

## PRESSURE SENSOR SIGNAL CONDITIONING INTERFACE

Check for Samples: [TPIC83000-Q1](#)

### FEATURES

- Qualified for Automotive Applications
- 10-Bit Pressure and Temperature Output
- On-Board Temperature Sensor
- Programmable Gain / Gain TC1
- Programmable Offset / Offset TC1 / TC2
- On-Board EEPROM for System Calibration
- Operating Temperature Range: –40°C to 85°C
- 16-Pin TSSOP (PW) Package
- UART Interface

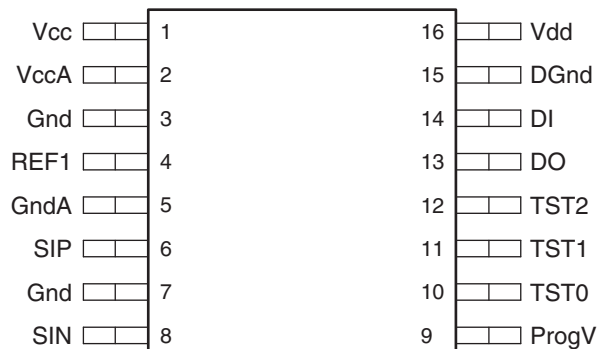
### APPLICATIONS

- Occupancy Weight Sensing
- Pedal-Pressure Sensing
- General Low-Pressure Sensing

### DESCRIPTION

The TPIC83000 is a single-channel, signal conditioning device for pressure sensors used in low-pressure sensing applications such as passenger occupancy indication/detection and pedal pressure sensing. The pressure sensor can be based on either a strain gauge or piezo-resistive elements configured as a full Wheatstone bridge. This device provides an analog signal conditioning interface between the pressure sensor and a microcontroller. The analog front end (AFE) inside the device processes the sensed signals from the pressure sensor by amplifying the signal and cancelling offset. This processed signal is then converted into a 14-bit, digital word using a sigma-delta analog-to-digital converter (ADC). The device also has a built-in 12-bit ADC that is used to sense ambient temperature to compensate for the temperature coefficient of the sensor and related processing circuitry. The compensated digital data is transferred to the microprocessor via a built-in UART interface.

PW PACKAGE  
(TOP VIEW)



### ORDERING INFORMATION<sup>(1)</sup>

| T <sub>A</sub> | PACKAGE <sup>(2)</sup> |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|------------------------|--------------|-----------------------|------------------|
| –40°C to 85°C  | TSSOP – PW             | Reel of 2000 | TPIC83000IPWRQ1       | TPIC83000I       |

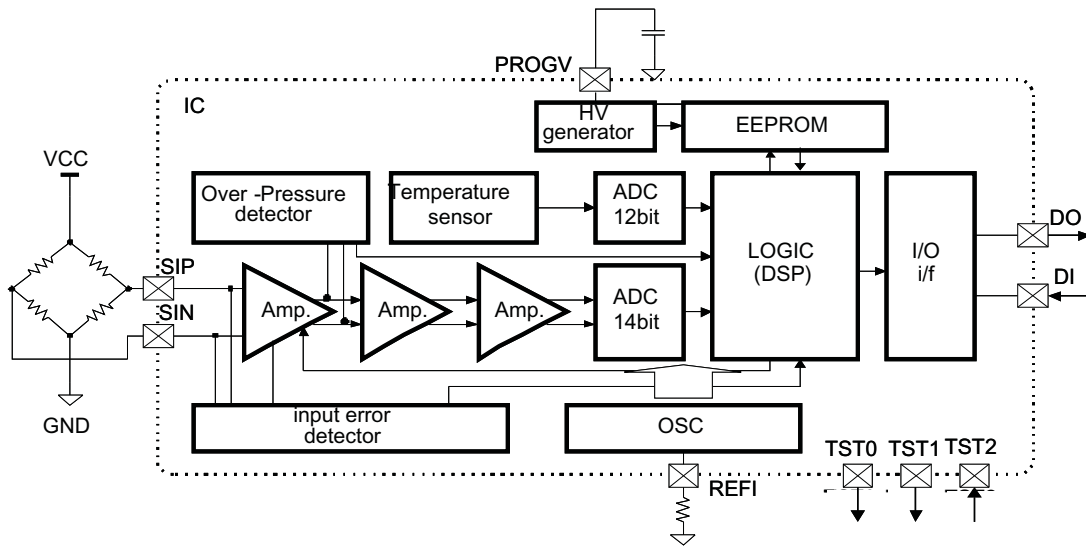
(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

(2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).



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## Functional Block Diagram



## TERMINAL FUNCTIONS

| NAME                     | NO. | TYPE <sup>(1)</sup> | DESCRIPTION                        |
|--------------------------|-----|---------------------|------------------------------------|
| Vcc                      | 1   | I                   | 5-V input analog supply            |
| VccA                     | 2   | I                   | ADC positive reference             |
| Gnd                      | 3   | I                   | Ground (analog)                    |
| REFI                     | 4   | I                   | Current reference ( $V_{bg} / R$ ) |
| GndA                     | 5   | I                   | ADC negative reference             |
| SIP                      | 6   | I / PD              | Positive sensor input              |
| Gnd                      | 7   | I                   | Ground (analog)                    |
| SIN                      | 8   | I / PD              | Negative sensor input              |
| ProgV                    | 9   | O / PD              | EEPROM programming voltage monitor |
| TST0 (NC) <sup>(2)</sup> | 10  | I/O                 | Test (analog / digital)            |
| TST1 (NC) <sup>(2)</sup> | 11  | I/O                 | Test (analog / digital)            |
| TST2 (NC) <sup>(2)</sup> | 12  | I/O                 | Test (digital)                     |
| DO                       | 13  | O                   | UART interface output              |
| DI                       | 14  | I                   | UART interface input               |
| DGnd                     | 15  | I                   | Digital ground                     |
| Vdd                      | 16  | I                   | 5-V digital supply                 |

(1) I = input, O = output, PD = pulldown, PU = pullup

(2) These pins are to be used for TI internal test purposes only and must be "no connection" in the system application. No signal traces should be connected to the NC pins.

## FUNCTIONAL DESCRIPTION

The TPIC83000 is designed for detection of low-pressure variations in many automotive applications. This device provides analog interface signal conditioning between a piezo-resistive or strain gauge pressure sensor and a microcontroller. The input amplifiers process the voltage from the sensor and amplify this voltage before feeding it to the 14-bit sigma-delta ADC for signal conditioning. Once the signal is converted into a digital format, this converted value of the analog signal is processed and transmitted to the microcontroller via the UART interface. There is also a 12-bit ADC to sense ambient temperature, which is used to compensate for non-ideality of the sensor and associated circuitry due to temperature.

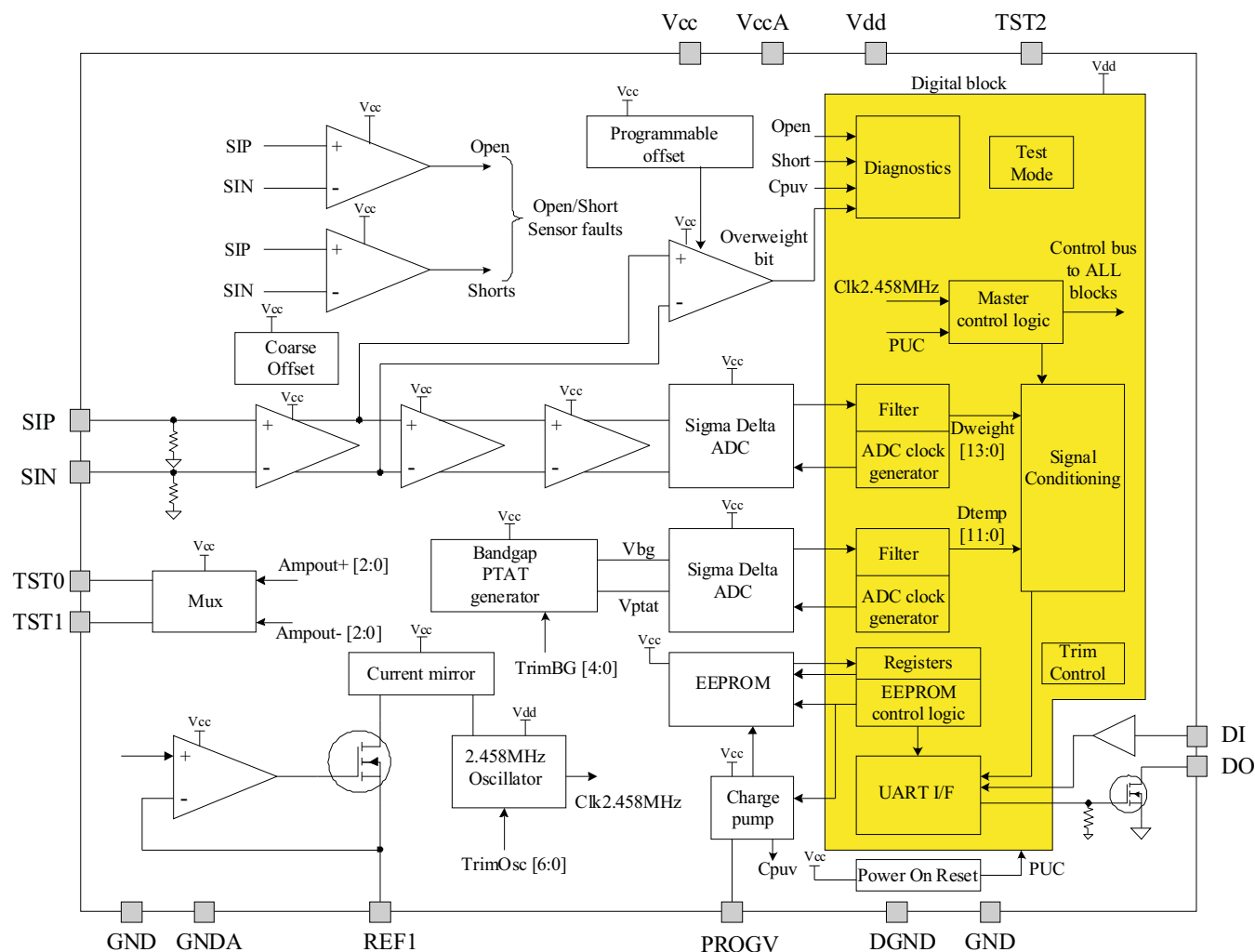


Figure 1. Detailed Functional Block Diagram

## Function Pin Description

### Supply Voltage (Vcc)

This terminal is the input supply for the analog circuits, typically 5 V +5%/-10% tolerant. A noise filter capacitor of 4.7  $\mu$ F (typical) is required on this terminal to ensure stability of the internal circuits.

### Ground (Gnd)

This terminal is connected to the system ground.

### Ground (DGnd)

This terminal is connected to the system ground.

### ADC Reference Voltage (VccA)

This terminal is the input reference for the ADC, typically 5 V. A noise filter capacitor of 0.1  $\mu$ F (typical) is required on this terminal to ensure stability of the internal circuits.

### Supply Voltage (Vdd)

This terminal is the input supply for the digital circuits, typically 5-V tolerant. A capacitor of 4.7  $\mu$ F (typical) is required on this terminal to ensure stability of the internal circuits.

### ADC Reference Voltage (GNDA)

This terminal is the input reference for the ADC, typically 0 V.

### Gauge OUTPUT (SIP)

The SIP is a positive sensor output. This is the input to the amplifier used for the signal conditioning.

### Gauge OUTPUT (SIN)

The SIN is a negative sensor output. This is the input to the amplifier used for the signal conditioning.

### Data Input/Data Output (DI/DO)

The DI and DO is the UART communication interface, reporting information back to the microprocessor. This is an open-drain output with the output set to high-impedance mode when other DO in the system is activated. The output is by default in RX mode.

### Reference Supply (REFI)

Internally generated reference voltage appears as resistor (10 k $\Omega$ ) is connected to this pin to set up reference current for internal oscillator.

Internal oscillator frequency  $f_{osc} = 2 \times (VBG/R) / (VBG \times C_{trim})$

VBG = Bandgap voltage (VREFI)

Ctrim = Internally trimmed capacitor

### EEPROM Supply (PROGV)

This terminal is the supply for EEPROM program. A capacitor of ~1 nF is required on this terminal.

## Principles of Operation

The system transfer equation is shown in [Equation 1](#).

$$VDIO_{\text{digital}} = (V_{\text{input}} - VOS - (TCVOS2 \times \text{Temp}) - (TCVOS2 \times \text{Temp}^2)) \times \frac{\text{Gain} \times (1 + (TC_{\text{Gain1}} \times \text{Temp}))}{V_{\text{ccA}} \times 1024} \quad (1)$$

Where

$V_{\text{input}}$  = Voltage input to the Logic (DSP) block. This voltage is the same as the output of the Analog Front End

$VDIO_{\text{digital}}$  = Digital output of the logic (DSP) block

Temp = Difference between ambient temperature and room temperature

VOS = Offset adjust

TCVOS1 = Offset TC1 adjust

TCVOS2 = Offset TC2 adjust

Gain = Gain

TCGain1 = Gain TC1 adjust

VccA = ADC reference

$VDIO_{\text{digital}} = 0$  for lower clamp ( $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$ )

$VDIO_{\text{digital}} = 1023$  for upper clamp ( $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$ )

The range and resolution of the parameters is given in [Table 1](#).

**Table 1. Output Parameters**

| ITEM                                              | SYMBOL    | BIT NO. | ADJUSTMENT RANGE                               | DEFAULT                          | DECIMAL VALUE | BINARY VALUE | ADJUSTMENT VALUE                            |
|---------------------------------------------------|-----------|---------|------------------------------------------------|----------------------------------|---------------|--------------|---------------------------------------------|
| Input coarse offset                               | TRVOSC    | 9       | $\pm 120$ mV                                   | 0 mV                             | 511           | 11111111     | +120 mV                                     |
|                                                   |           |         |                                                |                                  | 256           | 10000000     | 0 mV                                        |
|                                                   |           |         |                                                |                                  | 0             | 0            | -120 mV                                     |
| Input fine offset                                 | TRVOSF    | 8       | 0 to $4 \times 510$ $\mu\text{V}$              | 0 $\mu\text{V}$                  | 255           | 11111111     | $4 \times 510$ $\mu\text{V}$                |
|                                                   |           |         |                                                |                                  | 0             | 0            | 0                                           |
| Input offset first-order temperature coefficient  | TRTCVOS1  | 7       | $(\pm 25 \mu\text{V}/^\circ\text{C}) \times 3$ | 0 $\mu\text{V}/^\circ\text{C}$   | 63            | 11111111     | $(+25 \mu\text{V}/^\circ\text{C}) \times 3$ |
|                                                   |           |         |                                                |                                  | 0             | 0            | 0                                           |
|                                                   |           |         |                                                |                                  | -64           | 10000000     | $(-25 \mu\text{V}/^\circ\text{C}) \times 3$ |
| Input offset second-order temperature coefficient | TRTCVOS2  | 7       | $\pm 40$ $\text{nV}/^\circ\text{C}^2$          | 0 $\mu\text{V}/^\circ\text{C}^2$ | 63            | 11111111     | $40 \text{ nV}/^\circ\text{C}^2$            |
|                                                   |           |         |                                                |                                  | 0             | 0            | 0                                           |
|                                                   |           |         |                                                |                                  | -64           | 10000000     | $-40 \text{ nV}/^\circ\text{C}^2$           |
| Gain                                              | TRGAIN    | 9       | 100 + 25%                                      | 100%                             | 255           | 11111111     | 125%                                        |
|                                                   |           |         |                                                |                                  | 0             | 0            | 100%                                        |
|                                                   |           |         |                                                |                                  | -255          | 10000000     | 75%                                         |
| Gain first-order temperature coefficient          | TRTCGAIN1 | 6       | -900 to 0 $\text{ppm}/^\circ\text{C}$          | 0 $\text{ppm}/^\circ\text{C}$    | 0             | 0            | 0 $\text{ppm}/^\circ\text{C}$               |
|                                                   |           |         |                                                |                                  | -63           | 1            | -900 $\text{ppm}/^\circ\text{C}$            |

## DETAILED FUNCTIONAL DESCRIPTION

### Pre-Amplifier (Front End)

Due to initial large offset in the pressure sensor output, the analog front end has an offset correction as needed.

### Fault Detection

Sensor inputs SIP, SIN

The following faults are detected and a fault bit set in a register. The minimum fault detection filter time is 5 ms. There are 1- $\mu$ A pulldown current source on the SIP and SIN terminals. Fault detection capabilities of this device are for both SIP and SIN sensor inputs. The following type of faults are reported and sent to the DIAG bits.

- Shorts to Vcc
- Shorts to Gnd
- Open piezo-resistive or strain gauge (i.e., open-circuit between SIP and SIN inputs)

### ADC

The ADC is a 14-bit with resolution of  $\pm 3$  LSB (10 bit).

### Digital I/O

- I/O data transfer via DI/DO pins.
- Refer to data format communications between microprocessor to IC: Mode selection (microprocessor  $\rightarrow$  IC) chart.
- DI/DO interface become active only when specified data format and protocol are used.
- Start bit is used to initiate the communication: DI/DO repeats Rx-Tx-Rx-Tx, to realize one pin Tx-Rx communication. When sensor, temperature, diagnostics, and trimming data are requested, DI/DO remain in Rx mode until all frames are sent.
- DI/DO output current capability is 5 mA at low level.

### Memory

- EEPROM : Read/Write cycle is less than 25 times
- Data retention: 15 years at 90°C
- Data fault detection (CRC8)
- Fault write/erase prevention

### EEROM Write

- Generate programming voltage after receiving the write RQ.
- Output Diag during the write
- EEROM write sequence
  1. Send data to appropriate bank or field
  2. Send WE = 1
    - (a) Calculate new CRC
    - (b) Set charge pump on
    - (c) Reload all registers from EEPROM
    - (d) Check CRC value
  3. Read Diag register to confirm PROG\_OK = 1
  4. Send WE = 0 ( $\geq 15$  ms must elapse for write sequence to complete before microprocessor can disable EEPROM write)

## System Configuration/Programming

See the "Baud Rate Settings" table ([Table 21](#)).

### Programming Voltage

- Internally generated programming voltage
- Only active during the write mode
- The programming voltage can be monitored at PROG pin.
- 15-ms sec timer / internal undervoltage comparator to guarantee required programming time and voltage level. (12.5 V, 15 ms + system response time > 20 ms)

### Temperature Sensor

- Output data linearly proportional to temperature.

### Internal Oscillator

- 2.458 MHz
- External resistor is used for current reference
- 10 kΩ

### Sensor Output

- Input signal from sensor is analog/digitally processed and output 10-bit word via DIO
- Linear region: output is linear to the sensor input. Clamp region: output is at the clamp value.
- Output and DIAG data can be requested every 100 ms.
- Refer to Data format communications between microprocessor to IC Mode selection (microprocessor → IC) chart.

## Data Transfer Format

See [Table 16](#).

## Data Output Request (Sensor vs Calibration Mode)

### Sensor Mode

1. Receive sensor position ID
2. Output pressure or temperature + DIAG + MODE information

### Calibration Mode

A data access mode can be selected by setting ACSUNT

### Bank Mode (ACSUNT = 1)

1. Receive sensor position ID + command
2. Receive Bank address
3. Available output is: 1. Sensor output + diagnostics, 2. Temperature, 3. ADC output, 4. Configuration baud rate, 5. Sensor ID + Position ID, 6. Over-pressure setting, 7. Calibration setting, 8 Temperature data, 9. Over-pressure setting history, 10. Calibration history, 11. Mode data

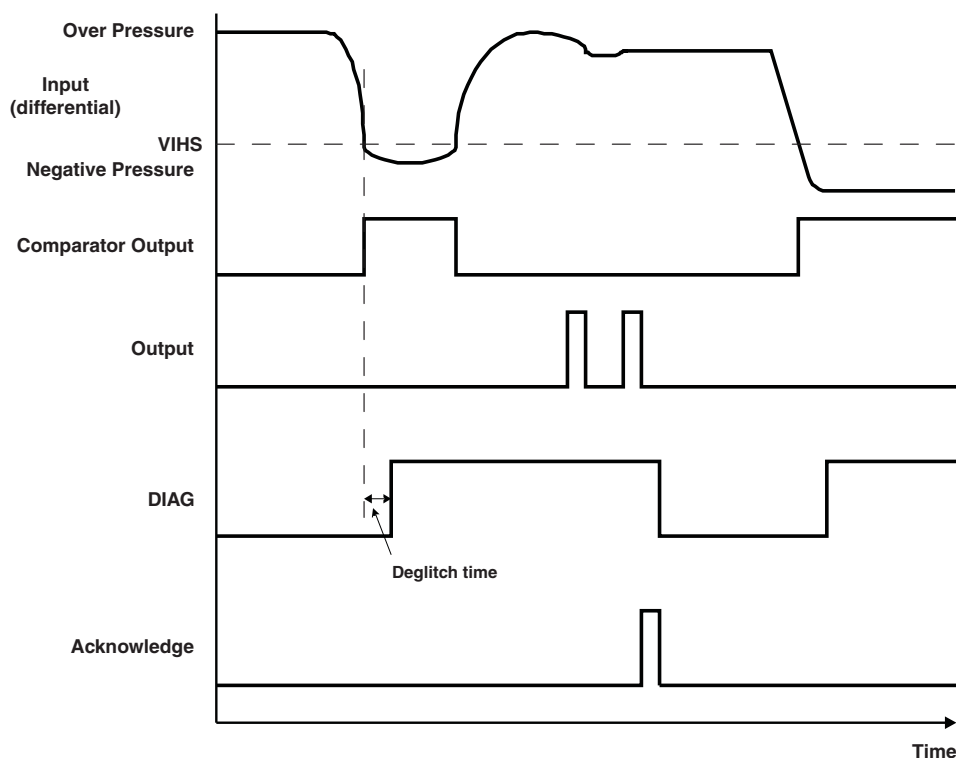
### Field Mode (ACSUNT = 0)

1. Receive sensor position ID + Command
2. Receive Field address
3. Available output is: 1. Sensor + diagnostics, 2. Temperature, 3. ADC output, 4. Mode data

## Programmable Input Over-Level Detection

**Table 2. Input Over-Level Detection Ranges**

| PARAMETER                    | MIN       | MAX      | NOTE                                |
|------------------------------|-----------|----------|-------------------------------------|
| Pressure range               | -19.94 mV | -6.93 mV | VSIP – VSIN TRHSGAIN = 5            |
| Programmable threshold level | -21.35 mV | -7.43 mV | TRHSGAIN = 4                        |
| Deglintch filter time        | 0.8 ms    | 3.2 ms   | EEPROM programmable                 |
| Programmable step size       | 0.93 mV   |          | EEPROM programmable<br>TRHSGAIN = 4 |



**Figure 2. Detection of Negative Pressure Condition**

## Power Sequence

### Power Up

- The IC starts functioning if  $V_{cc}$  is more than  $UV_{cc} + HV_{cc}$  (~4 V).
- Power on reset for digital circuit is ~2.5 V.
- EEPROM data loaded to registers
- DO is held low for ~10 ms.

### Power Down

- When  $V_{cc}$  is less than  $UV_{cc}$ , disable DO.

### Glitch on $V_{cc}$

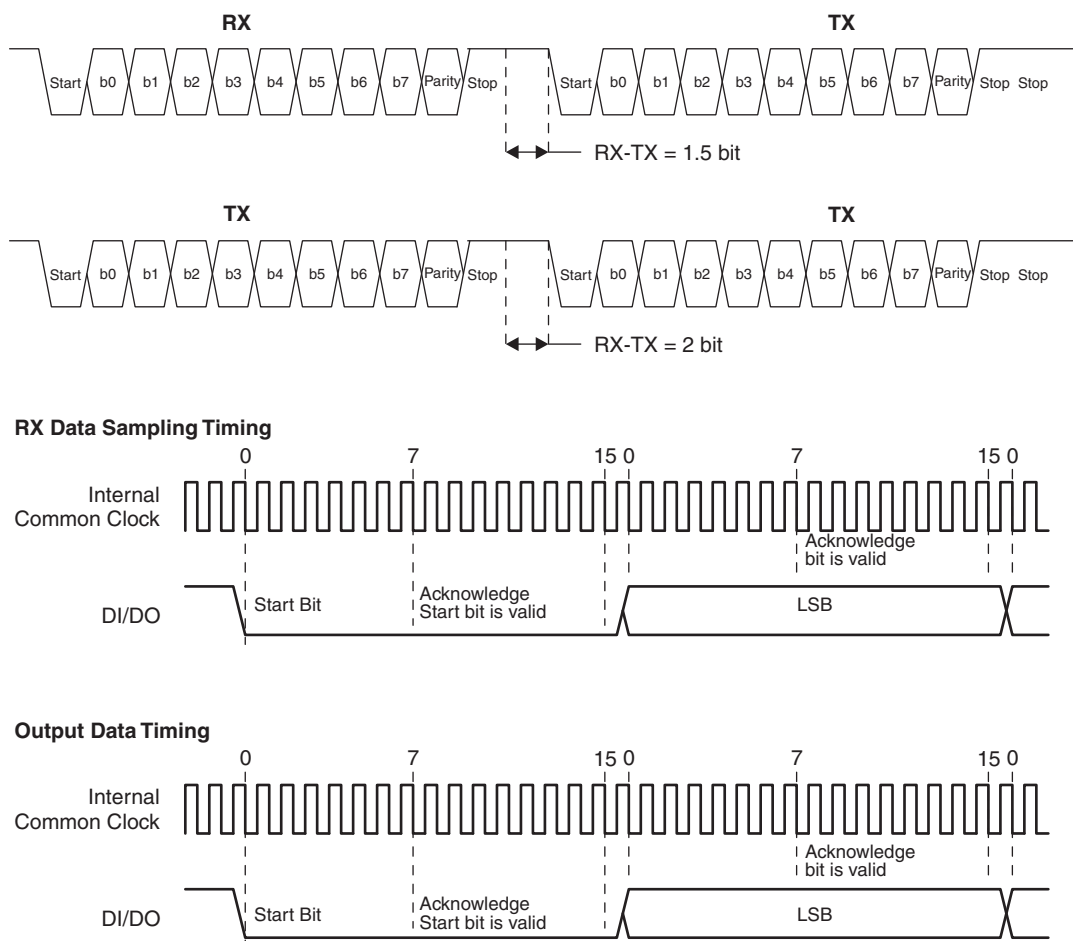
- Deglitch time : 320 ns (typical)
- Functionality during the glitch : disable DO
- Functionality after  $V_{cc}$  recovery: same as the Power up. EEPROM data is reloaded to registers if the glitch is lower than 2.5 V (typ).



## UART Communication

### Communication Protocol

- Protocol: UART
- Transfer Rate: See [Table 21](#)
- Data transfer: See [Table 21](#)
- Internal Oscillator :  $38.4k \times 16 \times 4 = 2.458 \text{ MHz}$
- Data length = 8 bit, Start bit = 1 bit, Stop bit = 1, Parity = even
- Error detection: parity error, over run error, framing error. Ignore the frame when error is detected.
- Time out for "packet not done" is 13 bit. Ignore received data. No response.
- NU: IC to microprocessor is 0. microprocessor to IC 1 or 0.
- Interval Rx-Rx = 2 bit to 13 bit, Rx-Tx = 1.5 bit, Tx-Tx = 2 bit



**Figure 3. UART Communication Frames, Sampling, and Timing**

## Device Communication Modes

The TPIC83000 is a pressure sensing conditioning device that interfaces with a microprocessor. The TPIC83000 has register addressing that is partitioned into seven bank mode addresses (labeled 00h to 06h) and 27 field mode addresses (labeled 00h to 1Ah) as shown in [Table 3](#) and [Table 4](#). Bank addresses 00h to 05h are located in the EEPROM, and bank address 06h is located in the logic (DSP) block. Field addresses 00h to 16h are located in the EEPROM, and field addresses 17h to 1Ah are located in the logic (DSP) block. See [Table 3](#) and [Table 4](#) for details.

**Table 3. EEPROM Map**

| BANK MODE ADDRESS | FIELD MODE ADDRESS | DATA FIELD      | FIELD NAME | DESCRIPTION                                            | READ/ WRITE | DEFAULT                                   |
|-------------------|--------------------|-----------------|------------|--------------------------------------------------------|-------------|-------------------------------------------|
| 0000              | 00000              | Sensor ID(43:0) | SENID      | Sensor ID                                              | R/W         | 0                                         |
| -                 | 00001              | PositionID(1:0) | PSNID      | Position ID                                            | R/W         | 0                                         |
| 0001              | 00010              | TRHS(3:0)       | TRHS       | Over-pressure comparator threshold                     | R/W         | 1101                                      |
| -                 | 00011              | TRDELAY(1:0)    | TRDELAY    | Over-pressure comparator timer                         | R/W         | 10                                        |
| -                 | 00100              | TRHSGAIN(2:0)   | TRHSGAIN   | Over-pressure comparator gain adjust                   | R/W         | 0                                         |
| 0010              | 00101              | Config(3:0)     | CONFBPS    | Baud rate                                              | R/W         | 10                                        |
| 0011              | 00110              | TRVOS(16:8)     | TRVOSC     | Input coarse offset                                    | R/W         | TRVOSC[16:8] = TEMP2[11:3] <sup>(1)</sup> |
| -                 | 00111              | TRVOS(7:0)      | TRVOSF     | Input fine offset                                      | R/W         | 10000000                                  |
| -                 | 01000              | TC1OFF(6:0)     | TRTCVOS1   | Input offset first-order temperature coefficient       | R/W         | 0                                         |
| -                 | 01001              | TC2OFF(6:0)     | TRTCVOS2   | Input offset second-order temperature coefficient      | R/W         | 0                                         |
| -                 | 01010              | GAIN(8:0)       | TRGAIN     | Gain adjust                                            | R/W         | 0                                         |
| -                 | 01011              | TCGAIN(5:0)     | TRTCGAIN1  | Gain first-order temperature coefficient               | R/W         | 100010                                    |
| 0100              | 01100              | TEMPOUT0(11:0)  | TEMP0      | Temperature sensor data 1                              | R/W         | 0                                         |
| -                 | 01101              | TEMPOUT1(11:0)  | TEMP1      | Temperature sensor data 2                              | R/W         | VPHS                                      |
| -                 | 01110              | TEMPOUT2(11:0)  | TEMP2      | Temperature sensor data 3                              | R/W         | 0                                         |
| 0101              | 01111              | MTRHS(3:0)      | MTRHS      | History of over-pressure comparator threshold          | R           | N/A                                       |
| -                 | 10000              | MTR DELAY(1:0)  | MTRDELAY   | History of over-pressure comparator timer              | R           | N/A                                       |
| -                 | 10001              | MTRHSGAIN(2:0)  | MTRHSGAIN  | History of over-pressure comparator gain               | R           | N/A                                       |
| -                 | 10010              | MTR VOS(16:0)   | MTRVOSC    | History of input coarse offset                         | R           | N/A                                       |
| -                 | 10011              | MTC1OFF(6:0)    | MTRTCVOS1  | History of input fine offset                           | R           | N/A                                       |
| -                 | 10100              | MTC2OFF(6:0)    | MTRTCVOS2  | History of offset first order temperature coefficient  | R           | N/A                                       |
| -                 | 10101              | MGAIN(8:0)      | MTRGAIN    | History of offset second order temperature coefficient | R           | N/A                                       |
| -                 | 10110              | MTCGAIN(5:0)    | MTRTCGAIN1 | History of gain first order temperature coefficient    | R           | N/A                                       |

(1) EED-1: All units are shipped with EEPROM values shown in "Default" column.

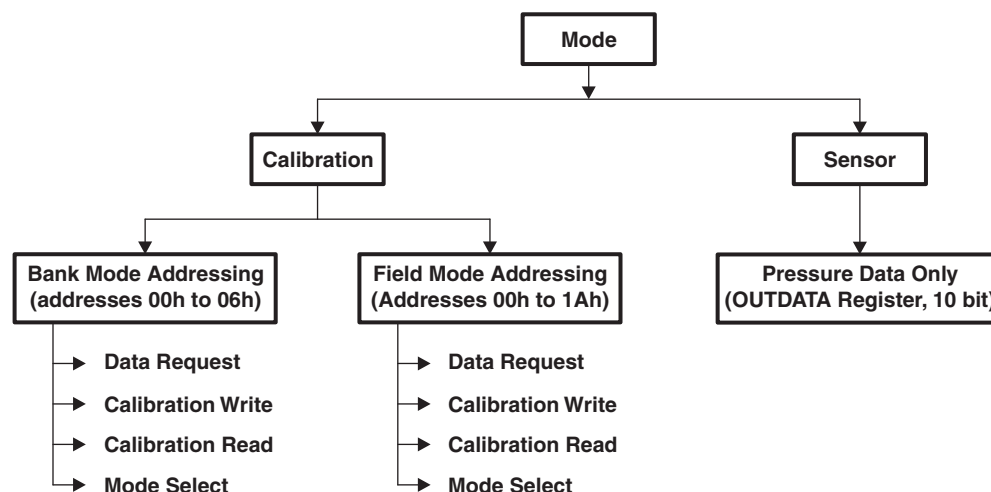
**Table 4. Logic (DSP) Map**

| BANK MODE ADDRESS | FIELD MODE ADDRESS | DATA FIELD   | FIELD NAME | DESCRIPTION                      | READ/ WRITE | DEFAULT <sup>(1)</sup> |
|-------------------|--------------------|--------------|------------|----------------------------------|-------------|------------------------|
| 0110              | 10111              | OUTDATA(9:0) | OUTDATA    | Sensor pressure data             | R           | 0                      |
| -                 | 11000              | OUTTEMP(9:0) | OUTTEMP    | Sensor temperature data          | R           | 0                      |
| -                 | 11001              | ADCDAT(13:0) | ADCDAT     | Sensor pressure data from ADC    | R           | 0                      |
| -                 | 11010              | ADCTMP(11:0) | ADCTMP     | Sensor temperature data from ADC | R           | 0                      |
| 1000              | -                  |              | DIAG/UART  | Diagnostics and UART             | W/R         | 0                      |

(1) EED-1: All units are shipped with EEPROM values shown in Default column.

The TPIC83000 has two primary modes in which it can be configured to communicate with the microprocessor: Sensor mode and Calibration mode (see [Figure 4](#)). In Sensor mode, the microprocessor requests pressure data from the device that is stored in designated registers of the Logic (DSP) block of the TPIC83000 as well as requests the device to switch from sensor mode to calibration mode. In Calibration mode, the microprocessor can request pressure and temperature data (i.e., Data Request mode), read data from the device (i.e., Calibration Read mode), write data to the device (i.e., Calibration Write mode), as well as allow the IC to switch back to Sensor mode from Calibration mode if desired (i.e., Mode Select mode). The data that is read, written, or requested in Calibration mode is accessed through registers that are located in either the Logic (DSP) or EEPROM.

The Logic (DSP) block and EEPROM of the TPIC83000 have registers that are accessible through addressing schemes. The two (2) addressing schemes that are used in the TPIC83000 are called Bank mode and Field mode addressing. Bank and Field mode addressing are only valid in Calibration mode. Sensor mode is restricted to only sending 10-bit resolution, pressure data to the microprocessor from the Logic (DSP) block. In other words, in Sensor mode, the pressure data comes from the same register in the Logic (DSP) block regardless of whether the device is set for Bank or Field addressing. However, in Calibration mode, the amount of data send via UART bus is dependent on whether the IC is in Bank or Field mode. For example, looking at the EEPROM Map in [Table 3](#), if you wanted to know the position ID configured in the device, you would just access address 00001 in Field Mode. However, if the IC was in Bank Mode, to access this same information, you would have access address 00000 and the microprocessor would simultaneously receive the Sensor ID and Position ID before the next set of instructions is set over the UART bus.



**Figure 4. Explanation of Device Modes and Addressing Schemes**

### Sensor Mode

In the Sensor Mode, the microprocessor sends a command frame to the TPIC83000 in Sensor mode and the TPIC83000 responds with a data frame. Note that in sensor mode, the data frame immediately follows the command frame. The following section explains the command and data frames in detail along with the meaning and action of each bit in these frames.

| 7          | 6        | 5                                                                                                                                                                                                                                                                                  | 4                                                           | 3      | 2      | 1       | 0      |
|------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|--------|--------|---------|--------|
| PSNID(1)   | PSNID(0) | WORDID                                                                                                                                                                                                                                                                             | ACOVLD                                                      | ACOVIN | DISPSN | ACTMODE | ACSUNT |
| PSNID[1:0] | Bits 7-6 | Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map.                                                                                                    |                                                             |        |        |         |        |
|            |          | 00                                                                                                                                                                                                                                                                                 | Position 0                                                  |        |        |         |        |
|            |          | 01                                                                                                                                                                                                                                                                                 | Position 1                                                  |        |        |         |        |
|            |          | 10                                                                                                                                                                                                                                                                                 | Position 2                                                  |        |        |         |        |
|            |          | 11                                                                                                                                                                                                                                                                                 | Position 3                                                  |        |        |         |        |
| WORDID     | Bit 5    | Frame ID of command byte. Sensor mode has only one command frame. Therefore, for sensor mode, always = 0.                                                                                                                                                                          |                                                             |        |        |         |        |
| ACOVLD     | Bit 4    | Acknowledge bit for DIAG1                                                                                                                                                                                                                                                          |                                                             |        |        |         |        |
|            |          | 0                                                                                                                                                                                                                                                                                  | Do not reset DIAG1                                          |        |        |         |        |
|            |          | 1                                                                                                                                                                                                                                                                                  | Reset DIAG1                                                 |        |        |         |        |
| ACOVIN     | Bit 3    | Acknowledge bit for DIAG0                                                                                                                                                                                                                                                          |                                                             |        |        |         |        |
|            |          | 0                                                                                                                                                                                                                                                                                  | Do not reset DIAG0                                          |        |        |         |        |
|            |          | 1                                                                                                                                                                                                                                                                                  | Reset DIAG0                                                 |        |        |         |        |
| DISPSN     | Bit 2    | Enable or disable position ID match                                                                                                                                                                                                                                                |                                                             |        |        |         |        |
|            |          | Recognizes device-specific commands vs global command. Compares position ID of command frame with EEPROM position ID (in device). The command frame position ID is specified in bits 7 and 6 of each frame. The EEPROM position ID is stored in the PSNID field in the EEPROM map. |                                                             |        |        |         |        |
|            |          | 0                                                                                                                                                                                                                                                                                  | Decode command frame only if position IDs match             |        |        |         |        |
|            |          | 1                                                                                                                                                                                                                                                                                  | Indicates global command. All devices decode command frame. |        |        |         |        |
| ACTMODE    | Bit 1    | Sets device to sensor or calibration mode after current command is completed.                                                                                                                                                                                                      |                                                             |        |        |         |        |
|            |          | 0                                                                                                                                                                                                                                                                                  | Sensor mode                                                 |        |        |         |        |
|            |          | 1                                                                                                                                                                                                                                                                                  | Calibration mode                                            |        |        |         |        |
| ACSUNT     | Bit 0    | Sets device to field addressing mode or bank addressing mode. Can be accessed only in calibration mode.                                                                                                                                                                            |                                                             |        |        |         |        |
|            |          | 0                                                                                                                                                                                                                                                                                  | Bank addressing mode                                        |        |        |         |        |
|            |          | 1                                                                                                                                                                                                                                                                                  | Field addressing mode                                       |        |        |         |        |

**Figure 5. Sensor Mode Command Frame Description**

| 7        | 6        | 5      | 4          | 3          | 2          | 1          | 0          |
|----------|----------|--------|------------|------------|------------|------------|------------|
| PSNID(1) | PSNID(0) | WORDID | OUTDATA(9) | OUTDATA(8) | OUTDATA(7) | OUTDATA(6) | OUTDATA(5) |
| ACOVLD   | ACOVIN   | WORDID | OUTDATA(4) | OUTDATA(3) | OUTDATA(2) | OUTDATA(1) | OUTDATA(0) |

**First Frame**

|              |          |                                                                                                                                                                                                                                                                                                    |
|--------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PSNID[1:0]   | Bits 7-6 | Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map.<br>00 Position 0<br>01 Position 1<br>10 Position 2<br>11 Position 3                                                |
| WORDID       | Bit 5    | Frame ID of command byte. Sensor mode has only one command frame. Therefore, for sensor mode, always = 0.                                                                                                                                                                                          |
| OUTDATA(9:5) | Bits 4-0 | Top five MSB of pressure data<br>In sensor mode, data is processed with 10-bit resolution. The data is sent on the UART bus in 5-bit increments until all data is transmitted. For example, if the data is 0100100011, the first five bits sent are 01001 and the second five bits sent are 00011. |

**Second Frame**

|              |          |                                                                                                                |
|--------------|----------|----------------------------------------------------------------------------------------------------------------|
| ACOVLD       | Bit 7    | Detection of over-pressure condition and CRC or input voltage error<br>0 No error detected<br>1 Error detected |
| ACOVIN       | Bit 6    | Detection of CRC or input voltage error across SIP and SIN pins<br>0 No error detected<br>1 Error detected     |
| WORDID       | Bit 5    | Frame ID of command byte. Sensor mode has only one command frame. Therefore, for sensor mode, always = 0.      |
| OUTDATA(4:0) | Bits 4-0 | Bottom five bits of pressure data                                                                              |

**Figure 6. Sensor Mode Data Frame Description**
**Table 5. Sensor Mode Command Frame Profile (RX)**

| DATA NAME  | FRAME NO. | B7 (MSB) | B6       | B5      | B4     | B3     | B2     | B1      | B0 (LSB) |
|------------|-----------|----------|----------|---------|--------|--------|--------|---------|----------|
| TX request | 1         | PSNID(1) | PSNID(0) | WORD ID | ACOVLD | ACOVIN | DISPSN | ACTMODE | ACSUNT   |

**Table 6. Sensor Mode Data Frame Profile (TX)**

| DATA NAME        | FRAME NO. | B7 (MSB) | B6       | B5      | B4         | B3         | B2         | B1         | B0 (LSB)   |
|------------------|-----------|----------|----------|---------|------------|------------|------------|------------|------------|
| Sensor OUT+ DIAG | 1         | PSNID(1) | PSNID(0) | ACTMODE | OUTDATA(9) | OUTDATA(8) | OUTDATA(7) | OUTDATA(6) | OUTDATA(5) |
|                  | 2         | DIAG(1)  | DIAG(0)  | ACSUNT  | OUTDATA(4) | OUTDATA(3) | OUTDATA(2) | OUTDATA(1) | OUTDATA(0) |

**Table 7. Bit Descriptions for Sensor Mode Command and Data Frames**

| CONTROL BIT              | VALUE  |                                                                                      |                                                       |
|--------------------------|--------|--------------------------------------------------------------------------------------|-------------------------------------------------------|
| DISPSN                   | 0      | Position ID matching is enabled and IC respond only when the ID is matched (default) |                                                       |
|                          | 1      | Ignore position ID                                                                   |                                                       |
| ACTMODE (left in Value)  | 0      | Sensor mode(Default)                                                                 |                                                       |
|                          | 1      | Invalid command                                                                      |                                                       |
| WORD ID (right in Value) | 10     | Calibration mode                                                                     |                                                       |
|                          | 11     | Invalid command                                                                      |                                                       |
| ACSUNT                   | 0      | Band access (default)                                                                |                                                       |
|                          | 1      | Field access                                                                         |                                                       |
| Command ID               | 00     | Data TX request (Default)                                                            |                                                       |
|                          | 01     | Write Request                                                                        |                                                       |
|                          | 10     | Read request                                                                         |                                                       |
|                          | 11     | Mode selection request                                                               |                                                       |
| WE                       | 0      | EEPROM Write disabled (Default)                                                      |                                                       |
|                          | 1      | EEPROM Write Enabled                                                                 |                                                       |
| DIAG FLAG                | NORMAL | FAULT/CLEAR                                                                          |                                                       |
| DIAG(1)                  | 0      | 1                                                                                    | Over-pressure fault condition detected (DIAG1 = 1)    |
| DIAG(0)                  | 0      | 1                                                                                    | CRC or input voltage error fault detected (DIAG0 = 1) |
| ACOVLD                   | 0      | 1                                                                                    | Clear DIAG1 bit (ACOVLD = 1)                          |
| ACOVIN                   | 0      | 1                                                                                    | Clear DIAG0 bit (ACOVIN = 1) <sup>(1)</sup>           |
| POSITION ID              | VALUE  |                                                                                      |                                                       |
| PSNID(1:0)               | 00     | ID:0                                                                                 | Default                                               |
|                          | 01     | ID:1                                                                                 |                                                       |
|                          | 10     | ID:2                                                                                 |                                                       |
|                          | 11     | ID:3                                                                                 |                                                       |

(1) If DIAG0 is high (i.e., DIAG0 = 1) because of CRC error, DIAG0 cannot be cleared by ACOVIN.

**Table 8. Overview of Self-Diagnostic and UART Errors**

| Function         | DIAG  | Register item  | Default        | Condition                           | Clear             |
|------------------|-------|----------------|----------------|-------------------------------------|-------------------|
| Self diagnostics | DIAG1 | Over-pressure  | 0              | Over-pressure condition             | ACOVLD = 1 or PUC |
|                  | DIAG0 | CRC Error      | 0              | CRC error exists                    | WE = 0 or PUC     |
|                  | DIAG0 | Input fault    | <sup>(1)</sup> | Input voltage error exists          | ACOVIN = 1 or PUC |
|                  | —     | PROG_OK        | 0              | Programming voltage = 12.5 V, 15 ms | WE = 0            |
| UART error       |       | Frame error    | 0              | Framing error exists                | ACVOIN = 1        |
|                  |       | Over run error | 0              | Over run error exists               | ACVOIN = 1        |
|                  |       | Parity error   | 0              | Parity error exists                 | ACVOIN = 1        |

(1) DIAG0 may be set to one depending upon Vcc / SIN / SIP power up condition.

### Calibration Mode

In calibration mode, microprocessor transmits data to the TPIC83000 in two parts: command frames and data frames. The data frame immediately follows the command frame. However, unlike Sensor mode, a complete instruction in Calibration mode needs two command frames and at least two data frames. Calibration mode consists of four "sub-modes" called Calibration Write, Data Request, Calibration Read, and Mode Select modes. Furthermore, access to information in the EEPROM and Logic (DSP) registers is dependent upon whether the device is in Bank or Field addressing mode. [Table 9](#) summarizes the four Calibration Mode command frames. The following section explains the command and data frames in detail along with the meaning and action of each bit in these frames.

**Table 9. Calibration Mode Profile of Command Frames<sup>(1) (2) (3) (4) (5)</sup>**

| Microprocessor→IC       |           | PSNID    |          | FLAG | MODE TYPE       |          | POSITION ID IGNORE    | DIAG ACKNOWLEDGE       |          |
|-------------------------|-----------|----------|----------|------|-----------------|----------|-----------------------|------------------------|----------|
| DATA NAME               | FRAME NO. | B7 (MSB) | B6       | B5   | B4              | B3       | B2                    | B1                     | B0 (LSB) |
| Data Request            | 1         | PSNID(1) | PSNID(0) | 1    | 0               | 0        | DISPSN                | ACVOLD                 | ACVOIN   |
|                         | 2         | PSNID(1) | PSNID(0) | 0    | NU              | RQADCTMP | RQADCDAT              | RQTEMP                 | RQDATA   |
| Calibration Read        | 1         | PSNID(1) | PSNID(0) | 1    | 1               | 0        | DISPSN                | NU                     | NU       |
|                         | 2         | PSNID(1) | PSNID(0) | 0    | Address (5 bit) |          |                       |                        |          |
| Calibration Mode Select | 1         | PSNID(1) | PSNID(0) | 1    | 1               | 1        | DISPSN                | NU                     | NU       |
|                         | 2         | PSNID(1) | PSNID(0) | 0    | NU              | NU       | ACSUNT <sup>(6)</sup> | ACTMODE <sup>(6)</sup> | WE       |
| Calibration Write       | 1         | PSNID(1) | PSNID(0) | 1    | 0               | 1        | DISPSN                | NU                     | NU       |
|                         | 2         | PSNID(1) | PSNID(0) | 0    | Address (5 bit) |          |                       |                        |          |

(1) The request should be ignored when invalid address is received

(2) Baud rate should be updated after all data is received

(3) For mode selection request, if WE = 1 and (ACSUNT and ACTMODE) = "old value" , there is no response from IC. Otherwise IC respond with "old ACSUNT and ACTMODE and WE" data then change mode and/or set WE = 1.

(4) RQADCTMP: Request 12-bit temperature data

RQADCDAT: Request 14-bit pressure data

RQTEMP: Request 10-bit temperature data

RQDATA: Request 10-bit pressure data

(5) NU = not used

(6) All modes should be updated after all data is received.

The command frame profiles are the same in both field and bank addressing modes.

## Calibration Mode - Data Request

### Data Request Command Frames

| 7        | 6        | 5      | 4        | 3        | 2        | 1      | 0      |
|----------|----------|--------|----------|----------|----------|--------|--------|
| PSNID(1) | PSNID(0) | WORDID | MODETYPE |          | DISPSN   | ACOVLD | ACOVIN |
| PSNID(1) | PSNID(0) | WORDID | NU       | RQADCTMP | RQADCDAT | RQTEMP | RQDATA |

#### First Frame

|            |          |                                                                                                                                                                                                                                                     |
|------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PSNID[1:0] | Bits 7-6 | Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map.<br>00 Position 0<br>01 Position 1<br>10 Position 2<br>11 Position 3 |
| WORDID     | Bit 5    | Frame ID of byte. 1 indicates frame 1 of 2.                                                                                                                                                                                                         |
| MODETYPE   | Bits 4-3 | Select mode type within calibration mode<br>00 Data request<br>01 Calibration write<br>10 Calibration read<br>11 Mode select                                                                                                                        |
| DISPSN     | Bit 2    | Disable or enable position ID matching<br>0 Decode command only if position IDs match<br>1 Indicates global command. All devices decode command frame.                                                                                              |
| ACOVLD     | Bit 1    | Acknowledge bit for DIAG1. Can be set to 1 only in Data Request mode (when bits 4:3 are 00). Must be set to 0 for the other mode types.<br>0 Do not reset DIAG1<br>1 Reset DIAG1                                                                    |
| ACOVIN     | Bit 0    | Acknowledge bit for DIAG0. Can be set to 1 only in Data Request mode (when bits 4:3 are 00). Must be set to 0 for the other mode types.<br>0 Do not reset DIAG0<br>1 Reset DIAG0                                                                    |



**Second Frame**

|            |          |                                                                                                                                                                                                                                                     |
|------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PSNID[1:0] | Bits 7-6 | Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map.<br>00 Position 0<br>01 Position 1<br>10 Position 2<br>11 Position 3 |
| WORDID     | Bit 5    | Frame ID of byte. 0 indicates frame 2 of 2.                                                                                                                                                                                                         |
| NU         | Bit 4    | Not used. Set to 0.                                                                                                                                                                                                                                 |
| RQADCTMP   | Bit 3    | Microcontroller request for 12-bit temperature data from device.<br>0 Do not send data in following data frames<br>1 Send data in following data frames                                                                                             |
| RQADCDAT   | Bit 2    | Microcontroller request for 14-bit pressure data from device.<br>0 Do not send data in following data frames<br>1 Send data in following data frames                                                                                                |
| RQTEMP     | Bit 1    | Microcontroller request for 10-bit temperature data from device.<br>0 Do not send data in following data frames<br>1 Send data in following data frames                                                                                             |
| RQDATA     | Bit 0    | Microcontroller request for 10-bit pressure data from device.<br>0 Do not send data in following data frames<br>1 Send data in following data frames                                                                                                |

**Figure 7. Data Request Command Frames**

**Data Request Data Frames**

|     |     |     |     |    |    |       |       |
|-----|-----|-----|-----|----|----|-------|-------|
| 7   | 6   | 5   | 4   | 3  | 2  | 1     | 0     |
| D13 | D12 | D11 | D10 | D9 | D8 | D7    | D6    |
| D5  | D4  | D3  | D2  | D1 | D0 | DIAG1 | DIAG0 |

**First Frame**

D[13:6] Bits 7-0 Data length ranges from 10 to 14 bits. Data is sent starting with D13, and any unused trailing bits are set to 0. Data requested in the preceding command frame is sent in the order shown below, with the data request of highest priority is sent in the first two data frames, and any lower-priority requests sent in order in following two-frame sets.

| Priority | Description                       |
|----------|-----------------------------------|
| 1        | Pressure data in 10-bit format    |
| 2        | Temperature data in 10-bit format |
| 3        | Pressure data in 14-bit format    |
| 4        | Temperature data in 12-bit format |

**Second Frame**

D[5:0] Bits 7-2 See D[13:6] description.  
 DIAG1 Bit 1 Over-pressure fault condition  
     0 Fault not detected  
     1 Fault detected  
 DIAG0 Bit 0 CRC or input voltage error fault  
     0 Fault not detected  
     1 Fault detected

**Figure 8. Data Request Data Frames****Table 10. Profile of Data Request Data Frames (Field Mode Addressing)**

| FIELD NAME<br>(BANK ADDRESS) | FIELD MODE ADDRESS | B7 (MSB)        | B6 | B5          | B4          | B3          | B2          | B1          | B0 (LSB)    | B1          | B0          |
|------------------------------|--------------------|-----------------|----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
|                              |                    |                 |    | DATA 8 BIT) |             |             |             |             |             |             |             |
| Sensor + DIAG                | Tx RQ              | (9:0)<br>+(1:0) | 1  | OUT DATA(9) | OUT DATA(8) | OUT DATA(7) | OUT DATA(6) | OUT DATA(5) | OUT DATA(4) | OUT DATA(3) | OUT DATA(2) |
|                              | Tx RQ              |                 | 2  | OUT DATA(1) | OUT DATA(0) | NU          | NU          | NU          | NU          | DIAG(1)     | DIAG(0)     |
| Temperature out              | Tx RQ              | (9:0)           | 1  | OUT TEMP(9) | OUT TEMP(8) | OUT TEMP(7) | OUT TEMP(6) | OUT TEMP(5) | OUT TEMP(4) | OUT TEMP(3) | OUT TEMP(2) |
|                              | Tx RQ              |                 | 2  | OUT TEMP(1) | OUT TEMP(0) | NU          | NU          | NU          | NU          | DIAG(1)     | DIAG(0)     |
| ADC pressure out             | Tx RQ              | (13:0)          | 1  | ADCDAT(13)  | ADCDAT(12)  | ADCDAT(11)  | ADCDAT(10)  | ADCDAT(9)   | ADCDAT(8)   | ADCDAT(7)   | ADCDAT      |
|                              | Tx RQ              |                 | 2  | ADCDAT(5)   | ADCDAT(4)   | ADCDAT(3)   | ADCDAT(2)   | ADCDAT(1)   | ADCDAT(0)   | DIAG(1)     | DIAG(0)     |
| ADC temperature out          | Tx RQ              | (11:0)          | 1  | ADC TMP(11) | ADC TMP(10) | ADCTMP(9)   | ADCTMP(8)   | ADCTMP(7)   | ADCTMP(6)   | ADCTMP(5)   | ADCTMP(4)   |
|                              | Tx RQ              |                 | 2  | ADCTMP(3)   | ADCTMP(2)   | ADCTMP(1)   | ADCTMP(0)   | NU          | NU          | DIAG(1)     | DIAG(0)     |

**Table 11. Profile of Data Request Data Frames (Bank Mode Addressing)**

| FIELD NAME<br>(BANK ADDRESS) | FIELD MODE ADDRESS | LENGTH           | FRAME NO. | B7 (MSB)    | B6          | B5          | B4          | B3          | B2          | B1          | B0 (LSB)    |
|------------------------------|--------------------|------------------|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
|                              |                    |                  |           | DATA        |             |             |             |             |             |             |             |
| Sensor OUT + Diag            | TX RQ              | (9:0)<br>+ (1:0) | 1         | OUT DATA(9) | OUT DATA(8) | OUT DATA(7) | OUT DATA(6) | OUT DATA(5) | OUT DATA(4) | OUT DATA(3) | OUT DATA(2) |
|                              | TX RQ              |                  | 2         | OUT DATA(1) | OUT DATA(0) | NU          | NU          | NU          | NU          | DIAG(1)     | DIAG(0)     |
| Temperature out              | TX RQ              | (9:0)            | 1         | OUT TEMP(9) | OUT TEMP(8) | OUT TEMP(7) | OUT TEMP(6) | OUT TEMP(5) | OUT TEMP(4) | OUT TEMP(3) | OUT TEMP(2) |
|                              | TX RQ              |                  | 2         | OUT TEMP(1) | OUT TEMP(0) | NU          | NU          | NU          | NU          | DIAG(1)     | DIAG(0)     |
| ADC pressure out             | TX RQ              | (13:0)           | 1         | ADCDAT(13)  | ADCDAT(12)  | ADCDAT(11)  | ADCDAT(10)  | ADCDAT(9)   | ADCDAT(8)   | ADCDAT(7)   | ADCDAT(6)   |
|                              | TX RQ              |                  | 2         | ADCDAT(5)   | ADCDAT(4)   | ADCDAT(3)   | ADCDAT(2)   | ADCDAT(1)   | ADCDAT(0)   | DIAG(1)     | DIAG(0)     |

**Table 11. Profile of Data Request Data Frames (Bank Mode Addressing) (continued)**

| FIELD NAME<br>(BANK ADDRESS) | FIELD MODE ADDRESS | LENGTH | FRAME NO. | B7 (MSB)    | B6          | B5         | B4         | B3         | B2         | B1         | B0 (LSB)   |
|------------------------------|--------------------|--------|-----------|-------------|-------------|------------|------------|------------|------------|------------|------------|
|                              |                    |        |           | DATA        |             |            |            |            |            |            |            |
| ADC temperature out          | TX RQ              | (11:0) | 1         | ADC TMP(11) | ADC TMP(10) | ADC TMP(9) | ADC TMP(8) | ADC TMP(7) | ADC TMP(6) | ADC TMP(5) | ADC TMP(4) |
|                              | TX RQ              |        | 2         | ADC TMP(3)  | ADC TMP(2)  | ADC TMP(1) | ADC TMP(0) | NU         | NU         | DIAG(1)    | DIAG(0)    |

## Calibration Mode – Data Write

### Calibration Write Command Frames

| 7        | 6        | 5      | 4        | 3     | 2      | 1     | 0     |
|----------|----------|--------|----------|-------|--------|-------|-------|
| PSNID(1) | PSNID(0) | WORDID | MODETYPE |       | DISPSN | 0     | 0     |
| PSNID(1) | PSNID(0) | WORDID | ADDR4    | ADDR3 | ADDR2  | ADDR1 | ADDR0 |

#### First Frame

|            |          |                                                                                                                                                                                                                                                     |
|------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PSNID[1:0] | Bits 7-6 | Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map.<br>00 Position 0<br>01 Position 1<br>10 Position 2<br>11 Position 3 |
| WORDID     | Bit 5    | Frame ID of byte. 1 indicates frame 1 of 2.                                                                                                                                                                                                         |
| MODETYPE   | Bits 4-3 | Select mode type within calibration mode<br>00 Data request<br>01 Calibration write<br>10 Calibration read<br>11 Mode select                                                                                                                        |
| DISPSN     | Bit 2    | Disable or enable position ID matching<br>0 Decode command only if position IDs match<br>1 Indicates global command. All devices decode command frame.                                                                                              |
| Reserved   | Bits 1-0 | Must be set to 0.                                                                                                                                                                                                                                   |

#### Second Frame

|            |          |                                                                                                                                                                                                                                                     |
|------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PSNID[1:0] | Bits 7-6 | Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map.<br>00 Position 0<br>01 Position 1<br>10 Position 2<br>11 Position 3 |
| WORDID     | Bit 5    | Frame ID of byte. 0 indicates frame 2 of 2.                                                                                                                                                                                                         |
| ADDR[4:0]  | Bits 4-0 | Address for bank or field mode addressing. See <a href="#">Table 3</a> for list of valid addresses.                                                                                                                                                 |

**Figure 9. Calibration Write Command Frames**

### Calibration Write Data Frames

|          |          |    |     |     |     |     |     |
|----------|----------|----|-----|-----|-----|-----|-----|
| 7        | 6        | 5  | 4   | 3   | 2   | 1   | 0   |
| PSNID(1) | PSNID(0) | NU | D43 | D42 | D41 | D40 | D39 |
| ⋮        |          |    |     |     |     |     |     |
| PSNID(1) | PSNID(0) | NU | D3  | D2  | D1  | D0  | 0   |

#### Frames 3 through (n – 1) (where n = 5 to 11)

PSNID[1:0] Bits 7-6 Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map.

- 00 Position 0
- 01 Position 1
- 10 Position 2
- 11 Position 3

NU Bit 5 Not used. Set to 0.

Dx Bits 4-0 Top five bits of bank or field data. See [Table 3](#) and [Table 4](#) for valid addresses and types of data.

#### Frame n (where n = 4 to 11)

PSNID[1:0] Bits 7-6 Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map.

- 00 Position 0
- 01 Position 1
- 10 Position 2
- 11 Position 3

NU Bit 5 Not used. Set to 0.

Dx Bits 4-0 Next or last five bits of bank or field data. See [Table 3](#) and [Table 4](#) for valid addresses and types of data. Data length for each calibration write frame is 5 bits. Maximum number of frames that can be written from one command is nine; therefore, maximum data length is 44 bits.

**Figure 10. Calibration Write Data Frames**

**Table 12. Profile of Calibration Write Data Frames (Field Addressing Mode)**

| DATA NAME                                         | FRAME NO. | B7 (MSB) | B6       | B5 | B4            | B3            | B2            | B1            | B0 (LSB)      |
|---------------------------------------------------|-----------|----------|----------|----|---------------|---------------|---------------|---------------|---------------|
| Data                                              | 3         | PSNID(1) | PSNID(0) | 0  | Data (5 bit)  |               |               |               |               |
| Sensor ID                                         | 3         | PSNID(1) | PSNID(0) | 0  | SENID(43)     | SENID(42)     | SENID(41)     | SENID(40)     | SENID(39)     |
|                                                   | 4         |          |          |    | SENID(38)     | SENID(37)     | SENID(36)     | SENID(35)     | SENID(34)     |
|                                                   | 5         |          |          |    | SENID(33)     | SENID(32)     | SENID(31)     | SENID(30)     | SENID(29)     |
|                                                   | 6         |          |          |    | SENID(28)     | SENID(27)     | SENID(26)     | SENID(25)     | SENID(24)     |
|                                                   | 7         |          |          |    | SENID(23)     | SENID(22)     | SENID(21)     | SENID(20)     | SENID(19)     |
|                                                   | 8         |          |          |    | SENID(18)     | SENID(17)     | SENID(16)     | SENID(15)     | SENID(14)     |
|                                                   | 9         |          |          |    | SENID(13)     | SENID(12)     | SENID(11)     | SENID(10)     | SENID(9)      |
|                                                   | 10        |          |          |    | SENID(8)      | SENID(7)      | SENID(6)      | SENID(5)      | SENID(4)      |
|                                                   | 11        |          |          |    | SENID(3)      | SENID(2)      | SENID(1)      | SENID(0)      | NU            |
| Position ID                                       | 3         |          |          |    | PSNID(1)      | PSNID(0)      | NU            | NU            | NU            |
| OP threshold                                      | 3         |          |          |    | TRHS(3)       | TRHS(2)       | TRHS(1)       | TRHS(0)       | NU            |
| OP timer                                          | 3         |          |          |    | TRDELAY(1)    | TRDELAY(0)    | NU            | NU            | NU            |
| OP gain                                           | 3         |          |          |    | TRHSGAIN(2)   | TRHSGAIN(1)   | TRHSGAIN(0)   | NU            | NU            |
| Baud rate                                         | 3         |          |          |    | CONF BPS(3)   | CONF BPS(2)   | CONF BPS(1)   | CONF BPS(0)   | NU            |
| Input coarse offset                               | 3         |          |          |    | TRV OSC(16)   | TRV OSC(15)   | TRV OSC(14)   | TRV OSC(13)   | TRV OSC(12)   |
|                                                   | 4         |          |          |    | TRV OSC(11)   | TRV OSC(10)   | TRV OSC(9)    | TRV OSC(8)    | NU            |
| Input fine offset                                 | 3         |          |          |    | TRVOSF(7)     | TRVOSF(6)     | TRVOSF(5)     | TRVOSF(4)     | TRVOSF(3)     |
|                                                   | 4         |          |          |    | TRVOSF(2)     | TRVOSF(1)     | TRVOSF(0)     | NU            | NU            |
| Input offset first order temperature coefficient  | 3         |          |          |    | TRTC VOS1(6)  | TRTC VOS1(5)  | TRTC VOS1(4)  | TRTC VOS1(3)  | TRTC VOS1(2)  |
|                                                   | 4         |          |          |    | TRTC VOS1(1)  | TRTC VOS1(0)  | NU            | NU            | NU            |
| Input offset second order temperature coefficient | 3         |          |          |    | TRTC VOS2(6)  | TRTC VOS2(5)  | TRTC VOS2(4)  | TRTC VOS2(3)  | TRTC VOS2(2)  |
|                                                   | 4         |          |          |    | TRTC VOS2(1)  | TRTC VOS2(0)  | NU            | NU            | NU            |
| GAIN adjust                                       | 3         |          |          |    | TRGAIN(8)     | TRGAIN(7)     | TRGAIN(6)     | TRGAIN(5)     | TRGAIN(4)     |
|                                                   | 4         |          |          |    | TRGAIN(3)     | TRGAIN(2)     | TRGAIN(1)     | TRGAIN(0)     | NU            |
| Gain first order temperature coefficient          | 3         |          |          |    | TRTC GAIN1(5) | TRTC GAIN1(4) | TRTC GAIN1(3) | TRTC GAIN1(2) | TRTC GAIN1(1) |
|                                                   | 4         |          |          |    | TRTC GAIN1(0) | NU            | NU            | NU            | NU            |
| Temperature sensor out 1                          | 3         |          |          |    | TEMP0(11)     | TEMP0(10)     | TEMP0(9)      | TEMP0(8)      | TEMP0(7)      |
|                                                   | 4         |          |          |    | TEMP0(6)      | TEMP0(5)      | TEMP0(4)      | TEMP0(3)      | TEMP0(2)      |
|                                                   | 5         |          |          |    | TEMP0(1)      | TEMP0(0)      | NU            | NU            | NU            |
| Temperature sensor out 2                          | 3         |          |          |    | TEMP1(11)     | TEMP1(10)     | TEMP1(9)      | TEMP1(8)      | TEMP1(7)      |
|                                                   | 4         |          |          |    | TEMP1(6)      | TEMP1(5)      | TEMP1(4)      | TEMP1(3)      | TEMP1(2)      |
|                                                   | 5         |          |          |    | TEMP1(1)      | TEMP1(0)      | NU            | NU            | NU            |
| Temperature sensor out 3                          | 3         |          |          |    | TEMP2(11)     | TEMP2(10)     | TEMP2(9)      | TEMP2(8)      | TEMP2(7)      |
|                                                   | 4         |          |          |    | TEMP2(6)      | TEMP2(5)      | TEMP2(4)      | TEMP2(3)      | TEMP2(2)      |
|                                                   | 5         |          |          |    | TEMP2(1)      | TEMP2(0)      | NU            | NU            | NU            |

**Table 13. Profile of Calibration Write Data Frames (Bank Addressing Mode)**

| DATA NAME                                             | FRAME NO. | B7 (MSB) | B6       | B5 | B4            | B3            | B2            | B1            | B0 (LSB)      |
|-------------------------------------------------------|-----------|----------|----------|----|---------------|---------------|---------------|---------------|---------------|
| Data (Bank Address)                                   | 3         | PSNID(1) | PSNID(0) | 0  | data 5bit     |               |               |               |               |
| Sensor ID (0)                                         | 3         | PSNID(1) | PSNID(0) | 0  | SENID(43)     | SENID(42)     | SENID(41)     | SENID(40)     | SENID(39)     |
|                                                       | 4         |          |          |    | SENID(38)     | SENID(37)     | SENID(36)     | SENID(35)     | SENID(34)     |
|                                                       | 5         |          |          |    | SENID(33)     | SENID(32)     | SENID(31)     | SENID(30)     | SENID(29)     |
|                                                       | 6         |          |          |    | SENID(28)     | SENID(27)     | SENID(26)     | SENID(25)     | SENID(24)     |
|                                                       | 7         |          |          |    | SENID(23)     | SENID(22)     | SENID(21)     | SENID(20)     | SENID(19)     |
|                                                       | 8         |          |          |    | SENID(18)     | SENID(17)     | SENID(16)     | SENID(15)     | SENID(14)     |
|                                                       | 9         |          |          |    | SENID(13)     | SENID(12)     | SENID(11)     | SENID(10)     | SENID(9)      |
|                                                       | 10        |          |          |    | SENID(8)      | SENID(7)      | SENID(6)      | SENID(5)      | SENID(4)      |
| PSN ID(0)                                             | 11        |          |          |    | SENID(3)      | SENID(2)      | SENID(1)      | SENID(0)      | NU            |
| OP threshold (1)                                      | 12        |          |          |    | PSNID(1)      | PSNID(0)      | NU            | NU            | NU            |
| OP timer (1)                                          | 3         | PSNID(1) | PSNID(0) | 0  | TRHS(3)       | TRHS(2)       | TRHS(1)       | TRHS(0)       | NU            |
| OP gain (1)                                           | 4         |          |          |    | TRDELAY(1)    | TRDELAY(0)    | NU            | NU            | NU            |
| Baud rate (2)                                         | 5         |          |          |    | TRHSGAIN(2)   | TRHSGAIN(1)   | TRHSGAIN(0)   | NU            | NU            |
| Input coarse offset (3)                               | 3         |          |          |    | CONF BPS(3)   | CONF BPS(2)   | CONF BPS(1)   | CONF BPS(0)   | NU            |
|                                                       | 4         |          |          |    | TRV OSC(16)   | TRV OSC(15)   | TRV OSC(14)   | TRV OSC(13)   | TRV OSC(12)   |
| Input fine offset (3)                                 | 5         |          |          |    | TRV OSC(11)   | TRV OSC(10)   | TRV OSC(9)    | TRV OSC(8)    | NU            |
|                                                       | 6         |          |          |    | TRVOSF(7)     | TRVOSF(6)     | TRVOSF(5)     | TRVOSF(4)     | TRVOSF(3)     |
| Input offset first order temperature coefficient (3)  | 7         |          |          |    | TRVOSF(2)     | TRVOSF(1)     | TRVOSF(0)     | NU            | NU            |
|                                                       | 8         |          |          |    | TRTC VOS1(6)  | TRTC VOS1(5)  | TRTC VOS1(4)  | TRTC VOS1(3)  | TRTC VOS1(2)  |
| Input offset second order temperature coefficient (3) | 9         |          |          |    | TRTC VOS1(1)  | TRTC VOS1(0)  | NU            | NU            | NU            |
|                                                       | 10        |          |          |    | TRTC VOS2(6)  | TRTC VOS2(5)  | TRTC VOS2(4)  | TRTC VOS2(3)  | TRTC VOS2(2)  |
| Gain adjust (3)                                       | 11        |          |          |    | TRTC VOS2(1)  | TRTC VOS2(0)  | NU            | NU            | NU            |
|                                                       | 12        |          |          |    | TRGAIN(8)     | TRGAIN(7)     | TRGAIN(6)     | TRGAIN(5)     | TRGAIN(4)     |
| Gain first order temperature coefficient (3)          | 13        |          |          |    | TRGAIN(3)     | TRGAIN(2)     | TRGAIN(1)     | TRGAIN(0)     | NU            |
|                                                       | 14        |          |          |    | TRTC GAIN1(5) | TRTC GAIN1(4) | TRTC GAIN1(3) | TRTC GAIN1(2) | TRTC GAIN1(1) |
| Temperature sensor out 1 (4)                          | 3         |          |          |    | TRTC GAIN1(0) | NU            | NU            | NU            | NU            |
|                                                       | 4         |          |          |    | TEMP0(11)     | TEMP0(10)     | TEMP0(9)      | TEMP0(8)      | TEMP0(7)      |
|                                                       | 5         |          |          |    | TEMP0(6)      | TEMP0(5)      | TEMP0(4)      | TEMP0(3)      | TEMP0(2)      |
| Temperature sensor out 2 (4)                          | 6         |          |          |    | TEMP0(1)      | TEMP0(0)      | NU            | NU            | NU            |
|                                                       | 7         |          |          |    | TEMP1(11)     | TEMP1(10)     | TEMP1(9)      | TEMP1(8)      | TEMP1(7)      |
|                                                       | 8         |          |          |    | TEMP1(6)      | TEMP1(5)      | TEMP1(4)      | TEMP1(3)      | TEMP1(2)      |
| Temperature sensor out 3 (4)                          | 9         |          |          |    | TEMP1(1)      | TEMP1(0)      | NU            | NU            | NU            |
|                                                       | 10        |          |          |    | TEMP2(11)     | TEMP2(10)     | TEMP2(9)      | TEMP2(8)      | TEMP2(7)      |
|                                                       | 11        |          |          |    | TEMP2(6)      | TEMP2(5)      | TEMP2(4)      | TEMP2(3)      | TEMP2(2)      |
| DIAG/UART                                             | 3         | PSNID(1) | PSNID(0) | 0  | TEMP2(1)      | TEMP2(0)      | NU            | NU            | NU            |
|                                                       | 4         |          |          |    | 0             | 0             | 0             | 0             | 0             |
|                                                       | 5         |          |          |    | 0             | 0             | 0             | 0             | 0             |
|                                                       | 6         |          |          |    | Stbit         | EO            | Pdis          | 0             | 0             |

**Table 14. DIAG/UART Register (Bank Address = 8)**

| ITEM    | DESCRIPTION                                      |
|---------|--------------------------------------------------|
| Pdis    | Parity disable<br>1 = Disable<br>0 = Enable      |
| EO      | Parity even or odd<br>1 = Odd<br>0 = Even        |
| Stbit   | Stop bit length<br>1 = 2 bit<br>0 = 1 bit        |
| Fastdis | Test mode baud rate<br>1 = Normal<br>0 = 153 kHz |

**Table 15. TPIC83000 Response and Mode Update Timing for Calibration Write Mode**

| ITEM                           | SYMBOL     | RESPONSE      | SETTING / MODE UPDATE TIMING                    |
|--------------------------------|------------|---------------|-------------------------------------------------|
| ID / Calibration / Temperature | SENID      | NEW VALUE     | After IC's response                             |
|                                | PSNID      | Current value | WE = 1                                          |
|                                | TRHS       | New value     | After IC's response                             |
|                                | TRDELAY    | New value     |                                                 |
|                                | TRHSGAIN   | New value     |                                                 |
|                                | CONFBPS    | New value     |                                                 |
|                                | TRVOSC     | New value     |                                                 |
|                                | TRVOSF     | New value     |                                                 |
|                                | TRTCVOS1   | New value     |                                                 |
|                                | TRTCVOS2   | New value     |                                                 |
|                                | TRGAIN     | New value     |                                                 |
|                                | TRTCGAIN1  | New value     |                                                 |
|                                | TEMP0      | New value     |                                                 |
|                                | TEMP1      | New value     |                                                 |
|                                | TEMP2      | New value     |                                                 |
| History                        | MTRHS      | N/A           | WE = 1                                          |
|                                | MTRDELAY   | N/A           |                                                 |
|                                | MTRHSGAIN  | N/A           |                                                 |
|                                | MTRVOSC    | N/A           |                                                 |
|                                | MTRVOSF    | N/A           |                                                 |
|                                | MTRTCVOS1  | N/A           |                                                 |
|                                | MTRTCVOS2  | N/A           |                                                 |
|                                | MTRGAIN    | N/A           |                                                 |
|                                | MTRTCGAIN1 | N/A           |                                                 |
| Mode / Setting                 | ACTMODE    | Current value | After IC's response<br>(No response for WE = 1) |
|                                | ACSUNT     | Current value |                                                 |
|                                | WE         | Current value |                                                 |

## Calibration Mode – Calibration Read

### Calibration Read Command Frames

| 7        | 6        | 5      | 4        | 3     | 2      | 1        | 0     |
|----------|----------|--------|----------|-------|--------|----------|-------|
| PSNID(1) | PSNID(0) | WORDID | MODETYPE |       | DISPSN | Reserved |       |
| PSNID(1) | PSNID(0) | WORDID | ADDR4    | ADDR3 | ADDR2  | ADDR1    | ADDR0 |

#### First Frame

|            |          |                                                                                                                                                                                 |
|------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PSNID[1:0] | Bits 7-6 | Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map. |
|            |          | 00 Position 0                                                                                                                                                                   |
|            |          | 01 Position 1                                                                                                                                                                   |
|            |          | 10 Position 2                                                                                                                                                                   |
|            |          | 11 Position 3                                                                                                                                                                   |
| WORDID     | Bit 5    | Frame ID of byte. 1 indicates frame 1 of 2.                                                                                                                                     |
| MODETYPE   | Bits 4-3 | Select mode type within calibration mode                                                                                                                                        |
|            |          | 00 Data request                                                                                                                                                                 |
|            |          | 01 Calibration write                                                                                                                                                            |
|            |          | 10 Calibration read                                                                                                                                                             |
|            |          | 11 Mode select                                                                                                                                                                  |
| DISPSN     | Bit 2    | Disable or enable position ID matching                                                                                                                                          |
|            |          | 0 Decode command only if position IDs match                                                                                                                                     |
|            |          | 1 Indicates global command. All devices decode command frame.                                                                                                                   |
| Reserved   | Bits 1-0 | Must be set to 0.                                                                                                                                                               |

#### Second Frame

|            |          |                                                                                                                                                                                 |
|------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PSNID[1:0] | Bits 7-6 | Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map. |
|            |          | 00 Position 0                                                                                                                                                                   |
|            |          | 01 Position 1                                                                                                                                                                   |
|            |          | 10 Position 2                                                                                                                                                                   |
|            |          | 11 Position 3                                                                                                                                                                   |
| WORDID     | Bit 5    | Frame ID of byte. 0 indicates frame 2 of 2.                                                                                                                                     |
| ADDR[4:0]  | Bits 4-0 | Address for bank or field mode addressing. See <a href="#">Table 3</a> for list of valid addresses.                                                                             |

**Figure 11. Calibration Read Command Frames**

**Table 16. Data Format Actual Values for Data Request Mode**

| ITEM                 | SYMBOL  | DATA LENGTH | NOTE/CONDITION                    | BINARY VALUE      | DECIMAL VALUE |
|----------------------|---------|-------------|-----------------------------------|-------------------|---------------|
| Pressure data        | OUTDATA | 10          | Input = -2.275 mV, 0 mV, 4.095 mV | 11 1111 1111      | 1023          |
|                      |         |             | Gain = nominal                    | 01 0110 1101      | 365           |
|                      |         |             |                                   | 00 0000 0000      | 0             |
| Pressure ADC data    | ADCDAT  | 14          | Input = -2.275 mV, 0 mV, 4.095 mV | 00 1111 1011 1010 | 4026          |
|                      |         |             | Gain = nominal                    | 00 0000 0000 0000 | 0             |
|                      |         |             | Twos compliment                   | 11 0111 0100 0100 | -2236         |
| Temperature data     | OUTTEMP | 10          | T <sub>A</sub> = 85°C             | 01 1000 1100      | 396           |
|                      |         |             | T <sub>A</sub> = 25°C             | 00 0000 0000      | 0             |
|                      |         |             | T <sub>A</sub> = -40°C            | 10 0101 0011      | -429          |
| Temperature ADC data | ADCTMP  | 12          | T <sub>A</sub> = 85°C             | 0110 0011 0001    | 1585          |
|                      |         |             | T <sub>A</sub> = 25°C             | 0000 0000 0000    | 0             |
|                      |         |             | T <sub>A</sub> = -40°C            | 1001 0100 1011    | -1717         |



**Calibration Read Data Frames**

|     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 7   | 6   | 5   | 4   | 3   | 2   | 1   | 0   |
| D43 | D42 | D41 | D40 | D39 | D38 | D37 | D36 |
| ⋮   |     |     |     |     |     |     |     |
| D3  | D2  | D1  | D0  | NU  | NU  | NU  | NU  |

**First Frame**

Dx Bits 7-0 Microcontroller reads data from the designated address in the device (from EEPROM). See [Table 3](#) for list of valid addresses.

**Second through (n – 1) Frame (where n = 2 to 6)**

Dx Bits 7-0 Microcontroller reads data from the designated address in the device (from EEPROM). The number of frames sent depends on the size of the data.

**Frame n (where n = 2 to 6)**

Dx Bits 7-4 Microcontroller reads data from the designated address in the device (from EEPROM).

NU Bits 3-0 Not used. Set to 0.

**Figure 12. Calibration Read Data Frames**
**Table 17. Profile of Calibration Read Data Frames (Field Mode Addressing)**

| FIELD NAME<br>(BANK ADDRESS)                      | FIELD<br>MODE<br>ADDRESS | LENGTH | FRAME<br>NO. | B7 (MSB)      | B6            | B5            | B4            | B3            | B2            | B1           | B0 (LSB)   |
|---------------------------------------------------|--------------------------|--------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------|------------|
|                                                   |                          |        |              | DATA          |               |               |               |               |               |              |            |
| Sensor ID                                         | 0000                     | (43:0) | 1            | SENID(43)     | SENID(42)     | SENID(41)     | SENID(40)     | SENID(39)     | SENID(38)     | SENID(37)    | SENID(36)  |
|                                                   |                          |        | 2            | SENID(35)     | SENID(34)     | SENID(33)     | SENID(32)     | SENID(31)     | SENID(30)     | SENID(29)    | SENID(28)  |
|                                                   |                          |        | 3            | SENID(27)     | SENID(26)     | SENID(25)     | SENID(24)     | SENID(23)     | SENID(22)     | SENID(21)    | SENID(20)  |
|                                                   |                          |        | 4            | SENID(19)     | SENID(18)     | SENID(17)     | SENID(16)     | SENID(15)     | SENID(14)     | SENID(13)    | SENID(12)  |
|                                                   |                          |        | 5            | SENID(11)     | SENID(10)     | SENID(9)      | SENID(8)      | SENID(7)      | SENID(6)      | SENID(5)     | SENID(4)   |
|                                                   |                          |        | 6            | SENID(3)      | SENID(2)      | SENID(1)      | SENID(0)      | NU            | NU            | NU           | NU         |
| Position ID                                       | 0001                     | (1:0)  | 1            | PSNID(1)      | PSNID(0)      | NU            | NU            | NU            | NU            | NU           | NU         |
| OP threshold                                      | 0010                     | (3:0)  | 1            | TRHS(3)       | TRHS(2)       | TRHS(1)       | TRHS(0)       | NU            | NU            | NU           | NU         |
| OP timer                                          | 0011                     | (1:0)  | 1            | TRDELAY(1)    | TRDELAY(0)    | NU            | NU            | NU            | NU            | NU           | NU         |
| OP gain                                           | 0100                     | (2:0)  | 1            | TRHSGAIN(2)   | TRHSGAIN(1)   | TRHSGAIN(0)   | NU            | NU            | NU            | NU           | NU         |
| Baud rate                                         | 0101                     | (3:0)  | 1            | CONF BPS(3)   | CONF BPS(2)   | CONF BPS(1)   | CONF BPS(0)   | NU            | NU            | NU           | NU         |
| Input Coarse offset                               | 0110                     | (16:8) | 1            | TRV OSC(16)   | TRV OSC(15)   | TRV OSC(14)   | TRV OSC(13)   | TRV OSC(12)   | TRV OSC(11)   | TRV OSC(10)  | TRV OSC(9) |
|                                                   |                          |        | 2            | TRVOSC        | NU            | NU            | NU            | NU            | NU            | NU           | NU         |
| Input fine offset                                 | 0111                     | (7:0)  | 1            | TRVOSF(7)     | TRVOSF(6)     | TRVOSF(5)     | TRVOSF(4)     | TRVOSF(3)     | TRVOSF(2)     | TRVOSF(1)    | TRVOSF(0)  |
| Input offset first order temperature coefficient  | 1000                     | (6:0)  | 1            | TRTC VOS1(6)  | TRTCVOS1      | TRTC VOS1(4)  | TRTC VOS1(3)  | TRTC VOS1(2)  | TRTC VOS1(1)  | TRTC VOS1(0) | NU         |
| Input offset second order temperature coefficient | 1001                     | (6:0)  | 1            | TRTC VOS2(6)  | TRTC VOS2(5)  | TRTC VOS2(4)  | TRTC VOS2(3)  | TRTC VOS2(2)  | TRTC VOS2(1)  | TRTC VOS2(0) | NU         |
| Gain adjust                                       | 1010                     | (8:0)  | 1            | TRGAIN(8)     | TRGAIN(7)     | TRGAIN(6)     | TRGAIN(5)     | TRGAIN(4)     | TRGAIN(3)     | TRGAIN(2)    | TRGAIN(1)  |
|                                                   |                          |        | 2            | TRGAIN(0)     | NU            | NU            | NU            | NU            | NU            | NU           | NU         |
| Gain first order temperature coefficient          | 1011                     | (5:0)  | 1            | TRTC GAIN1(5) | TRTC GAIN1(4) | TRTC GAIN1(3) | TRTC GAIN1(2) | TRTC GAIN1(1) | TRTC GAIN1(0) | NU           | NU         |
| Temperature sensor OUT 1                          | 1100                     | (11:0) | 1            | TEMP0(11)     | TEMP0(10)     | TEMP0(9)      | TEMP0(8)      | TEMP0(7)      | TEMP0(6)      | TEMP0(5)     | TEMP0(4)   |
|                                                   |                          |        | 2            | TEMP0(3)      | TEMP0(2)      | TEMP0(1)      | TEMP0(0)      | NU            | NU            | NU           | NU         |
| Temperature sensor OUT 2                          | 1101                     | (11:0) | 1            | TEMP1(11)     | TEMP1(10)     | TEMP1(9)      | TEMP1(8)      | TEMP1(7)      | TEMP1(6)      | TEMP1(5)     | TEMP1(4)   |
|                                                   |                          |        | 2            | TEMP1(3)      | TEMP1(2)      | TEMP1(1)      | TEMP1(0)      | NU            | NU            | NU           | NU         |
| Temperature sensor OUT 3                          | 1110                     | (11:0) | 1            | TEMP2(11)     | TEMP2(10)     | TEMP2(9)      | TEMP2(8)      | TEMP2(7)      | TEMP2(6)      | TEMP2(5)     | TEMP2(4)   |
|                                                   |                          |        | 2            | TEMP2(3)      | TEMP2(2)      | TEMP2(1)      | TEMP2(0)      | NU            | NU            | NU           | NU         |
| History of OP threshold                           | 1111                     | (3:0)  | 1            | MTRHS(3)      | MTRHS(2)      | MTRHS(1)      | MTRHS(0)      | NU            | NU            | NU           | NU         |

**Table 17. Profile of Calibration Read Data Frames (Field Mode Addressing) (continued)**

| FIELD NAME<br>(BANK ADDRESS)                                         | FIELD<br>MODE<br>ADDRESS | LENGTH | FRAME<br>NO. | B7 (MSB)          | B6                | B5                | B4                | B3                | B2                | B1               | B0 (LSB)       |
|----------------------------------------------------------------------|--------------------------|--------|--------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------------------|----------------|
|                                                                      |                          |        |              | DATA              |                   |                   |                   |                   |                   |                  |                |
| History of OP timer                                                  | 10000                    | (1:0)  | 1            | MTR<br>DELAY(1)   | MTR<br>DELAY(0)   | NU                | NU                | NU                | NU                | NU               | NU             |
| History OP gain                                                      | 10001                    | (2:0)  | 1            | MTRHS<br>GAIN(2)  | MTRHS<br>GAIN(1)  | MTRHS<br>GAIN(0)  | NU                | NU                | NU                | NU               | NU             |
| History of Input<br>offset                                           | 10010                    | (17:0) | 1            | MTR<br>VOS(17)    | MTR<br>VOS(16)    | MTR<br>VOS(15)    | MTR<br>VOS(14)    | MTR<br>VOS(13)    | MTR<br>VOS(12)    | MTR<br>VOS(11)   | MTR<br>VOS(10) |
|                                                                      |                          |        | 2            | MTR VOS(9)        | MTR VOS(8)        | MTR VOS(7)        | MTR VOS(6)        | MTR VOS(5)        | MTR VOS(4)        | MTR VOS(3)       | MTR VOS(2)     |
|                                                                      |                          |        | 3            | MTR VOS(1)        | MTR VOS(0)        | NU                | NU                | NU                | NU                | NU               | NU             |
| History of Input<br>offset first order<br>temperature<br>coefficient | 10011                    | (6:0)  | 1            | MTRTC<br>VOS1(6)  | MTRTC<br>VOS1(5)  | MTRTC<br>VOS1(4)  | MTRTC<br>VOS1(3)  | MTRTC<br>VOS1(2)  | MTRTC<br>VOS1(1)  | MTRTC<br>VOS1(0) | NU             |
| History of Input<br>offset 2nd order<br>temperature<br>coefficient   | 10100                    | (6:0)  | 1            | MTRTC<br>VOS2(6)  | MTRTC<br>VOS2(5)  | MTRTC<br>VOS2(4)  | MTRTC<br>VOS2(3)  | MTRTC<br>VOS2(2)  | MTRTC<br>VOS2(1)  | MTRTC<br>VOS2(0) | NU             |
| History of Gain<br>adjust                                            | 10101                    | (8:0)  | 1            | MTRGAIN(8)        | MTRGAIN(7)        | MTRGAIN(6)        | MTRGAIN(5)        | MTRGAIN(4)        | MTRGAIN(3)        | MTRGAIN(2)       | MTRGAIN(1)     |
|                                                                      |                          |        | 2            | MTRGAIN(0)        | NU                | NU                | NU                | NU                | NU                | NU               | NU             |
| History of Gain first<br>order temperature<br>coefficient            | 10110                    | (5:0)  | 1            | MTRTC<br>GAIN1(5) | MTRTC<br>GAIN1(4) | MTRTC<br>GAIN1(3) | MTRTC<br>GAIN1(2) | MTRTC<br>GAIN1(1) | MTRTC<br>GAIN1(0) | NU               | NU             |

**Table 18. Profile of Calibration Read Data Frames (Bank Mode Addressing)**

| FIELD NAME<br>(BANK ADDRESS)                               | FIELD<br>MODE<br>ADDRESS | LENGTH | FRAME<br>NO. | B7 (MSB)         | B6               | B5               | B4               | B3               | B2               | B1              | B0 (LSB)   |
|------------------------------------------------------------|--------------------------|--------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|-----------------|------------|
|                                                            |                          |        |              | DATA             |                  |                  |                  |                  |                  |                 |            |
| Sensor ID 0                                                | 00000                    | (43:0) | 1            | SENID(43)        | SENID(42)        | SENID(41)        | SENID(40)        | SENID(39)        | SENID(38)        | SENID(37)       | SENID(36)  |
|                                                            |                          |        | 2            | SENID(35)        | SENID(34)        | SENID(33)        | SENID(32)        | SENID(31)        | SENID(30)        | SENID(29)       | SENID(28)  |
|                                                            |                          |        | 3            | SENID(27)        | SENID(26)        | SENID(25)        | SENID(24)        | SENID(23)        | SENID(22)        | SENID(21)       | SENID(20)  |
|                                                            |                          |        | 4            | SENID(19)        | SENID(18)        | SENID(17)        | SENID(16)        | SENID(15)        | SENID(14)        | SENID(13)       | SENID(12)  |
|                                                            |                          |        | 5            | SENID(11)        | SENID(10)        | SENID(9)         | SENID(8)         | SENID(7)         | SENID(6)         | SENID(5)        | SENID(4)   |
|                                                            |                          |        | 6            | SENID(3)         | SENID(2)         | SENID(1)         | SENID(0)         | NU               | NU               | NU              | NU         |
| Position ID (0)                                            |                          | (1:0)  | 7            | PSNID(1)         | PSNID(0)         | NU               | NU               | NU               | NU               | NU              | NU         |
| OP threshold(1)                                            | 00001                    | (3:0)  | 1            | TRHS(3)          | TRHS(2)          | TRHS(1)          | TRHS(0)          | NU               | NU               | NU              | NU         |
| OP timer(1)                                                |                          | (1:0)  | 2            | TRDELAY(1)       | TRDELAY(0)       | NU               | NU               | NU               | NU               | NU              | NU         |
| OP gain(1)                                                 |                          | (2:0)  | 3            | TRHS<br>GAIN(2)  | TRHS<br>GAIN(1)  | TRHS<br>GAIN(0)  | NU               | NU               | NU               | NU              | NU         |
| Baud rate(2)                                               | 00010                    | (3:0)  | 1            | CONF<br>BPS(3)   | CONF<br>BPS(2)   | CONF<br>BPS(1)   | CONF<br>BPS(0)   | NU               | NU               | TRV<br>OSC(10)  | NU         |
| Input coarse offset<br>(3)                                 | 00011                    | (16:8) | 1            | TRV<br>OSC(16)   | TRV<br>OSC(15)   | TRV<br>OSC(14)   | TRV<br>OSC(13)   | TRV<br>OSC(12)   | TRV<br>OSC(11)   | NU              | TRV OSC(9) |
|                                                            |                          |        | 2            | TRV OSC(8)       | NU               | NU               | NU               | NU               | NU               | TRVOSF(1)       | NU         |
| Input fine offset(3)                                       |                          | (7:0)  | 3            | TRVOSF(7)        | TRVOSF(6)        | TRVOSF(5)        | TRVOSF(4)        | TRVOSF(3)        | TRVOSF(2)        | TRTC<br>VOS1(1) | TRVOSF(0)  |
| Input offset first<br>order temperature<br>coefficient(3)  |                          | (6:0)  | 4            | TRTC<br>VOS1(6)  | TRTC<br>VOS1(5)  | TRTC<br>VOS1(4)  | TRTC<br>VOS1(3)  | TRTC<br>VOS1(2)  | TRTC<br>VOS1(1)  | TRTC<br>VOS2(0) | NU         |
| Input offset second<br>order temperature<br>coefficient(3) |                          | (6:0)  | 5            | TRTC<br>VOS2(6)  | TRTC<br>VOS2(5)  | TRTC<br>VOS2(4)  | TRTC<br>VOS2(3)  | TRTC<br>VOS2(2)  | TRTC<br>VOS2(1)  | TRGAIN(2)       | NU         |
| Gain adjust(3)                                             |                          | (8:0)  | 6            | TRGAIN(8)        | TRGAIN(7)        | TRGAIN(6)        | TRGAIN(5)        | TRGAIN(4)        | TRGAIN(3)        | NU              | TRGAIN(1)  |
|                                                            |                          |        | 7            | TRGAIN(0)        | NU               | NU               | NU               | NU               | NU               | NU              | NU         |
| Gain first order<br>temperature<br>coefficient(3)          |                          | (5:0)  | 8            | TRTC<br>GAIN1(5) | TRTC<br>GAIN1(4) | TRTC<br>GAIN1(3) | TRTC<br>GAIN1(2) | TRTC<br>GAIN1(1) | TRTC<br>GAIN1(0) | TEMP0(5)        | NU         |
| Temperature sensor<br>OUT 1 (4)                            | 00100                    | (11:0) | 1            | TEMP0(11)        | TEMP0(10)        | TEMP0(9)         | TEMP0(8)         | TEMP0(7)         | TEMP0(6)         | NU              | TEMP0(4)   |
|                                                            |                          | 2      | TEMP0(3)     | TEMP0(2)         | TEMP0(1)         | TEMP0(0)         | NU               | NU               | TEMP1(5)         | NU              |            |
| Temperature sensor<br>OUT 2 (4)                            |                          | (11:0) | 3            | TEMP1(11)        | TEMP1(10)        | TEMP1(9)         | TEMP1(8)         | TEMP1(7)         | TEMP1(6)         | NU              | TEMP1(4)   |
|                                                            |                          |        | 4            | TEMP1(3)         | TEMP1(2)         | TEMP1(1)         | TEMP1(0)         | NU               | NU               | TEMP2(5)        | NU         |
| Temperature sensor<br>OUT 3 (4)                            |                          | (11:0) | 5            | TEMP2(11)        | TEMP2(10)        | TEMP2(9)         | TEMP2(8)         | TEMP2(7)         | TEMP2(6)         | NU              | TEMP2(4)   |
|                                                            |                          |        | 6            | TEMP2(3)         | TEMP2(2)         | TEMP2(1)         | TEMP2(0)         | NU               | NU               | NU              | NU         |

**Table 18. Profile of Calibration Read Data Frames (Bank Mode Addressing) (continued)**

| FIELD NAME<br>(BANK ADDRESS)                                   | FIELD<br>MODE<br>ADDRESS | LENGTH | FRAME<br>NO. | B7 (MSB)       | B6             | B5             | B4             | B3             | B2             | B1            | B0 (LSB)    |
|----------------------------------------------------------------|--------------------------|--------|--------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------|-------------|
|                                                                |                          |        |              | DATA           |                |                |                |                |                |               |             |
| History of OP threshold (5)                                    | 00101                    | (3:0)  | 1            | MTRHS(3)       | MTRHS(2)       | MTRHS(1)       | MTRHS(0)       | NU             | NU             |               | NU          |
| History of OP timer (6)                                        |                          | (1:0)  | 2            | MTR DELAY(1)   | MTR DELAY(0)   | NU             | NU             | NU             | NU             | NU            | NU          |
| History OP gain (6)                                            |                          | (2:0)  | 3            | MTRHS GAIN(2)  | MTRHS GAIN(1)  | MTRHS GAIN(0)  | NU             | NU             | NU             | NU            | NU          |
| History of input offset(6)                                     |                          | (16:0) | 4            | MTR VOS(17)    | MTR VOS(16)    | MTR VOS(15)    | MTR VOS(14)    | MTR VOS(13)    | MTR VOS(12)    | MTR VOS(11)   | MTR VOS(10) |
|                                                                |                          |        | 5            | MTR VOS(9)     | MTR VOS(8)     | MTR VOS(7)     | MTR VOS(6)     | MTR VOS(5)     | MTR VOS(4)     | MTR VOS(3)    | MTR VOS(2)  |
|                                                                |                          |        | 6            | MTR VOS(1)     | MTR VOS(0)     | NU             | NU             | NU             | NU             | NU            | NU          |
| History of Input offset first order temperature coefficient(6) |                          | (6:0)  | 7            | MTRTC VOS1(6)  | MTRTC VOS1(5)  | MTRTC VOS1(4)  | MTRTC VOS1(3)  | MTRTC VOS1(2)  | MTRTC VOS1(1)  | MTRTC VOS1(0) | NU          |
| History of Input offset 2nd order temperature coefficient(6)   |                          | (6:0)  | 8            | MTRTC VOS2(6)  | MTRTC VOS2(5)  | MTRTC VOS2(4)  | MTRTC VOS2(3)  | MTRTC VOS2(2)  | MTRTC VOS2(1)  | MTRTC VOS2(0) | NU          |
| History of Gain adjust(6)                                      |                          | (8:0)  | 9            | MTRGAIN(8)     | MTRGAIN(7)     | MTRGAIN(6)     | MTRGAIN(5)     | MTRGAIN(4)     | MTRGAIN(3)     | MTRGAIN(2)    | MTRGAIN(1)  |
|                                                                |                          |        | 10           | MTRGAIN(0)     | NU             | NU             | NU             | NU             | NU             | NU            | NU          |
| History of Gain first order temperature coefficient(6)         |                          | (5:0)  | 11           | MTRTC GAIN1(5) | MTRTC GAIN1(4) | MTRTC GAIN1(3) | MTRTC GAIN1(2) | MTRTC GAIN1(1) | MTRTC GAIN1(0) | NU            | NU          |
| DIAG/UART                                                      |                          | (7:0)  | 1            | Reserved       | DG1            | ECRC           | PROG_OK        | EIVCM          | EFRAME         | EOVER         | EPAR        |
|                                                                |                          | (7:0)  | 2            | Reserved       | Reserved       | Reserved       | Reserved       | Fastdis        | Stbit          | EO            | Pdis        |

**Table 19. DIAG/UART Register (Bank Address = 8)**

| ITEM     | DESCRIPTION                               |
|----------|-------------------------------------------|
| DG1      | Over pressure flag                        |
| ECRC     | CRC error                                 |
| PROG_OK  | PROGV pin monitor                         |
| EIVCM    | SIP and SIN pin common mode voltage error |
| EFRAME   | Framing error                             |
| EOVER    | Over run error                            |
| EPAR     | Parity error                              |
| Pdis     | Parity disable                            |
| EO       | Parity even or odd                        |
| Stbit    | Stop bit setting                          |
| Fastdis  | Test mode baud rate disable               |
| Reserved | Reserved                                  |

**Calibration Mode – Mode Select****Mode Select Command Frames**

| 7        | 6        | 5      | 4        | 3  | 2      | 1        | 0  |
|----------|----------|--------|----------|----|--------|----------|----|
| PSNID(1) | PSNID(0) | WORDID | MODETYPE |    | DISPSN | Reserved |    |
| PSNID(1) | PSNID(0) | WORDID | NU       | NU | ACSUNT | ACTMODE  | WE |

**First Frame**

PSNID[1:0] Bits 7-6 Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map.

- 00 Position 0
- 01 Position 1
- 10 Position 2
- 11 Position 3

WORDID Bit 5 Frame ID of byte. 1 indicates frame 1 of 2.

MODETYPE Bits 4-3 Select mode type within calibration mode

- 00 Data request
- 01 Calibration write
- 10 Calibration read
- 11 Mode select

DISPSN Bit 2 Disable or enable position ID matching

- 0 Decode command only if position IDs match
- 1 Indicates global command. All devices decode command frame.

Reserved Bits 1-0 Must be set to 0.

**Second Frame**

PSNID[1:0] Bits 7-6 Position ID of device on UART bus. Each device process information for one sensor. Four sensors can be sensed on the UART bus. Position settings are defined in the EEPROM map.

- 00 Position 0
- 01 Position 1
- 10 Position 2
- 11 Position 3

WORDID Bit 5 Frame ID of byte. 0 indicates frame 2 of 2.

NU Bits 4-3 Not use. Set to 0.

ACSUNT Bit 0 Sets device to field addressing mode or bank addressing mode. Can be accessed only in calibration mode.

- 0 Bank addressing mode
- 1 Field addressing mode

ACTMODE Bit 1 Sets device to sensor or calibration mode after current command is completed.

- 0 Sensor mode
- 1 Calibration mode

WE Bit 0 Disable/enable write to EEPROM (see [EEPROM Write](#) for details)

- 0 EEPROM write disabled (default)
- 1 EEPROM write enabled

**Figure 13. Mode Select Command Frames**

**Mode Select Data Frames**

| 7       | 6        | 5                                                                                               | 4  | 3  | 2      | 1       | 0  |
|---------|----------|-------------------------------------------------------------------------------------------------|----|----|--------|---------|----|
| NU      | NU       | NU                                                                                              | NU | NU | ACSUNT | ACTMODE | WE |
| NU      | Bits 7-3 | Not use. Set to 0.                                                                              |    |    |        |         |    |
| ACSUNT  | Bit 0    | Reports field addressing mode or bank addressing mode                                           |    |    |        |         |    |
|         |          | 0 Bank addressing mode                                                                          |    |    |        |         |    |
|         |          | 1 Field addressing mode                                                                         |    |    |        |         |    |
| ACTMODE | Bit 1    | Reports sensor or calibration mode                                                              |    |    |        |         |    |
|         |          | 0 Sensor mode                                                                                   |    |    |        |         |    |
|         |          | 1 Calibration mode                                                                              |    |    |        |         |    |
| WE      | Bit 0    | Reports status of disable/enable write to EEPROM (see <a href="#">EEPROM Write</a> for details) |    |    |        |         |    |
|         |          | 0 EEPROM write disabled (default)                                                               |    |    |        |         |    |
|         |          | 1 EEPROM write enabled                                                                          |    |    |        |         |    |

**Figure 14. Mode Select Data Frames**
**Table 20. Profile of Mode Select Data Frames (Field and Bank Mode Addressing)**

| FIELD NAME (BANK ADDRESS) | FIELD MODE ADDRESS | LENGTH | FRAME NO. | B7 (MSB) | B6 | B5 | B4 | B3 | B2     | B1      | B0 (LSB) |
|---------------------------|--------------------|--------|-----------|----------|----|----|----|----|--------|---------|----------|
|                           |                    |        |           | DATA     |    |    |    |    |        |         |          |
| Mode registers read       | -                  | -      | 1         | NU       | NU | NU | NU | NU | ACSUNT | ACTMODE | WE       |

## Device Configuration and Thresholds

The following tables show the actual data settings needed in the specific control bits for setting the baud rates and threshold levels for the TPIC83000. These settings can only be implemented in Calibration mode.

**Table 21. Baud Rate Settings**

| BAUD RATE     | DATA | TYPICAL VALUE | COMMUNICATION CLOCK        |
|---------------|------|---------------|----------------------------|
| CONF BPS(3:0) | 0000 | 500 bps       | 2.458 MHz / 307 = 8.0 kHz  |
|               | 0001 | 750 bps       | 2.458 MHz / 205 = 12.0 kHz |
|               | 0010 | 1000 bps      | 2.458 MHz / 154 = 16.0 kHz |
|               | 0011 | 1250 bps      | 2.458 MHz / 123 = 20.0 kHz |
|               | 0100 | 1500 bps      | 2.458 MHz / 102 = 24.0 kHz |
|               | 0101 | 1750 bps      | 2.458 MHz / 88 = 27.9 kHz  |
|               | 0110 | 2000 bps      | 2.458 MHz / 77 = 31.9 kHz  |
|               | 0111 | 2250 bps      | 2.458 MHz / 68 = 36.1 kHz  |
|               | 1000 | 2500 bps      | 2.458 MHz / 61 = 40.0 kHz  |
|               | 1001 | 2750 bps      | 2.458 MHz / 56 = 43.9 kHz  |
|               | 1010 | 3000 bps      | 2.458 MHz / 51 = 48.2 kHz  |
|               | 1011 | 3250 bps      | 2.458 MHz / 47 = 52.3 kHz  |
|               | 1100 | 4800 bps      | 2.458 MHz / 32 = 76.8 kHz  |
|               | 1101 | 9600 bps      | 2.458 MHz / 16 = 153.6 kHz |
|               | 1110 | 19.2 kbps     | 2.458 MHz / 8 = 307.3 kHz  |
|               | 1111 | 38.4 kbps     | 2.458 MHz / 4 = 614.5 kHz  |

**Table 22. Over-Pressure Gain Settings via TRHSGAIN Control Bits**

| OVER-PRESSURE GAIN | DATA | MIN VALUE | TYPICAL VALUE | MAX VALUE |
|--------------------|------|-----------|---------------|-----------|
| TRHSGAIN(2:0)      | 0000 |           | 2.2           |           |
|                    | 0001 |           | 2.4           |           |
|                    | 0010 |           | 2.6           |           |
|                    | 0011 |           | 2.8           |           |
|                    | 0100 |           | 3             |           |
|                    | 0101 |           | 3.2           |           |
|                    | 0110 |           | 3.4           |           |
|                    | 0111 |           | 3.6           |           |

**Table 23. Over-Pressure Thresholds at Over-Pressure Gain = 2.2**

| OVER-PRESSURE THRESHOLD                                                                           | DATA | MIN VALUE | TYPICAL VALUE | MAX VALUE |
|---------------------------------------------------------------------------------------------------|------|-----------|---------------|-----------|
| TRHS(3:0)                                                                                         | 0000 | -20%      | 9.41 mV       | 20%       |
| TRHSGAIN = 0<br>Error due to coarse offset value should be taken into account.<br>Input referred. | 0001 | -20%      | 10.59 mV      | 20%       |
|                                                                                                   | 0010 | -20%      | 11.77 mV      | 20%       |
|                                                                                                   | 0011 | -20%      | 12.93 mV      | 20%       |
|                                                                                                   | 0100 | -20%      | 14.11 mV      | 20%       |
|                                                                                                   | 0101 | -20%      | 15.29 mV      | 20%       |
|                                                                                                   | 0110 | -20%      | 16.47 mV      | 20%       |
|                                                                                                   | 0111 | -20%      | 17.64 mV      | 20%       |
|                                                                                                   | 1000 | -10%      | 18.82 mV      | 10%       |
|                                                                                                   | 1001 | -10%      | 20.00 mV      | 10%       |
|                                                                                                   | 1010 | -10%      | 21.17 mV      | 10%       |
|                                                                                                   | 1011 | -10%      | 22.34 mV      | 10%       |
|                                                                                                   | 1100 | -10%      | 23.52 mV      | 10%       |
|                                                                                                   | 1101 | -10%      | 24.70 mV      | 10%       |
|                                                                                                   | 1110 | -10%      | 25.88 mV      | 10%       |
|                                                                                                   | 1111 | -10%      | 27.06 mV      | 10%       |

**Table 24. Over-Pressure Thresholds at Over-Pressure Gain = 2.4**

| OVER-PRESSURE THRESHOLD                                                                           | DATA | MIN VALUE | TYPICAL VALUE | MAX VALUE |
|---------------------------------------------------------------------------------------------------|------|-----------|---------------|-----------|
| TRHS(3:0)                                                                                         | 0000 | -20%      | 8.92 mV       | 20%       |
| TRHSGAIN = 1<br>Error due to coarse offset value should be taken into account.<br>Input referred. | 0001 | -20%      | 10.03 mV      | 20%       |
|                                                                                                   | 0010 | -20%      | 11.15 mV      | 20%       |
|                                                                                                   | 0011 | -20%      | 12.25 mV      | 20%       |
|                                                                                                   | 0100 | -20%      | 13.37 mV      | 20%       |
|                                                                                                   | 0101 | -20%      | 14.48 mV      | 20%       |
|                                                                                                   | 0110 | -20%      | 15.60 mV      | 20%       |
|                                                                                                   | 0111 | -20%      | 16.72 mV      | 20%       |
|                                                                                                   | 1000 | -10%      | 17.83 mV      | 10%       |
|                                                                                                   | 1001 | -10%      | 18.95 mV      | 10%       |
|                                                                                                   | 1010 | -10%      | 20.05 mV      | 10%       |
|                                                                                                   | 1011 | -10%      | 21.17 mV      | 10%       |
|                                                                                                   | 1100 | -10%      | 22.28 mV      | 10%       |
|                                                                                                   | 1101 | -10%      | 23.40 mV      | 10%       |
|                                                                                                   | 1110 | -10%      | 24.52 mV      | 10%       |
|                                                                                                   | 1111 | -10%      | 25.63 mV      | 10%       |

**Table 25. Over-Pressure Thresholds at Over-Pressure Gain = 2.6**

| OVER-PRESSURE THRESHOLD                                                                           | DATA | MIN VALUE | TYPICAL VALUE | MAX VALUE |
|---------------------------------------------------------------------------------------------------|------|-----------|---------------|-----------|
| TRHS(3:0)                                                                                         | 0000 | -20%      | 8.42 mV       | 20%       |
| TRHSGAIN = 2<br>Error due to coarse offset value should be taken into account.<br>Input referred. | 0001 | -20%      | 9.47 mV       | 20%       |
|                                                                                                   | 0010 | -20%      | 10.53 mV      | 20%       |
|                                                                                                   | 0011 | -20%      | 11.57 mV      | 20%       |
|                                                                                                   | 0100 | -20%      | 12.63 mV      | 20%       |
|                                                                                                   | 0101 | -20%      | 13.67 mV      | 20%       |
|                                                                                                   | 0110 | -20%      | 14.73 mV      | 20%       |
|                                                                                                   | 0111 | -20%      | 15.78 mV      | 20%       |
|                                                                                                   | 1000 | -10%      | 16.84 mV      | 10%       |
|                                                                                                   | 1001 | -10%      | 17.89 mV      | 10%       |
|                                                                                                   | 1010 | -10%      | 18.94 mV      | 10%       |
|                                                                                                   | 1011 | -10%      | 19.99 mV      | 10%       |
|                                                                                                   | 1100 | -10%      | 21.04 mV      | 10%       |
|                                                                                                   | 1101 | -10%      | 22.10 mV      | 10%       |
|                                                                                                   | 1110 | -10%      | 23.15 mV      | 10%       |
|                                                                                                   | 1111 | -10%      | 24.21 mV      | 10%       |

**Table 26. Over-Pressure Thresholds at Over-Pressure Gain = 2.8**

| OVER-PRESSURE THRESHOLD                                                                           | DATA | MIN VALUE | TYPICAL VALUE | MAX VALUE |
|---------------------------------------------------------------------------------------------------|------|-----------|---------------|-----------|
| TRHS(3:0)                                                                                         | 0000 | -20%      | 7.93 mV       | 20%       |
| TRHSGAIN = 3<br>Error due to coarse offset value should be taken into account.<br>Input referred. | 0001 | -20%      | 8.92 mV       | 20%       |
|                                                                                                   | 0010 | -20%      | 9.91 mV       | 20%       |
|                                                                                                   | 0011 | -20%      | 10.89 mV      | 20%       |
|                                                                                                   | 0100 | -20%      | 11.88 mV      | 20%       |
|                                                                                                   | 0101 | -20%      | 12.87 mV      | 20%       |
|                                                                                                   | 0110 | -20%      | 13.87 mV      | 20%       |
|                                                                                                   | 0111 | -20%      | 14.86 mV      | 20%       |
|                                                                                                   | 1000 | -10%      | 15.85 mV      | 10%       |
|                                                                                                   | 1001 | -10%      | 16.84 mV      | 10%       |
|                                                                                                   | 1010 | -10%      | 17.82 mV      | 10%       |
|                                                                                                   | 1011 | -10%      | 18.82 mV      | 10%       |
|                                                                                                   | 1100 | -10%      | 19.81 mV      | 10%       |
|                                                                                                   | 1101 | -10%      | 20.80 mV      | 10%       |
|                                                                                                   | 1110 | -10%      | 21.79 mV      | 10%       |
|                                                                                                   | 1111 | -10%      | 22.78 mV      | 10%       |



**Table 27. Over-Pressure Thresholds at Over-Pressure Gain = 3.0**

| OVER-PRESSURE THRESHOLD                                                                           | DATA | MIN VALUE | TYPICAL VALUE | MAX VALUE |
|---------------------------------------------------------------------------------------------------|------|-----------|---------------|-----------|
| TRHS(3:0)                                                                                         | 0000 | -20%      | 7.43 mV       | 20%       |
| TRHSGAIN = 4<br>Error due to coarse offset value should be taken into account.<br>Input referred. | 0001 | -20%      | 8.36 mV       | 20%       |
|                                                                                                   | 0010 | -20%      | 9.29 mV       | 20%       |
|                                                                                                   | 0011 | -20%      | 10.21 mV      | 20%       |
|                                                                                                   | 0100 | -20%      | 11.14 mV      | 20%       |
|                                                                                                   | 0101 | -20%      | 12.07 mV      | 20%       |
|                                                                                                   | 0110 | -20%      | 13.00 mV      | 20%       |
|                                                                                                   | 0111 | -20%      | 13.93 mV      | 20%       |
|                                                                                                   | 1000 | -10%      | 14.86 mV      | 10%       |
|                                                                                                   | 1001 | -10%      | 15.79 mV      | 10%       |
|                                                                                                   | 1010 | -10%      | 16.71 mV      | 10%       |
|                                                                                                   | 1011 | -10%      | 17.64 mV      | 10%       |
|                                                                                                   | 1100 | -10%      | 18.57 mV      | 10%       |
|                                                                                                   | 1101 | -10%      | 19.50 mV      | 10%       |
|                                                                                                   | 1110 | -10%      | 20.43 mV      | 10%       |
|                                                                                                   | 1111 | -10%      | 21.36 mV      | 10%       |

**Table 28. Over-Pressure Thresholds at Over-Pressure Gain = 3.2**

| OVER-PRESSURE THRESHOLD                                                                           | DATA | MIN VALUE | TYPICAL VALUE | MAX VALUE |
|---------------------------------------------------------------------------------------------------|------|-----------|---------------|-----------|
| TRHS(3:0)                                                                                         | 0000 | -20%      | 6.93 mV       | 20%       |
| TRHSGAIN = 5<br>Error due to coarse offset value should be taken into account.<br>Input referred. | 0001 | -20%      | 7.80 mV       | 20%       |
|                                                                                                   | 0010 | -20%      | 8.67 mV       | 20%       |
|                                                                                                   | 0011 | -20%      | 9.53 mV       | 20%       |
|                                                                                                   | 0100 | -20%      | 10.40 mV      | 20%       |
|                                                                                                   | 0101 | -20%      | 11.27 mV      | 20%       |
|                                                                                                   | 0110 | -20%      | 12.13 mV      | 20%       |
|                                                                                                   | 0111 | -20%      | 13.00 mV      | 20%       |
|                                                                                                   | 1000 | -10%      | 13.87 mV      | 10%       |
|                                                                                                   | 1001 | -10%      | 14.73 mV      | 10%       |
|                                                                                                   | 1010 | -10%      | 15.59 mV      | 10%       |
|                                                                                                   | 1011 | -10%      | 16.46 mV      | 10%       |
|                                                                                                   | 1100 | -10%      | 17.33 mV      | 10%       |
|                                                                                                   | 1101 | -10%      | 18.2 mV       | 10%       |
|                                                                                                   | 1110 | -10%      | 19.07 mV      | 10%       |
|                                                                                                   | 1111 | -10%      | 19.94 mV      | 10%       |

**Table 29. Over-Pressure Thresholds at Over-Pressure Gain = 3.4**

| OVER-PRESSURE THRESHOLD                                                                           | DATA | MIN VALUE | TYPICAL VALUE | MAX VALUE |
|---------------------------------------------------------------------------------------------------|------|-----------|---------------|-----------|
| TRHS(3:0)                                                                                         | 0000 | -20%      | 6.44 mV       | 20%       |
| TRHSGAIN = 6<br>Error due to coarse offset value should be taken into account.<br>Input referred. | 0001 | -20%      | 7.25 mV       | 20%       |
|                                                                                                   | 0010 | -20%      | 8.05 mV       | 20%       |
|                                                                                                   | 0011 | -20%      | 8.84 mV       | 20%       |
|                                                                                                   | 0100 | -20%      | 9.65 mV       | 20%       |
|                                                                                                   | 0101 | -20%      | 10.46 mV      | 20%       |
|                                                                                                   | 0110 | -20%      | 11.27 mV      | 20%       |
|                                                                                                   | 0111 | -20%      | 12.07 mV      | 20%       |
|                                                                                                   | 1000 | -10%      | 12.87 mV      | 10%       |
|                                                                                                   | 1001 | -10%      | 13.69 mV      | 10%       |
|                                                                                                   | 1010 | -10%      | 14.48 mV      | 10%       |
|                                                                                                   | 1011 | -10%      | 15.29 mV      | 10%       |
|                                                                                                   | 1100 | -10%      | 16.09 mV      | 10%       |
|                                                                                                   | 1101 | -10%      | 16.90 mV      | 10%       |
|                                                                                                   | 1110 | -10%      | 17.71 mV      | 10%       |
|                                                                                                   | 1111 | -10%      | 18.51 mV      | 10%       |

**Table 30. Over-Pressure Thresholds at Over-Pressure Gain = 3.6**

| OVER-PRESSURE THRESHOLD                                                                           | DATA | MIN VALUE | TYPICAL VALUE | MAX VALUE |
|---------------------------------------------------------------------------------------------------|------|-----------|---------------|-----------|
| TRHS(3:0)                                                                                         | 0000 | -20%      | 5.94 mV       | 20%       |
| TRHSGAIN = 7<br>Error due to coarse offset value should be taken into account.<br>Input referred. | 0001 | -20%      | 6.69 mV       | 20%       |
|                                                                                                   | 0010 | -20%      | 7.43 mV       | 20%       |
|                                                                                                   | 0011 | -20%      | 8.17 mV       | 20%       |
|                                                                                                   | 0100 | -20%      | 8.91 mV       | 20%       |
|                                                                                                   | 0101 | -20%      | 9.66 mV       | 20%       |
|                                                                                                   | 0110 | -20%      | 10.4 mV       | 20%       |
|                                                                                                   | 0111 | -20%      | 11.14 mV      | 20%       |
|                                                                                                   | 1000 | -10%      | 11.89 mV      | 10%       |
|                                                                                                   | 1001 | -10%      | 12.63 mV      | 10%       |
|                                                                                                   | 1010 | -10%      | 13.37 mV      | 10%       |
|                                                                                                   | 1011 | -10%      | 14.11 mV      | 10%       |
|                                                                                                   | 1100 | -10%      | 14.85 mV      | 10%       |
|                                                                                                   | 1101 | -10%      | 15.60 mV      | 10%       |
|                                                                                                   | 1110 | -10%      | 16.34 mV      | 10%       |
|                                                                                                   | 1111 | -10%      | 17.08 mV      | 10%       |

**Table 31. Over-Pressure Timer Configuration via TRDELAY Control Bits**

| OVER-PRESSURE TIMER | DATA | MIN VALUE                                      | TYPICAL VALUE                                 | MAX VALUE                                      |
|---------------------|------|------------------------------------------------|-----------------------------------------------|------------------------------------------------|
| TRDELAY(1:0)        | 00   | $(2/2.458 \text{ MHz}) \times 1000 \times 0.9$ | $(2/2.458 \text{ MHz}) \times 1000 \text{ s}$ | $(2/2.458 \text{ MHz}) \times 1000 \times 1.1$ |
|                     | 01   | $(2/2.458 \text{ MHz}) \times 2000 \times 0.9$ | $(2/2.458 \text{ MHz}) \times 2000 \text{ s}$ | $(2/2.458 \text{ MHz}) \times 2000 \times 1.1$ |
|                     | 10   | $(2/2.458 \text{ MHz}) \times 3000 \times 0.9$ | $(2/2.458 \text{ MHz}) \times 3000 \text{ s}$ | $(2/2.458 \text{ MHz}) \times 3000 \times 1.1$ |
|                     | 11   | $(2/2.458 \text{ MHz}) \times 4000 \times 0.9$ | $(2/2.458 \text{ MHz}) \times 4000 \text{ s}$ | $(2/2.458 \text{ MHz}) \times 4000 \times 1.1$ |

**Table 32. Default Settings for Temperature Sensor (Data 2) With Respect to Over-Pressure Comparator Timer and Gain Adjust**

|                              | TEST CONDITIONS         |            |
|------------------------------|-------------------------|------------|
| <b>OP-1</b>                  |                         | TEMP1[5:0] |
| 12.483 mV ≤ VPHS ≤ 12.57 mV  | TRHS = 8, TRHSGAIN = 5  | 10         |
| 12.57 mV < VPHS ≤ 13.44 mV   | TRHS = 8, TRHSGAIN = 5  | 9          |
| 13.44 mV < VPHS ≤ 14.30 mV   | TRHS = 8, TRHSGAIN = 5  | 8          |
| 14.30 mV < VPHS ≤ 15.257 mV  | TRHS = 8, TRHSGAIN = 5  | 7          |
| <b>OP-2</b>                  |                         | TEMP1[9:6] |
| 16.38 mV < VPHS ≤ 16.895 mV  | TRHS = 13, TRHSGAIN = 5 | 15         |
| 16.895 mV < VPHS ≤ 17.765 mV | TRHS = 13, TRHSGAIN = 5 | 14         |
| 17.765 mV < VPHS ≤ 18.635 mV | TRHS = 13, TRHSGAIN = 5 | 13         |
| 18.635 mV < VPHS ≤ 19.505 mV | TRHS = 13, TRHSGAIN = 5 | 12         |
| 19.505 mV < VPHS ≤ 20.020 mV | TRHS = 13, TRHSGAIN = 5 | 11         |

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

over operating free-air temperature range (unless otherwise noted)

|                                  |                                          | VALUE                         | UNIT |
|----------------------------------|------------------------------------------|-------------------------------|------|
| V <sub>cc</sub> /V <sub>dd</sub> | Regulated input <sup>(2) (3)</sup>       | –0.3 to 7                     | V    |
| DO                               | Output <sup>(2) (4)</sup>                | –0.3 to 7                     | V    |
| DI                               | Input <sup>(2) (4)</sup>                 | –0.3 to 7                     | V    |
| SIN/SIP                          | Input voltage <sup>(2) (3)</sup>         | –0.3 to V <sub>cc</sub> + 0.3 | V    |
| P <sub>D</sub>                   | Continuous power dissipation             | 71                            | mW   |
| θ <sub>JA</sub>                  | Thermal impedance, junction to ambient   | 100                           | °C/W |
| ESD1 <sup>(5)</sup>              | Electrostatic discharge <sup>(6)</sup>   | ±2                            | kV   |
| ESD2 <sup>(7)</sup>              | Electrostatic discharge on all terminals | –200 (Minimum)                | V    |
|                                  |                                          | 200 (Maximum)                 | V    |
| T <sub>OP</sub>                  | Operating ambient temperature range      | –40 to 85                     | °C   |
| T <sub>S</sub>                   | Storage temperature range                | –40 to 125                    | °C   |
| T <sub>J</sub>                   | Maximum junction temperature             | 150                           | °C   |

- (1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to GND.
- (3) Absolute negative voltage on these pins not to go below –0.5 V. This is to prevent the ESD diode from forward-biasing during normal operation.
- (4) Absolute negative voltage on these pins not to go below –1.0 V. This is to prevent the ESD diode from forward-biasing during normal operation.
- (5) ESD1: DO pin with 220 Ω and 1 nF (cannot be disruptive or destructive)
- (6) The human body model is a 100 pF capacitor discharged through a 1.5-kΩ resistor into each pin
- (7) ESD2: On all other terminals 0 Ω with 200 pF

**RECOMMENDED OPERATING CONDITIONS**

|                                                      |                                               | MIN                      | NOM | MAX                      | UNIT |
|------------------------------------------------------|-----------------------------------------------|--------------------------|-----|--------------------------|------|
| V <sub>dd</sub> , V <sub>cc</sub> , V <sub>ccA</sub> | Regulated input                               | 4.5                      | 5   | 5.25                     | V    |
| DO                                                   | Output                                        | 0                        |     | V <sub>dd</sub>          | V    |
| DI                                                   | Input                                         | 0                        |     | V <sub>dd</sub>          | V    |
| SIN, SIP                                             | Amplifier input voltage                       | V <sub>cc</sub> /2 – 0.2 |     | V <sub>cc</sub> /2 + 0.2 | V    |
| C <sub>ProgV</sub>                                   | Programming voltage capacitor for charge pump | 500                      |     | 1500                     | pF   |
| R <sub>refl</sub>                                    | Current reference setting                     |                          | 10  |                          | kΩ   |
| Q <sub>Vcc</sub>                                     | Low ESR capacitance on V <sub>cc</sub> line   | 1                        |     |                          | μF   |
| T <sub>A</sub>                                       | Operating ambient temperature                 | –40                      |     | 85                       | °C   |

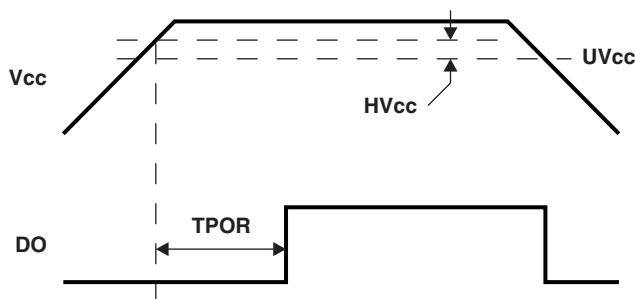
## ELECTRICAL CHARACTERISTICS – POWER SUPPLY

V<sub>dd</sub> = V<sub>cc</sub> = V<sub>ccA</sub> = 5 V +5%/–10%, T<sub>A</sub> = –40°C to 85°C (unless otherwise noted)

| PARAMETER                                                 |                                                 | TEST CONDITIONS                                              | MIN  | TYP  | MAX   | UNIT |
|-----------------------------------------------------------|-------------------------------------------------|--------------------------------------------------------------|------|------|-------|------|
| Power Supply                                              |                                                 |                                                              |      |      |       |      |
| Vcc<br>Vdd<br>VccA                                        | Power supply voltage                            |                                                              | 4.5  | 5.0  | 5.25  | V    |
| I <sub>Vcc</sub><br>I <sub>Vdd</sub><br>I <sub>VccA</sub> | Total current consumption of all three supplies | Vcc = 5 V, T <sub>A</sub> = 25°C                             | 10   |      |       | mA   |
|                                                           |                                                 | All specified operating conditions                           | 13   |      |       | mA   |
|                                                           |                                                 | Vcc = 5 V, T <sub>A</sub> = 25°C,<br>EEPROM programming mode | 13.5 |      |       | mA   |
| Power-On Reset                                            |                                                 |                                                              |      |      |       |      |
| UVcc <sup>(1) (2)</sup>                                   | Vcc undervoltage detection threshold            | DO = 0                                                       | 3.5  | 3.7  | 3.8   | V    |
| HVcc                                                      | Vcc undervoltage detection hysteresis           | Vcc = Vdd = VccA                                             | 0.2  |      |       | V    |
| TPOR <sup>(1) (2)</sup>                                   |                                                 | See <a href="#">Figure 15</a>                                | 9.54 | 10.6 | 11.66 | ms   |

(1) 1.3-ms timer between PUC (power up clear, V<sub>cc</sub> = 2.5 V) to UV<sub>cc</sub>

(2) PUC clears digital logic core. UV<sub>cc</sub> holds DO to low state. After UV<sub>cc</sub> condition cleared, DO is low for TPOR.



**Figure 15. Power-On Reset Voltage and Timing Thresholds**

## ELECTRICAL CHARACTERISTICS – INPUT AMPLIFIER (SIP, SIN)

V<sub>dd</sub> = V<sub>cc</sub> = V<sub>ccA</sub> = 5 V +5%/–10%, T<sub>A</sub> = –40°C to 85°C (unless otherwise noted)

| PARAMETER                       |                                                | TEST CONDITIONS                                                                   | MIN                     | TYP | MAX                     | UNIT |
|---------------------------------|------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------|-----|-------------------------|------|
| VICOM                           | Input common mode range SIP and SIN            | $\Delta DO/\Delta V_{cm}$ (10-bit scale)<br><1-bit error at output                | V <sub>cc</sub> /2 –0.2 |     | V <sub>cc</sub> /2 +0.2 | V    |
| V <sub>IDF</sub> <sup>(1)</sup> | Input differential voltage between SIP and SIN | Coarse offset range                                                               | –120                    |     | 120                     | mV   |
| VOS                             | Input offset voltage                           | V <sub>cc</sub> = 5 V, V <sub>SIP</sub> = V <sub>SIN</sub> = 2.5 V                | –20                     |     | 20                      | μV   |
| ISI                             | Input offset current                           | R <sub>in</sub> = 500 k, V <sub>SIP</sub> = V <sub>SIN</sub> = V <sub>cc</sub> /2 | –0.2                    |     | 0.2                     | μA   |
| IS                              | Input sink current                             | SIP = SIN = V <sub>cc</sub> /2                                                    | 0.5                     | 1   | 2.5                     | μA   |
| CSI                             | Amplifier input load capacitance               | SIP to Gnd<br>SIN to Gnd<br>SIP to SIN                                            |                         |     | 0.1                     | μF   |

(1) This is typical coarse offset range correction range. Refer to the coarse offset DAC section for accuracy information.

**ELECTRICAL CHARACTERISTICS – CALIBRATION AND FAULT DETECTION**V<sub>dd</sub> = V<sub>cc</sub> = V<sub>ccA</sub> = 5 V +5%/–10%, T<sub>A</sub> = –40°C to 85°C (unless otherwise noted)

| PARAMETER              |                                                      | TEST CONDITIONS                                                 | MIN                    | TYP                         | MAX                    | UNIT         |
|------------------------|------------------------------------------------------|-----------------------------------------------------------------|------------------------|-----------------------------|------------------------|--------------|
| <b>Calibration</b>     |                                                      |                                                                 |                        |                             |                        |              |
| V <sub>os</sub>        | Input offset trim range                              |                                                                 | –120                   |                             | 120                    | mV           |
|                        | Input offset trimming step                           |                                                                 |                        | 8                           |                        | μV           |
|                        | Input offset trimming resolution                     |                                                                 |                        | 17                          |                        | bits         |
|                        | VOSC (coarse)                                        | V <sub>in</sub> = 0, Gain = Nom                                 | –132                   |                             | 132                    | mV           |
|                        | VOSF (fine)                                          | V <sub>in</sub> = 0, Gain = Nom                                 |                        | 328                         |                        | bits         |
| TCV <sub>os1</sub>     | Input offset TC1 trim range +                        | VO(TCV <sub>os1</sub> = 63 or –64) – VO(TCV <sub>os1</sub> = 0) | 48                     | 72                          | 96                     | LSB          |
|                        | Input offset TC1 trim range –                        |                                                                 | –99                    | –74                         | –48                    | LSB          |
|                        | Input offset TC1 trim step                           | V <sub>in</sub> = 0, GAIN = Mid, T <sub>A</sub> = 85°C,         |                        | 1.14                        |                        | LSB/<br>Code |
|                        | Input offset TC1 trimming resolution                 |                                                                 |                        | 7                           |                        | bits         |
| TCV <sub>os2</sub>     | Input offset TC2 trim range +                        | VO(TCV <sub>os2</sub> = 63 or –64) – VO(TCV <sub>os2</sub> = 0) | 12                     | 24                          | 35                     | LSB          |
|                        | Input offset TC2 trim range –                        |                                                                 | –35                    | –24                         | –12                    | LSB          |
|                        | Input offset TC2 trim step                           | V <sub>in</sub> = 0, GAIN = Mid, T <sub>A</sub> = 85°C          |                        | 0.38                        |                        | LSB/<br>Code |
|                        | Input offset TC2 trimming resolution                 |                                                                 |                        | 7                           |                        | bits         |
| Gain                   | Programmable gain range                              | With respect to Analog Gain                                     | 75                     |                             | 125                    | %            |
|                        | Gain programming step                                | V <sub>in</sub> = SIP – SIN                                     |                        |                             | 0.1                    | %            |
|                        | Gain programming resolution                          |                                                                 |                        | 9                           |                        | bits         |
| TCG <sub>ain1</sub>    | Gain TC1 trimming range                              | VO(TCG <sub>ain1</sub> = 1) – VO(TCG <sub>ain1</sub> = 0)       | –44                    | –35                         | –20                    | LSB          |
|                        | Gain TC1 trimming step                               |                                                                 |                        | 0.55                        |                        | LSB/<br>Code |
|                        | Gain TC1 number of bits                              | V <sub>in</sub> = 1.1/ 300 V, GAIN = Mid, T <sub>A</sub> = 85°C |                        | 6                           |                        | bits         |
| <b>Fault Detection</b> |                                                      |                                                                 |                        |                             |                        |              |
| VIOVL                  | Input under levels                                   | SIP and SIN                                                     | 0.1<br>V <sub>cc</sub> |                             | 0.3<br>V <sub>cc</sub> | V            |
| VIOVH                  | Input over levels                                    | SIP and SIN                                                     | 0.7<br>V <sub>cc</sub> |                             | 0.9<br>V <sub>cc</sub> | V            |
| TIOV                   | Input fault deglitch timer                           | SIP and SIN                                                     | 4.5                    | 5                           | 5.5                    | ms           |
| VIHS                   | Typical excess pressure detection programmable range | SIP and SIN<br>TRHSGAIN = 5<br>TRHS = 0 to 15                   | –19.94                 |                             | –6.93                  | mV           |
| VPHS                   | Typical programmable step accuracy                   | SIP and SIN                                                     | –1.1                   |                             | 1.1                    | mV           |
| VRHS                   | Typical programmable step                            | SIP and SIN<br>TRHSGAIN = 5                                     |                        | 0.87                        |                        | mV           |
| TIOW                   | Deglitch timer programmable range                    | TRDELAY = 3                                                     |                        | (2/<br>2.458 MHz)<br>× 4000 |                        | s            |
| TIOWE                  | Over-pressure deglitch time error                    | SIP and SIN                                                     | –10                    | 0                           | 10                     | %            |
| TSF                    | Supply glitch time                                   | V <sub>cc</sub> < 2.5 V                                         |                        | 320                         |                        | ns           |

## ELECTRICAL CHARACTERISTICS – EEPROM

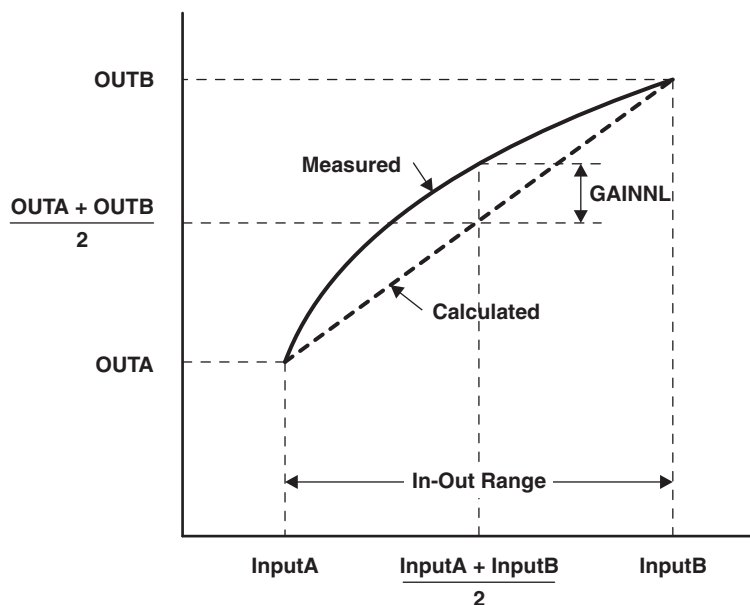
V<sub>dd</sub> = V<sub>cc</sub> = V<sub>ccA</sub> = 5 V +5%/–10%, T<sub>A</sub> = –40°C to 85°C (unless otherwise noted)

| PARAMETER            |                                                                  | TEST CONDITIONS                                              | MIN  | TYP | MAX  | UNIT  |
|----------------------|------------------------------------------------------------------|--------------------------------------------------------------|------|-----|------|-------|
| Write cycle          |                                                                  | DIO and PROGV                                                |      |     | 25   | times |
| Write time           | EEPROM write time<br>T <sub>prog_ok</sub> + system response time | DIO and PROGV<br>T <sub>prog_ok</sub> + system response time | 20   |     | 120  | ms    |
| PROG_OK timer        | T <sub>prog_ok</sub>                                             | PROGV > VPROG                                                | 13.5 | 15  | 16.5 | ms    |
| Programming voltage  | VPROG                                                            | PROGV                                                        | 12.5 |     | 18   | V     |
| Write T <sub>A</sub> |                                                                  |                                                              | –40  |     | 85   | °C    |

## ELECTRICAL CHARACTERISTICS – AFE

V<sub>dd</sub> = V<sub>cc</sub> = V<sub>ccA</sub> = 5 V +5%/–10%, T<sub>A</sub> = –40°C to 85°C (unless otherwise noted)

| PARAMETER      |                                         | TEST CONDITIONS                                                                     | MIN  | TYP | MAX | UNIT |
|----------------|-----------------------------------------|-------------------------------------------------------------------------------------|------|-----|-----|------|
| A <sub>v</sub> | Analog front end gain                   | At TST1 and TST0, V <sub>in</sub> = ±3 mV, T <sub>A</sub> = 25°C                    | 285  | 300 | 321 | V/V  |
| ASIG           | Signal path absolute error              | V <sub>in</sub> = ±3 mV                                                             | –16  |     | 16  | LSB  |
| RE4085         | Ratiometric error at –40°C and 85°C     | DIO Pin, V <sub>cc</sub> = 4.92±50 mV, Gain = Max                                   | –13  |     | 13  | LSB  |
| TCVO1          | Output temperature drift                | Input = GND, Temp = –40°C to 25°C, the offset TCs are set to the middle, Gain = Max | –15  |     | 15  | LSB  |
| TCVO2          | Output temperature drift                | Input = GND, Temp = 25°C to 85°C, the offset TCs are set to the middle, Gain = Max  | –10  |     | 10  | LSB  |
| TCAG           | Analog front end gain temperature drift | At TST1 and TST0, V <sub>in</sub> = ±3 mV                                           | –0.5 | 0   | 0.5 | %    |
| TCVIONL        | Output drift, second order              | TCVO1 – TCVO2                                                                       | –20  | 0   | 20  | LSB  |
| GAINNL         | Gain non linearity                      | At TST1/ TST0, V <sub>in</sub> = –3 mV, 1 mV                                        | –20  | 0   | 20  | mV   |



**Figure 16. Analog Front-End Gain Non-Linearity (Measured vs Calculated)**

**ELECTRICAL CHARACTERISTICS – Data Input-Output (DI/DO)**V<sub>DD</sub> = V<sub>CC</sub> = V<sub>CCA</sub> = 5 V +5%/–10%, T<sub>A</sub> = –40°C to 85°C (unless otherwise noted)

| PARAMETER                                    |                                                 | TEST CONDITIONS                                     | MIN                 | TYP                                                           | MAX                 | UNIT |
|----------------------------------------------|-------------------------------------------------|-----------------------------------------------------|---------------------|---------------------------------------------------------------|---------------------|------|
| <b>Data Input-Output (DI/DO)</b>             |                                                 |                                                     |                     |                                                               |                     |      |
| LD                                           | Data length                                     | Word length                                         |                     | 10                                                            |                     | Bits |
| VDOL                                         | Output low level                                | I <sub>sink</sub> = 5 mA                            |                     |                                                               | 0.1 V <sub>CC</sub> | V    |
| VDOH                                         | Output high level                               | External pullup                                     | 0.9 V <sub>CC</sub> |                                                               |                     | V    |
| CDIO                                         | Capacitive load                                 | No Oscillation                                      | 1000                |                                                               |                     | pF   |
| Isink2                                       | Output sink current                             | Rx mode, High impedance (Z state)                   | 0                   |                                                               | 1                   | μA   |
| DOH                                          | Output high clamp                               |                                                     |                     | 1023                                                          |                     |      |
| DOL                                          | Output low clamp                                |                                                     |                     | 0                                                             |                     |      |
| DOER                                         | Accuracy                                        | Include life-time drift                             | -1                  |                                                               | 1                   | %FS  |
| VDIL                                         | Input low level                                 |                                                     |                     |                                                               | 0.3 V <sub>CC</sub> | V    |
| VDIH                                         | Input high level                                |                                                     | 0.7 V <sub>CC</sub> |                                                               |                     | V    |
| RDI1                                         | Input resistance                                | Pullup / DI = 2.5 V / 0 V                           | 30                  | 50                                                            | 70                  | kΩ   |
| ID1                                          | Input leakage                                   | DI = V <sub>CC</sub>                                |                     |                                                               | 1                   | μA   |
| TRFDO1 <sup>(1)</sup>                        | DO rise / fall time for 500 to 2250 baud rate   | f <sub>osc</sub> = 2.458 MHz, C = 1 nF, CONFBPS < 8 |                     |                                                               | 4.7                 | μs   |
| TRFDO2 <sup>(1)</sup>                        | DO rise / fall time for 2500 to 38.4k baud rate | f <sub>osc</sub> = 2.458 MHz, C = 1 nF, CONFBPS > 7 |                     |                                                               | 1                   | μs   |
| <b>Data Input-Output Tx, Rx requirements</b> |                                                 |                                                     |                     |                                                               |                     |      |
| f <sub>osc</sub>                             | Internal clock frequency                        | T <sub>A</sub> = -40, 85°C, REFI = 10 kΩ            | 2.25                | 2.4575                                                        | 2.65                | MHz  |
| f <sub>comclk</sub>                          | Internal communication clock frequency          | f <sub>osc</sub> = 2.458 MHz, At TST1 in test mode  |                     | BR <sup>(2)</sup> × 16                                        |                     | Hz   |
| t <sub>strto</sub>                           | Start bit output time                           | f <sub>osc</sub> = 2.458 MHz                        |                     | 1/ baud rate                                                  |                     | ms   |
| t <sub>strt1</sub>                           | Start bit decision time                         | f <sub>osc</sub> = 2.458 MHz                        |                     | 8 / (BR <sup>(2)</sup> × 16)<br>16 / (BR <sup>(2)</sup> × 16) |                     | ms   |
| t <sub>stpo</sub>                            | Stop bit                                        | f <sub>osc</sub> = 2.458 MHz                        |                     | 1/ BR <sup>(2)</sup>                                          |                     | ms   |
| t <sub>stpi</sub>                            | Stop bit decision time                          | f <sub>osc</sub> = 2.458 MHz                        |                     | 8 / (BR <sup>(2)</sup> × 16)<br>16 / (BR <sup>(2)</sup> × 16) |                     | ms   |
| t <sub>rtx</sub>                             | RX-TX interval                                  | f <sub>osc</sub> = 2.458 MHz                        | 1                   | 1.5                                                           | 2                   | bit  |
| t <sub>btx</sub>                             | TX-TX interval                                  | f <sub>osc</sub> = 2.458 MHz                        | 1.5                 | 2                                                             | 2.5                 | bit  |

(1) External R and C need to be chosen so that total communication speed error is less than (4.5% - system error).

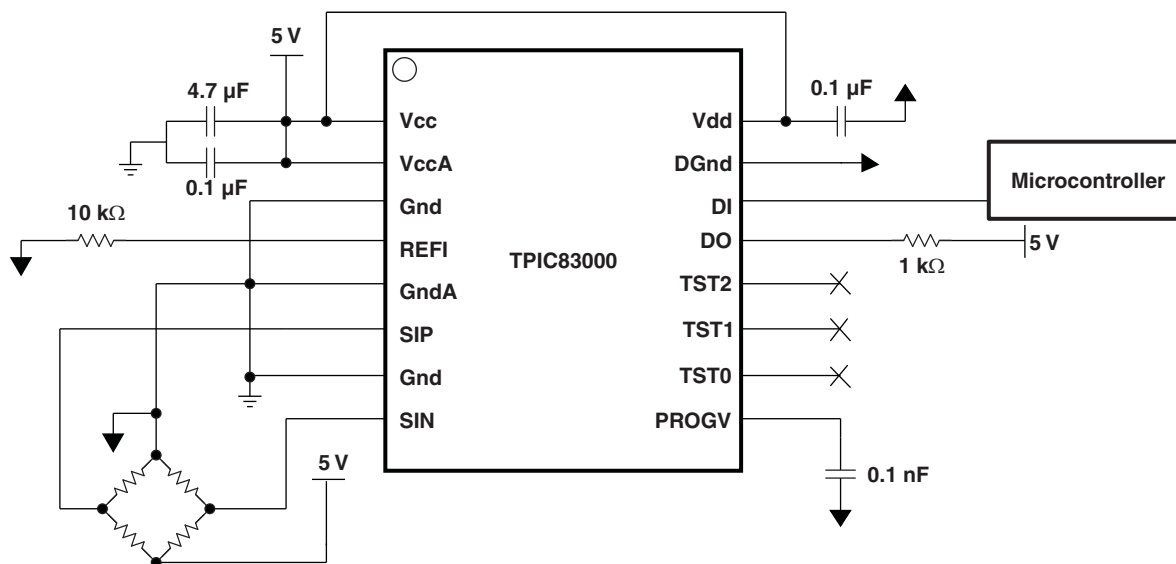
(2) BR = baud rate

**ELECTRICAL CHARACTERISTICS – REFI**V<sub>DD</sub> = V<sub>CC</sub> = V<sub>CCA</sub> = 5 V +5%/–10%, T<sub>A</sub> = –40°C to 85°C (unless otherwise noted)

| PARAMETER         |                         | TEST CONDITIONS | MIN   | TYP | MAX   | UNIT |
|-------------------|-------------------------|-----------------|-------|-----|-------|------|
| V <sub>REFI</sub> | Voltage across REFI pin | R = 10 kΩ       | 1.425 | 1.5 | 1.575 | V    |
| I <sub>REFI</sub> | Current out of REFI pin | R = 10 kΩ       | 142.5 | 150 | 157.5 | μA   |
| C <sub>REFI</sub> | Maximum capacitance     |                 |       |     | 20    | pF   |



## APPLICATION INFORMATION



**Figure 17. General Application Circuit**

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TPIC83000IPWRQ1  | ACTIVE                | TSSOP        | PW              | 16   | 2000        | TBD                     | CU NIPDAU        | Level-1-240C-UNLIM           |
| TPIC83000IPWRQ1  | PREVIEW               | TSSOP        | PW              | 16   |             | TBD                     | Call TI          | Call TI                      |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

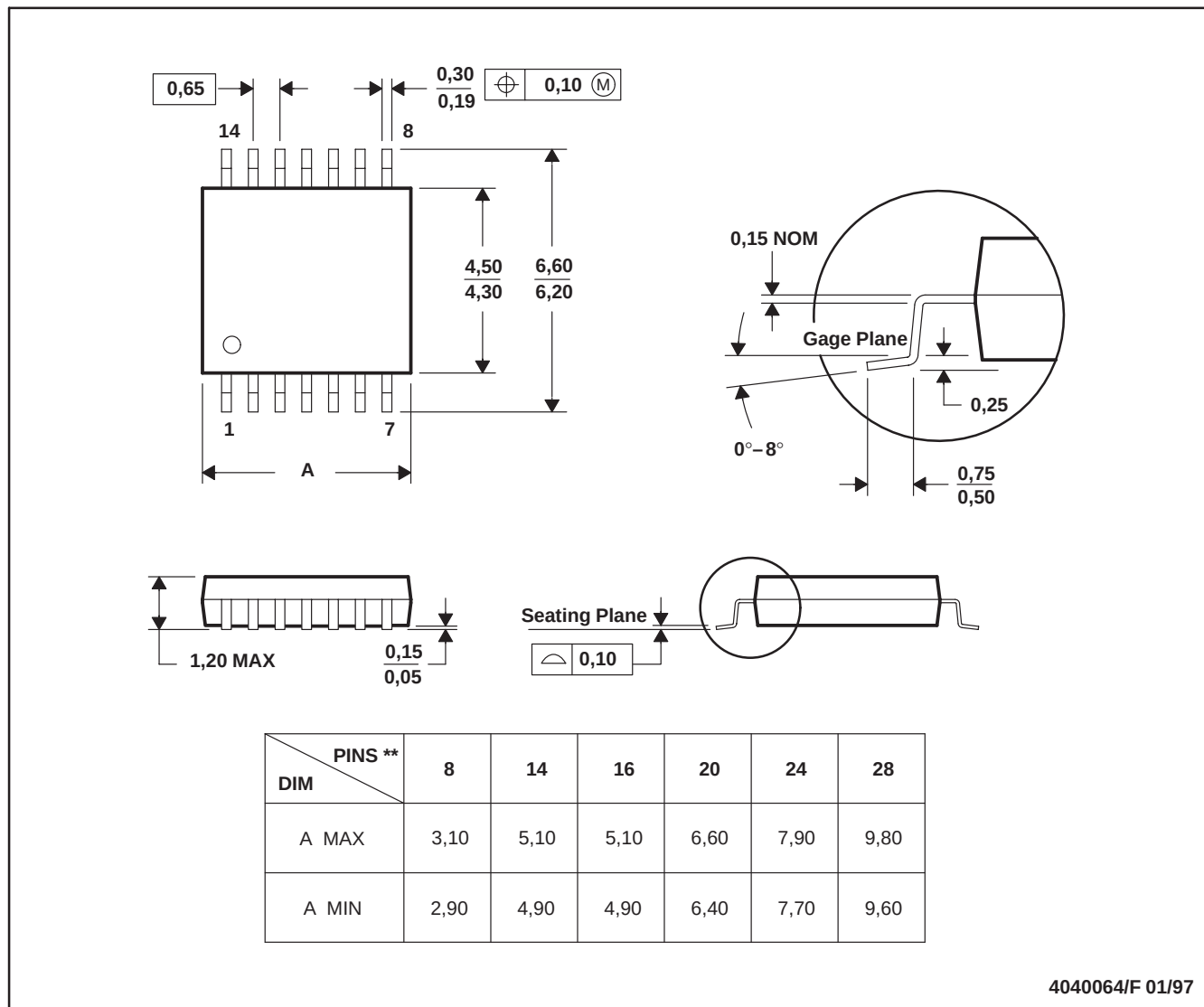
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## PW (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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