RE46C181

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
- Programmable Low Battery Test Duration
- Internal Power-on Reset (POR) and Power-Up Low Battery Test
- Alarm Memory
- IO Filter and Charge Dump
- Interconnect Up to 40 Detectors
- ±5% All Internal Oscillator
- 9-Minute Timer for Sensitivity Control
- Temporal Horn Pattern
- Guard Outputs for Ion Detector Input
- ±0.75 pA Detect Input Current
- 10-year End of Life Indication
- Chamber Monitor Warning

Description

The RE46C181 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 10s to keep the standby current to a minimum.

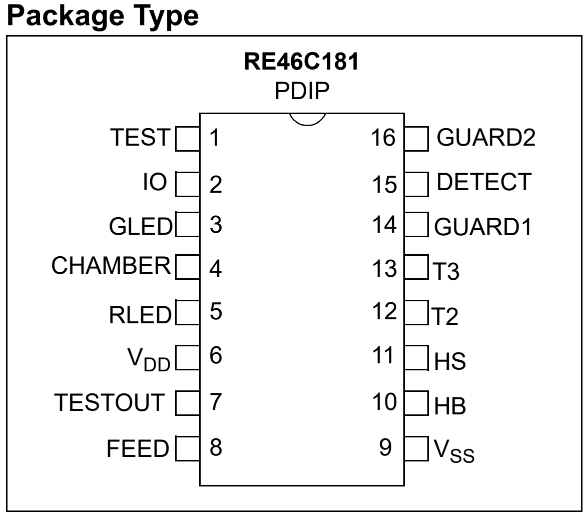
A check for a low battery condition is performed every 80s and an ionization chamber test is performed once every 320s when in Standby mode. The temporal horn pattern complies with the National Fire Protection Association NFPA 72® National Fire Alarm and Signaling Code® for emergency evacuation signals.

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.

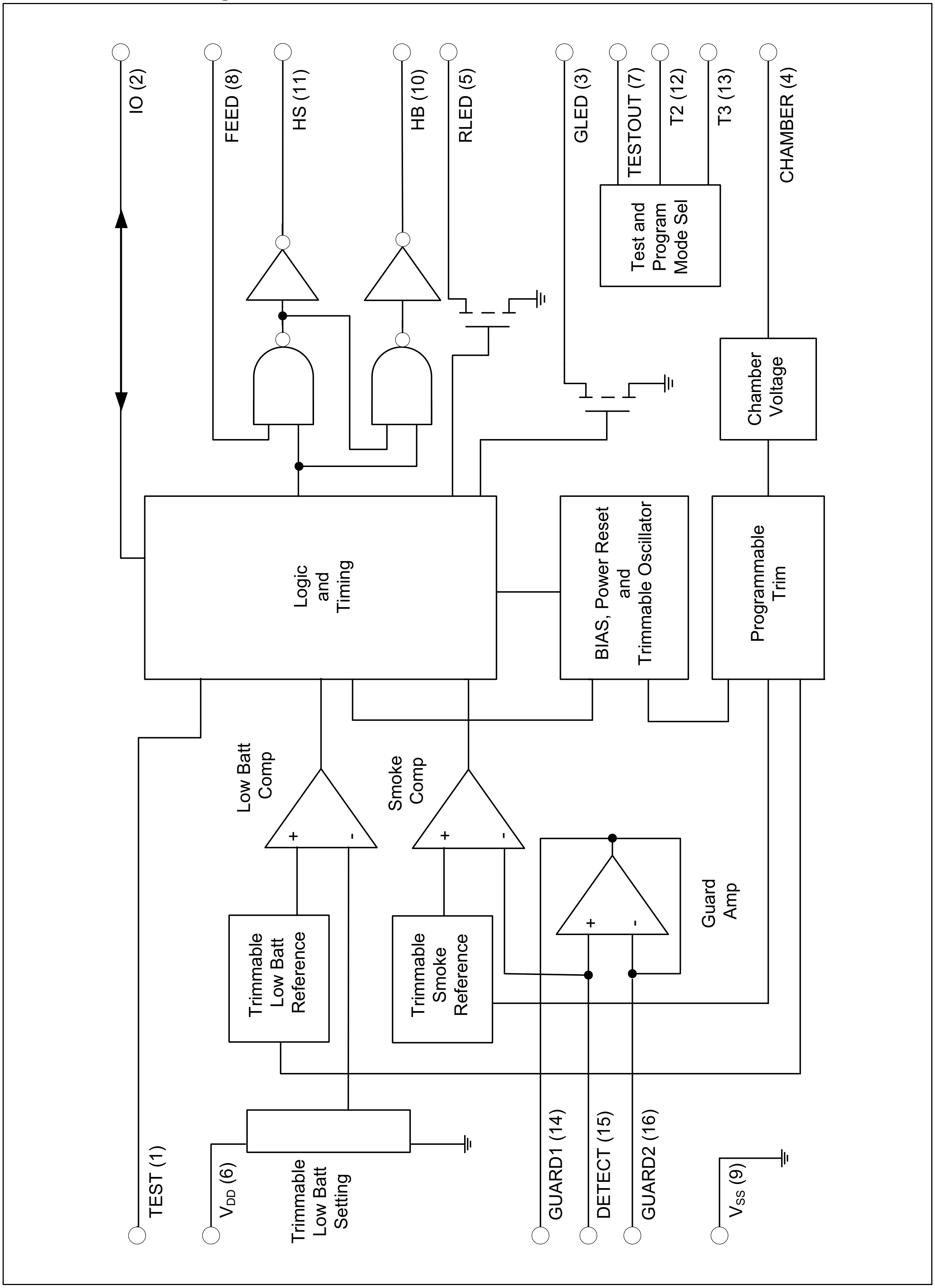
An internal 9-minute timer can be used for a Reduced Sensitivity mode.

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

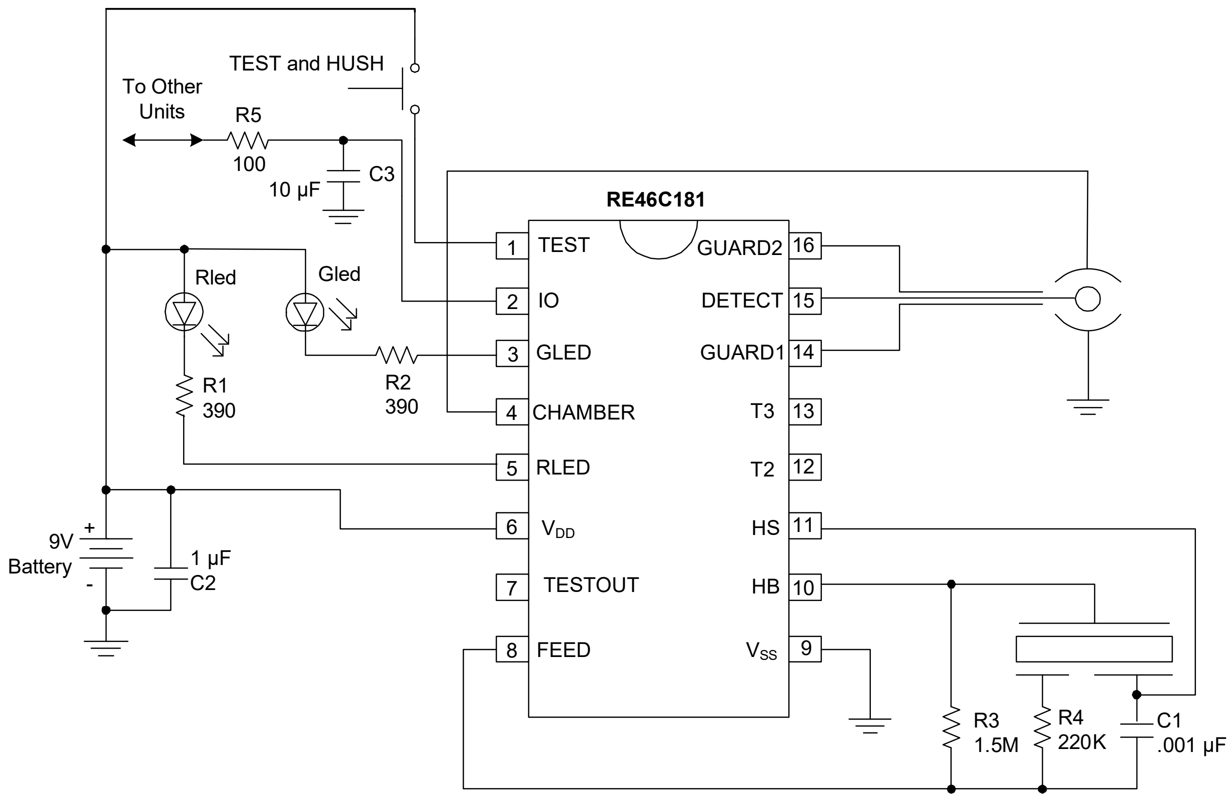
Package Type



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.

NOTES:

1.0 ELECTRICAL CHARACTERISTICS

1.1 Absolute Maximum Ratings†

Supply Voltage .... V_{DD} = 12.5V
Input Voltage Range Except FEED, IO .... V_{IN} = -0.3V to V_{DD} + 0.3V
FEED Input Voltage Range .... V_{INFD} = -10 to +22V
IO Input Voltage Range .... V_{IO1} = -0.3 to 15V
Input Current Except FEED .... I_{IN} = 10 mA
Storage Temperature .... T_{STG} = -55 to +125°C
Maximum Junction Temperature .... T_J = +150°

† Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

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**)

Parameters	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	V	
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**)

Parameters	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] = `10`
			7.05	7.2	7.35	V	LBTR[2:1] = `11`
			7.35	7.5	7.65	V	LBTR[2:1] = `00`
			7.65	7.8	7.95	V	LBTR[2:1] = `01`
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} – 0.5	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.

Parameters	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, LBSEL = 0
	T_{ON2}	5	2.37	2.5	2.63	ms	Operating, LBSEL = 1
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 Time-out Period	T_{AMTO}	3	22.8	24	25.2	h	AMTO[2:1] = 00
			45.6	48	50.4	h	AMTO[2:1] = 01
			0	0	0	h	AMTO[2:1] = 10, No alarm memory indication
			—	—	—	—	AMTO[2:1] = 11, Alarm memory indication never times out, as long as the 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 the timing diagram for smoke alarm temporal pattern.

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.							
Parameters	**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
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
Horn On Time	T_{HON1}	10, 11	9.5	10	10.5	ms	1. Low battery 2. Chamber failure 3. Alarm memory indication upon PTT, AMHCEn = 1 4. EOL
	T_{HON2}	10, 11	475	500	525	ms	Smoke alarm, temporal horn pattern (Note 2)
Horn Off Time	T_{HOF1}	10, 11	475	500	525	ms	Smoke alarm, temporal horn pattern (Note 2)
	T_{HOF2}	10, 11	1.43	1.5	1.58	s	Smoke alarm, temporal horn pattern (Note 2)
	T_{HOF3}	10, 11	36	38	40	ms	EOL horn off time between pulse trains (5x)
	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/EOL horn off time between pulses
Interconnect							
IO Active Delay	$T_{IODLY1A}$	2	2.8	3.0	3.2	s	From start of local alarm to IO active
	$T_{IODLY1B}$	2	0	—	3.2	s	From start of PTT alarm to IO active
Remote Smoke Alarm Delay	T_{IODLY2}	2	769	810	851	ms	No local alarm, from IO active to alarm, temporal 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 Charge Dump Duration	T_{IODMP1}	2	475	500	525	ms	At conclusion of local alarm
	T_{IODMP2}	2	237	—	525	ms	At conclusion of PTT alarm
Chamber Monitor							
CM Sample Period	T_{PCM1}	—	—	5120	—	s	Standby; no alarms

Note 1: T_{POSC} is 100% production tested. All other timing is verified by functional testing.
2: See the timing diagram for smoke alarm temporal pattern.

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.

Parameters	Symbol	Test Pin	Min.	Typ.	Max.	Units	Conditions
HUSH Timer Operation							
HUSH Timer Period	T_{TPER}	—	8.5	9	9.5	min	No alarm
EOL							
End of Life Age Sample	T_{EOL}	—	346	364	382	h	Standby, EOLEn = 1

Note 1: T_{POSC} is 100% production tested. All other timing is verified by functional testing.

2: See the timing diagram for smoke alarm temporal pattern.

TEMPERATURE CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, V_{DD} = 9V, V_{SS} = 0V

Parameter	Symbols	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	θ_{JA}	—	70	—	°C/W	

NOTES:

2.0 PIN DESCRIPTIONS

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

TABLE 2-1: PIN FUNCTION TABLE

RE46C181 PDIP	**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 DESCRIPTION

3.1 Standby Internal Timing

The internal oscillator is manufactured to ±5% tolerance. The oscillator period, T_{POSC}, 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 2.5 or 10 ms. At the conclusion of the 2.5 or 10 ms, the status of the low battery comparator is latched. RLED is enabled for 2.5 or 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 end 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 predetermined 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 fail 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.

The 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)

Push-to-Test (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 predetermined 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 activates 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 tests 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 the 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 3.0s 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.

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 predetermined level, which is user-programmable. RLED is turned on for 10 ms every 10s.

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 End of Life (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 five 10 ms horn chirps.

3.9 Tone Pattern

The temporal horn pattern supports the NFPA 72 National Fire Alarm and Signaling Code for emergency evacuation signals.

3.10 Chamber Monitor

The chamber monitor provides a means of monitoring chamber degradation. During calibration, based on the expected or measured clean air value CEV value and the sensitivity setting from Table 4-2, a chamber monitor sensitivity value must be stored in the five CMTR EE bits. These bits represent an alternate sensitivity based on the voltages defined in Table 4-2. During normal standby operation, the chamber will be sampled every 1.42 hours and compared to the CMTR value. If the measurement falls below this level (CEV < CM measurement for six successive measurements), a chamber failure warning will be signaled. At any time after this, if a single measurement exceeds this level, the warning will stop and will not start again until six more successive failures occur. The chamber monitor is suspended during HUSH, Local Smoke and Remote Smoke conditions and will reset if one of these events occurs.

If the chamber monitor function is not needed, the CMTR bits should all be set to 10,000.

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 $(29/90)V_{DD}$ → $(60/90)V_{DD}$, the 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 $+(0.5/90)V_{DD}$ → $+(2.25/90)V_{DD}$, the 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 $-(16/90)V_{DD}$ → $-(1/90)V_{DD}$, the resolution is $V_{DD}/90$.

4: The $V_{CHAMBER}$ listed value is based on V_{DD} = 9V. The actual range is $(21/90)V_{DD}$ → $(67.5/90)V_{DD}$, the 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: FEATURES PROGRAMMING

Features	Options
Low Battery Detection Selection	6.9V 7.2V 7.5V 7.8V
10 Year End of Life Indicator	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	0/24/48h or no limit
Alarm Memory	Enable/Disable
Smart HUSH	Enable/Disable
HUSH-In-Alarm Only	Enable/Disable
HUSH	Enable/Disable
Low Battery Select	2.5 ms or 10 ms

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 reconfigured 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	Horn Test/LED On; IO High/Low	1	HornEnB **Note 3**	V_{DD}	IOHi En IO Dump EnB HB/HS En **Note 4**	LEDEn	not used	not used
TM1	Load Timer for Spill	2	EOL Timer Clock	V_{DD}	HUSH/LB HUSH Timer Clock	Alarm Mem Timer Clock	not used	not used

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 TM3, the digital output TESTOUT is driven by the internal IO dump signal.

3: In TM0, 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
TM2	User Feature Programming	3	ProgData	V_{DD}	ProgClk	ProgEn	not used	not used
TM3	Speedup Mode	4	PTT/HUSH	V_{DD}	CLK	IO	not used	IO Dump **Note 2**
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**
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	Serial Out
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 TM3, the digital output TESTOUT is driven by the internal IO dump signal.

3: In TM0, 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).

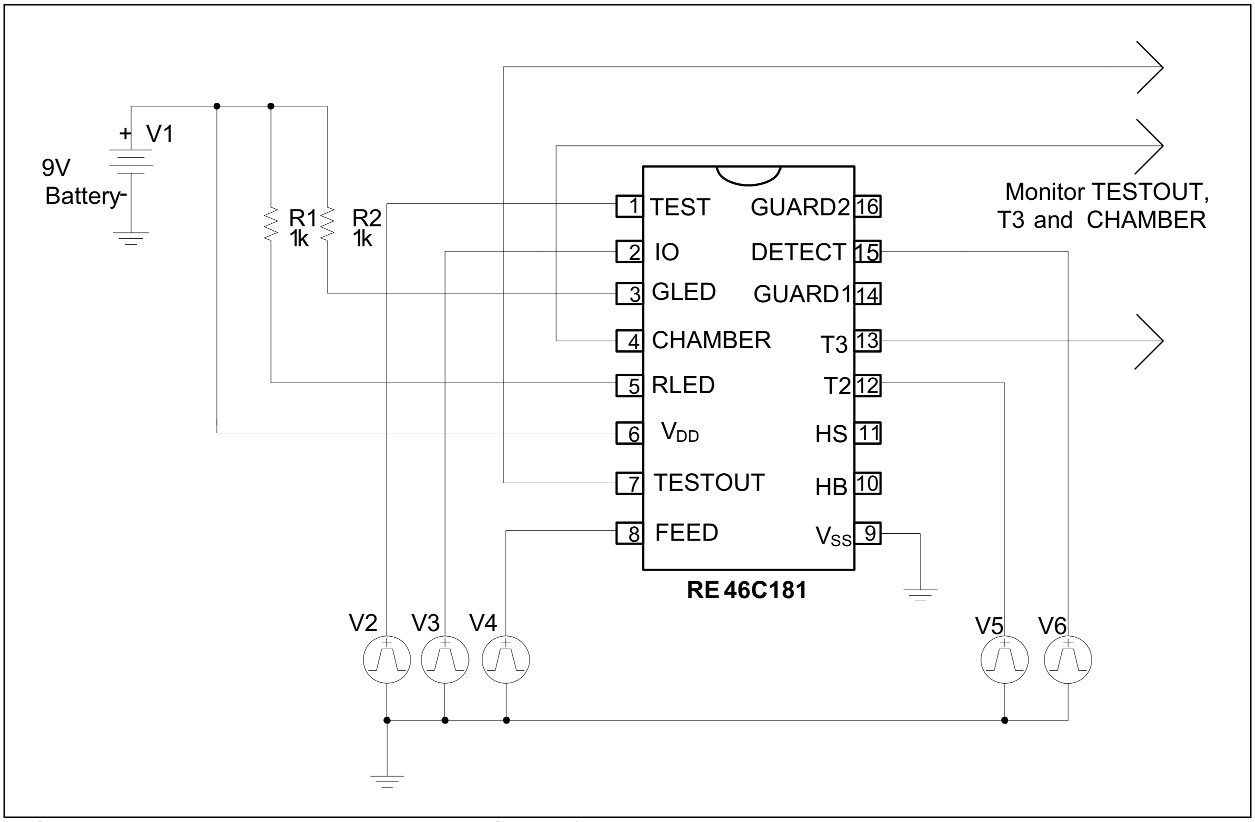


FIGURE 4-1: *Nominal Application Circuit for Programming.*

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 the 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 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 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 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 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. Drive TEST from V_{SS} to V_{DD} and hold at V_{DD}. Apply another clock pulse to the T2 input to enter in TM8 mode. Pulse IO to save all results into memory. Before this step, no settings are stored into memory. Power down the part to take effect.

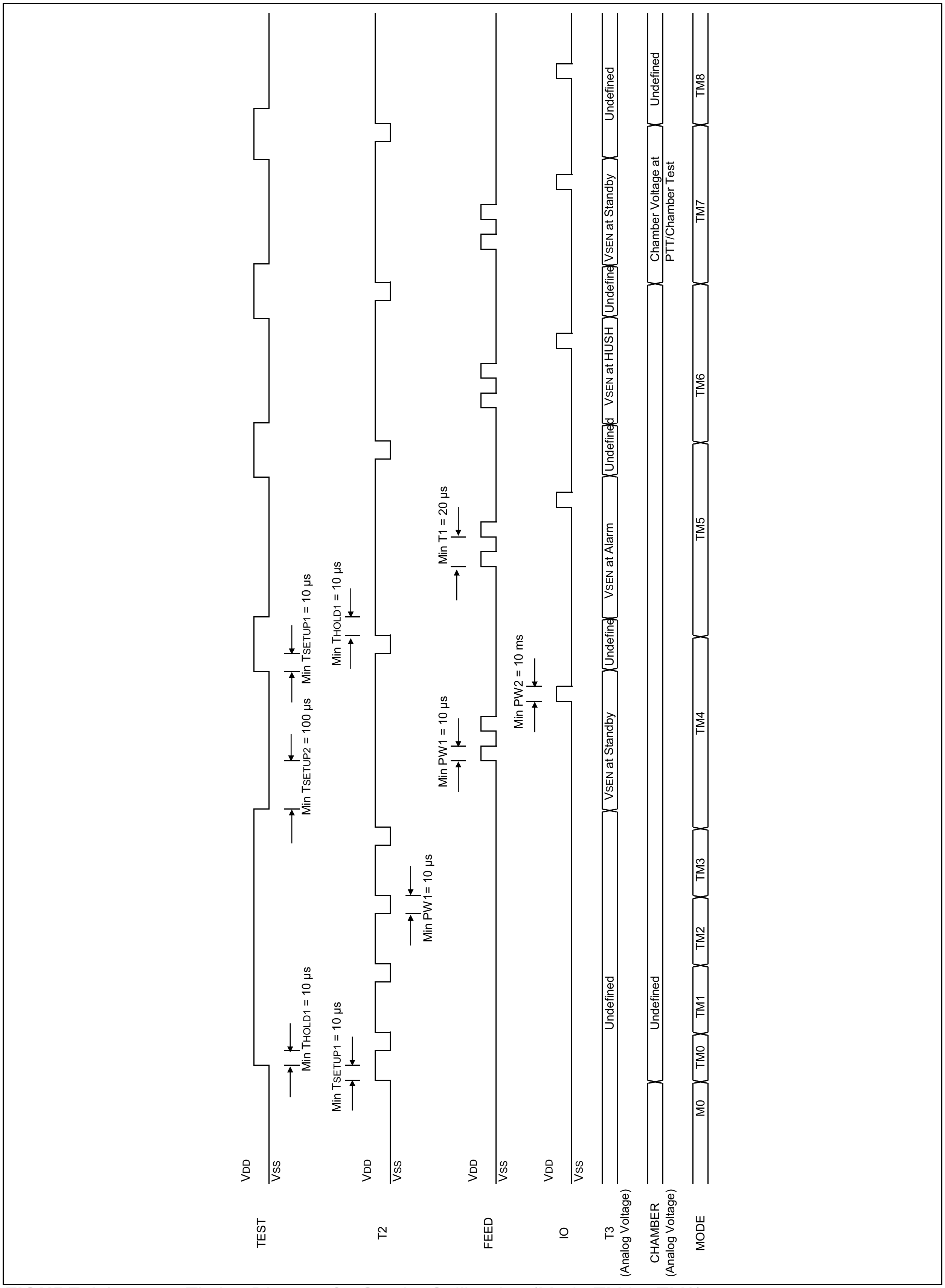


FIGURE 4-2: *Timing Diagram for Smoke Calibration (Mode TM4 ~ TM8).*

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 the 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 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. Power down the part to take effect.

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 9

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

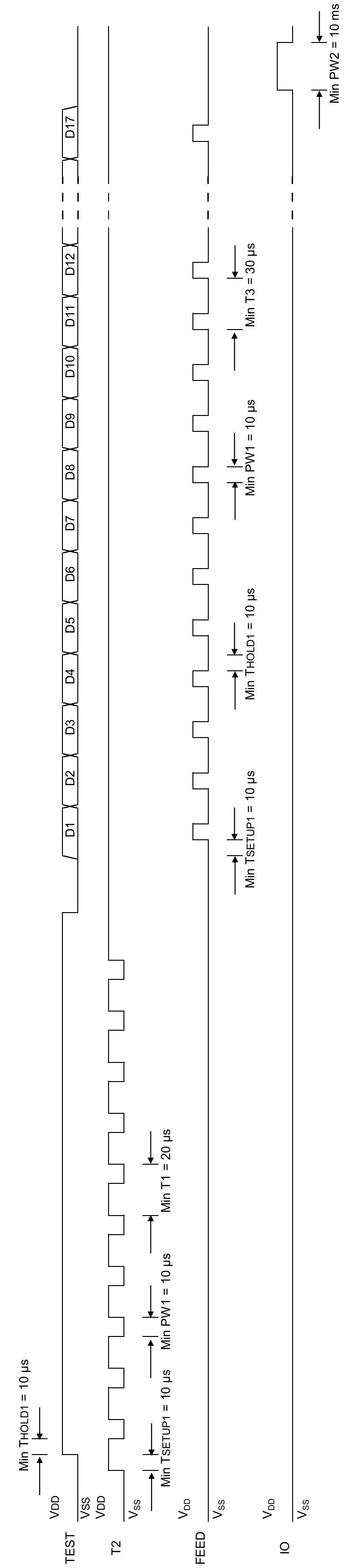


FIGURE 4-3: *Timing Diagram for Mode TM10.*

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 the 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 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

	W-x	W-x
	LBHshEn	LBTR2
	bit 18	bit 17

W-x	W-x	W-x	W-x	W-x	W-x	W-x	W-x
LBTR1	CMTR5	CMTR4	CMTR3	CMTR2	CMTR1	AMHCEn	AMLEDEn
bit 16							bit 9

W-x	W-x	W-x	W-x	W-x	W-x	W-x	W-x
AMTO2	AMTO1	AMEn	EOLEn	SmrtH	HIAO	HushEnB	LBSEL
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 **LBHshEn**: Low Battery Hush Enable Bit
1 = Enable
0 = Disable

bit 17 **LBTR2:** MSB

bit 16 **LBTR1:** LSB
00 =7.5V
01 =7.8V
10 =6.9V
11 =7.2V

bit 15 **CMTR5**: MSB (see STTR values in Table 4-2)

bit 14 **CMTR4**: 4SB

bit 13 **CMTR3**: 3SB

bit 12 **CMTR2**: 2SB

bit 11 **CMTR1**: LSB

bit 10 **AMHCEn:** Alarm Memory PTT Indicator Horn Chirp Enable Bit
1 = Enable
0 = Disable

bit 9 **AMLEDEn:** Alarm Memory PTT Indicator LED Flashing Enable Bit
1 = Enable
0 = Disable

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

bit 8	**AMTO2:** MSB
bit 7	**AMTO1:** LSB 00 =24 Hours Time-out 01 =48 Hours Time-out 10 =0 Hours Time-out 11 =Never Time-out
bit 6	**AMEn:** Alarm Memory Enable Bit 1 = Enable 0 = Disable
bit 5	**EOLEn**: End of Life Indicator Enable Bit 1 = Enable 0 = Disable
bit 4	**SmrtH:** Smart HUSH Bit 1 = Enable (HUSH is canceled by either high smoke, or remote smoke) 0 = Disable (HUSH is never canceled until time-out)
bit 3	**HIAO:** HUSH-in-Alarm -Only Bit 1 = Enable (Hush is activated upon release of PTT during local smoke only) 0 = Disable (Hush is activated upon release of PTT at any time)
bit 2	**HushEnB:** HUSH Enable Bit 1 = Enable (HUSH is disabled) 0 = Disable (HUSH is enabled)
bit 1	**LBSEL**: Low Battery Select Bit 1 = 2.5 ms 0 = 10 ms

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	–	1	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 HUSH Enable	=	Yes
Low Battery Trip Point	=	6.9V
Chamber Monitor Sensitivity (11110)	=	4.3V
Alarm Memory PTT Indicator Horn Chirp Enable	=	Yes
Alarm Memory PTT Indicator LED Flashing Enable	=	No
Alarm Memory LED Indicator Time-Out	=	24h
Alarm Memory Enable	=	Yes
End of Life Enable	=	No
Smart HUSH	=	No
HUSH-In-Alarm Only	=	Yes
Hush Enable	=	Yes
Low Battery Select	=	10 ms

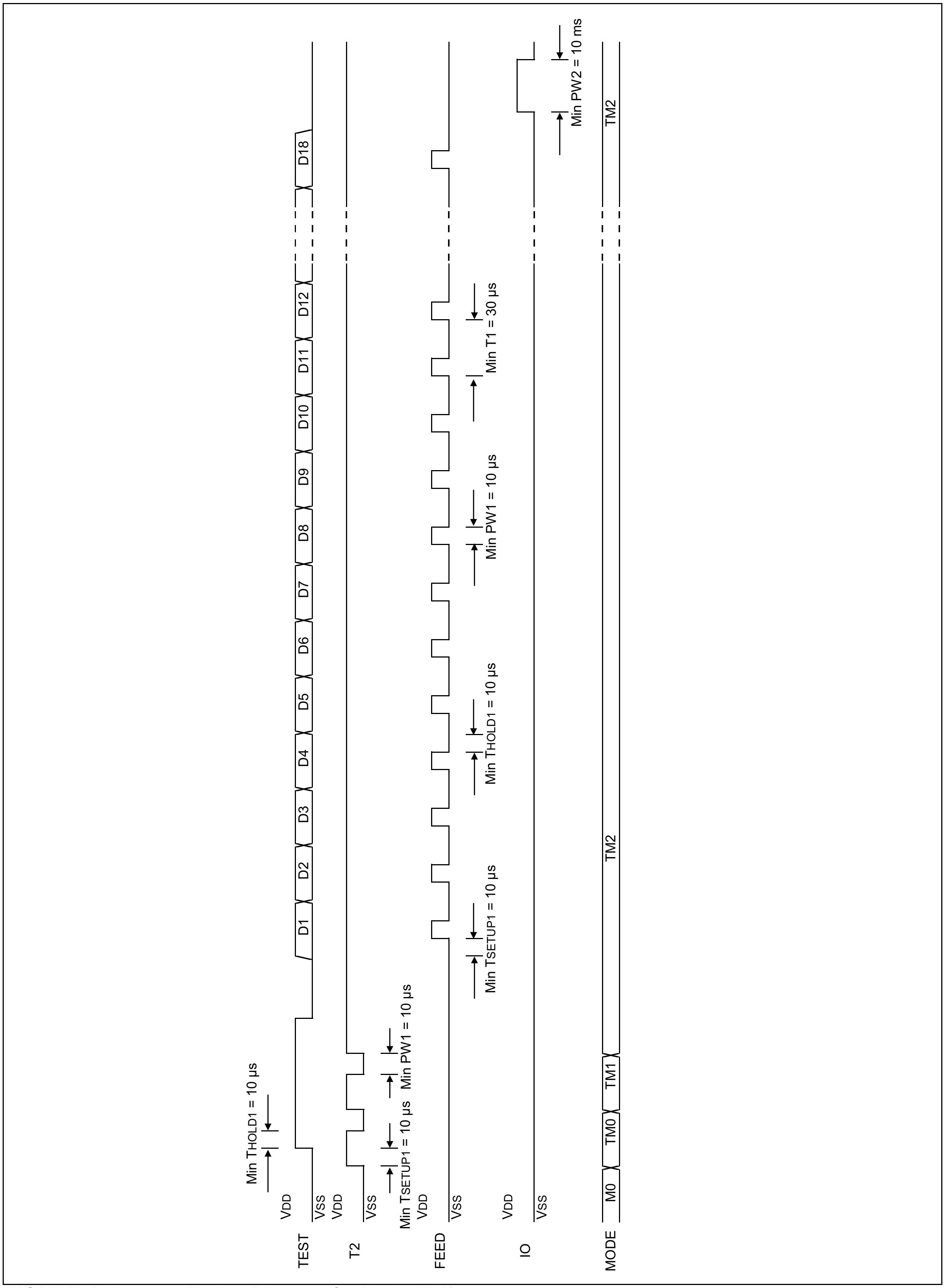


FIGURE 4-4: *Timing Diagram for Mode TM2.*

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.

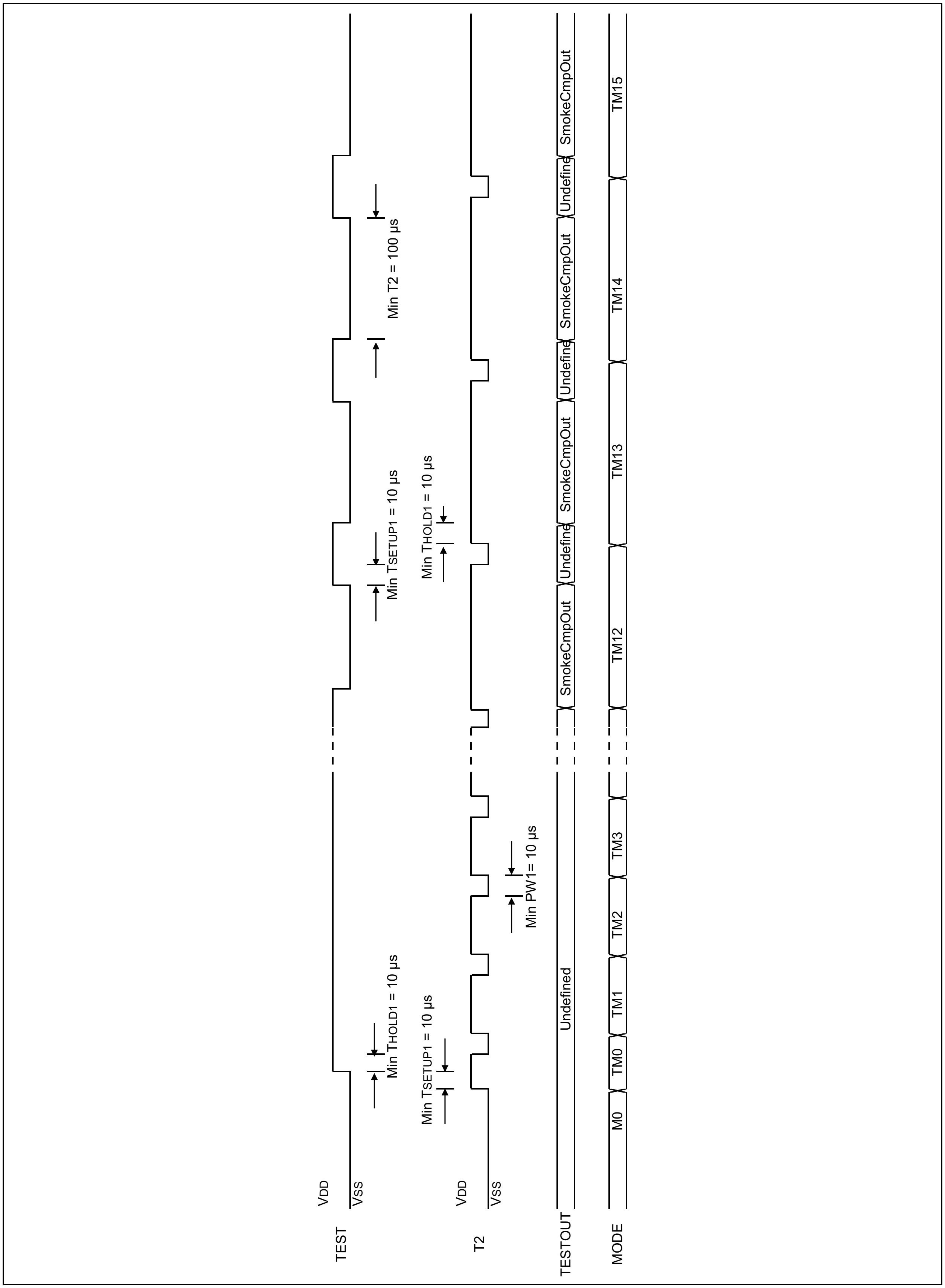


FIGURE 4-5: *Timing Diagram for Sensitivity Verification in Mode TM12 ~ TM15.*

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 the 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 the 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.
7. Use test mode TM19 to set the lock bit to unlocked. This will insure TM18 can be used to read back the data to verify the TM18 write completed properly.

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	W-x	W-x
HYTR1	STTR5	STTR4	STTR3	STTR2	STTR1	LBHshEn	LBTR2
bit 24							bit 17

W-x	W-x	W-x	W-x	W-x	W-x	W-x	W-x
LBTR1	CMTR5	CMTR4	CMTR3	CMTR2	CMTR1	AMHCEn	AMLEDEn
bit 16							bit 9

W-x	W-x	W-x	W-x	W-x	W-x	W-x	W-x
AMTO2	AMTO1	AMEn	EOLEn	SmrtH	HIAO	HushEnB	LBSEL
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

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

bit 32 **PTTR2:** 2SB

bit 31 **PTTR1:** LSB

bit 30 **TMTR4:** MSB (See Table 4-4)

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 **LBHshEn**: Low Battery HUSH Enable Bit
1 = Enable
0 = Disable

bit 17 **LBTR2:** MSB

bit 16 **LBTR1:** LSB
00 = 7.5V
01 = 7.8V
10 = 6.9V
11 = 7.2V

bit 15 **CMTR5**: MSB

bit 14 **CMTR4**: 4SB

bit 13 **CMTR3**: 3SB

bit 12 **CMTR2**: 2SB

bit 11 **CMTR1**: LSB

bit 10 **AMHCEn:** Alarm Memory PTT Indicator Horn Chirp Enable Bit
1 = Enable
0 = Disable

bit 9 **AMLEDEn:** Alarm Memory PTT Indicator LED Flashing Enable Bit
1 = Enable
0 = Disable

bit 8 **AMTO2:** MSB

bit 7 **AMTO1:** LSB
00 =24 Hours Time-out
01 =48 Hours Time-out
10 =0 Hours Time-out
11 =Never Time-out

bit 6 **AMEn:** Alarm Memory Enable Bit
1 = Enable
0 = Disable

bit 5 **EOLEn**: End of Life Indicator Enable Bit
1 = Enable
0 = Disable

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

bit 4	**SmrtH:** Smart HUSH Bit 1 = Enable (HUSH is canceled by either high smoke, or remote smoke) 0 = Disable (HUSH is never canceled until time-out)
bit 3	**HIAO:** HUSH-in-Alarm-Only Bit 1 = Enable (HUSH is activated upon release of PTT during local smoke only) 0 = Disable (HUSH is activated upon release of PTT at any time)
bit 2	**HushEnB:** HUSH Enable Bit 1 = Enable (HUSH is disabled) 0 = Disable (HUSH is enabled)
bit 1	**LBSEL:** Low Battery Select Bit 1 = 2.5 ms 0 = 10 ms

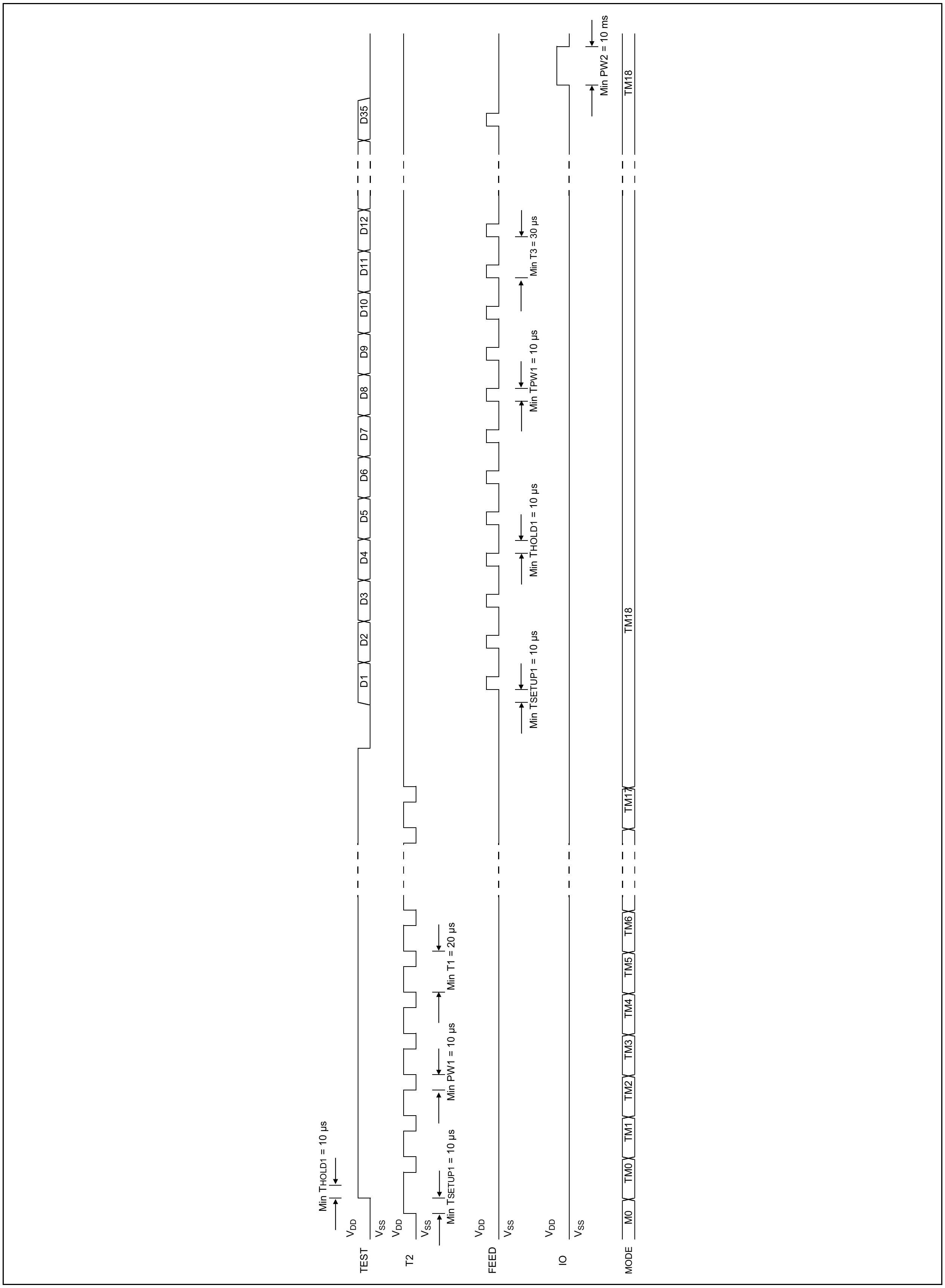


FIGURE 4-6: *Timing Diagram for Serial Read/Write Calibration and User Features in Mode TM18.*

4.7 Horn Test

Test mode TM0 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 the T2 input from V_{SS} to V_{DD} and hold at V_{DD} to enter TM0.
3. To disable the horn, drive TEST from V_{SS} to V_{DD}.

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 the 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 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 the TESTOUT output. The TESTOUT output will indicate the Low Battery status (High = Low Battery detected).

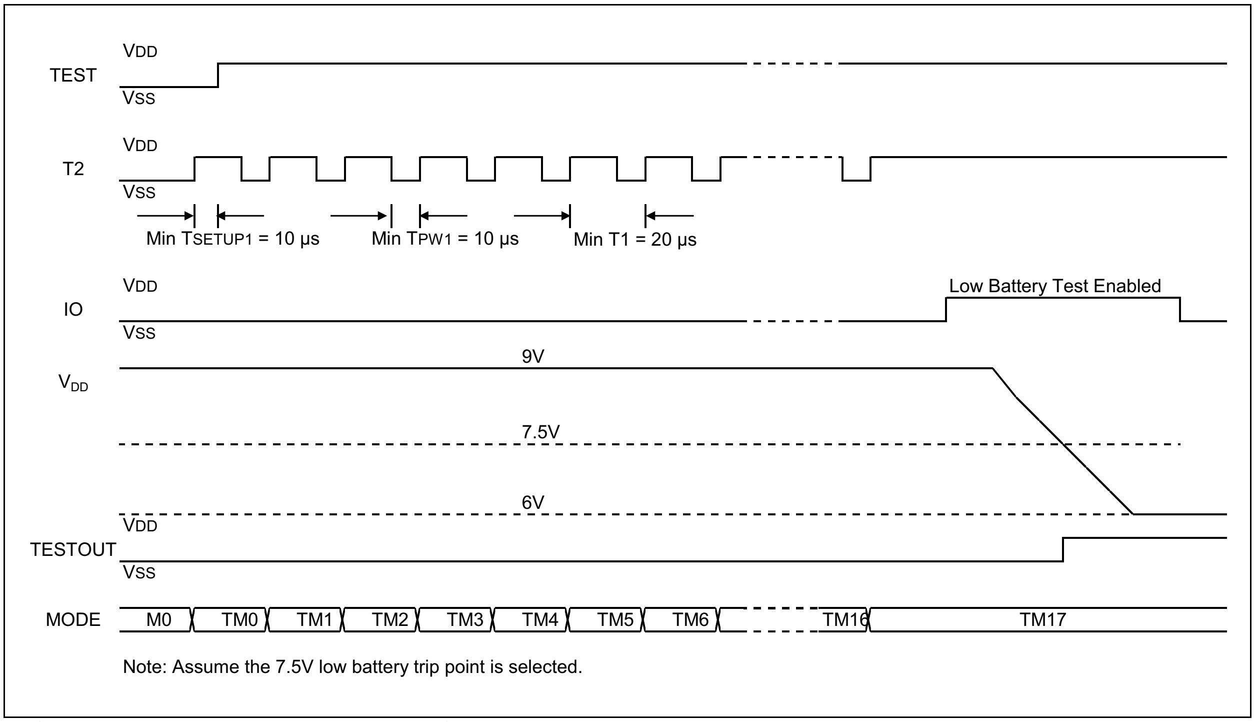


FIGURE 4-7: *Timing Diagram for Low Battery Test in Mode TM17.*

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 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 the 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 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.

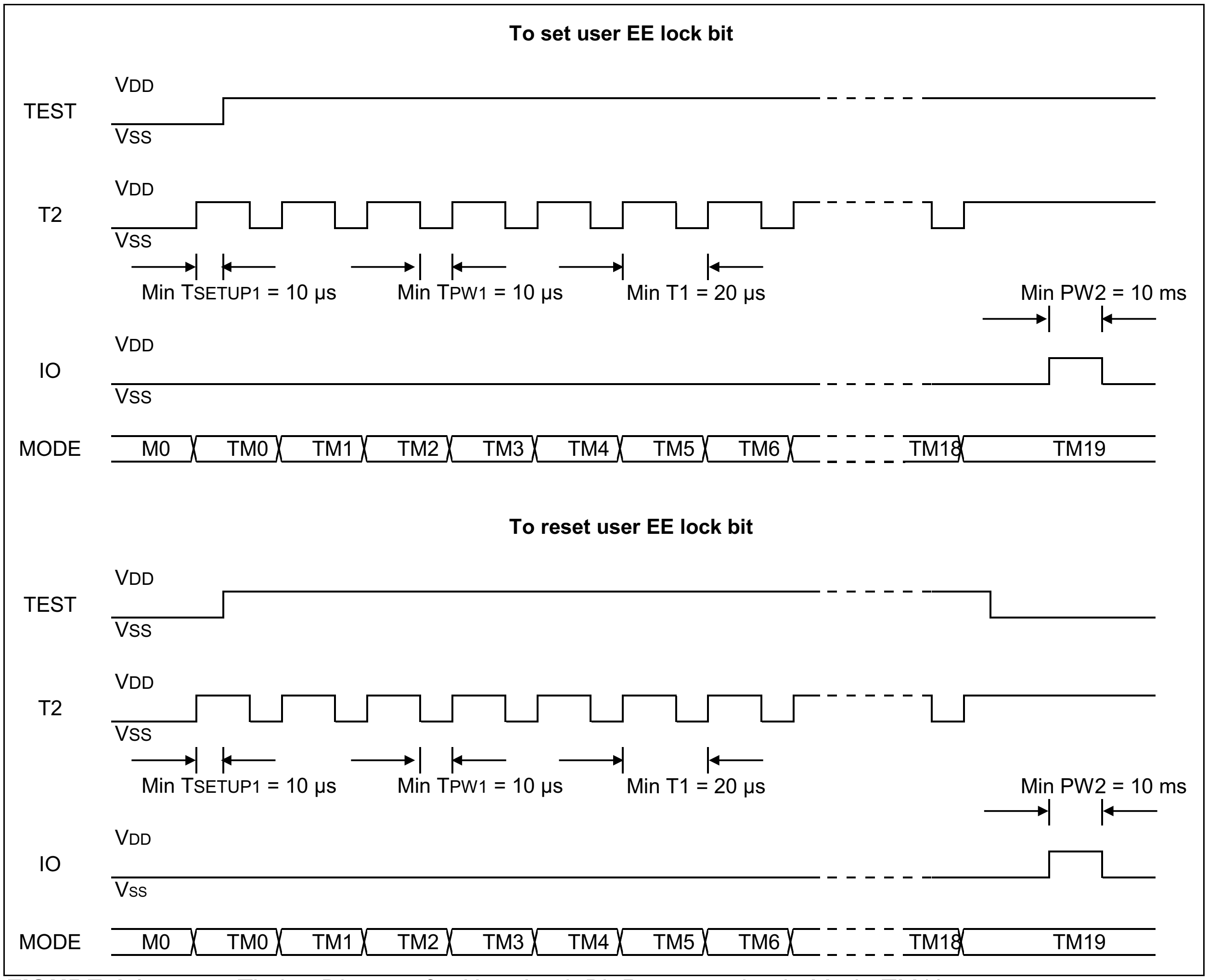


FIGURE 4-8: *Timing Diagram for User Lock Bit Programming in Mode TM19.*

NOTES:

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 drawn 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 increased 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 5-6 show the timing diagrams for the smoke detector functions described in **Section 3.0, Device Description**.

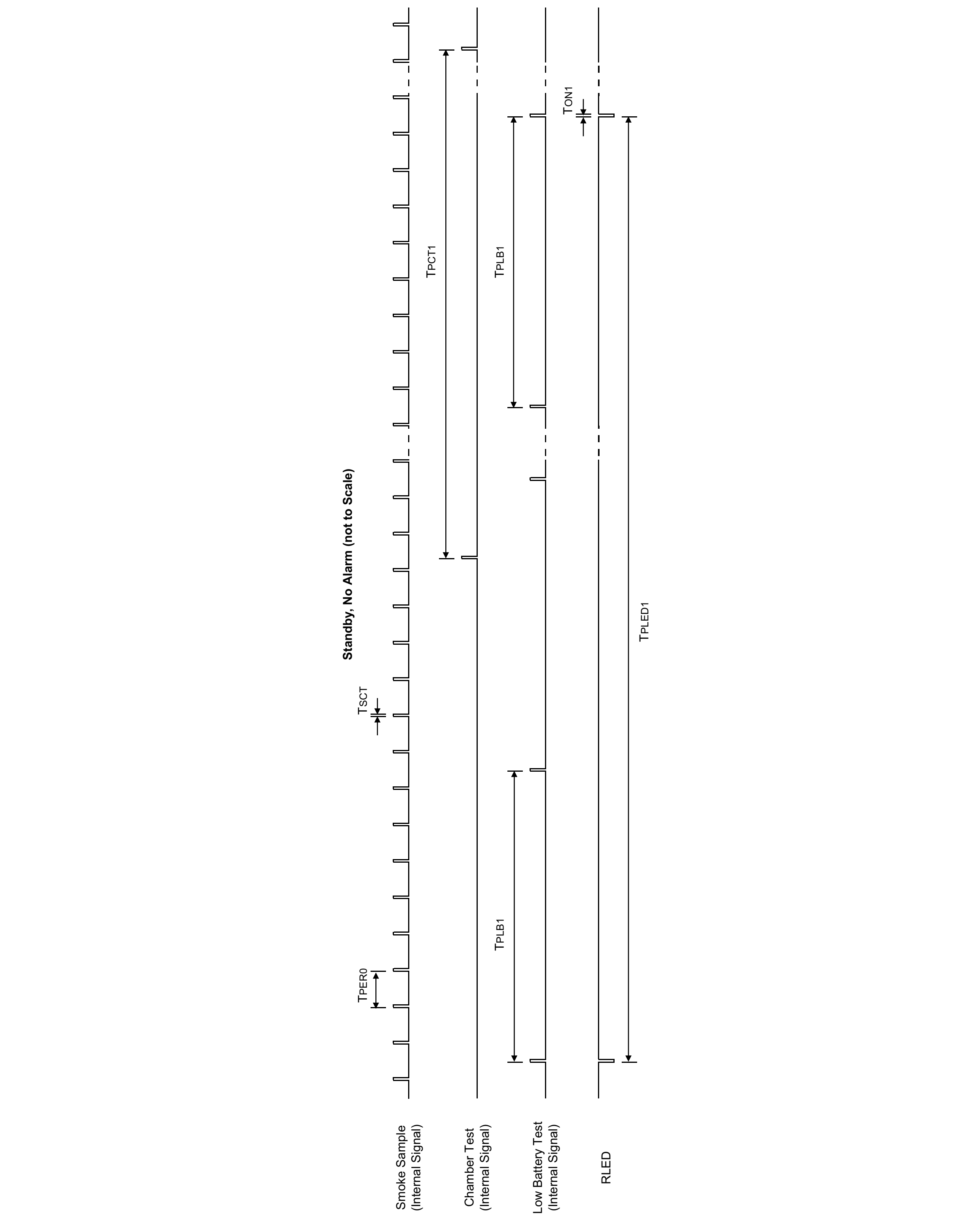


FIGURE 5-1: *Timing Diagram – Standby, No Alarm.*

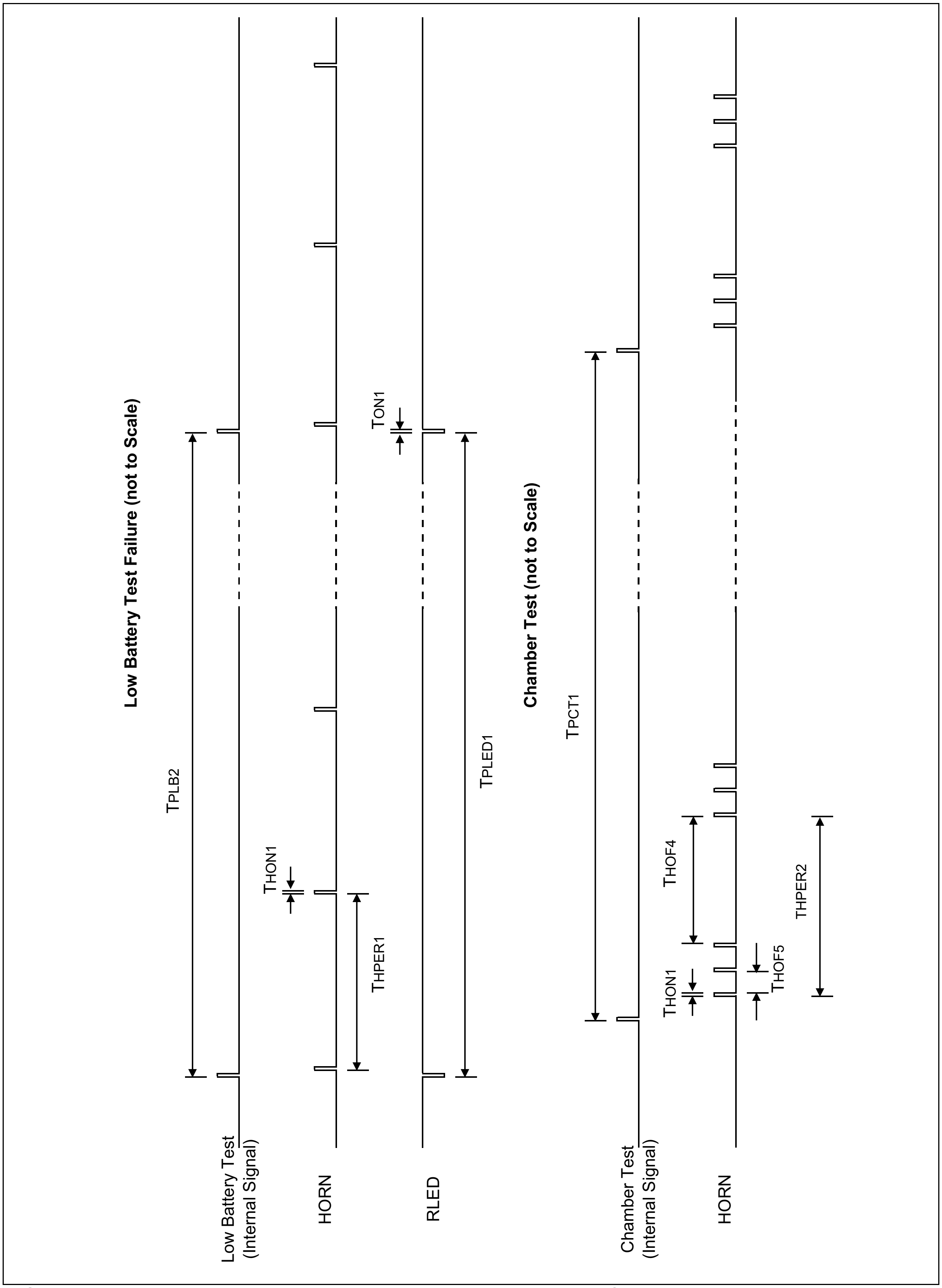


FIGURE 5-2: *Timing Diagram – Low Battery Test Failure and Chamber Test Failure.*

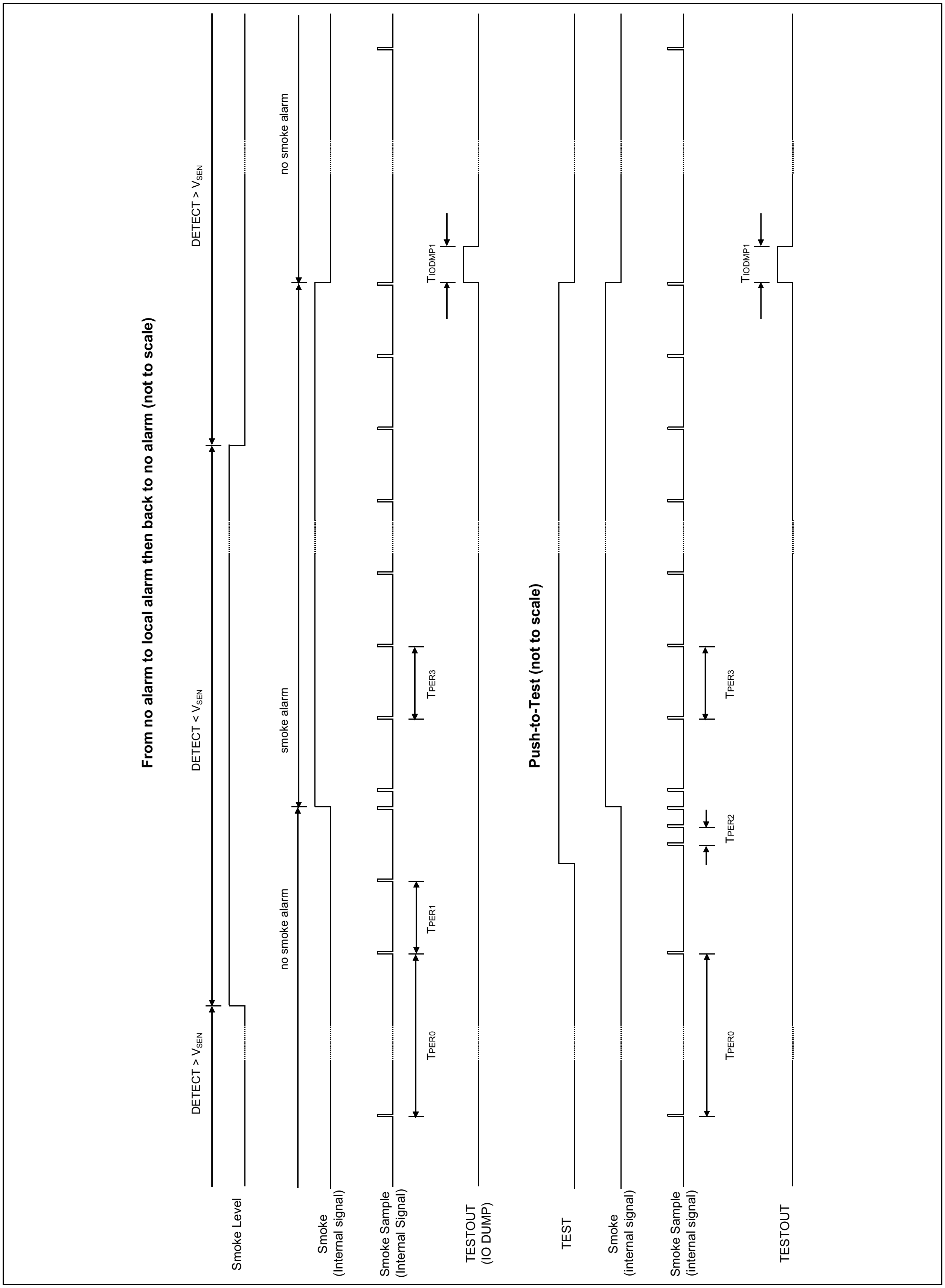


FIGURE 5-3: *Timing Diagram – From Standby to Local Smoke and Push-To-Test.*

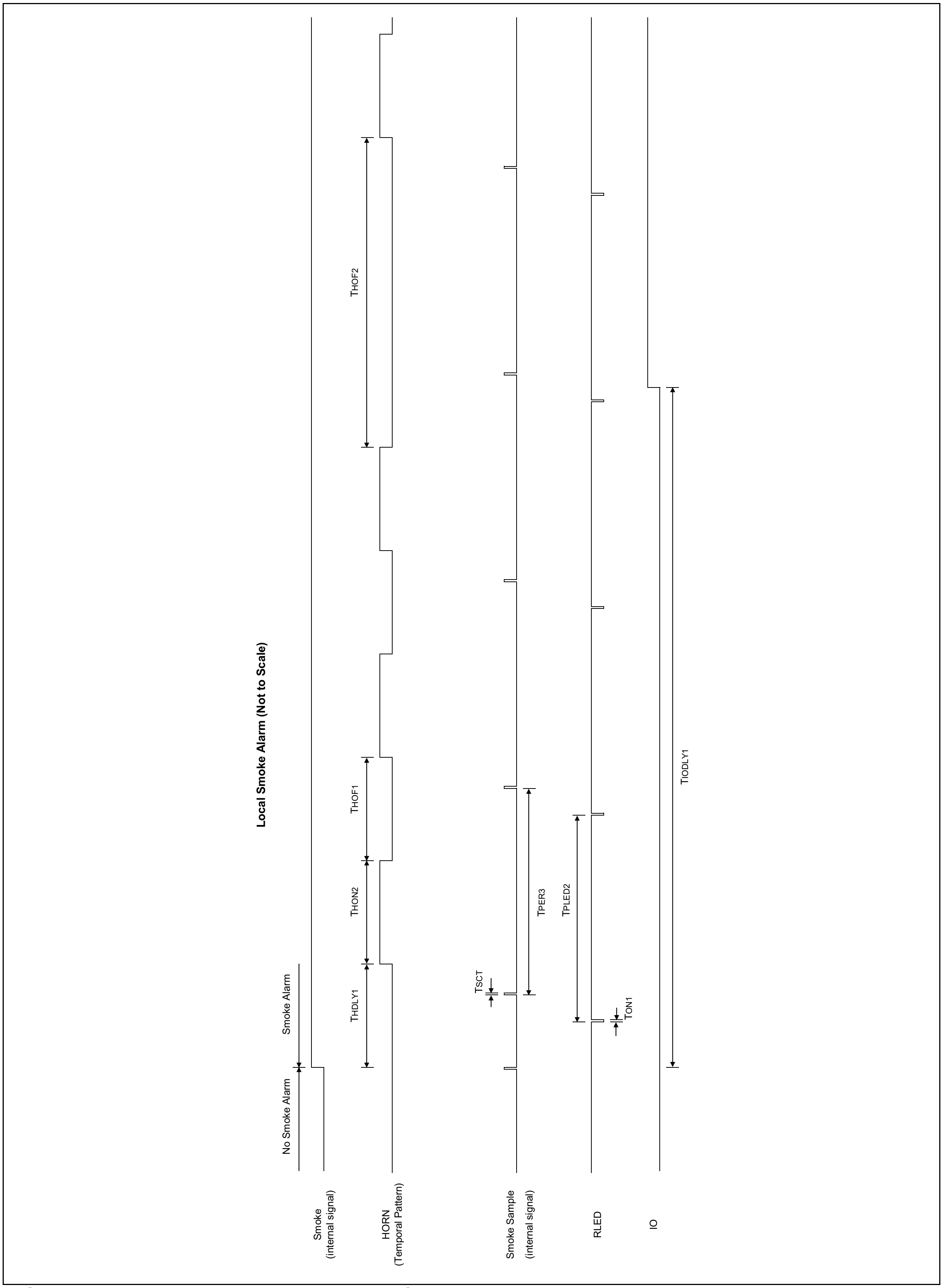


FIGURE 5-4: *Timing Diagram – Local Smoke Alarm.*

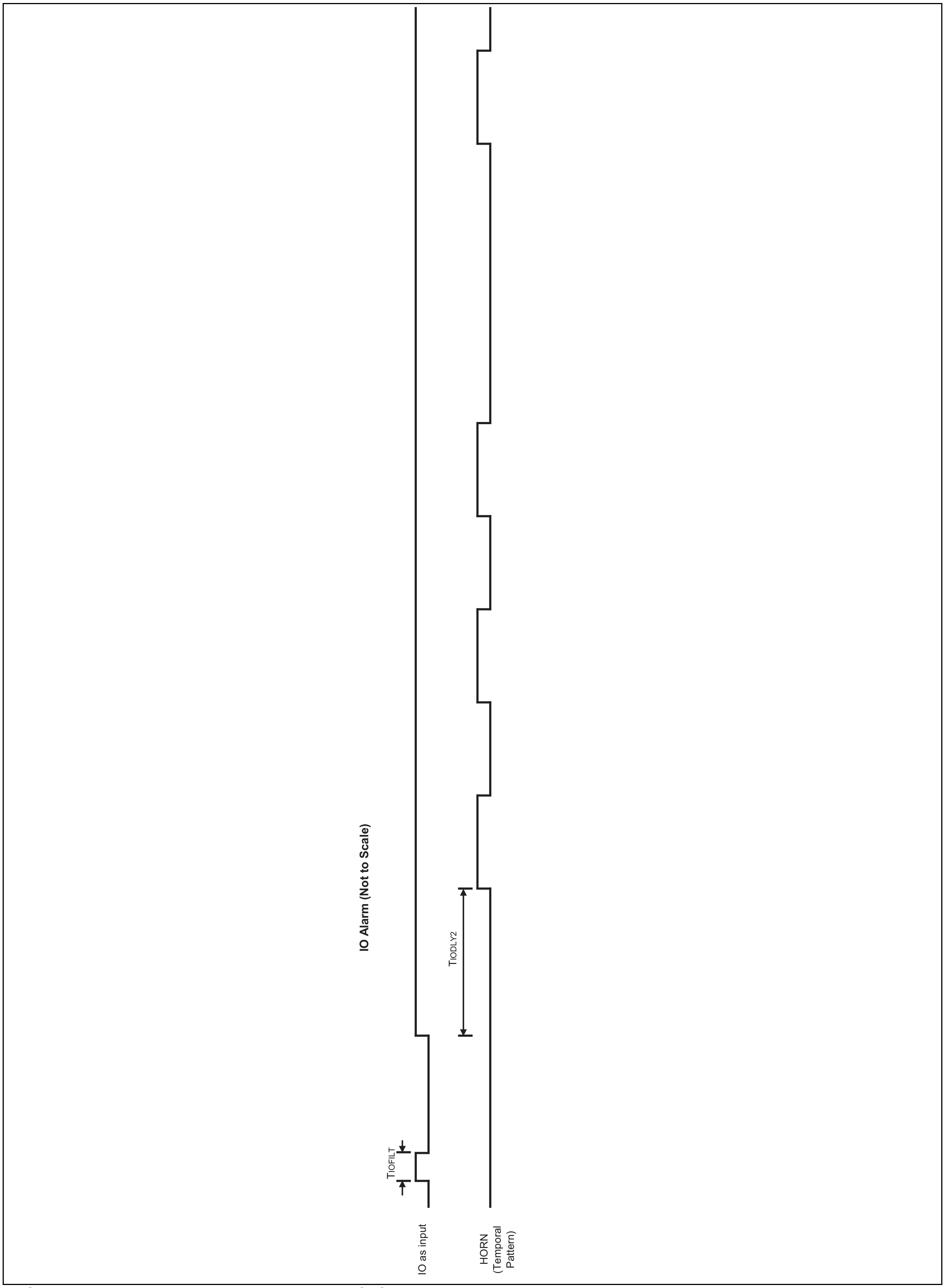


FIGURE 5-5: *Timing Diagram – IO Smoke Alarm.*

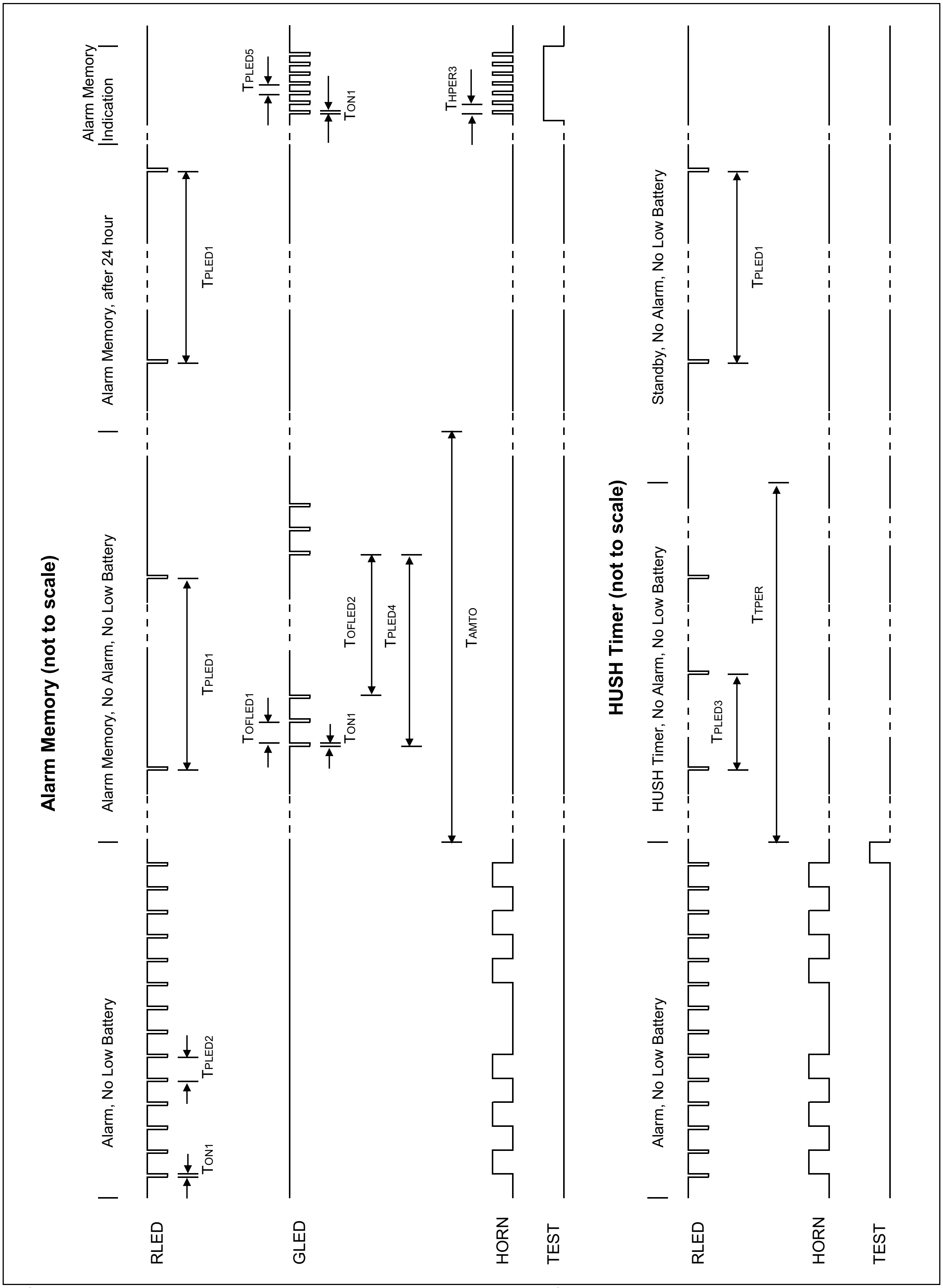


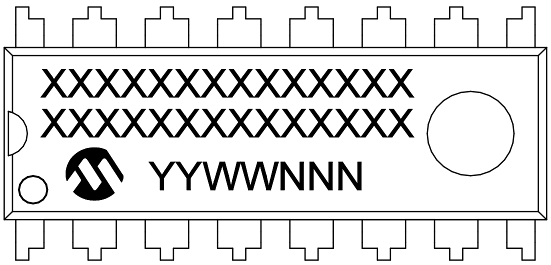
FIGURE 5-6: *Timing Diagram – Alarm Memory and HUSH Timer.*

NOTES:

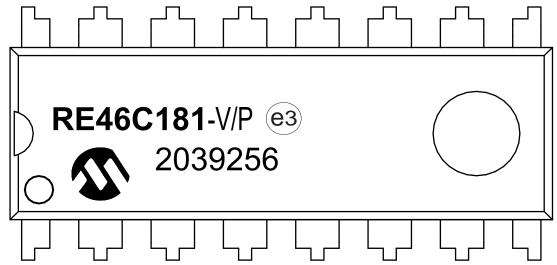
6.0 PACKAGING INFORMATION

6.1 Package Marking Information

16-Lead PDIP (300 mil)



Example

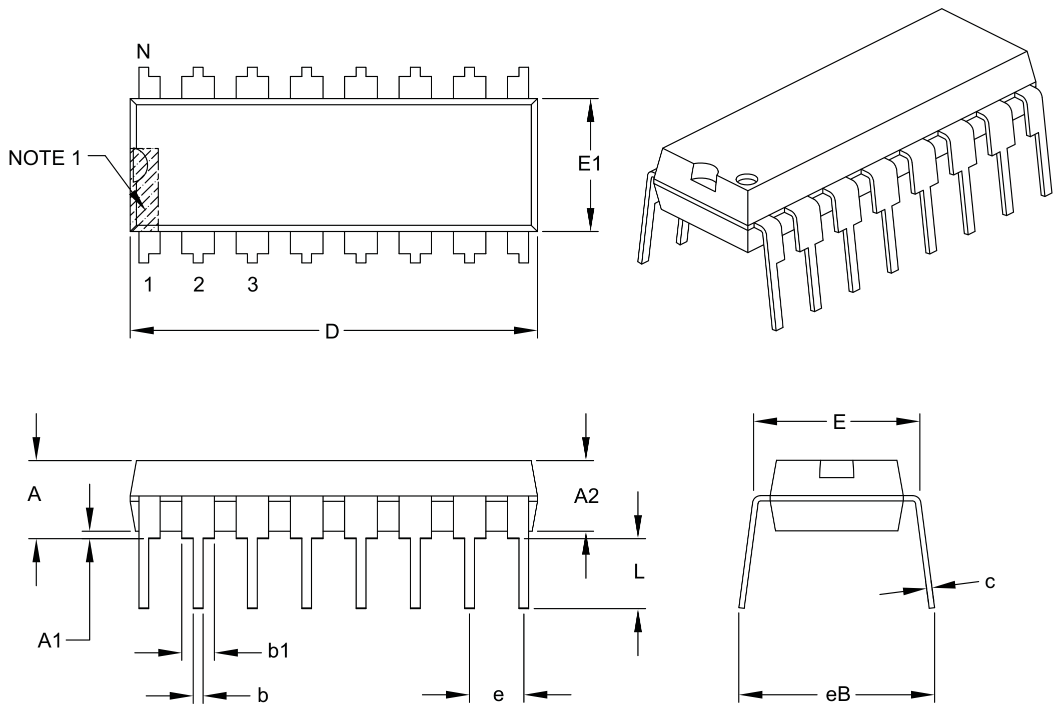


Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The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

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

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

APPENDIX A: REVISION HISTORY

Revision C (June 2021)

- Updated **Table 4-7**
- Updated **Section 4.2, Smoke Calibration**
- Updated **Section 4.3, Serial Read/Write Calibration**
- Updated **Section 4.6, Serial Read/Write Calibration and User Features**

Revision B (February 2021)

- Updated the IO Active Delay and IO Charge Dump Duration parameters in **Section 1.0, Electrical Characteristics**.

Revision A (September 2020)

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	RE46C181:	CMOS Programmable Ionization Smoke Detector ASIC
Package	E =	Plastic Dual In-Line, 16-Lead (PDIP)
Number of Pins	16-Lead	

Examples:

a) RE46C181E16: 16LD PDIP package

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods being used in attempts to breach the code protection features of the Microchip devices. We believe that these methods require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Attempts to breach these code protection features, most likely, cannot be accomplished without violating Microchip's intellectual property rights.
- Microchip is willing to work with any customer who is concerned about the integrity of its code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is "unbreakable." Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.

Trademarks

ISBN: 978-1-5224-8409-7

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800

Raleigh, NC
Tel: 919-844-7510

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110
Tel: 408-436-4270

Canada - Toronto
Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733

China - Beijing
Tel: 86-10-8569-7000

China - Chengdu
Tel: 86-28-8665-5511

China - Chongqing
Tel: 86-23-8980-9588

China - Dongguan
Tel: 86-769-8702-9880

China - Guangzhou
Tel: 86-20-8755-8029

China - Hangzhou
Tel: 86-571-8792-8115

China - Hong Kong SAR
Tel: 852-2943-5100

China - Nanjing
Tel: 86-25-8473-2460

China - Qingdao
Tel: 86-532-8502-7355

China - Shanghai
Tel: 86-21-3326-8000

China - Shenyang
Tel: 86-24-2334-2829

China - Shenzhen
Tel: 86-755-8864-2200

China - Suzhou
Tel: 86-186-6233-1526

China - Wuhan
Tel: 86-27-5980-5300

China - Xian
Tel: 86-29-8833-7252

China - Xiamen
Tel: 86-592-2388138

China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444

India - New Delhi
Tel: 91-11-4160-8631

India - Pune
Tel: 91-20-4121-0141

Japan - Osaka
Tel: 81-6-6152-7160

Japan - Tokyo
Tel: 81-3-6880- 3770

Korea - Daegu
Tel: 82-53-744-4301

Korea - Seoul
Tel: 82-2-554-7200

Malaysia - Kuala Lumpur
Tel: 60-3-7651-7906

Malaysia - Penang
Tel: 60-4-227-8870

Philippines - Manila
Tel: 63-2-634-9065

Singapore
Tel: 65-6334-8870

Taiwan - Hsin Chu
Tel: 886-3-577-8366

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600

Thailand - Bangkok
Tel: 66-2-694-1351

Vietnam - Ho Chi Minh
Tel: 84-28-5448-2100

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4485-5910
Fax: 45-4485-2829

Finland - Espoo
Tel: 358-9-4520-820

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Garching
Tel: 49-8931-9700

Germany - Haan
Tel: 49-2129-3766400

Germany - Heilbronn
Tel: 49-7131-72400

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Rosenheim
Tel: 49-8031-354-560

Israel - Ra’anana
Tel: 972-9-744-7705

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Padova
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Norway - Trondheim
Tel: 47-7288-4388

Poland - Warsaw
Tel: 48-22-3325737

Romania - Bucharest
Tel: 40-21-407-87-50

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Gothenberg
Tel: 46-31-704-60-40

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

02/28/20