time | $T_{OFLED1}$ | 3 | 0.95 | 1 | 1.05 | s | Alarm Memory Indication GLED off time between pulses |
| | $T_{OFLED2}$ | 3 | 36 | 38 | 40 | s | Alarm Memory Indication GLED off time between pulse trains (3x) |
| Alarm Memory Indication Timeout Period | $T_{AMTO}$ | 3 | 22.8 | 24 | 25.2 | Hour | AMTO[2:1] = `0 0` |
| | | | 45.6 | 48 | 50.4 | Hour | AMTO[2:1] = `0 1` |
| | | | 0 | 0 | 0 | Hour | AMTO[2:1] = `1 0`, No Alarm Memory Indication |
| | | | — | — | — | — | AMTO[2:1] = `1 1`, Alarm Memory Indication never times out, as long as Alarm Memory Latch is set |
| **Smoke Check** | | | | | | | |
| Smoke Check Time | $T_{SCT}$ | — | 4.7 | 5 | 5.3 | ms | Operating |
| Smoke Check Period | $T_{PER0}$ | — | 9.5 | 10 | 10.5 | s | Standby, No Alarm |
| | $T_{PER1}$ | — | 0.95 | 1 | 1.05 | s | Standby, after one valid smoke sample and before entering Local Alarm, no PTT |
| | $T_{PER2}$ | — | 237 | 250 | 263 | ms | Standby, upon start of PTT and before entering Local Alarm |
| | $T_{PER3}$ | — | 0.95 | 1 | 1.05 | s | Local Alarm (after three consecutive valid smoke samples) or Remote Alarm |
| Chamber Test Period | $T_{PCT1}$ | — | 304 | 320 | 336 | s | Operating |

**Note 1:** $T_{POSC}$ is 100% production tested. All other timing is verified by functional testing.
**2:** See timing diagram for CO alarm horn pattern.
**3:** See timing diagram for smoke alarm temporal and non-temporal horn pattern.
**4:** See timing diagram for horn synchronization and Auto Alarm Locate (AAL).

## AC ELECTRICAL CHARACTERISTICS (CONTINUED)

**AC Electrical Characteristics:** Unless otherwise indicated, all parameters apply at $T_A$ = -10°C to +60°C, $V_{DD}$ = 9V, $V_{SS}$ = 0V.

| Parameter | Symbol | Test Pin | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|---|
| **Low Battery** | | | | | | | |
| Low Battery Check Period | $T_{PLB1}$ | — | 76 | 80 | 84 | s | Standby, No Alarm, No Low Battery |
| | $T_{PLB2}$ | — | 304 | 320 | 336 | s | Standby, No Alarm, Low Battery |
| **Horn Operation** | | | | | | | |
| Horn Delay | $T_{HDLY1}$ | 10, 11 | 475 | 500 | 525 | ms | From Local Alarm to Horn Active, temporal horn pattern |
| | $T_{HDLY2}$ | 10, 11 | 380 | 400 | 420 | ms | From Local Alarm to Horn Active, continuous horn pattern |
| Horn Period | $T_{HPER1}$ | 10, 11 | 38 | 40 | 42 | s | Low Battery, No Alarm |
| | $T_{HPER2}$ | 10, 11 | 38 | 40 | 42 | s | Chamber Failure, No Alarm |
| | $T_{HPER3}$ | 10, 11 | 237 | 250 | 263 | ms | Alarm Memory Indication upon PTT, AMHCEn=1 |
| | $T_{HPER4}$ | 10, 11 | 5.5 | 5.8 | 6.1 | s | CO Alarm horn period (Note 2) |
| Horn On Time | $T_{HON1}$ | 10, 11 | 9.5 | 10 | 10.5 | ms | 1. Low Battery, No Alarm<br>2. Chamber Failure<br>3. Alarm Memory Indication upon PTT, AMHCEn = 1 |
| | $T_{HON2}$ | 10, 11 | 475 | 500 | 525 | ms | Smoke Alarm, temporal horn pattern (Note 3) |
| | $T_{HON3}$ | 10, 11 | 332 | 350 | 368 | ms | Smoke Alarm, continuous horn pattern (Note 3) |
| | $T_{HON4}$ | 10, 11 | 95 | 100 | 105 | ms | CO Alarm, COEn = 1 |
| Horn Off Time | $T_{HOF1}$ | 10, 11 | 475 | 500 | 525 | ms | Smoke Alarm, temporal horn pattern (Note 3) |
| | $T_{HOF2}$ | 10, 11 | 1.43 | 1.5 | 1.58 | s | Smoke Alarm, temporal horn pattern (Note 3) |
| | $T_{HOF3}$ | 10, 11 | 143 | 150 | 158 | ms | Smoke Alarm, continuous horn pattern (Note 3) |
| | $T_{HOF4}$ | 10, 11 | 37 | 39 | 41 | s | Chamber Fail horn off time between pulse trains (3x) |
| | $T_{HOF5}$ | 10, 11 | 465 | 490 | 515 | ms | Chamber Fail horn off time between pulses |
| | $T_{HOF6}$ | 10, 11 | 95 | 100 | 105 | ms | CO Alarm horn off time between pulses, COEn = 1 (Note 2) |
| | $T_{HOF7}$ | 10, 11 | 4.8 | 5.1 | 5.4 | s | CO alarm horn off time between pulse trains, COEn = 1 (Note 2) |

**Note 1:** $T_{POSC}$ is 100% production tested. All other timing is verified by functional testing.
**2:** See timing diagram for CO alarm horn pattern.
**3:** See timing diagram for smoke alarm temporal and non-temporal horn pattern.
**4:** See timing diagram for horn synchronization and Auto Alarm Locate (AAL).

## AC ELECTRICAL CHARACTERISTICS (CONTINUED)

**AC Electrical Characteristics:** Unless otherwise indicated, all parameters apply at $T_A$ = -10°C to +60°C, $V_{DD}$ = 9V, $V_{SS}$ = 0V.

| Parameter | Symbol | Test Pin | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|---|
| **Interconnect** | | | | | | | |
| IO Active Delay | $T_{IODLY1}$ | 2 | 3.5 | 3.7 | 3.9 | s | From start of Local Alarm to IO Active. SyncEn = 1 |
| | | 2 | 3.1 | 3.3 | 3.5 | s | From start of Local Alarm to IO Active. SyncEn = 0 |
| Remote Smoke Alarm Delay | $T_{IODLY2}$ | 2 | 769 | 810 | 851 | ms | No Local Alarm, from IO Active to Alarm, temporal horn pattern |
| | $T_{IODLY3}$ | 2 | 299 | 315 | 331 | ms | No Local Alarm, from IO Active to alarm, continuous horn pattern |
| IO Filter for Remote Smoke Alarm | $T_{IOFILT}$ | 2 | — | — | 291 | ms | IO pulse-width to be filtered IO as input, no Local Alarm |
| IO Pulse On Time for CO Alarm | $T_{IOPW1}$ | 2 | 37 | — | 290 | ms | No Local Alarm, 2 valid pulses required for CO |
| IO Pulse Off Time for CO Alarm | $T_{IOTO1}$ | 2 | — | — | 5.4 | s | IO = Low |
| IO Dump | $T_{IODMP1}$ | 2 | 475 | 500 | 525 | ms | At conclusion of Local Alarm or PTT |
| **Horn Synchronization** | | | | | | | |
| IO Pulse Period | $T_{PIO1}$ | 2 | 3.8 | 4 | 4.2 | s | Local Alarm, temporal horn pattern, SyncEn =1 (Note 4) |
| IO Pulse On Time | $T_{ONIO}$ | 2 | 3.41 | 3.59 | 3.77 | s | Local Alarm, temporal horn pattern, SyncEn =1 (Note 4) |
| Horn Sync IO Dump | $T_{IODMP2}$ | 2 | 95 | 100 | 105 | ms | Local Alarm, SyncEn =1 (Note 4) |
| Horn Sync IO Dump Delay | $T_{IODLY4}$ | 2 | 285 | 300 | 315 | ms | Local Alarm, SyncEn =1 (Note 4) |
| **Auto Alarm Locate (AAL)** | | | | | | | |
| IO Cycle Period | $T_{PIO2}$ | 2 | 15.2 | 16 | 16.8 | s | Local Alarm, temporal horn pattern, SyncEn =1, NoAAL = 0 (Note 4) |
| IO Cycle Off Time | $T_{OFIO}$ | 2 | 4.19 | 4.41 | 4.63 | s | Local Alarm, temporal horn pattern, SyncEn = 1, No AAL = 0, IO off time between IO pulse trains (3x) (Note 4) |
| **HUSH Timer Operation** | | | | | | | |
| HUSH Timer Period | $T_{TPER}$ | — | 8.5 | 9 | 9.5 | min | No Alarm, ShrtTO = 0 |
| | | — | 76 | 80 | 84 | s | No Alarm, ShrtTO = 1 |
| **EOL** | | | | | | | |
| End-of-Life Age Sample | $T_{EOL}$ | — | 346 | 364 | 382 | Hours | Standby, EOLEn = 1 |

**Note 1:** $T_{POSC}$ is 100% production tested. All other timing is verified by functional testing.
**2:** See timing diagram for CO alarm horn pattern.
**3:** See timing diagram for smoke alarm temporal and non-temporal horn pattern.
**4:** See timing diagram for horn synchronization and Auto Alarm Locate (AAL).

## TEMPERATURE CHARACTERISTICS

| Electrical Specifications: Unless otherwise indicated, $V_{DD}$ = 9V, $V_{SS}$ = 0V | | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **Sym** | **Min** | **Typ** | **Max** | **Units** | **Conditions** |
| **Temperature Ranges** | | | | | | |
| Operating Temperature Range | $T_A$ | -10 | — | +60 | °C | |
| Storage Temperature Range | $T_{STG}$ | -55 | — | +125 | °C | |
| **Thermal Package Resistances** | | | | | | |
| Thermal Resistance, 16L-PDIP | $\theta J_A$ | — | 70 | — | °C/W | |
| Thermal Resistance, 16L-SOIC (150 mil.) | $\theta J_A$ | — | 86.1 | — | °C/W | |

## 2.0 PIN DESCRIPTIONS

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

**TABLE 2-1: PIN FUNCTION TABLE**

| **RE46C180** PDIP, SOIC | **Symbol** | **Function** |
|---|---|---|
| 1 | TEST | This input is used to invoke Push-to-Test, Timer mode and Alarm Memory Indication. This input has an internal pull-down. |
| 2 | IO | This bidirectional pin provides the capability to interconnect many detectors in a single system. This pin has an internal pull-down device and a charge dump device. |
| 3 | GLED | Open drain NMOS output, used to drive a visible LED to provide visual indication of an Alarm Memory condition. |
| 4 | CHAMBER | Connect to the ionization smoke chamber. This pin provides power to the chamber |
| 5 | RLED | Open drain NMOS output, used to drive a visible LED. This pin provides the load current for the Low Battery test, and is a visual indicator for alarm and HUSH mode. |
| 6 | $V_{DD}$ | Connect to the positive supply voltage |
| 7 | TESTOUT | This output is an indicator of the internal IO dump signal. This pin is also used for Test modes. |
| 8 | FEED | Usually connected to the feedback electrode through a current limiting resistor. If not used, this pin must be connected to $V_{DD}$ or $V_{SS}$. |
| 9 | $V_{SS}$ | Connect to the negative supply voltage. |
| 10 | HB | This pin is connected to the metal electrode of a piezoelectric transducer. |
| 11 | HS | This pin is a complementary output to HB, connected to the ceramic electrode of the piezoelectric transducer. |
| 12 | T2 | Test input to invoke Test modes. This pin has an internal pull-down. |
| 13 | T3 | Test output for Test modes. |
| 14 | GUARD1 | Output of the guard amplifier. This allows for measurement of the DETECT input without loading the ionization chamber. |
| 15 | DETECT | Connect to the CEV of the ionization smoke chamber. |
| 16 | GUARD2 | Output of the guard amplifier. This allows for measurement of the DETECT input without loading the ionization chamber. |

## 3.0 DEVICE DESCRIPTIONS

### 3.1 Standby Internal Timing

The internal oscillator is manufactured to ±5% tolerance. The oscillator period, TPOSC, is 625 µs. The internal clock period, TPCLK, of 10 ms is derived from the internal oscillator period.

In Standby, once every 10s, the smoke detection circuitry is powered on for 5 ms. At the conclusion of the 5 ms, the status of the smoke comparator is latched. If a Smoke condition is present, the period to the next detection decreases and additional checks are made.

In Standby, once every 80s, the Low Battery detection circuitry is powered on for 10 ms. At the conclusion of the 10 ms, the status of the Low Battery comparator is latched. RLED is enabled for 10 ms every 320s to provide a battery load in the loaded battery test.

In Standby, once every 320s, the chamber test circuitry is powered on for 5 ms. At the conclusion of the 5 ms, the status of the chamber test is latched. See **Section 3.3 "Supervisory Tests"** for details.

### 3.2 Smoke Detection Circuitry

The collection electrode voltage (CEV) of the ionization chamber is compared to the stored reference voltage at the conclusion of the 5 ms smoke sample period. After the first Smoke condition is detected, the smoke detection rate increases to once every 1s. Three consecutive smoke detections will cause the device to go into Local Alarm, and the horn circuit and IO will be active. RLED will turn on for 10 ms at 1 Hz rate.

In Local Alarm, the smoke reference voltage (smoke sensitivity) is internally increased to provide alarm hysteresis.

There are three separate smoke sensitivity settings (all user programmable):

- Standby sensitivity
- Local alarm (hysteresis) sensitivity
- HUSH sensitivity

During PTT, the standby smoke sensitivity is used in smoke detection; but the CHAMBER voltage is user programmable.

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

### 3.3 Supervisory Tests

Once every 80s, the status of the battery voltage is checked by comparing a fraction of the $V_{DD}$ voltage to an internal reference. In each period of 320s, the battery is checked four times. Of these four battery checks, three are unloaded and one is loaded with RLED enabled, which provides a battery load. Low battery status is latched at the end of the 10 ms RLED pulse.

If the Low Battery test fails, the horn will chirp for 10 ms every 40s, and will continue to chirp until the next loaded Low Battery check is passed. The unloaded Low Battery checks are skipped in Low Battery condition.

As a user programmable option, a Low Battery Hush mode can be selected. If a Low Battery condition exists, upon release of PTT, the unit will enter the Low Battery Hush mode, and the 10 ms horn chirp will be silenced for 8 hours. At the conclusion of the 8 hours the audible indication will resume, if the Low Battery condition still exists

In addition, every 320s, a background chamber test is performed by internally lowering the CHAMBER voltage to a pre-determined level (user programmable) for 3.7s. This will emulate a Smoke condition. At the end of this 3.7s period, the smoke detection circuitry is powered on for 5 ms, and the Smoke condition is detected.

If two consecutive chamber tests failed to detect a simulated Smoke condition, the chamber fail latch is set and the failure warning is generated. The horn will chirp three times every 40s. Each chirp is 10 ms long and three chirps are spaced at a 0.5s interval. The chamber fail warning chirp is separated from the Low Battery warning chirp by about 20s.

The horn will continue this pattern until the chamber fail latch is reset. The chamber fail latch resets when any one of the followings is active:

- Two consecutive chamber tests pass
- Local smoke alarm
- PTT smoke alarm

After the chamber test is completed, the CHAMBER voltage goes back to its normal standby level.

Chamber test is performed approximately 140s after the loaded Low Battery test.

In a Local Alarm, PTT Alarm or Remote Alarm condition, the chamber test is not performed, and the Low Battery chirping is prohibited.

### 3.4 Push-to-Test (PTT)

PTT is an event when TEST is activated ($V_{IH3}$). Release of PTT is an event when TEST is deactivated ($V_{IL3}$). PTT has different functions for different circumstances. In Standby, PTT tests the unit. Upon start of PTT, the CHAMBER voltage is lowered to a pre-determined level (user programmable) to emulate a Smoke condition. The smoke detection rate increases to once every 250 ms. After three consecutive smoke detections, the unit will go into a Local Alarm condition. In alarm, the smoke detection rate decreases to once every 1s. Upon release of PTT, the unit is immediately reset out of Local Alarm, and the horn is silenced. The chamber voltage goes back to the normal standby level, and the detection rate goes back to once every 10s.

When the unit exits a Local Alarm condition, the alarm memory latch is set. PTT will activate the alarm memory indication if the alarm memory latch is set and if the alarm memory indication function has been enabled. If the alarm memory indication function has not been enabled and the alarm memory latch is set, PTT will test the unit as described above. The release of PTT will always reset the alarm memory latch.

In Standby and Low Battery conditions, PTT tests the unit and RLED will be constantly enabled. This allows the user to easily identify the low battery unit without waiting for 40s to hear a horn chirp. Upon release of PTT, RLED goes back to normal standby pulse rate. The Low Battery HUSH mode is then activated, if this function is enabled.

### 3.5 Interconnect Operation

The bidirectional IO pin allows the interconnection of multiple detectors. In a Local Alarm condition, this pin is driven high 3.7s after a Local Alarm condition is sensed through a constant current source. Shorting this output to ground will not cause excessive current. The IO is ignored as input during a Local Alarm.

The IO also has an NMOS discharge device that is active for 0.5s 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 device goes into Remote Alarm and the horn will be active. RLED will be off, indicating a Remote Alarm condition. Internal protection circuitry allows the signaling unit to have higher supply voltage than the signaled unit, without excessive current draw.

The interconnect input has a 291 ms maximum digital filter. This allows for interconnection to other types of alarms (CO, for example) that may have a pulsed interconnect signal.

As a user-programmable option, the smart interconnect (smart IO) function can be selected. If the IO input is pulsed high twice with a nominal pulse on time greater than 37 ms and within 5.4s, a CO Alarm condition is detected, and the CO temporal horn pattern will sound. The CO temporal pattern will sound at least two times, if a CO Alarm condition is detected.

### 3.6 Reduced Sensitivity Mode (HUSH Mode)

Upon release of PTT, the unit may or may not go into a HUSH mode, depending on the user's selection.

If the hush-in-alarm-only option is selected, then only the release of PTT in a Local Alarm condition can initiate a HUSH mode. Upon release of PTT, the unit is immediately reset out of alarm, and the horn is silenced.

If the hush-in-alarm-only option is not selected, then anytime a release of PTT occurs, the HUSH mode is initiated.

In HUSH mode, the smoke sensitivity is lowered to a pre-determined level, which is user programmable. RLED is turned on for 10 ms every 10s.

The HUSH mode period is user programmable – it can be either 9 minutes or 80s. After this period times out, the unit goes back to its standby sensitivity.

If the unit is currently in a HUSH mode, then PTT will test the unit with the standby sensitivity. Upon release of PTT, a new HUSH mode will be initiated.

As another user-programmable option, HUSH mode can be terminated earlier by a smart hush function. This function allows the HUSH mode to be canceled by either a high smoke alarm, or a remote smoke alarm. High smoke alarm is the local smoke alarm caused by a smoke level that exceeds the reduced sensitivity level.

### 3.7 Alarm Memory

Alarm memory is a user-programmable option. If a unit has entered a Local Alarm, when exiting that Local Alarm, the alarm memory latch is set. The GLED can be used to visually identify any unit that had previously been in a Local Alarm condition. The GLED is pulsed on three times every 40s. Each GLED pulse is 10 ms long and 1s spaced from the next pulse. This alarm memory indication period can be 0, 24, 48 hours or no limit, depending on the user's selection.

The user will be able to identify a unit with an active alarm memory anytime by PTT. Upon start of PTT, the alarm memory indication will be activated. Depending on the user's selection, it can be 4 Hz horn chirp, 4 Hz GLED pulse, or both. Upon release of PTT, the alarm memory latch will be reset.

Anytime a release of PTT occurs, the alarm memory latch will be reset. The initial visual GLED indication is not displayed if a Low Battery condition exists.

## 3.8 End-of-Life (EOL) Indicator

The EOL indicator is a user-programmable function. If the EOL indicator function is enabled, then approximately every 15 days of continuous operation, $T_{EOL}$, the circuit will read an age count stored in EEPROM, and will increment this age. After 10 years of operation, an audible indication will be given to signal that the unit should be replaced. The EOL indicator is the same as the chamber test failure warning.

## 3.9 Tone Pattern

The smoke alarm tone pattern can be either a temporal pattern, or a continuous pattern, depending on the user's selection. The temporal horn pattern supports the NFPA 72® National Fire Alarm and Signaling Code® for emergency evacuation signals. The continuous pattern is a 70% duty cycle continuous pattern.

If a CO alarm is detected through the IO, the unit will sound the CO tone pattern. The CO tone pattern consists of 4 horn beeps in every 5.8s. Each horn beep is 100ms long and separated by 100ms.

## 3.10 Horn Synchronization

The horn synchronization function is programmable by the user.

In an interconnected system, if one unit goes into Local Alarm, other units will also go into Remote Alarm. The IO line is driven high by the origination local smoke unit, and stays high during the alarm.

If the Horn Synchronization function is enabled, at the end of every temporal horn pattern and when the horn is off, the origination unit will drive IO low, then high again. This periodic IO pulsing high and low will cause the remote smoke units to go into and out of the Remote Alarm repeatedly. Each time a unit goes into a Remote Alarm, its timing is reset. The horn sound of all remote smoke units will be synchronized with the horn sound of the origination unit.

A protection circuit ensures that the unit that goes first into a Local Alarm will be the master unit that conducts the horn synchronization. The units that go later into Local Alarm will not drive the IO line. This prevents bus contention problem.

This function works with the temporal tone pattern only.

## 3.11 Auto Alarm Locate

Auto Alarm Locate (AAL) is also a user-programmable function. To use AAL, the horn synchronization has to be selected first. The purpose of AAL is to let users quickly find the local alarm units just by listening. The local alarm units will sound the temporal pattern without interruption. The remote alarm units will sound the pattern with interruption. Every four temporal patterns (or 16s), the remote units are kept silenced for one pattern (or 4s).

The originating unit conducts the IO cycling. Every four temporal patterns the IO is driven low for one temporal pattern. In the remaining three temporal patterns, the IO is still pulsing to keep the horn synchronized.

The RLED of the origination unit and other local smoke units will be turned on 10 ms every 1s. The RLED of the remote smoke units will be off.

**NOTES:**

## 4.0 USER PROGRAMMING MODES

Tables 4-1 to 4-6 show the parameters for user smoke calibration.

**TABLE 4-1: PARAMETRIC PROGRAMMING**

| Parametric Programming | Range | Resolution |
|---|---|---|
| Standby Smoke Sensitivity ($V_{STD}$) | 2.9 → 6.0V (Note 1) | 100 mV (Note 1) |
| Hysteresis ($V_{HYS}$) | +50 → +225 mV (Note 2) | 25 mV (Note 2) |
| HUSH Smoke Sensitivity ($V_{HSH}$) | -1600 mV→-100 mV (Note 3) | 100 mV (Note 3) |
| CHAMBER Voltage at PTT/Chamber Test ($V_{CHAMBER}$) | 2.10 → 6.75V (Note 4) | 150 mV (Note 4) |

**Note 1:** $V_{STD}$ listed is based on $V_{DD}$ = 9V. The actual range is $(29/90)V_{DD} \rightarrow (60/90)V_{DD}$, resolution is $V_{DD}/90$.

**2:** $V_{HYS}$ is a positive offset from $V_{STD}$. The listed value is based on $V_{DD}$ = 9V. The actual range is $+(0.5/90)V_{DD} \rightarrow +(2.25/90)V_{DD}$, resolution is $(0.25/90)V_{DD}$.

**3:** $V_{HSH}$ is a negative offset from $V_{STD}$. The listed value is based on $V_{DD}$ = 9V. The actual range is $-(16/90)V_{DD} \rightarrow -(1/90)V_{DD}$, resolution is $V_{DD}/90$

**4:** $V_{CHAMBER}$ listed value is based on $V_{DD}$ = 9V. Actual range is $(21/90)V_{DD} \rightarrow (67.5/90)V_{DD}$, resolution is $(1.5/90)V_{DD}$.

**TABLE 4-2: STANDBY SENSITIVITY ($V_{STD}$) PROGRAMMING CONFIGURATION AT $V_{DD}$ = 9V**

| $V_{STD}$ Register STTR [5:1] Configuration | | | | | Values |
|---|---|---|---|---|---|
| STTR5 | STTR4 | STTR3 | STTR2 | STTR1 | $V_{STD}$ |
| 0 | 0 | 0 | 0 | 0 | 4.5V |
| 0 | 0 | 0 | 0 | 1 | 4.6V |
| 0 | 0 | 0 | 1 | 0 | 4.7V |
| 0 | 0 | 0 | 1 | 1 | 4.8V |
| 0 | 0 | 1 | 0 | 0 | 4.9V |
| 0 | 0 | 1 | 0 | 1 | 5.0V |
| 0 | 0 | 1 | 1 | 0 | 5.1V |
| 0 | 0 | 1 | 1 | 1 | 5.2V |
| 0 | 1 | 0 | 0 | 0 | 5.3V |
| 0 | 1 | 0 | 0 | 1 | 5.4V |
| 0 | 1 | 0 | 1 | 0 | 5.5V |
| 0 | 1 | 0 | 1 | 1 | 5.6V |
| 0 | 1 | 1 | 0 | 0 | 5.7V |
| 0 | 1 | 1 | 0 | 1 | 5.8V |
| 0 | 1 | 1 | 1 | 0 | 5.9V |
| 0 | 1 | 1 | 1 | 1 | 6.0V |
| 1 | 0 | 0 | 0 | 0 | 2.9V |
| 1 | 0 | 0 | 0 | 1 | 3.0V |
| 1 | 0 | 0 | 1 | 0 | 3.1V |
| 1 | 0 | 0 | 1 | 1 | 3.2V |
| 1 | 0 | 1 | 0 | 0 | 3.3V |
| 1 | 0 | 1 | 0 | 1 | 3.4V |
| 1 | 0 | 1 | 1 | 0 | 3.5V |
| 1 | 0 | 1 | 1 | 1 | 3.6V |
| 1 | 1 | 0 | 0 | 0 | 3.7V |
| 1 | 1 | 0 | 0 | 1 | 3.8V |
| 1 | 1 | 0 | 1 | 0 | 3.9V |
| 1 | 1 | 0 | 1 | 1 | 4.0V |
| 1 | 1 | 1 | 0 | 0 | 4.1V |
| 1 | 1 | 1 | 0 | 1 | 4.2V |
| 1 | 1 | 1 | 1 | 0 | 4.3V |
| 1 | 1 | 1 | 1 | 1 | 4.4V |

### TABLE 4-3: HYSTERESIS ($V_{HYS}$) PROGRAMMING CONFIGURATION AT $V_{DD}$ = 9V

| $V_{HYS}$ Register HYTR[3:1] Configuration | | | Values |
|---|---|---|---|
| HYTR3 | HYTR2 | HYTR1 | $V_{HYS}$ |
| 0 | 0 | 0 | 150 mV |
| 0 | 0 | 1 | 175 mV |
| 0 | 1 | 0 | 200 mV |
| 0 | 1 | 1 | 225 mV |
| 1 | 0 | 0 | 50 mV |
| 1 | 0 | 1 | 75 mV |
| 1 | 1 | 0 | 100 mV |
| 1 | 1 | 1 | 125 mV |

### TABLE 4-4: HUSH SENSITIVITY ($V_{HSH}$) PROGRAMMING CONFIGURATION AT $V_{DD}$ = 9V

| $V_{HSH}$ Register TMTR[4:1] Configuration | | | | Values |
|---|---|---|---|---|
| TMTR4 | TMTR3 | TMTR2 | TMTR1 | $V_{HSH}$ |
| 0 | 0 | 0 | 0 | $V_{STD}$ – 800 mV |
| 0 | 0 | 0 | 1 | $V_{STD}$ – 700 mV |
| 0 | 0 | 1 | 0 | $V_{STD}$ – 600 mV |
| 0 | 0 | 1 | 1 | $V_{STD}$ – 500 mV |
| 0 | 1 | 0 | 0 | $V_{STD}$ – 400 mV |
| 0 | 1 | 0 | 1 | $V_{STD}$ – 300 mV |
| 0 | 1 | 1 | 0 | $V_{STD}$ – 200 mV |
| 0 | 1 | 1 | 1 | $V_{STD}$ – 100 mV |
| 1 | 0 | 0 | 0 | $V_{STD}$ – 1600 mV |
| 1 | 0 | 0 | 1 | $V_{STD}$ – 1500 mV |
| 1 | 0 | 1 | 0 | $V_{STD}$ – 1400 mV |
| 1 | 0 | 1 | 1 | $V_{STD}$ – 1300 mV |
| 1 | 1 | 0 | 0 | $V_{STD}$ – 1200 mV |
| 1 | 1 | 0 | 1 | $V_{STD}$ – 1100 mV |
| 1 | 1 | 1 | 0 | $V_{STD}$ – 1000 mV |
| 1 | 1 | 1 | 1 | $V_{STD}$ – 900 mV |

### TABLE 4-5: CHAMBER VOLTAGE ($V_{CHAMBER}$) PROGRAMMING CONFIGURATION AT $V_{DD}$ = 9V

| $V_{CHAMBER}$ Register PTTR[5:1] Configuration | | | | | Values |
|---|---|---|---|---|---|
| PTTR5 | PTTR4 | PTTR3 | PTTR2 | PTTR1 | $V_{CHAMBER}$ |
| 0 | 0 | 0 | 0 | 0 | 4.50V |
| 0 | 0 | 0 | 0 | 1 | 4.65V |
| 0 | 0 | 0 | 1 | 0 | 4.80V |
| 0 | 0 | 0 | 1 | 1 | 4.95V |
| 0 | 0 | 1 | 0 | 0 | 5.10V |
| 0 | 0 | 1 | 0 | 1 | 5.25V |
| 0 | 0 | 1 | 1 | 0 | 5.40V |
| 0 | 0 | 1 | 1 | 1 | 5.55V |
| 0 | 1 | 0 | 0 | 0 | 5.70V |
| 0 | 1 | 0 | 0 | 1 | 5.85V |
| 0 | 1 | 0 | 1 | 0 | 6.00V |
| 0 | 1 | 0 | 1 | 1 | 6.15V |
| 0 | 1 | 1 | 0 | 0 | 6.30V |
| 0 | 1 | 1 | 0 | 1 | 6.45V |
| 0 | 1 | 1 | 1 | 0 | 6.60V |
| 0 | 1 | 1 | 1 | 1 | 6.75V |
| 1 | 0 | 0 | 0 | 0 | 2.10V |
| 1 | 0 | 0 | 0 | 1 | 2.25V |
| 1 | 0 | 0 | 1 | 0 | 2.40V |
| 1 | 0 | 0 | 1 | 1 | 2.55V |
| 1 | 0 | 1 | 0 | 0 | 2.70V |
| 1 | 0 | 1 | 0 | 1 | 2.85V |
| 1 | 0 | 1 | 1 | 0 | 3.00V |
| 1 | 0 | 1 | 1 | 1 | 3.15V |
| 1 | 1 | 0 | 0 | 0 | 3.30V |
| 1 | 1 | 0 | 0 | 1 | 3.45V |
| 1 | 1 | 0 | 1 | 0 | 3.60V |
| 1 | 1 | 0 | 1 | 1 | 3.75V |
| 1 | 1 | 1 | 0 | 0 | 3.90V |
| 1 | 1 | 1 | 0 | 1 | 4.05V |
| 1 | 1 | 1 | 1 | 0 | 4.20V |
| 1 | 1 | 1 | 1 | 1 | 4.35V |

**TABLE 4-6: FEATURE PROGRAMMING**

| Features | Options |
|---|---|
| Low Battery Detection Selection | 6.9V<br>7.2V<br>7.5V<br>7.8V |
| 10 Year End-of-Life Indicator | Enable/Disable |
| Smart IO with CO Alarm Sensing | Enable/Disable |
| Auto Alarm Locate | Enable/Disable |
| Horn Synchronization | Enable/Disable |
| Low Battery Hush | Enable/Disable |
| Alarm Memory Indicator at PTT: Horn Chirping | Enable/Disable |
| Alarm Memory Indicator at PTT: GLED Flashing | Enable/Disable |
| Alarm Memory Indicator at Standby Time Out Period | 0/24/48 hr or no limit |
| Alarm Memory | Enable/Disable |
| HUSH Time Out Period | 9 minutes or 80s |
| Smart HUSH | Enable/Disable |
| HUSH In Alarm Only | Enable/Disable |
| HUSH | Enable/Disable |
| Tone Select | Temporal or Continuous |

## 4.1 Calibration and Programming Procedures

Sixteen separate programming and Test modes are available for user customization. The T2 input is used to enter these modes and step through them. To enter these modes, after power-up, T2 must be driven to $V_{DD}$ and held at that level. To step through the modes, the TEST input must first be driven to $V_{DD}$. T2 is then clocked. TEST has to be high when clocking T2. Anytime T2 and TEST are both driven to low, the unit will come out of these modes and go back to the normal operation mode. FEED and IO are re-configured to become Test mode inputs. A T2 clock occurs when it switches from $V_{SS}$ to $V_{DD}$. The Test mode functions are outlined in the Table 4-7.

**TABLE 4-7: TEST MODE FUNCTIONS**

| Mode | Descriptions | T2 Clock | TEST | T2 | FEED | IO | T3 | TESTOUT |
|---|---|---|---|---|---|---|---|---|
| M0 Note 1 | Normal Operation | 0 | PTT/HUSH | 0 | FEED | IO | Not Used | IO Dump Note 2 |
| TM0 | Speedup Mode | 1 | PTT/HUSH | $V_{DD}$ | CLK | IO | Not Used | IO Dump Note 2 |
| TM1 | Load Timer for Spill | 2 | EOL Timer Clock | $V_{DD}$ | HUSH/LB HUSH Timer Clock | Alarm Mem Timer Clock | Not Used | Not Used |
| TM2 | User Feature Programming | 3 | ProgData | $V_{DD}$ | ProgClk | ProgEn | Not Used | Not Used |
| TM3 | Horn Test/LED On; IO High/Low | 4 | HornEnB Note 3 | $V_{DD}$ | IOHi En<br>IO Dump EnB<br>HB/HS En<br>Note 4 | LEDEn | Not Used | Not Used |
| TM4 | Standby Sen Set | 5 | SmkCompEnB T3EnB | $V_{DD}$ | CalClk | ReadReg | $V_{SEN}$ | SmkCompOut Note 5 |
| TM5 | Hyst Sen Set | 6 | SmkCompEnB T3EnB | $V_{DD}$ | CalClk | ReadReg | $V_{SEN}$ | SmkCompOut Note 5 |

**Note 1:** After power-up, the unit is in M0, the normal operation mode. When in M0, if T2 is driven to $V_{DD}$, the unit will enter TM0.

**2:** In M0 and TM0, the digital output TESTOUT is driven by the internal IO dump signal.

**3:** In TM3, if TEST = $V_{SS}$, the horn is turned on. IO is in weak pull-down; If TEST = $V_{DD}$, the horn is off. FEED controls IO and HB/HS.

**4:** Valid when TEST = $V_{DD}$;

**5:** SmkCompOut – digital comparator output (high if DETECT < $V_{SEN}$; low if DETECT > $V_{SEN}$).

**6:** LBCompOut – digital comparator output (high if $V_{DD}$ < LB trip point; low if $V_{DD}$ > LB trip point).

### TABLE 4-7: TEST MODE FUNCTIONS (CONTINUED)

| Mode | Descriptions | T2 Clock | TEST | T2 | FEED | IO | T3 | TESTOUT |
|---|---|---|---|---|---|---|---|---|
| TM6 | HUSH Sen Set | 7 | SmkCompEnB T3EnB | $V_{DD}$ | CalClk | ReadReg | $V_{SEN}$ | SmkCompOut Note 5 |
| TM7 | PTT/Chamber Test Set | 8 | SmkCompEnB T3EnB | $V_{DD}$ | CalClk | ReadReg | $V_{SEN}$ | SmkCompOut Note 5 |
| TM8 | Program Calibration | 9 | Not Used | $V_{DD}$ | Not Used | ProgEn | Not Used | Not Used |
| TM9 | Not Used | 10 | | | | | | |
| TM10 | Serial Read/Write Calibration | 11 | ProgData | $V_{DD}$ | ProgClk | ProgEn | Not Used | Not Used |
| TM11 | Not Used | 12 | | | | | | |
| TM12 | Standby Sen Check | 13 | SmkCompEnB T3EnB | $V_{DD}$ | Not Used | Not Used | $V_{SEN}$ | SmkCompOut Note 5 |
| TM13 | Hyst Sen Check | 14 | SmkCompEnB T3EnB | $V_{DD}$ | Not Used | Not Used | $V_{SEN}$ | SmkCompOut Note 5 |
| TM14 | HUSH Sen Check | 15 | SmkCompEnB T3EnB | $V_{DD}$ | Not Used | Not Used | $V_{SEN}$ | SmkCompOut Note 5 |
| TM15 | PTT/Chamber Test CHAMBER Voltage Check | 16 | SmkCompEnB T3EnB | $V_{DD}$ | Not Used | Not Used | $V_{SEN}$ | SmkCompOut Note 5 |
| TM16 | Not Used | 17 | | | | | | |
| TM17 | LB Test | 18 | Not Used | $V_{DD}$ | Not Used | LB Test En RLED En | Not Used | LBCompOut Note 6 |
| TM18 | Serial Read/Write Feature and Calibration | 19 | ProgData | $V_{DD}$ | ProgClk | ProgEn | Not Used | Serial Out |
| TM19 | User EE Lock Bit | 20 | LockSetEn | $V_{DD}$ | Not used | ProgEn | Not Used | Lock Out |

**Note 1:** After power-up, the unit is in M0, the normal operation mode. When in M0, if T2 is driven to $V_{DD}$, the unit will enter TM0.

**2:** In M0 and TM0, the digital output TESTOUT is driven by the internal IO dump signal.

**3:** In TM3, if TEST = $V_{SS}$, the horn is turned on. IO is in weak pull-down; If TEST = $V_{DD}$, the horn is off. FEED controls IO and HB/HS.

**4:** Valid when TEST = $V_{DD}$;

**5:** SmkCompOut – digital comparator output (high if DETECT < $V_{SEN}$; low if DETECT > $V_{SEN}$).

**6:** LBCompOut – digital comparator output (high if $V_{DD}$ < LB trip point; low if $V_{DD}$ > LB trip point).

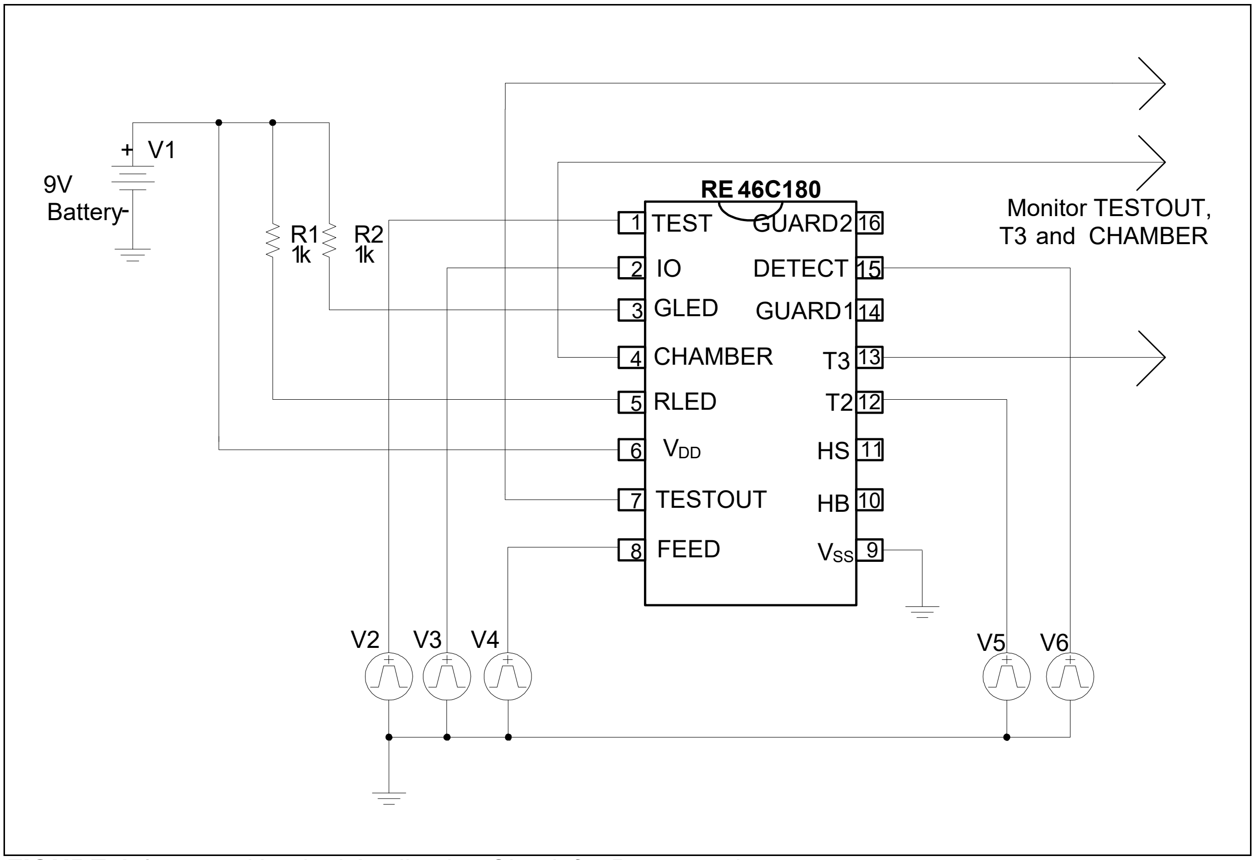



*FIGURE 4-1: Nominal Application Circuit for Programming.*

## 4.2 Smoke Calibration

A separate calibration mode is entered for each measurement mode (Normal, Hysteresis, HUSH and PTT/ Chamber Test) so that independent limits can be set for each.

In all calibration modes the $V_{SEN}$ voltage, which represents the smoke sensitivity level, can be accessed at T3 output. The SmkCompOut output voltage is the result of the comparison of DETECT and $V_{SEN}$, and can be accessed at TESTOUT output. The FEED input can be clocked to cycle through the available smoke sensitivity levels. Once the desired smoke sensitivity level is reached, the IO input is pulsed low to high to store the result.

The detailed procedure is described in the following steps:

1. Power up with the bias condition shown in Figure 4-1. At power-up:

   TEST = IO = FEED = T2 = $V_{SS}$,

   DETECT = $V_{DD}$. Now in mode M0.
2. Drive T2 input from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$ to enter TM0.
3. Drive TEST from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$.
4. Apply four clock pulses to the T2 input ($V_{DD}$ to $V_{SS}$ and back to $V_{DD}$) to enter in TM4 mode. This initiates the Calibration mode for the normal sensitivity setting. Drive TEST from $V_{DD}$ to $V_{SS}$ to turn on the smoke comparator and enable the T3 switch. The standby smoke sensitivity $V_{SEN}$ will appear at T3. The smoke comparator output will appear at TESTOUT. Clock FEED to increase or decrease the $V_{SEN}$ levels as needed. The IO input is pulsed low-to-high to save the result.
5. Drive TEST from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$. Apply another clock pulse to the T2 input, to enter in TM5 mode. This initiates the Calibration mode for the hysteresis setting. Drive TEST from $V_{DD}$ to $V_{SS}$ to turn on the smoke comparator and enable the T3 switch. The local alarm smoke sensitivity $V_{SEN}$ will appear at T3. The smoke comparator output will appear at TESTOUT. Clock FEED to increase or decrease the $V_{SEN}$ levels as needed. The IO input is pulsed low-to-high to save the result.

6. Drive TEST from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$. Apply another clock pulse to the T2 input, to enter in TM6 mode. This initiates the calibration mode for the HUSH sensitivity setting. Drive TEST from $V_{DD}$ to $V_{SS}$ to turn on the smoke comparator and enable the T3 switch. The HUSH smoke sensitivity $V_{SEN}$ will appear at T3. The smoke comparator output will appear at TESTOUT. Clock FEED to increase or decrease the $V_{SEN}$ levels as needed. The IO input is pulsed low-to-high to save the result
7. Drive TEST from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$. Apply another clock pulse to the T2 input to enter in TM7 mode. This initiates the calibration mode for the CHAMBER voltage at PTT/Chamber Test. Drive TEST from $V_{DD}$ to $V_{SS}$ to turn on the smoke comparator and enable the T3 switch. The standby smoke sensitivity $V_{SEN}$ will appear at T3. The smoke comparator output will appear at TESTOUT. Clock FEED to increase or decrease the CHAMBER voltages as needed. The IO input is pulsed low-to-high to save the result.
8. After sensitivity settings and CHAMBER voltage calibrations have been made, pulse IO to store all results into memory. Before this step, no settings are stored into memory.

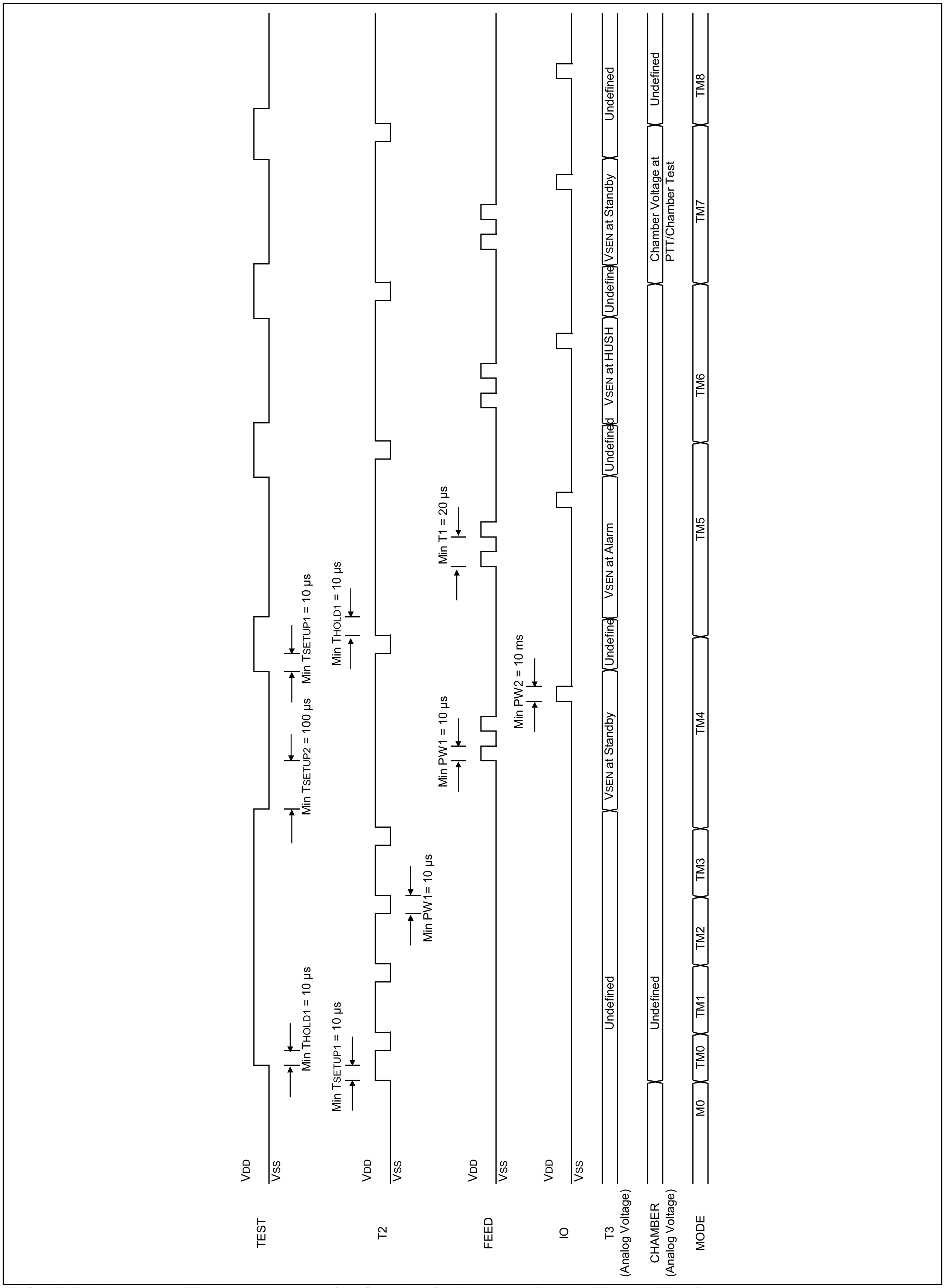



***FIGURE 4-2:*** *Timing Diagram for Smoke Calibration (Mode TM4 ~ TM8).*

## 4.3 Serial Read/Write Calibration

As an alternative to the steps in **Section 4.2, Smoke Calibration**, the sensitivity settings can be entered directly from a Serial Read/Write Calibration mode (if the system has been well characterized).

To enter this mode, follow these steps:

1. Power up with the bias condition shown in Figure 4-1 to enter M0. At power-up:

   TEST = IO = FEED = T2 = $V_{SS}$,

   DETECT = $V_{DD}$,
2. Drive T2 input from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$ to enter TM0.
3. Drive TEST from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$.
4. Apply 10 clock pulses to the T2 input ($V_{DD}$ to $V_{SS}$ and back to $V_{DD}$) to enter in TM10 mode. This enables the Serial Read/Write Calibration mode.
5. TEST now acts as a data input (High = $V_{DD}$, Low = $V_{SS}$). FEED acts as the clock input (High = $V_{DD}$, Low = $V_{SS}$). Clock in the sensitivity settings.

   The data sequence should be as follows:

   | | |
   |---|---|
   | 5 bit | Standby Sensitivity (LSB first) |
   | 3 bit | Hysteresis (LSB first) |
   | 4 bit | HUSH Sensitivity (LSB first) |
   | 5 bit | CHAMBER voltage in PTT/Chamber Test (LSB first) |
6. After all 17 bits have been entered, pulse IO to store into the EEPROM memory.

### REGISTER 4-1: CALIBRATION CONFIGURATION REGISTER

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | W-x |
| | | | | | | | PTTR5 |
| | | | | | | | bit 17 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W-x | W-x | W-x | W-x | W-x | W-x | W-x | W-x |
| PTTR4 | PTTR3 | PTTR2 | PTTR1 | TMTR4 | TMTR3 | TMTR2 | TMTR1 |
| bit 16 | | | | | | | bit 8 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W-x | W-x | W-x | W-x | W-x | W-x | W-x | W-x |
| HYTR3 | HYTR2 | HYTR1 | STTR5 | STTR4 | STTR3 | STTR2 | STTR1 |
| bit 8 | | | | | | | bit 1 |

| **Legend:** | | | |
|---|---|---|---|
| R = Readable bit | W = Writable bit | U = Unimplemented bit, read as ‘0’ | |
| -n = Value at POR | ‘1’ = Bit is set | ‘0’ = Bit is cleared | x = Bit is unknown |

bit 17 **PTTR5:** MSB (See Table 4-5)
bit 16 **PTTR4:** 4SB
bit 15 **PTTR3:** 3SB
bit 14 **PTTR2:** 2SB
bit 13 **PTTR1:** LSB
bit 12 **TMTR4:** MSB (See Table 4-4)
bit 11 **TMTR3:** 3SB
bit 10 **TMTR2:** 2SB
bit 9 **TMTR1:** LSB
bit 8 **HYTR3:** MSB (See Table 4-3)
bit 7 **HYTR2:** 2SB
bit 6 **HYTR1:** LSB
bit 5 **STTR5:** MSB (See Table 4-2)
bit 4 **STTR4:** 4SB
bit 3 **STTR3:** 3SB
bit 2 **STTR2:** 2SB
bit 1 **STTR1:** LSB

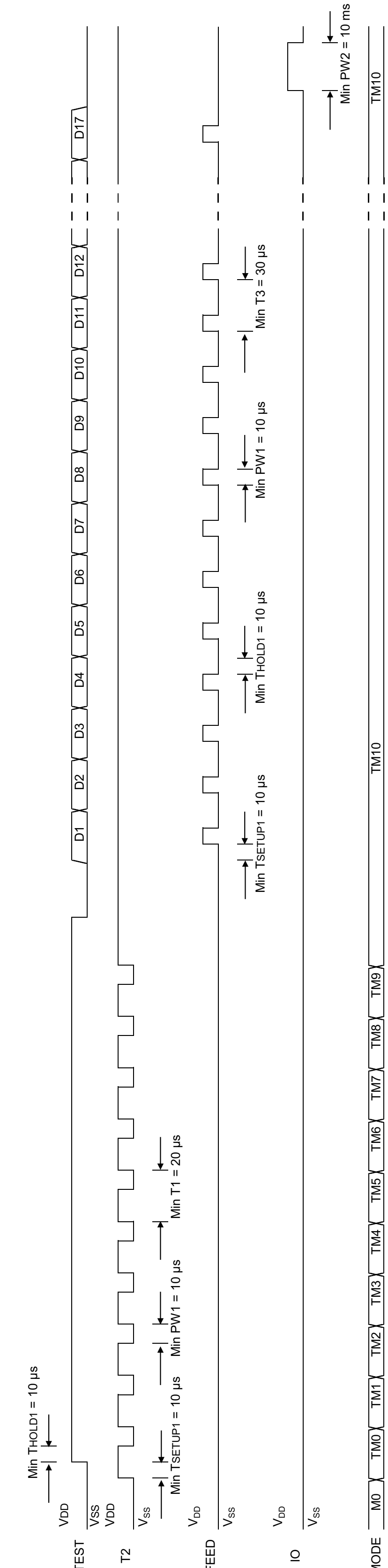



***FIGURE 4-3:*** *Timing Diagram for Mode TM10.*

## 4.4 User Feature Selections

User feature selections can be clocked in serially using TEST as data input, and FEED, as a clock input, then stored in the internal EEPROM.

The detailed steps are as follows:

1. Power up with the bias condition shown in Figure 4-1. At power-up:

   TEST = IO = FEED = T2 = $V_{SS}$,
   DETECT = $V_{DD}$. Now in mode M0.
2. Drive T2 input from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$ to enter TM0.
3. Drive TEST from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$.
4. Apply two clock pulses to the T2 input ($V_{DD}$ to $V_{SS}$ and then back to $V_{DD}$) to enter in TM2.
5. Using TEST as data and FEED as clock, shift in values of 18 bits as selected from Register 4-2.
6. After shifting in data, pull IO input to $V_{DD}$, then $V_{SS}$ (minimum pulse-width of 10 ms) to store shift register contents in the memory.
7. If any changes are required, power down the part and return to Step 1. All bit values must be reentered.

**REGISTER 4-2: USER FEATURE CONFIGURATION REGISTER**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | U | W-x |
| | | | | | | — | LBTR2 |
| | | | | | | bit 18 | bit 17 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W-x | W-x | W-x | W-x | W-x | W-x | W-x | W-x |
| LBTR1 | EOLEn | COEn | NoAAL | SyncEn | LBHshEn | AMHCEn | AMLEDEn |
| bit 16 | | | | | | | bit 8 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W-x | W-x | W-x | W-x | W-x | W-x | W-x | W-x |
| AMTO2 | AMTO1 | AMEn | ShrTO | SmrtH | HIAO | HushEnB | TSEL |
| bit 8 | | | | | | | bit 1 |

| **Legend:** | | | |
|---|---|---|---|
| R = Readable bit | W = Writable bit | U = Unimplemented bit, read as ‘0’ | |
| -n = Value at POR | ‘1’ = Bit is set | ‘0’ = Bit is cleared | x = Bit is unknown |

bit 18 **Unimplemented:** Read as ‘x’

bit 17 **LBTR2:** MSB

bit 16 **LBTR1:** LSB

00 =7.5V
01 =7.8V
10 =6.9V
11 =7.2V

bit 15 **EOLEn:** End-of-Life Indicator Enable Bit

1 = Enable
0 = Disable

bit 14 **COEn:** CO Alarm Function (Smart IO) Enable Bit

1 = Enable
0 = Disable

bit 13 **NoAAL:** Auto Alarm Locate Disable Bit

1 = AAL is Disabled
0 = AAL is Enabled

bit 12 **SyncEn:** Horn Synchronization Enable Bit

1 = Enable
0 = Disable

**REGISTER 4-2: USER FEATURE CONFIGURATION REGISTER (CONTINUED)**

| | | |
|---|---|---|
| bit 11 | **LBHshEn:** Low Battery Hush Enable Bit<br>1 = Enable<br>0 = Disable | |
| bit 10 | **AMHCEn:** Alarm Memory PTT Indicator Horn Chirp Enable Bit<br>1 = Enable<br>0 = Disable | |
| bit 9 | **AMLEDEn:** Alarm Memory PTT Indicator LED Flashing Enable Bit<br>1 = Enable<br>0 = Disable | |
| bit 8 | **AMTO2:** MSB | |
| bit 7 | **AMTO1:** LSB<br>00 =24 Hours Timeout<br>01 =48 Hours Timeout<br>10 =0 Hour Timeout<br>11 =Never Timeout | |
| bit 6 | **AMEn:** Alarm Memory Enable Bit<br>1 = Enable<br>0 = Disable | |
| bit 5 | **ShrTO:** HUSH Timer Time Out Select Bit<br>1 = 80 seconds<br>0 = 9 minutes | |
| bit 4 | **SmrtH:** Smart HUSH Bit<br>1 = Enable (Hush is canceled by either high smoke, or remote smoke)<br>0 = Disable (Hush is never canceled until timeout) | |
| bit 3 | **HIAO:** HUSH-in-Alarm -Only Bit<br>1 = Enable (Hush is activated upon release of PTT during local smoke only)<br>0 = Disable (Hush is activated upon release of PTT at anytime) | |
| bit 2 | **HushEnB:** HUSH Enable Bit<br>1 = Enable (Hush is disabled)<br>0 = Disable (Hush is enabled) | |
| bit 1 | **TSEL:** Tone Select Bit<br>1 = Continuous Tone Pattern<br>0 = Temporal Tone Pattern | |

The minimum pulse-width for FEED is 10 µs, while the minimum pulse-width for TEST is 100 µs.

For example, for the following options, the sequence would be:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Data | – | X | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| Bit | – | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 |
| Data | – | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| Bit | – | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

| | | |
|---|---|---|
| Low battery Trip Point | = | 6.9V |
| End of Life Enable | = | Yes |
| CO Enable | = | Yes |
| Auto Alarm Locate Disable | = | Yes |
| Horn Synchronization Enable | = | Yes |
| Low Battery Hush Enable | = | No |
| Alarm Memory PTT Indicator Horn Chirp Enable | = | Yes |
| Alarm Memory PTT Indicator LED Flashing Enable | = | No |
| Alarm memory LED indicator time out | = | 24 hours |
| Alarm Memory Enable | = | Yes |
| HUSH time out | = | 9 minutes |
| Smart HUSH | = | No |
| Hush in alarm only | = | Yes |
| Hush Enable | = | Yes |
| Tone Select | = | Temporal |

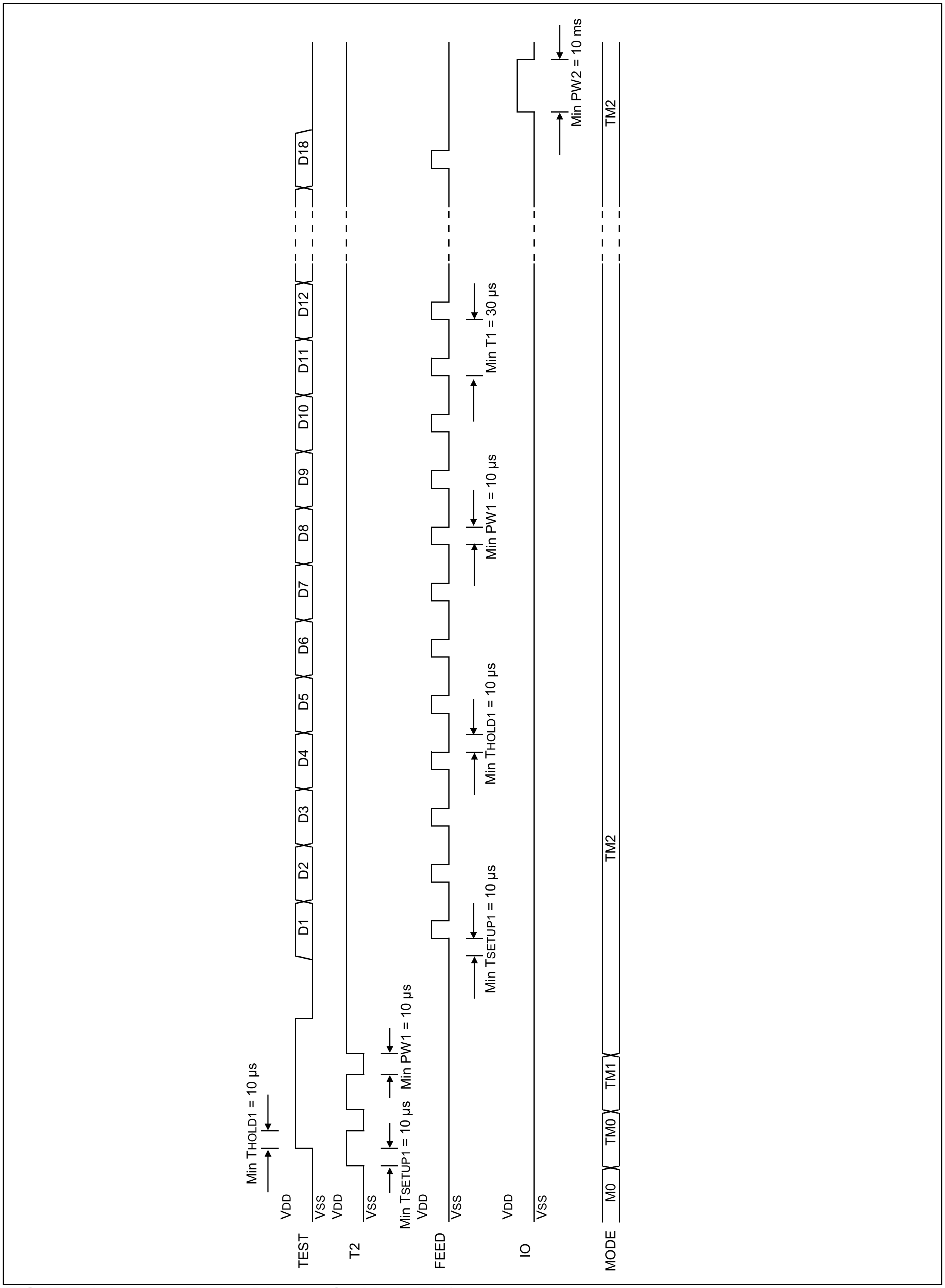



**FIGURE 4-4:** *Timing Diagram for Mode TM2.*

## 4.5 Sensitivity Verification

After all sensitivity levels and CHAMBER voltage at PTT/Chamber Test have been entered and stored into the memory, additional Test modes are available to verify if the sensitivities are functioning as expected. Table 4-8 describes several verification tests.

**TABLE 4-8: SENSITIVITY VERIFICATION DESCRIPTION**

| Sensitivity | Test Description |
|---|---|
| Standby Sensitivity | Clock T2 to Mode TM12 (12 clocks). With appropriate smoke level in the chamber, pull TEST to $V_{SS}$ and hold for at least 1 ms. The TESTOUT output will indicate the detection status (High = smoke detected). |
| Hysteresis | Clock T2 to Mode TM13 (13 clocks). Pulse TEST and monitor TESTOUT. |
| HUSH Sensitivity | Clock T2 to Mode TM14 (14 clocks). Pulse TEST and monitor TESTOUT. |
| CHAMBER voltage at PTT/Chamber Test | Clock T2 to Mode TM15 (15 clocks). Pulse TEST and monitor TESTOUT. |

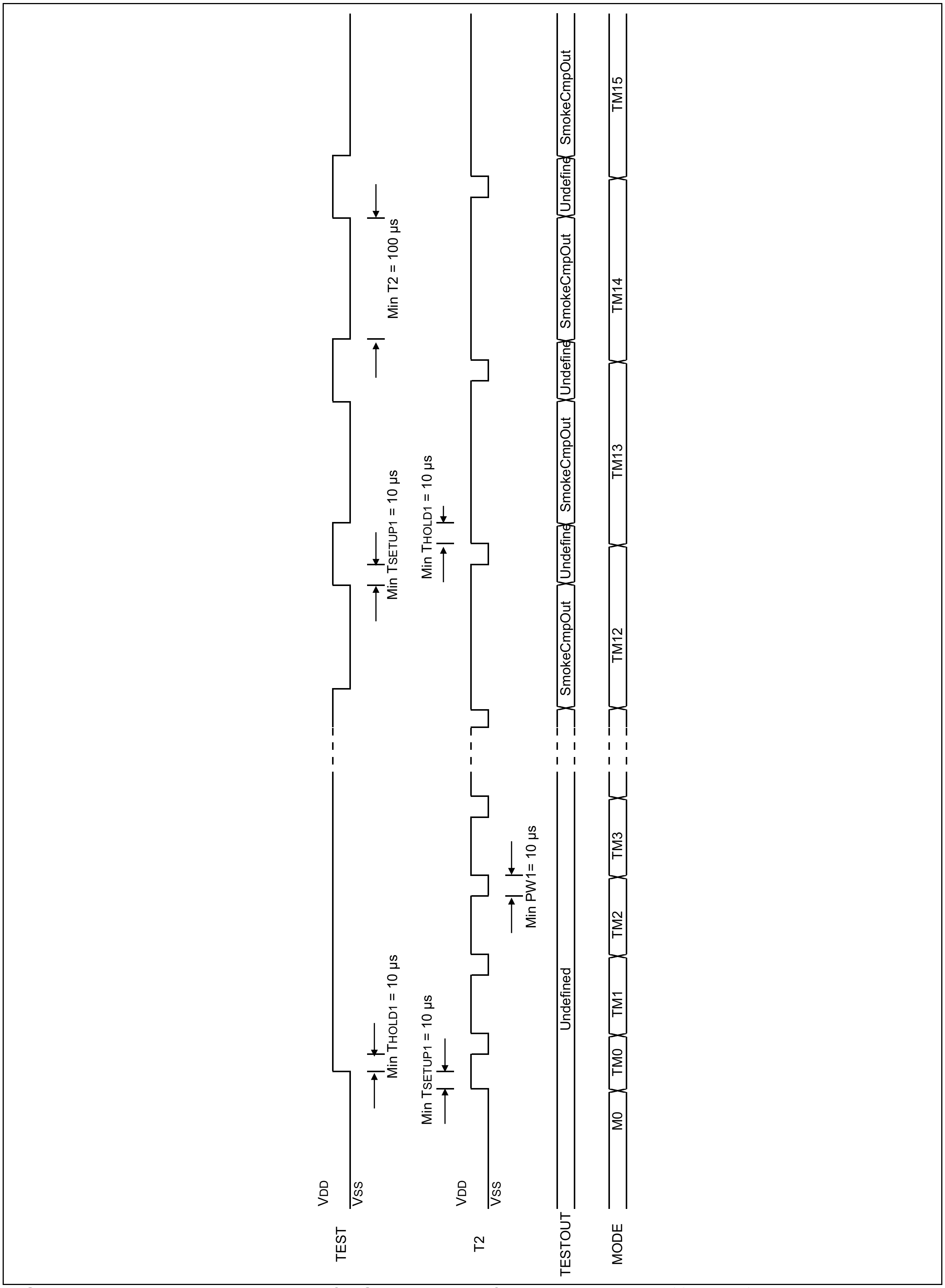



**FIGURE 4-5:** *Timing Diagram for Sensitivity Verification in Mode TM12 ~ TM15.*

## 4.6 Serial Read/Write Calibration and User Features

As an alternative to the steps in **Section 4.2, Smoke Calibration** and **Section 4.4, User Feature Selections**, the sensitivity settings and user feature selections can be entered directly from a Serial Read/Write Calibration mode.

To enter this mode, follow these steps:

1. Power up with the bias condition shown in Figure 4-1 to enter M0. At power-up:

   TEST = IO = FEED = T2 = $V_{SS}$,

   DETECT = $V_{DD}$.
2. Drive T2 input from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$ to enter TM0.
3. Drive TEST from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$.
4. Apply 18 clock pulses to the T2 input ($V_{DD}$ to $V_{SS}$ and then back to $V_{DD}$) to enter in TM18 mode. This enables the Serial Read/Write Calibration and User Features modes.
5. TEST now acts as a data input (High = $V_{DD}$, Low = $V_{SS}$). FEED acts as the clock input (High = $V_{DD}$, Low = $V_{SS}$). Clock in the sensitivity settings. The data sequence should be as follows:

   D1 ~ D18 User Features (18 bits, LSB first)

   D19 ~ D35 Calibration (17 bits, LSB First)
6. After all 35 bits have been entered, pulse IO to store into the EEPROM memory.

### REGISTER 4-3: SERIAL READ/WRITE REGISTER

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | W-x | W-x | W-x |
| | | | | | PTTR5 | PTTR4 | PTTR3 |
| | | | | | bit 35 | | bit 33 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W-x | W-x | W-x | W-x | W-x | W-x | W-x | W-x |
| PTTR2 | PTTR1 | TMTR4 | TMTR3 | TMTR2 | TMTR1 | HYTR3 | HYTR2 |
| bit 32 | | | | | | | bit 25 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W-x | W-x | W-x | W-x | W-x | W-x | U | W-x |
| HYTR1 | STTR5 | STTR4 | STTR3 | STTR2 | STTR1 | — | LBTR2 |
| bit 24 | | | | | | | bit 17 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W-x | W-x | W-x | W-x | W-x | W-x | W-x | W-x |
| LBTR1 | EOLEn | COEn | NoAAL | SyncEn | LBHshEn | AMHCEn | AMLEDEn |
| bit 16 | | | | | | | bit 8 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W-x | W-x | W-x | W-x | W-x | W-x | W-x | W-x |
| AMTO2 | AMTO1 | AMEn | ShrTO | SmrtH | HIAO | HushEnB | TSEL |
| bit 8 | | | | | | | bit 1 |

| **Legend:** | | | |
|---|---|---|---|
| R = Readable bit | W = Writable bit | U = Unimplemented bit, read as ‘0’ | |
| -n = Value at POR | ‘1’ = Bit is set | ‘0’ = Bit is cleared | x = Bit is unknown |

bit 35 **PTTR5:** MSB (See Table 4-5)
bit 34 **PTTR4:** 4SB
bit 33 **PTTR3:** 3SB
bit 32 **PTTR2:** 2SB
bit 31 **PTTR1:** LSB
bit 30 **TMTR4:** MSB (See Table 4-4)

**REGISTER 4-3: SERIAL READ/WRITE REGISTER (CONTINUED)**

| | |
|---|---|
| bit 29 | **TMTR3:** 3SB |
| bit 28 | **TMTR2:** 2SB |
| bit 27 | **TMTR1:** LSB |
| bit 26 | **HYTR3:** MSB (See Table 4-3) |
| bit 25 | **HYTR2:** 2SB |
| bit 24 | **HYTR1:** LSB |
| bit 23 | **STTR5:** MSB (See Table 4-2) |
| bit 22 | **STTR4:** 4SB |
| bit 21 | **STTR3:** 3SB |
| bit 20 | **STTR2:** 2SB |
| bit 19 | **STTR1:** LSB |
| bit 18 | **Unimplemented:** Read as ‘x’ |
| bit 17 | **LBTR2:** MSB |
| bit 16 | **LBTR1:** LSB<br>00 =7.5V<br>01 =7.8V<br>10 =6.9V<br>11 =7.2V |
| bit 15 | **EOLEn:** End-of-Life Indicator Enable Bit<br>1 = Enable<br>0 = Disable |
| bit 14 | **COEn:** CO Alarm Function (Smart IO) Enable Bit<br>1 = Enable<br>0 = Disable |
| bit 13 | **NoAAL:** Auto Alarm Locate Disable Bit<br>1 = AAL is Disabled<br>0 = AAL is Enabled |
| bit 12 | **SyncEn:** Horn Synchronization Enable Bit<br>1 = Enable<br>0 = Disable |
| bit 11 | **LBHshEn:** Low Battery Hush Enable Bit<br>1 = Enable<br>0 = Disable |
| bit 10 | **AMHCEn:** Alarm Memory PTT Indicator Horn Chirp Enable Bit<br>1 = Enable<br>0 = Disable |
| bit 9 | **AMLEDEn:** Alarm Memory PTT Indicator LED Flashing Enable Bit<br>1 = Enable<br>0 = Disable |
| bit 8 | **AMTO2:** MSB |
| bit 7 | **AMTO1:** LSB<br>00 =24 Hours Timeout<br>01 =48 Hours Timeout<br>10 =0 Hours Timeout<br>11 =Never Timeout |
| bit 6 | **AMEn:** Alarm Memory Enable Bit<br>1 = Enable<br>0 = Disable |

**REGISTER 4-3: SERIAL READ/WRITE REGISTER (CONTINUED)**

| | |
|---|---|
| bit 5 | **ShrTO:** HUSH Timer Time Out Select Bit<br>1 = 80 secondse<br>0 = 9 minutes |
| bit 4 | **SmrtH:** Smart HUSH Bit<br>1 = Enable (Hush is canceled by either high smoke, or remote smoke)<br>0 = Disable (Hush is never canceled until timeout) |
| bit 3 | **HIAO:** HUSH-in-Alarm-Only Bit<br>1 = Enable (Hush is activated upon release of PTT during local smoke only)<br>0 = Disable (Hush is activated upon release of PTT at anytime) |
| bit 2 | **HushEnB:** HUSH Enable Bit<br>1 = Enable (Hush is disabled)<br>0 = Disable (Hush is enabled) |
| bit 1 | **TSEL:** Tone Select Bit<br>1 = Continuous Tone Pattern<br>0 = Temporal Tone Pattern |

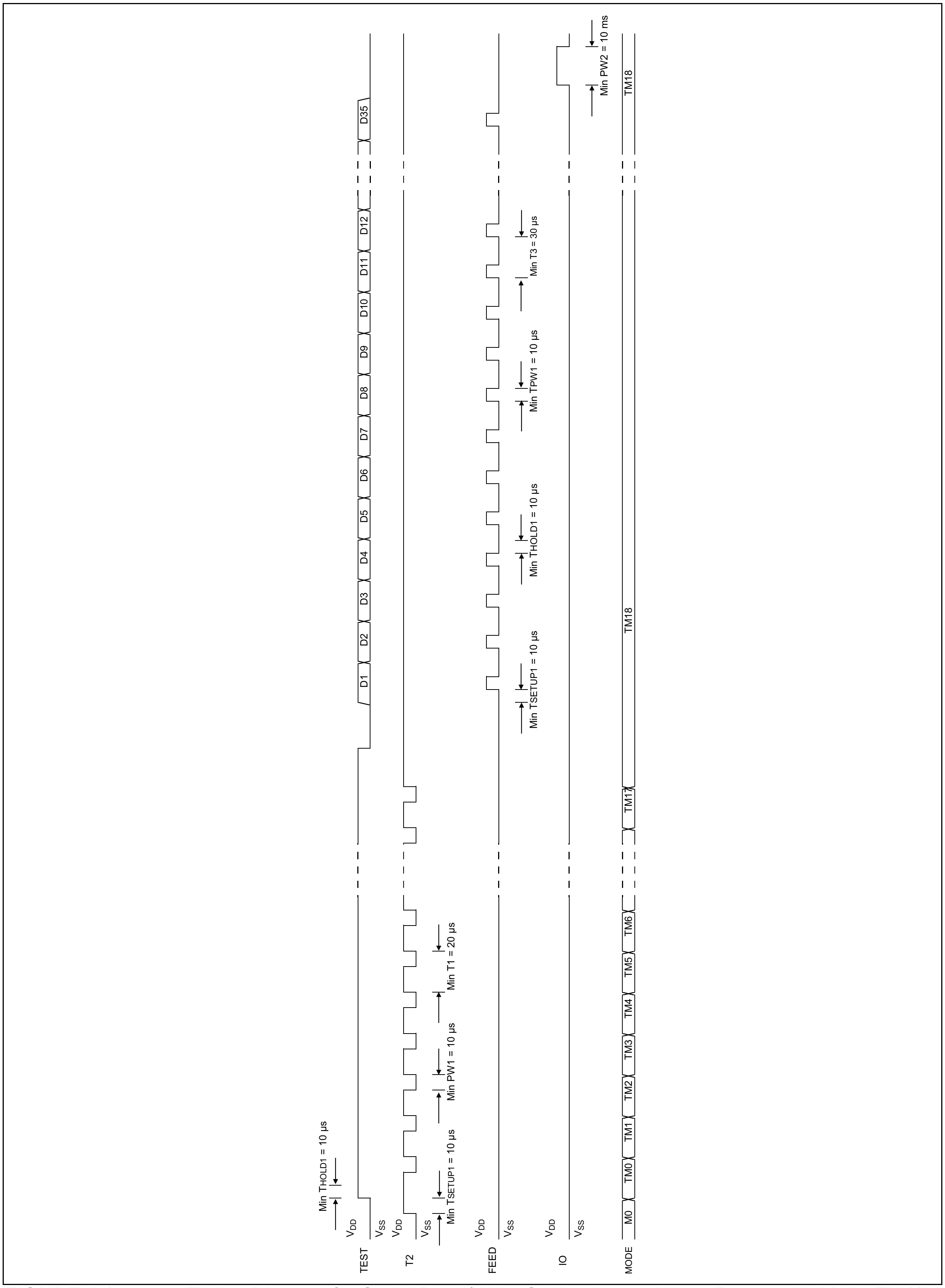



***FIGURE 4-6:*** *Timing Diagram for Serial Read/Write Calibration and User Features in Mode TM18.*

## 4.7 Horn Test

Test mode TM3 allows the horn to be enabled indefinitely for audibility testing.

To enter this mode, follow the next steps:

1. Power up with the bias condition shown in Figure 4-1 to enter M0. At power-up:

   TEST = IO = FEED = T2 = $V_{SS}$,

   DETECT = $V_{DD}$.
2. Drive T2 input from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$ to enter TM0.
3. Drive TEST from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$.
4. Apply three clock pulses to the T2 input ($V_{DD}$ to $V_{SS}$ and then back to $V_{DD}$) to enter in TM3 mode.
5. Drive TEST from $V_{DD}$ to $V_{SS}$ to enable the horn.

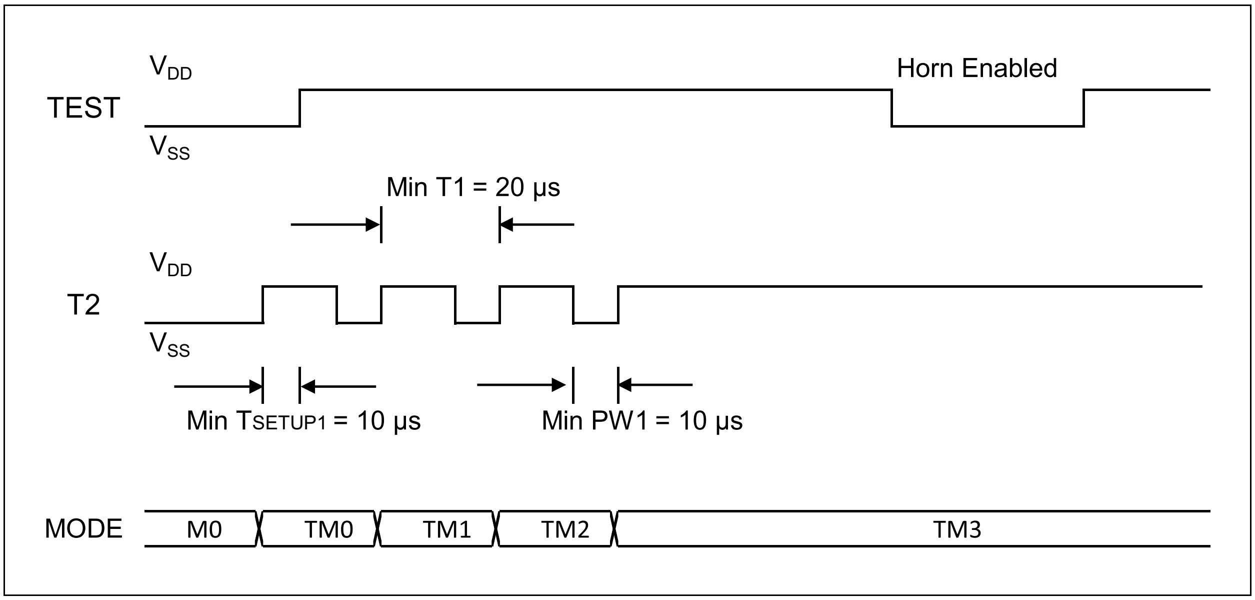



***FIGURE 4-7:*** *Timing Diagram for Horn Test in Mode TM3.*

## 4.8 Low Battery Test

Test mode TM17 allows the low battery trip point to be tested. To enter this mode, follow these steps:

1. Power up with the bias condition shown in Figure 4-1 to enter M0. At power-up:

   TEST = IO = FEED = T2 = $V_{SS}$,

   DETECT = $V_{DD}$.
2. Drive T2 input from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$ to enter TM0.
3. Drive TEST from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$.
4. Apply 17 clock pulses to the T2 input ($V_{DD}$ to $V_{SS}$ and then back to $V_{DD}$) to enter in TM17 mode.
5. Drive IO from $V_{SS}$ to $V_{DD}$ to enable the low battery testing and turn on the RLED. Sweep $V_{DD}$ from high to low and monitor TESTOUT output. The TESTOUT output will indicate the Low Battery status (High = Low Battery detected).

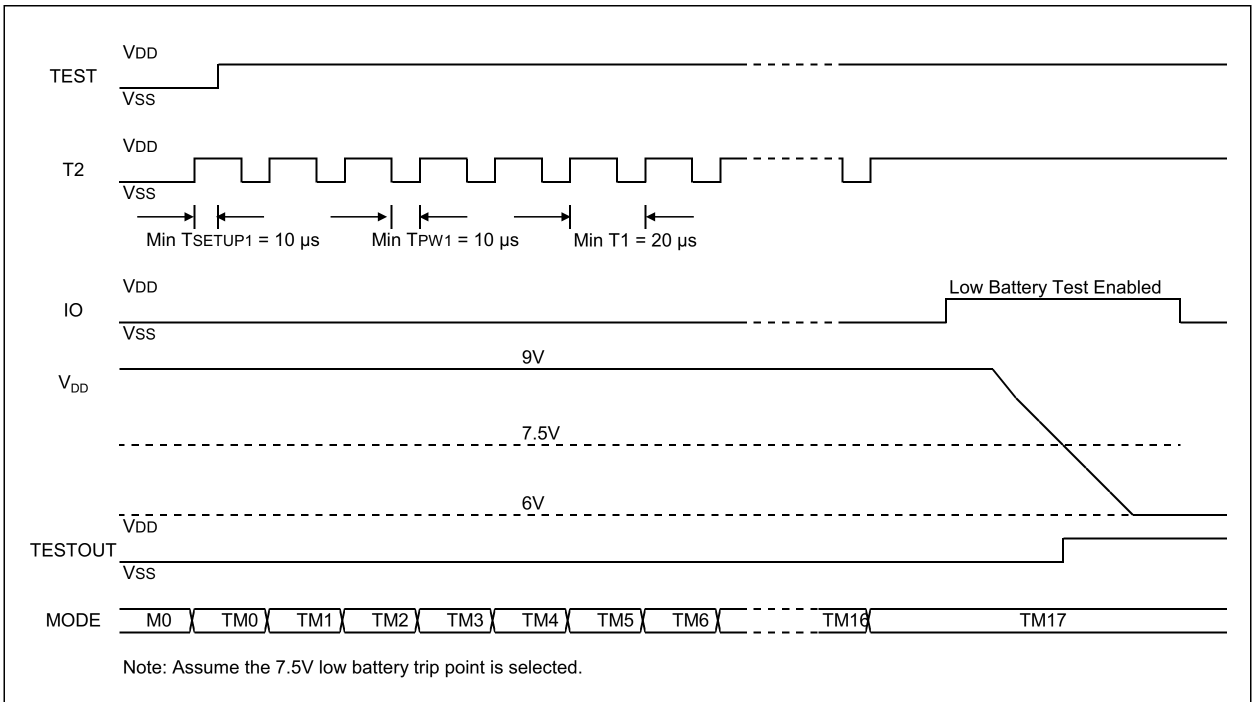



***FIGURE 4-8:*** *Timing Diagram for Low Battery Test in Mode TM17.*

## 4.9 User Lock Bit Programming

Test mode TM19 allows users to program the user EE lock bit. Once the user EE lock bit is set, the programmed user EE data can not be changed unless the lock bit is reset.

To enter this mode, follow these steps:

1. Power up with the bias condition shown in Figure 4-1 to enter M0. At power-up:

   TEST = IO = FEED = T2 = $V_{SS}$,

   DETECT = $V_{DD}$.
2. Drive T2 input from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$ to enter TM0.
3. Drive TEST from $V_{SS}$ to $V_{DD}$ and hold at $V_{DD}$.
4. Apply 19 clock pulses to the T2 input ($V_{DD}$ to $V_{SS}$ and then back to $V_{DD}$) to enter in TM19 mode.
5. Hold TEST at $V_{DD}$ and pulse IO once to set the lock bit and store into the EEPROM memory.
6. To reset the lock bit from Step 5, drive TEST to $V_{SS}$ and pulse IO once.

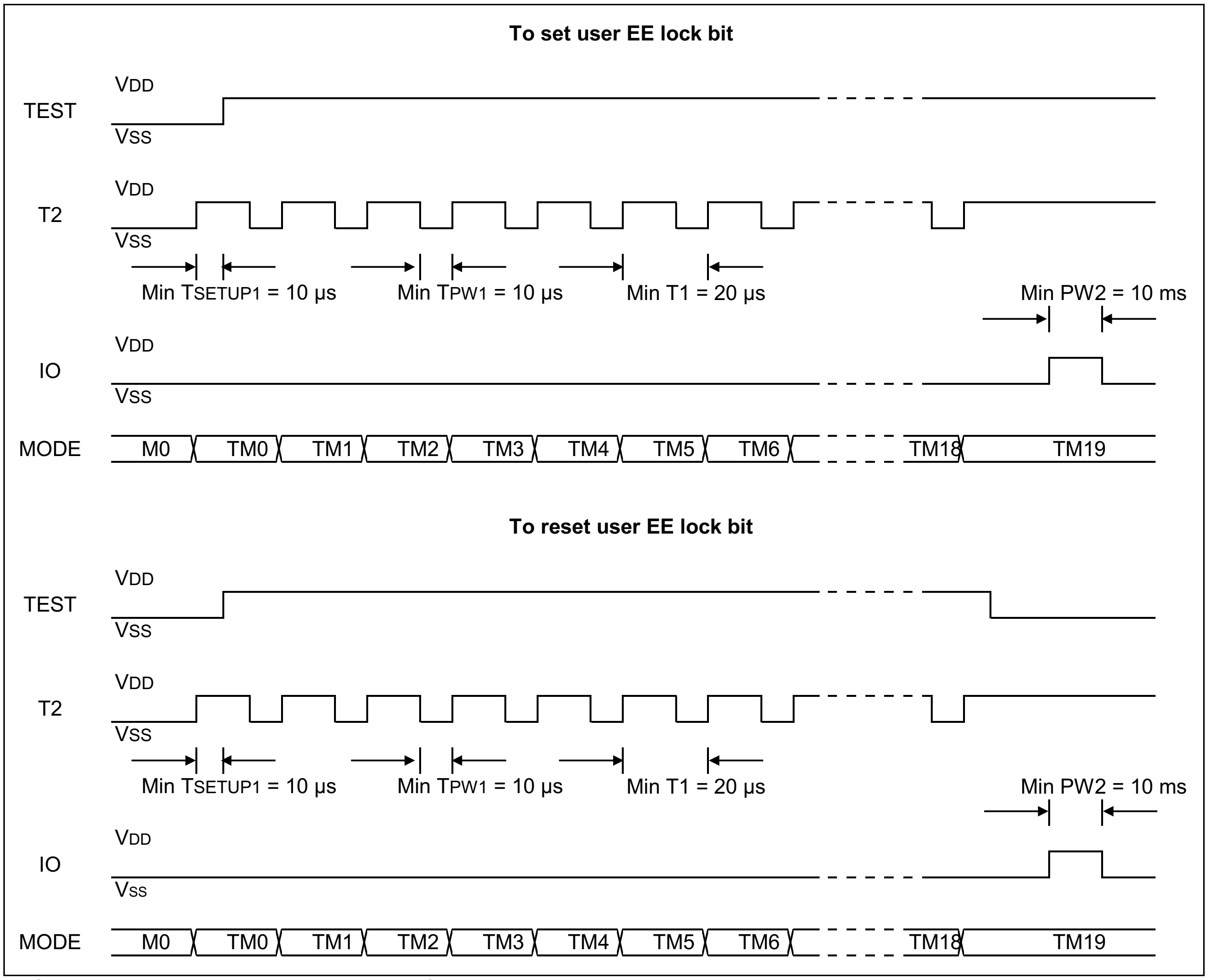



***FIGURE 4-9:*** *Timing Diagram for User Lock Bit Programming in Mode TM19*

# 5.0 APPLICATION NOTES

## 5.1 Standby Current Calculation

A calculation of the standby current is shown in Table 5-1, based on the following conditions:

| | | |
|---|---|---|
| $V_{DD}$ | = | 9V |
| LED current in loaded battery check | = | 10 mA |
| EOLEn | = | 1 |

**TABLE 5-1: STANDBY CURRENT CALCULATION**

| $I_{DD}$ Component | Current (µA) | Duration (s) | Period (s) | Factor | Average Current (µA) |
|---|---|---|---|---|---|
| Fixed $I_{DD}$ | 3.8 | Always | Always | 1 | 3.8 |
| Smoke Check | 9.6 | 0.005 | 10 | 0.0005 | 0.0048 |
| Low Battery Check (unloaded) | 21.4 | 0.01 | 80 | 0.00013 | 0.0028 |
| Low Battery Check (loaded) | 10000 | 0.01 | 320 | 3.10E-05 | 0.31 |
| Chamber Test (smoke check) | 9.6 | 0.005 | 320 | 1.60E-05 | 0.00015 |
| Chamber Test (chamber low) | 3.2 | 3.7 | 320 | 0.012 | 0.038 |
| End-of-Life (reading EE and counting) | 35 | 0.14 | 1310400 | 1.10E-07 | 3.74E-06 |
| End-of-Life (writing EE) | 100 | 0.01 | 1310400 | 7.40E-09 | 7.63E-07 |
| | | | | **Total** | 4.16 |

### 5.1.1 FIXED $I_{DD}$

The fixed $I_{DD}$ is the current from the constantly active internal oscillator, bias circuit and guard amplifier.

### 5.1.2 SMOKE CHECK

The current draw from the smoke detection circuitry during the 5 ms smoke check period.

### 5.1.3 LOW BATTERY CHECK (UNLOADED)

The current drawn by the low battery detection circuitry during the 10 ms unloaded low battery check period.

### 5.1.4 LOW BATTERY CHECK (LOADED)

The current drawn by the RLED during the 10 ms loaded low battery check period.

### 5.1.5 CHAMBER TEST (SMOKE CHECK)

The current drawn by the smoke detection circuitry during the 5 ms smoke check period, while the chamber is pulled low.

### 5.1.6 CHAMBER TEST (CHAMBER LOW)

The current drawn to pull the chamber low when the chamber test is performed.

### 5.1.7 END-OF-LIFE (READING EE AND COUNTING)

The current drawn to read EOL bits from EE and then increase by 1.

### 5.1.8 END-OF-LIFE (WRITING EE)

The current drawn to write EOL bits back to EE.

### 5.1.9 TOTAL CURRENT

The average total current drawn in Standby

## 5.2 FUNCTIONAL TIMING DIAGRAMS

Figures 5-1 to 5-8 show the timing diagrams for the smoke detector functions described in **Section 3.0, Device Descriptions**.

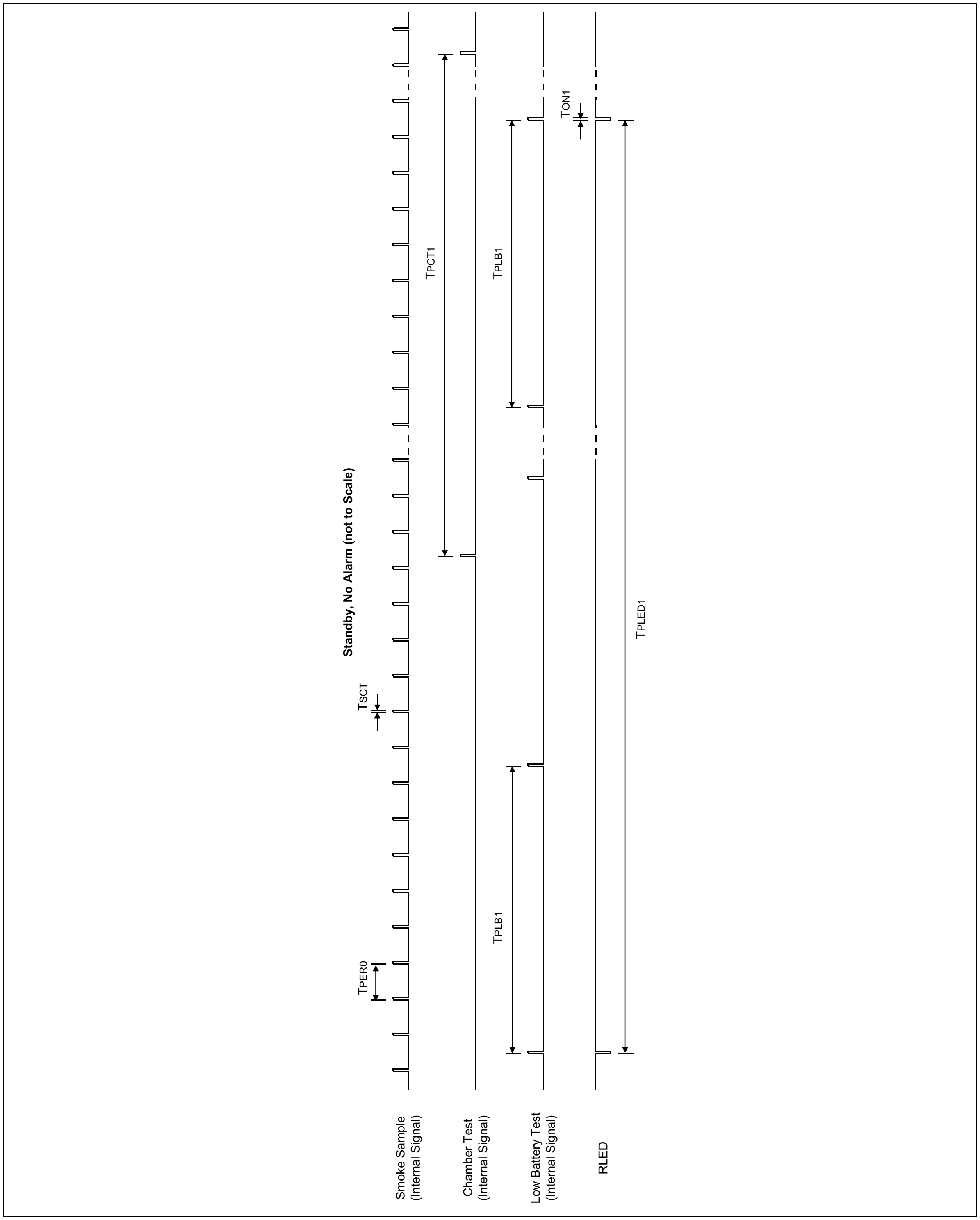



***FIGURE 5-1:*** *Timing Diagram – Standby, No Alarm.*

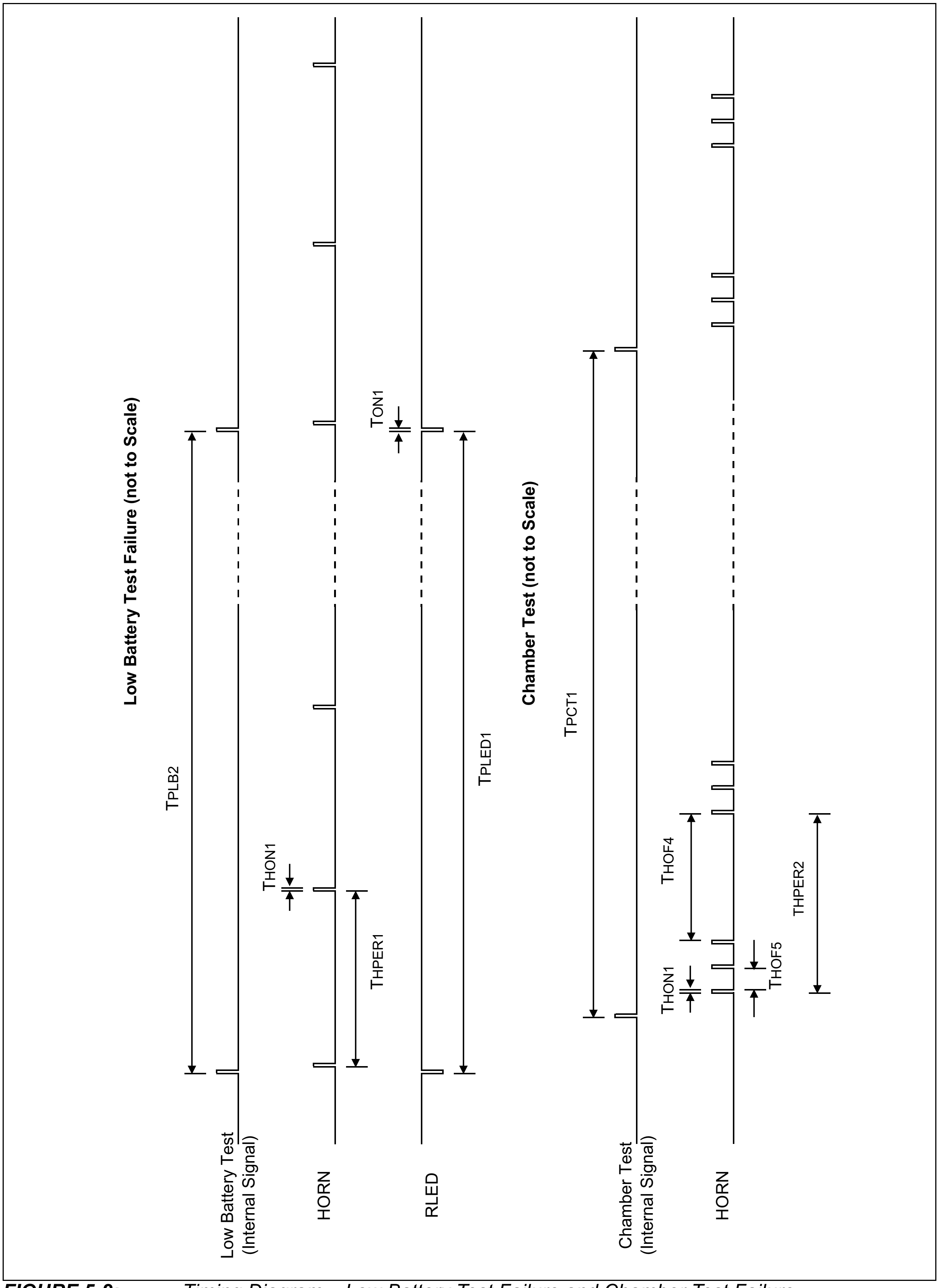



**FIGURE 5-2:** *Timing Diagram – Low Battery Test Failure and Chamber Test Failure.*

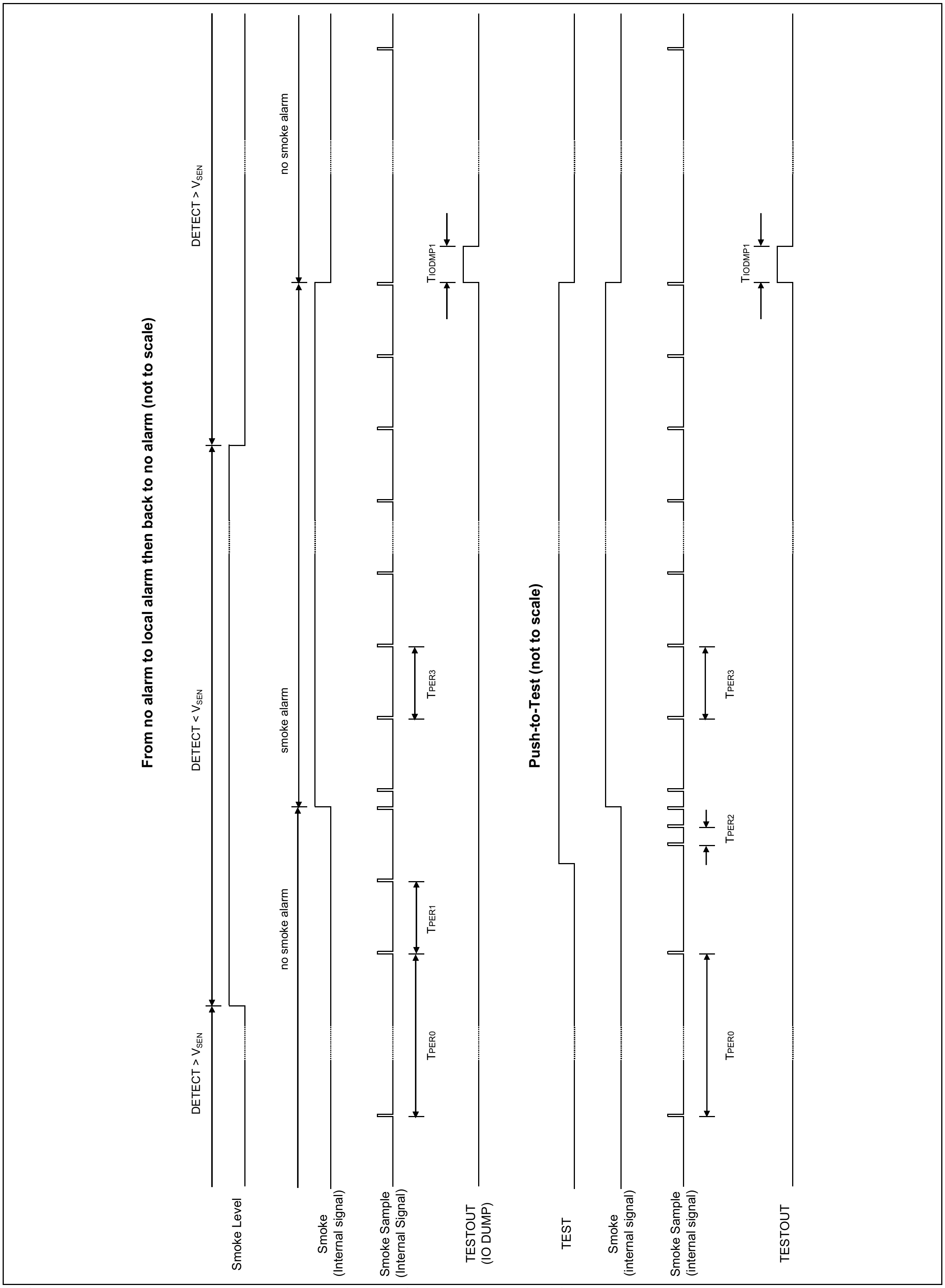



***FIGURE 5-3:*** *Timing Diagram – From Standby to Local Smoke and Push-To-Test.*

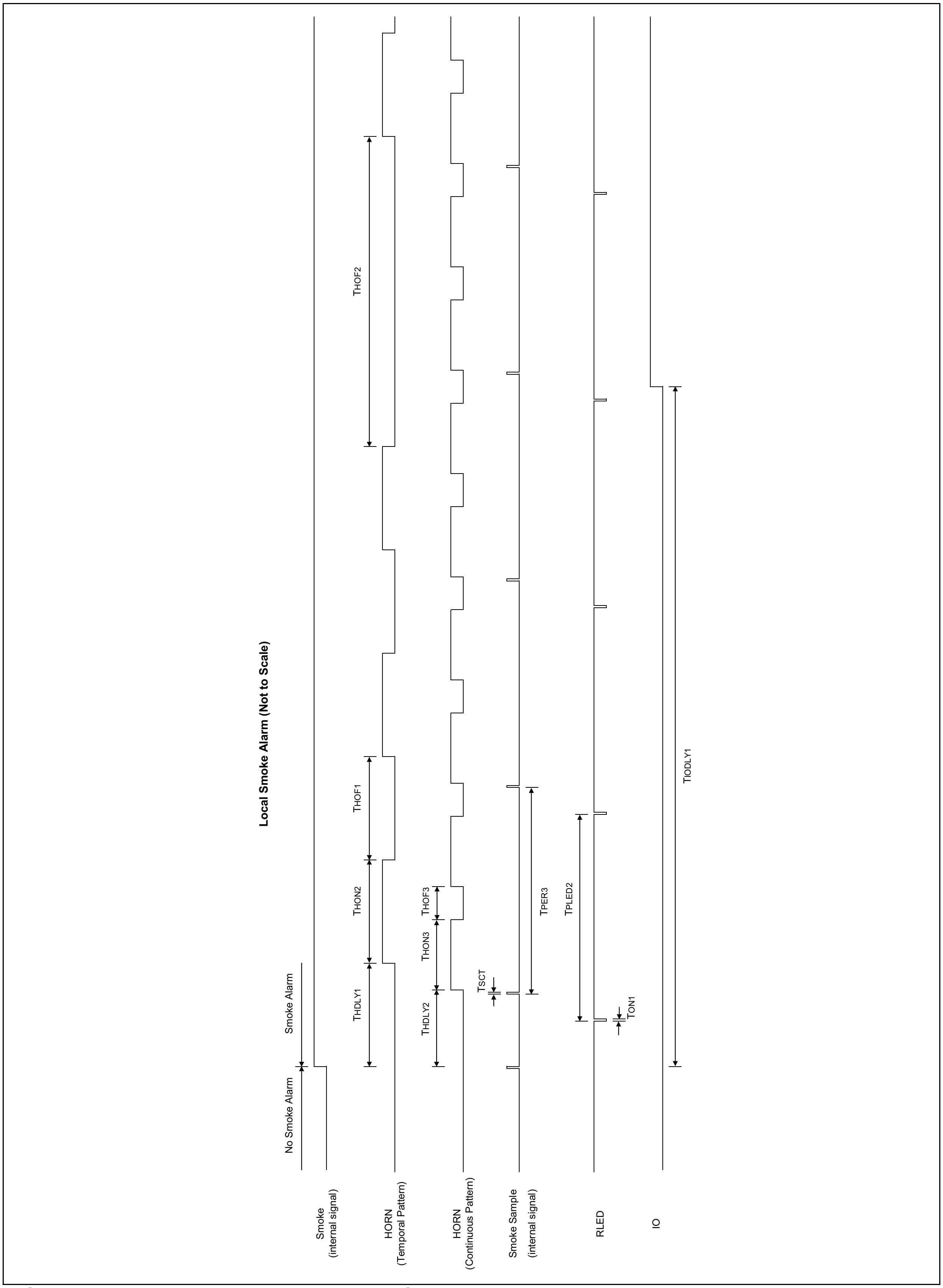



*FIGURE 5-4:* *Timing Diagram – Local Smoke Alarm.*

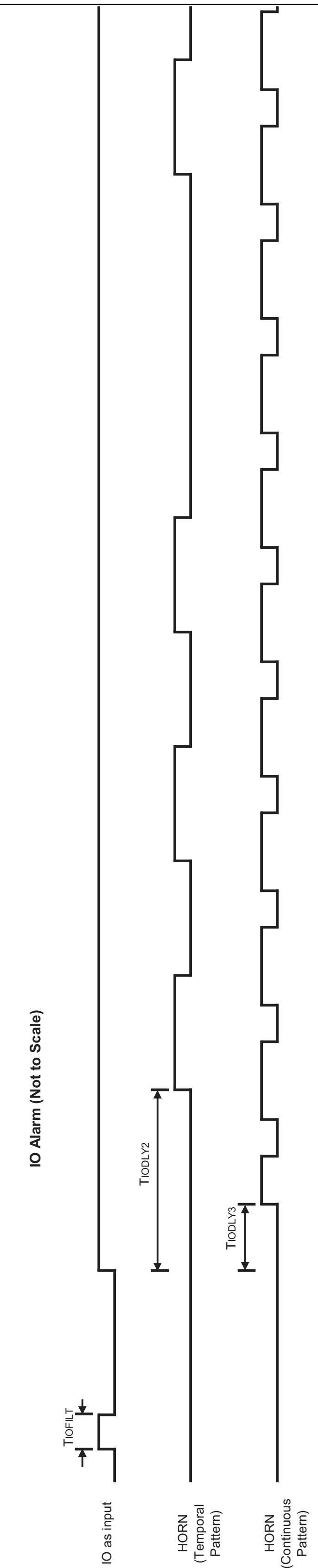



***FIGURE 5-5:*** *Timing Diagram – IO Smoke Alarm.*

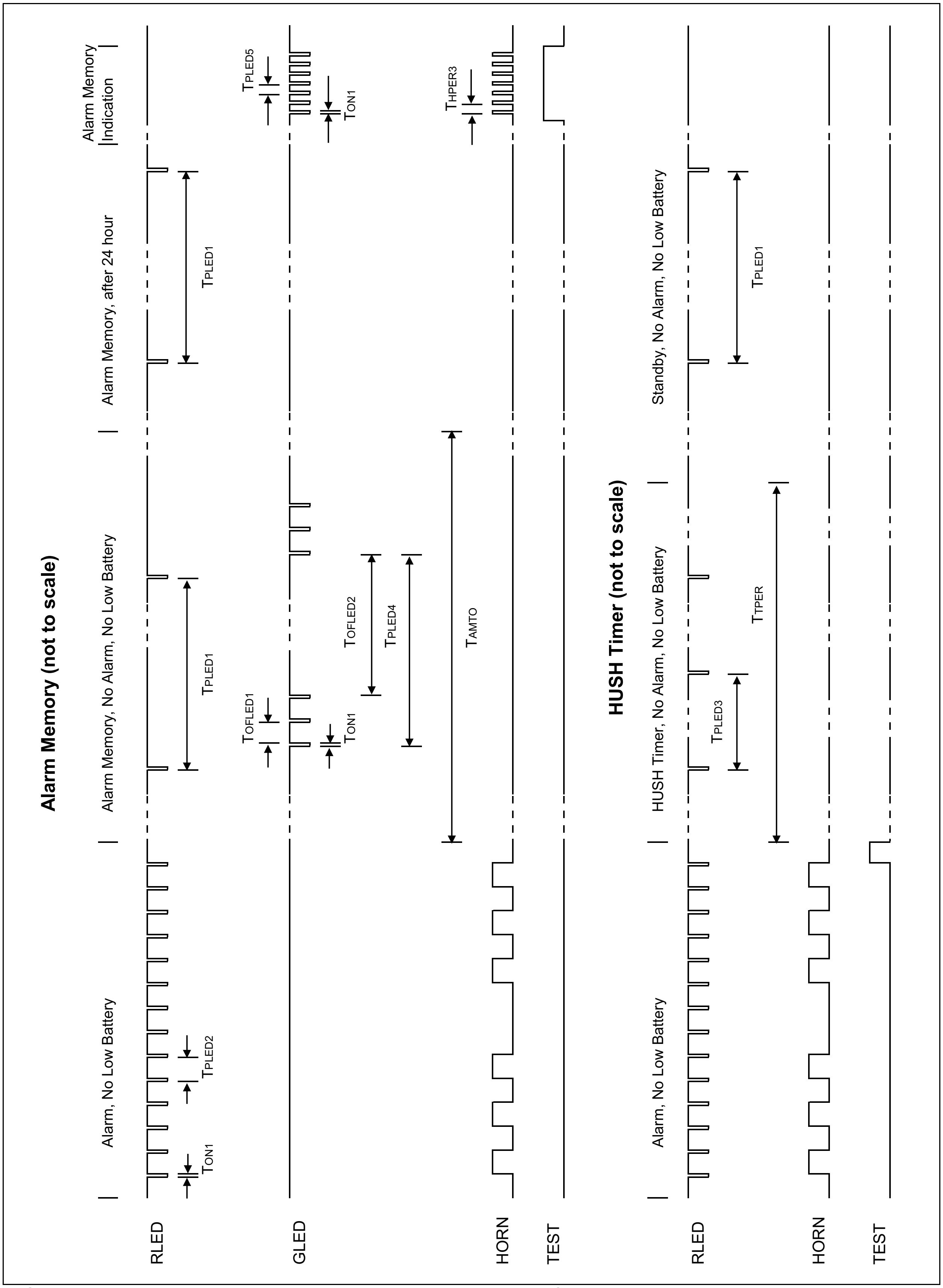



***FIGURE 5-6:*** *Timing Diagram – Alarm Memory and HUSH Timer.*

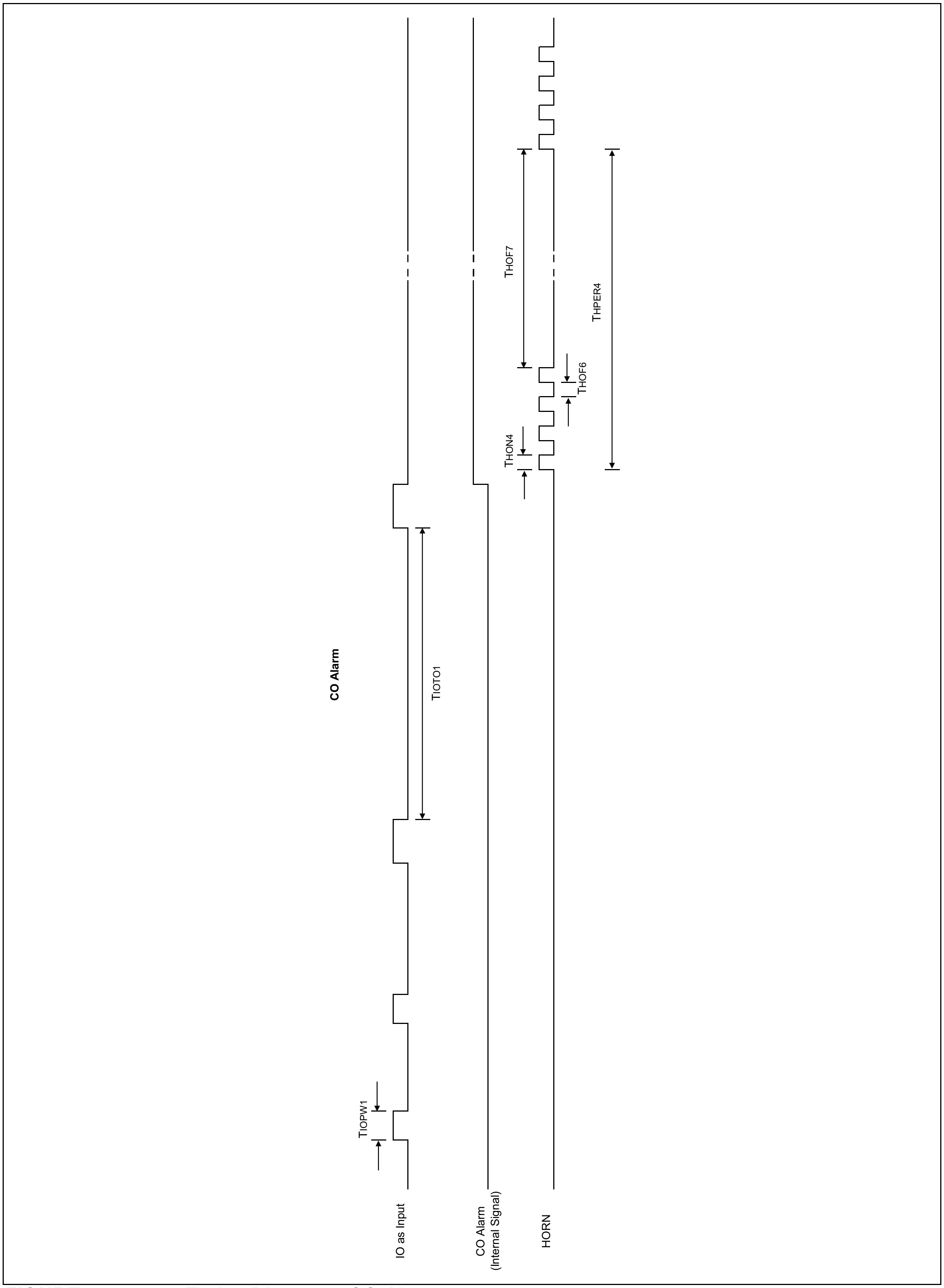



***FIGURE 5-7:*** *Timing Diagram – CO Alarm.*

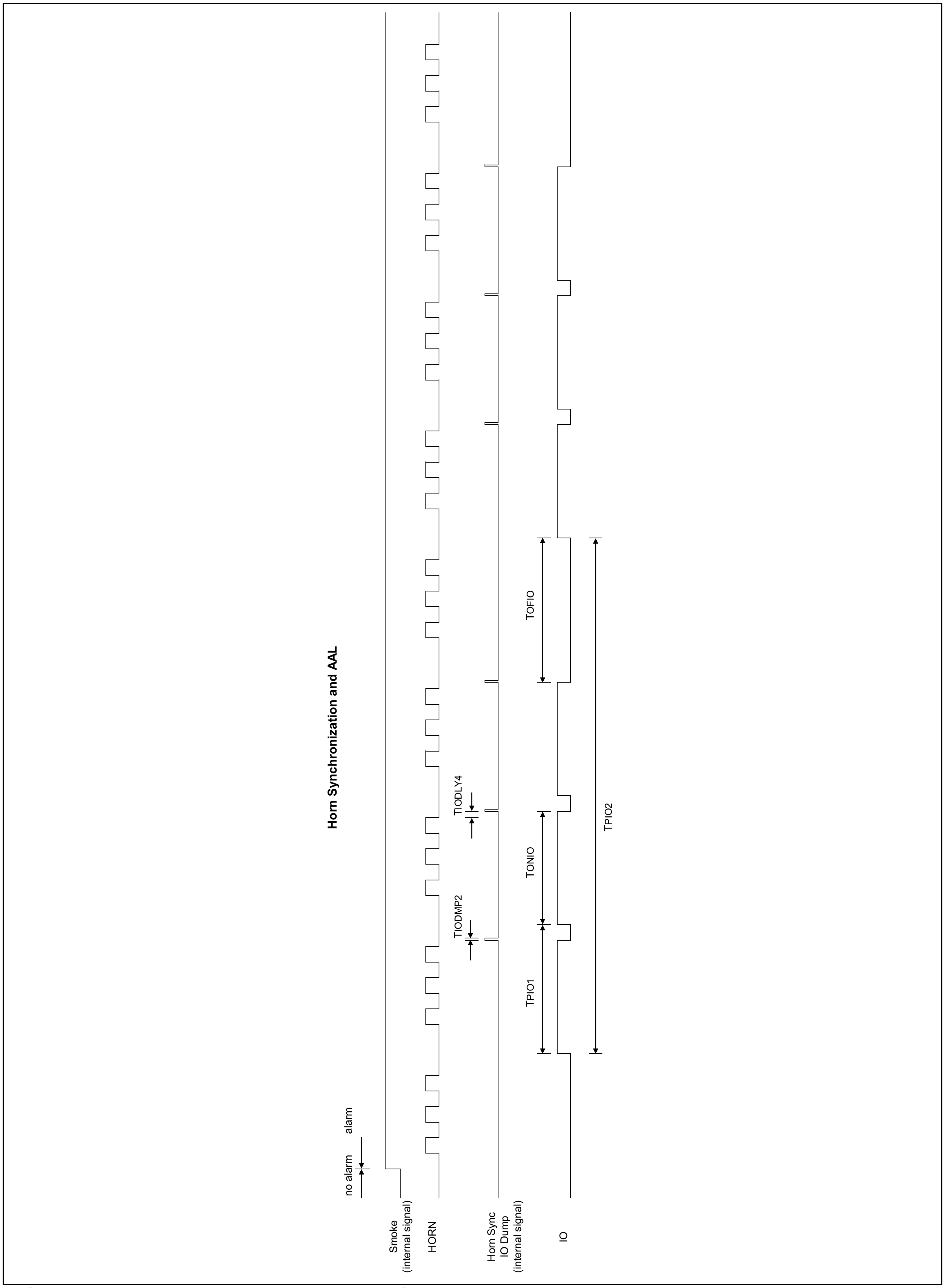


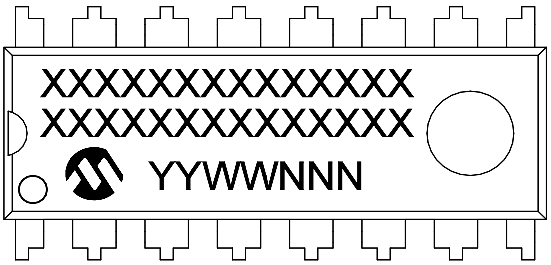

*FIGURE 5-8: Timing Diagram – Horn Synchronization and AAL.*

**NOTES:**

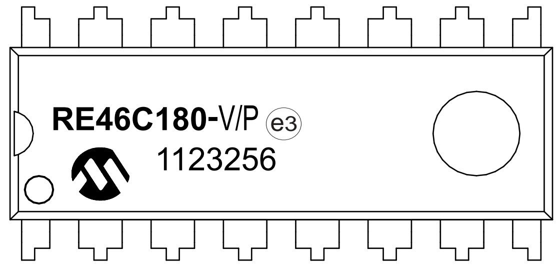
## 6.0 PACKAGING INFORMATION

### 6.1 Package Marking Information

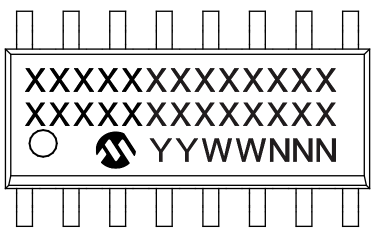
16-Lead PDIP (300 mil)



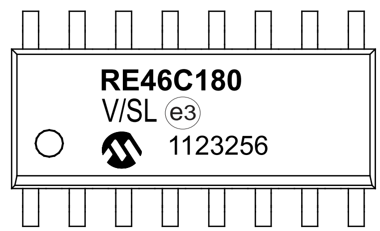

Example




16-Lead Narrow SOIC (3.90 mm)




Example

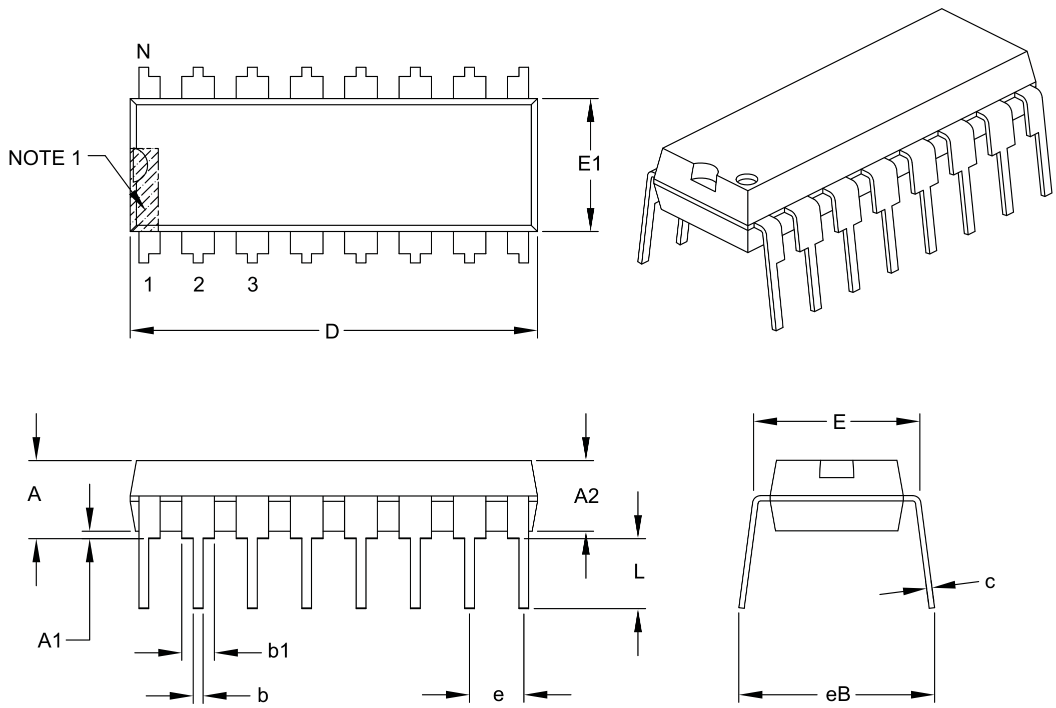



**Legend:**XX...XCustomer-specific information
YYear code (last digit of calendar year)
YYYear code (last 2 digits of calendar year)
WWWeek code (week of January 1 is week '01')
NNNAlphanumeric traceability code
Pb-free JEDEC designator for Matte Tin (Sn)
***This package is Pb-free. The Pb-free JEDEC 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




| 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 |

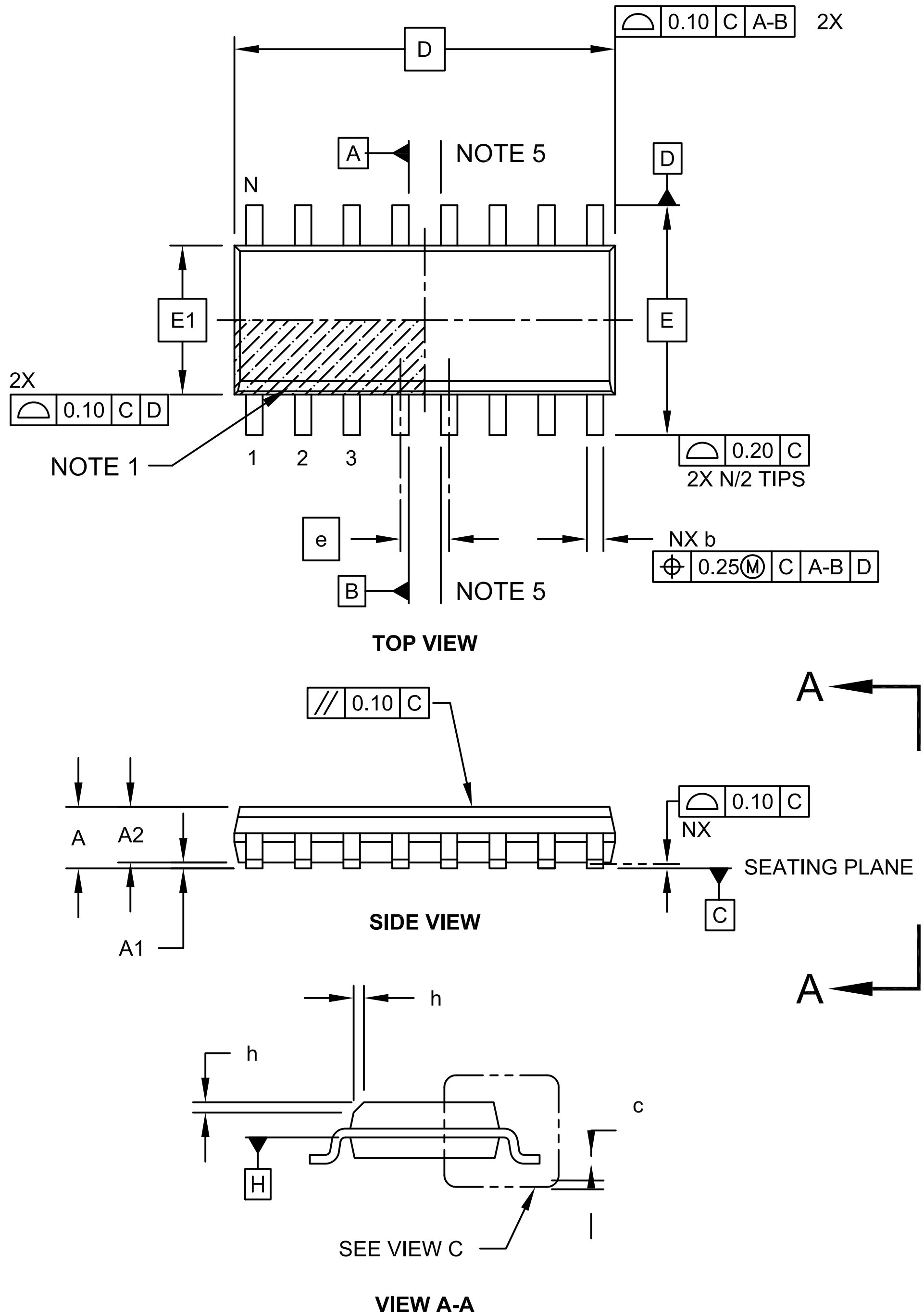
**Notes:**

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 C04-017B

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

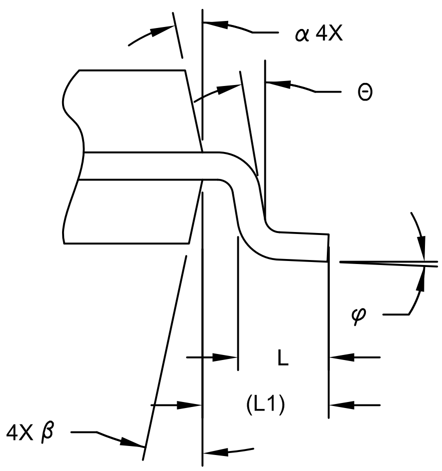
| | |
|---|---|
| **Note:** | For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging |



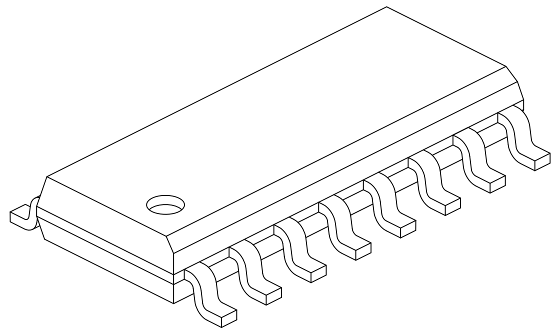

Microchip Technology Drawing No. C04-108C Sheet 1 of 2

### 16-Lead Plastic Small Outline (SL) - 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




VIEW C



| Units | | MILLIMETERS | | |
|---|---|---|---|---|
| Dimension Limits | | MIN | NOM | MAX |
| Number of Pins | N | | 16 | |
| Pitch | e | | 1.27 BSC | |
| Overall Height | A | - | - | 1.75 |
| Molded Package Thickness | A2 | 1.25 | - | - |
| Standoff § | A1 | 0.10 | - | 0.25 |
| Overall Width | E | | 6.00 BSC | |
| Molded Package Width | E1 | | 3.90 BSC | |
| Overall Length | D | | 9.90 BSC | |
| Chamfer (Optional) | h | 0.25 | - | 0.50 |
| Foot Length | L | 0.40 | - | 1.27 |
| Footprint | L1 | | 1.04 REF | |
| Lead Angle | Θ | 0° | - | - |
| Foot Angle | φ | 0° | - | 8° |
| Lead Thickness | c | 0.10 | - | 0.25 |
| Lead Width | b | 0.31 | - | 0.51 |
| Mold Draft Angle Top | α | 5° | - | 15° |
| Mold Draft Angle Bottom | β | 5° | - | 15° |

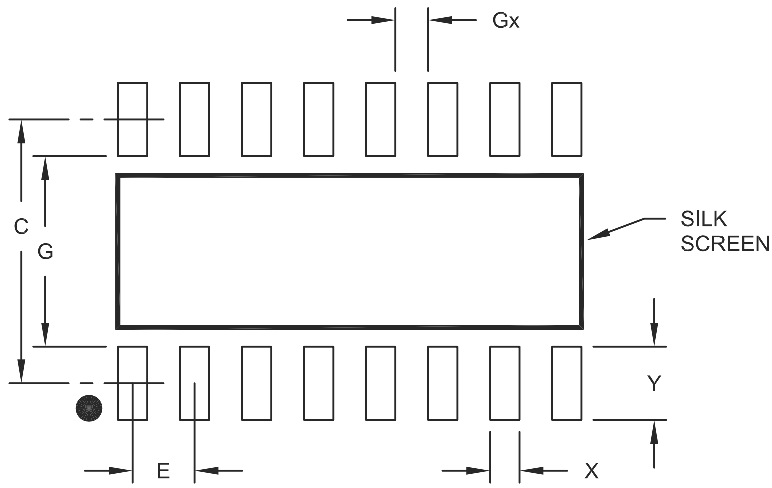
**Notes:**

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 No. C04-108C Sheet 2 of 2

16-Lead Plastic Small Outline (SL) - 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 | X | | | 0.60 |
| Contact Pad Length | Y | | | 1.50 |
| Distance Between Pads | Gx | 0.67 | | |
| Distance Between Pads | G | 3.90 | | |

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2108A

**NOTES:**

## APPENDIX A: REVISION HISTORY

### Revision B (March 2019)

- Updated **Section 6.0 “Packaging Information”**;
- Updated **Section “Product Identification System”**.

### Revision A (August 2011)

Original 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 |
|---|---|---|
| Device | Package | Number of Pins |

| | | |
|---|---|---|
| Device | RE46C180: | CMOS Programmable Ionization Smoke Detector ASIC |
| | RE46C180T: | CMOS Programmable Ionization Smoke Detector ASIC (Tape and Reel, SOIC only) |
| Package | E = | Plastic Dual In-Line, 150 mil. Body, 16-Lead (PDIP) |
| | S = | Small Plastic Outline - Narrow, 3.90 mm Body, 16-Lead (SOIC) |

**Examples:**

a) RE46C180E16FA: 16LD PDIP Package
b) RE46C180S16F: 16LD SOIC Package
c) RE46C180S16TF: 16LD SOIC Package, Tape and Reel

**NOTES:**

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