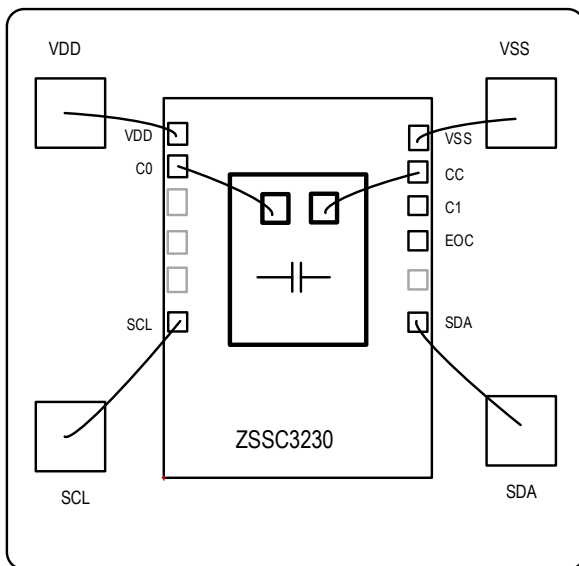


## Description

The ZSSC3230 is a CMOS integrated circuit for accurate capacitance-to-digital conversion and sensor-specific correction of capacitive sensor signals. Digital compensation of sensor offset, sensitivity, and temperature drift is accomplished via an internal digital signal processor running a correction algorithm with calibration coefficients stored in a nonvolatile, multiple-time programmable (NVM) memory. Programming the ZSSC3230 is simple via the serial interface. The interface is used for the PC-controlled calibration procedure, which programs the set of calibration coefficients in memory. The ZSSC3230 is configurable for capacitive sensors with capacitances up to 30pF and will provide an output resolution that is scalable up to 18-bit. It is compatible with single-ended capacitive sensors. Measured and corrected sensor values can be output as I2C ( $\leq 3.4\text{MHz}$ ).

The ZSSC3230 provides accelerated signal processing, increased resolution, and improved noise immunity in order to support high-speed control, safety, and real-time sensing applications with the highest requirements for energy efficiency.

## Basic Application Diagram



## Typical Applications

- Humidity sensors
- Pressure sensors, level sensors
- Smart, digital, capacitive sensors for energy-efficient solutions
- Consumer / white goods (e.g., HVAC)
- Medical applications

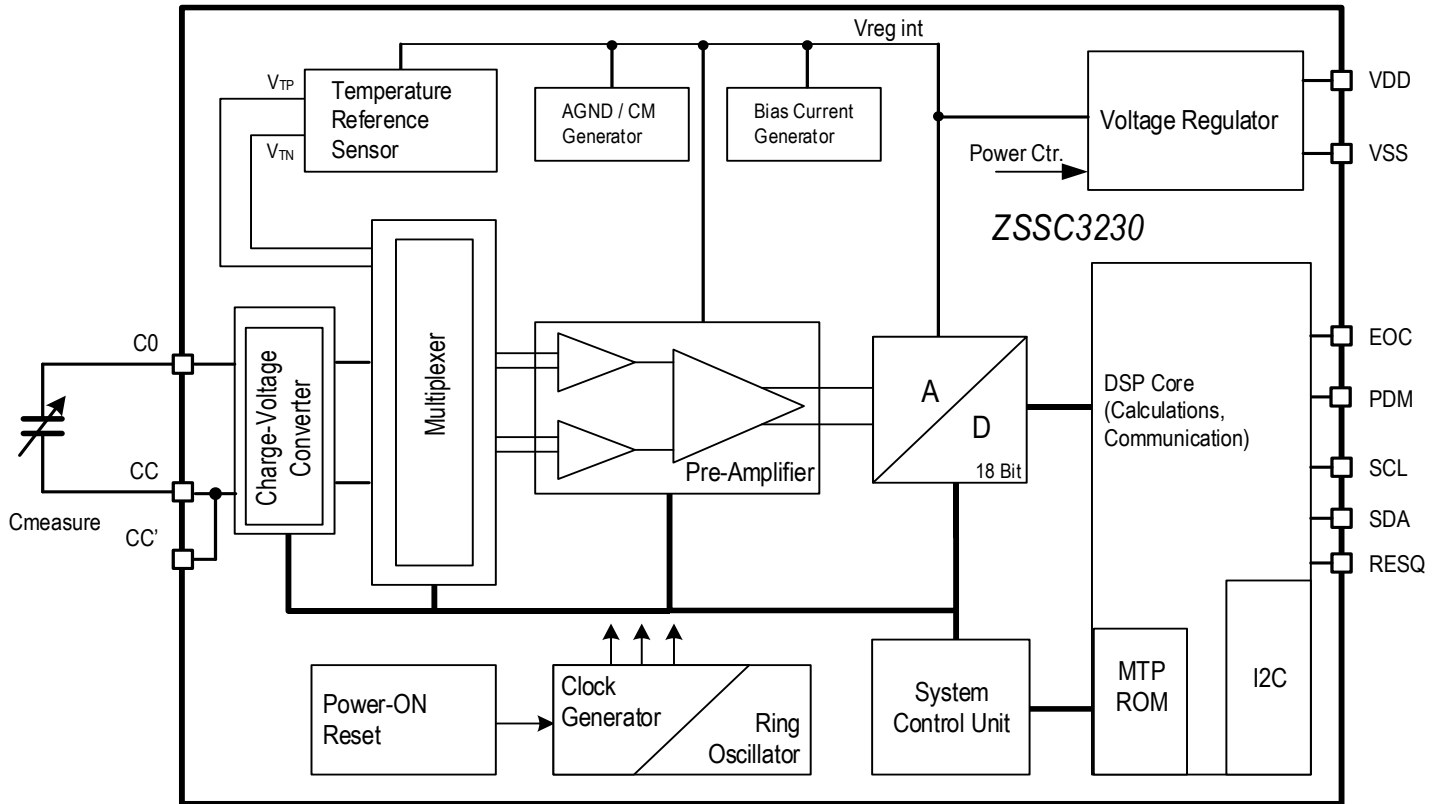
## Features

- Low current consumption: 1.3 $\mu\text{A}$  at 1 sample per second
- Maximum target input capacitance: 30pF
- Programmable capacitance span and offset
- High sampling rate with 2ms at 14-bit resolution
- ADC resolution: Adjustable in speed and resolution, 18-bit maximum
- Internal auto-compensated temperature sensor; not stress sensitive
- Programmable measurement sequence, single-shot and automatic cycling of measurements with end-of-sequence interrupt output
- Oversampling modes using internal averaging
- Interrupt features
- Integrated NVM for configuration and free space for customer use
- Small die size
- External reset pin (low active)
- No external trimming components required
- Highly integrated CMOS design

## Physical Characteristics

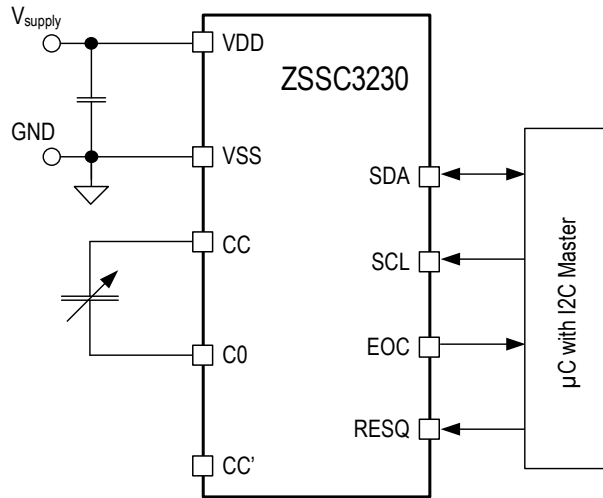
- Supply voltage  $V_{DD}$ : 1.68V to 3.6V
- Operating temperature:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  depending on the part code
- I2C Interface compatible, supporting
  - Standard Mode(100kHz)
  - Fast Mode (400kHz)
  - High-Speed Mode (3.4MHz)
- Capacitive input range 0 to 30pF
- Capacitive offset compensation 0 to 15pF
- Available in  $4 \times 4 \text{ mm}^2$  24-PQFN package or as die

## Block Diagram

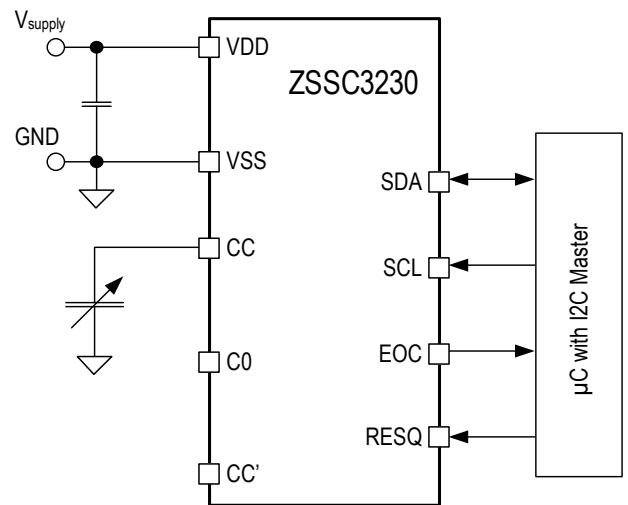


## Typical Application Examples

**Figure 1. Isolated C Mode**



**Figure 2. Grounded C Mode**



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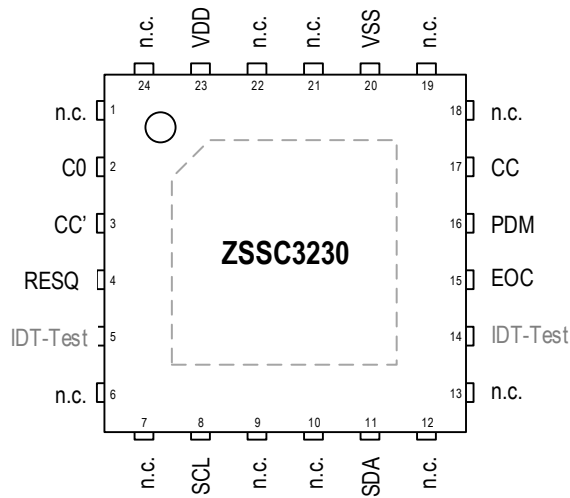
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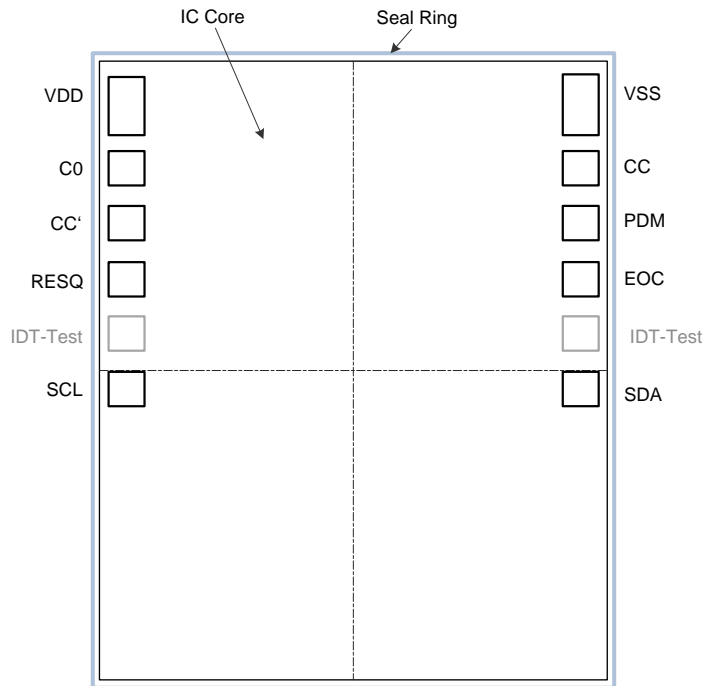
# 1. Pin Assignments

The ZSSC3230 is available as 8-inch wafer\* and QFN24 package. Details about the package are provided in section 7.

**Figure 3. Pin Assignments for 4 × 4 mm 24-PQFN Package – Top View**



**Figure 4. Pin (Pad) Assignments for Bare-Die**



\* Detailed information about wafer-shipments, etc., is available on request. See last page for contact information.

## 2. Pin Descriptions

**Table 1. Pin Descriptions**

| Pin Number | Name     | Type                 | Description                                                  |
|------------|----------|----------------------|--------------------------------------------------------------|
| 1          | n.c.     | –                    | No connection. Leave pin floating.                           |
| 2          | C0       | Analog Input         | Capacitor input signal.                                      |
| 3          | CC'      | Analog Input         | Capacitor input signal, duplicate of CC (pin 17).            |
| 4          | RESQ     | Digital Input        | RESET, low active; internal pull-up.                         |
| 5          | IDT-Test | –                    | Connect to VSS; otherwise no connection; leave pin floating. |
| 6          | n.c.     | –                    | No connection. Leave pin floating.                           |
| 7          | n.c.     | –                    | No connection. Leave pin floating.                           |
| 8          | SCL      | Digital Input        | Clock input for I2C interface.                               |
| 9          | n.c.     | –                    | No connection. Leave pin floating.                           |
| 10         | n.c.     | –                    | No connection. Leave pin floating.                           |
| 11         | SDA      | Digital Input/Output | Bi-directional data I/O for I2C. Pull-up to VDD.             |
| 12         | n.c.     | –                    | No connection. Leave pin floating.                           |
| 13         | n.c.     | –                    | No connection. Leave pin floating.                           |
| 14         | IDT-Test | –                    | Connect to VSS; otherwise no connection; leave pin floating. |
| 15         | EOC      | Digital Output       | End-of-conversion and output interrupt signal.               |
| 16         | PDM      | Digital Output       | Digital output for pulse-density modulated output.           |
| 17         | CC       | Analog Input         | Capacitor input signal, duplicate to CC' (pin 3).            |
| 18         | n.c.     | –                    | No connection. Leave pin floating.                           |
| 19         | n.c.     | –                    | No connection. Leave pin floating.                           |
| 20         | VSS      | Ground               | Power supply ground.                                         |
| 21         | n.c.     | –                    | No connection. Leave pin floating.                           |
| 22         | n.c.     | –                    | No connection. Leave pin floating.                           |
| 23         | VDD      | Supply               | Power supply.                                                |
| 24         | n.c.     | –                    | No connection. Leave pin floating.                           |

### 3. Absolute Maximum Ratings

The absolute maximum ratings are stress ratings only. Stresses greater than those listed below can cause permanent damage to the device. Functional operation of the ZSSC3230 at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

**Table 2. Absolute Maximum Ratings**

| Symbol         | Parameter                         | Conditions         | Minimum | Maximum                       | Units |
|----------------|-----------------------------------|--------------------|---------|-------------------------------|-------|
| $T_J$          | Junction temperature              |                    | –       | 135                           | °C    |
| $T_S$          | Storage temperature               |                    | -45     | 150                           | °C    |
|                | ESD – Human Body Model            |                    | –       | 2000                          | V     |
|                | ESD – Charged Device Model        |                    | –       | 750                           | V     |
|                | Latch-up                          |                    | -100    | +100                          | mA    |
| $V_{DD_{max}}$ | Voltage supply range              | Referenced to VSS  | -0.3    | 3.63                          | V     |
| $V_{IF_{max}}$ | Voltage at digital interface pins | I2C pins: SDA, SCL | -0.3    | VDD +0.5V<br>or 3.63V<br>max. | V     |

### 4. Recommended Operating Conditions

**Table 3. Recommended Operating Conditions**

| Symbol          | Parameter                                                                   | Minimum | Typical | Maximum | Units |
|-----------------|-----------------------------------------------------------------------------|---------|---------|---------|-------|
| $V_{DD}$        | Power supply voltage                                                        | 1.68    | –       | 3.6     | V     |
| $T_A$           | Ambient temperature                                                         | -40     | –       | 125     | °C    |
| $C_{VDD}$       | External (parasitic) capacitance between VDD and VSS                        | 0       | 10      | –       | nF    |
| $SR_{VDD\_POR}$ | Recommended $V_{DD}$ rise slew rate for power-on-reset (POR) <sup>[a]</sup> | 10      | –       | –       | V/ms  |

[a] Per design, there is no (theoretical) minimum  $V_{DD}$  slew-rate to trigger a clean POR; however, a reasonable slew rate is recommended.



## 5. Electrical Characteristics

All parameter values are valid only under specified operating conditions. All voltages are referenced to  $V_{SS}$ .

**Table 4. Electrical Characteristics**

| Symbol                                        | Parameter                                                      | Conditions                                                                                                                  | Minimum | Typical | Maximum | Units   |
|-----------------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|---------|---------|---------|---------|
| <b>IC Supply</b>                              |                                                                |                                                                                                                             |         |         |         |         |
| $I_{IC}$                                      | Current consumption, active ZSSC3230                           | Excluding connected sensor elements; $noise\_mode = 0$ ; see Table 16                                                       | –       | 750     | 1100    | $\mu A$ |
| $I_{IDLE}$                                    | Idle current consumption, ZSSC3230 in Sleep State              |                                                                                                                             | –       | 0.07    | 1       | $\mu A$ |
| $I_{AVE}$                                     | Average current draw                                           | Mean current consumption for one complete SSC-measurement cycle per second at 14-bit digital-only output, $noise\_mode = 0$ | –       | 1.7     | 3.3     | $\mu A$ |
| PSRR                                          | Static power supply rejection ratio (PSRR)                     | $V_{DD} = 3V$                                                                                                               | –       | 40      | –       | dB      |
| <b>CDC Characteristics</b>                    |                                                                |                                                                                                                             |         |         |         |         |
| $C_{RANGE}$                                   | Sensor capacitance range                                       |                                                                                                                             | 0       | –       | 30      | pF      |
| $C_{OFFSET}$                                  | Absolute sensor capacitance offset                             |                                                                                                                             | 0       | –       | 15      | pF      |
| $C_{SIGNAL}$                                  | Effective sensor capacitance                                   |                                                                                                                             | -15     | –       | 15      | pF      |
| $f_{clk}$                                     | Analog base clock frequency                                    |                                                                                                                             | –       | 750     | –       | kHz     |
| ENOB                                          | Effective number of bits, $\pm 3\sigma_{Noise}$                | $r_{ADC} = 18$ -bit, no oversampling                                                                                        | –       | 14.4    | –       | Bit     |
| <b>Analog-to-Digital Converter (ADC, A2D)</b> |                                                                |                                                                                                                             |         |         |         |         |
| $r_{ADC}$                                     | Resolution                                                     |                                                                                                                             | 12      | –       | 18      | Bit     |
| $f_{S,RAW}$                                   | Conversion rate; conversions per second                        | Single external sensor A2D conversion (including auto-zero measurement AZ); resolution and mode dependent                   | 94      | –       | 1250    | Hz      |
| $f_{S,CORR}$                                  | SSC-conversion rate for full SSC cycle; conversions per second | Full SSC-measurements per second: temperature (14-bit) + capacitance (12 to 18 bit)                                         | 86      | –       | 555     | Hz      |
| $f_{S,TEMP}$                                  | SSC-conversion rate for temperature measurement                | 14-bit resolution                                                                                                           | –       | 960     | –       | Hz      |
| ADCnoise                                      | ADC-noise sigma                                                | $r_{ADC} = 16$ -bit                                                                                                         | –       | 1       | –       | LSB     |
| ENOB                                          | Effective number of bits, $\pm 3\sigma_{Noise}$                | $r_{ADC} = 18$ -bit, no oversampling                                                                                        | –       | 16      | –       | Bit     |

| Symbol                                        | Parameter                                                   | Conditions                                                                                                                                      | Minimum | Typical | Maximum | Units   |
|-----------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|---------|---------|
| <b>Power-Up Conditions</b>                    |                                                             |                                                                                                                                                 |         |         |         |         |
| $t_{\text{stup1}}$                            | Start-up time communication                                 | Delay between VDD ramp up and start of first command (proven by design)                                                                         | –       | –       | 1       | ms      |
| $t_{\text{stup2}}$                            | Start-up time analog operation                              | Delay between VDD ramp up and analog operation (proven by design)                                                                               | –       | –       | 2.5     | ms      |
| $t_{\text{wup1}}$                             | Wake-up time communication                                  | Delay between sleep state and start of first command (proven by design)                                                                         | –       | –       | 0.5     | ms      |
| $t_{\text{wup2}}$                             | Wake-up time analog operation                               | Delay between sleep state and analog operation (proven by design)                                                                               | –       | –       | 2       | ms      |
| <b>Sensor Signal Conditioning Performance</b> |                                                             |                                                                                                                                                 |         |         |         |         |
| $f_{\text{SSCout}}$                           | Output (update) rate                                        | SSC-corrected digital output rate; capacitance sensor measurement: 16-bit; temperature measurement: 14-bit; <i>noise_mode</i> = 0; see Table 16 | –       | 290     | –       | Hz      |
| $\text{Err}_{\text{A,IC}}$                    | ZSSC3230 accuracy error using internal SSC calculation math | Accuracy error for sensor being ideally linear (for temperature and measurand)                                                                  | –       | 0.1     | –       | %FSO    |
| <b>Oscillator</b>                             |                                                             |                                                                                                                                                 |         |         |         |         |
| $f_{\text{CLK}}$                              | Internal oscillator frequency                               |                                                                                                                                                 | –       | 3.0     | –       | MHz     |
| <b>Temperature Sensor(s)</b>                  |                                                             |                                                                                                                                                 |         |         |         |         |
| $r_{\text{Temp}}$                             | Internal temperature sensor resolution                      |                                                                                                                                                 | –       | 55      | –       | LSB/K   |
| <b>Interface and Memory</b>                   |                                                             |                                                                                                                                                 |         |         |         |         |
| $f_{\text{C,I2C}}$                            | I2C clock frequency                                         |                                                                                                                                                 | –       | –       | 3.4     | MHz     |
| $t_{\text{PROG}}$                             | NVM program time                                            | Programming time per 16-bit word                                                                                                                | –       | 20      | –       | ms      |
| $n_{\text{NVM}}$                              | NVM endurance                                               | Number of reprogramming cycles                                                                                                                  | 1000    | 10000   | –       | Numeric |
| $t_{\text{RET,NVM}}$                          | Data retention                                              |                                                                                                                                                 | 10      | –       | –       | Years   |

## 6. Device Description

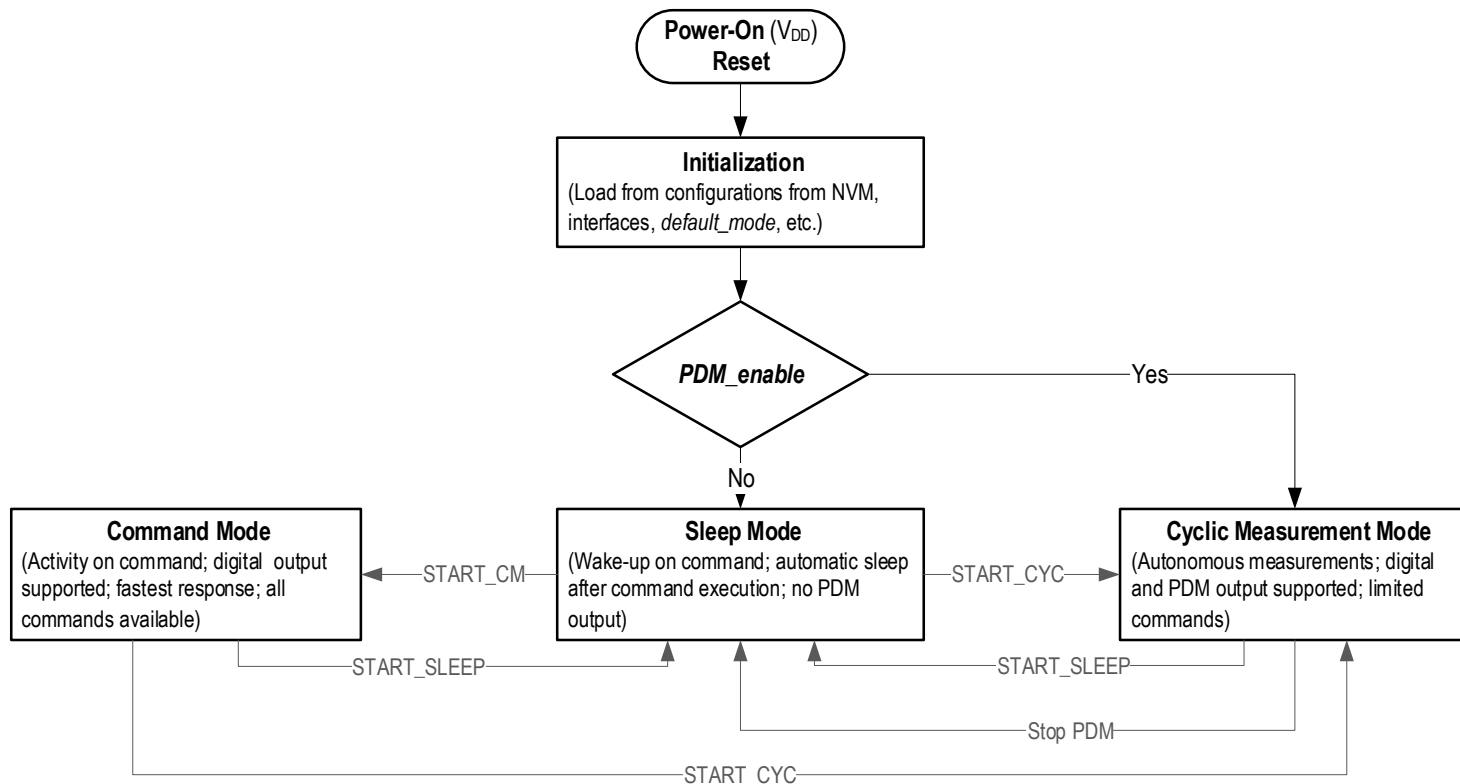
The ZSSC3230 can be set up for one of three main operating modes:

- **Sleep Mode** – Sleep Mode based operation is recommended for smart sensors for the lowest average power consumption. The ZSSC3230 automatically enters an idle state after command execution for minimum current consumption; however, the interface is still listening and accepts commands. After receiving of a valid command, the ZSSC3230 wakes up, executes the command, and provides the results at the digital interface and then returns to Sleep State.
- **Command Mode** – Command Mode is most appropriate for evaluation, test, and calibration purposes. In this mode, all commands are available, both digital and analog outputs are supported, and no restrictions for any functionality need to be considered. Command Mode can be used for applications requiring re-occurring (or even continuous) digital interaction and minimum latency. Applications in Command Mode are only active on command request. See Table 15 for definitions of the commands.
- **Cyclic Measurement Mode** – Cyclic operation means autonomous, cyclically repeated sensor measurements and related digital and output updates.

After power-on, the voltage regulators are switched on, and the ZSSC3230's low-voltage section (LV) is active while the related interface configuration information is read from memory. Then the LV section is switched off, the ZSSC3230 goes into Sleep Mode, and the interface is ready to receive commands. The interface is always powered by  $V_{DD}$ , so it is referred to as the high voltage section (HV).

Figure 5 shows the ZSSC3230 main operation modes: Normal Mode (which uses two operation principles: "Sleep" and "Cyclic") and Command Mode. The Normal Mode automatically returns to Sleep Mode after executing the requested measurements, or periodically wakes up and conducts another measurement according to the setting for the sleep duration configured by the *CYC\_period* (bits[14:12] in memory register 02<sub>HEX</sub>; see Table 16). In Command Mode, the ZSSC3230 remains active if a dedicated command (e.g., Start\_NOM) is sent, which is helpful during calibration. Command Mode can only be entered if a Start\_CM (command A9<sub>HEX</sub>; see Table 15) is the first command received after a POR.

**Figure 5. Main Operating Modes of the ZSSC3230**



## 6.1 Signal Flow

See Figure 1 and Figure 2 for the ZSSC3230 block diagram sensors input options. The CC pin is duplicated as CC' depending on the preferred physical sensor connection. Selecting CC or CC' can be done using the signal setup *CC\_pin\_selection* bits[1:0] in memory register 19<sub>HEX</sub> (see Table 16).

Two sensor connections are possible:

- Differential Measurement Mode, which is an isolated C mode with  $C_{MEAS}$  connected between CC and C0 or CC' and C0 so that both ends of the capacitor are connected to the ZSSC3230.
- Single-Ended Measurement Mode, which is a grounded C mode with  $C_{MEAS}$  connected between CC and VSS or CC' and VSS/ground. In this mode, C0 is switched to VSS. In this mode, only one capacitor input pin needs to be directly connected to the ZSSC3230.

The capacitance amplifier (CapAmp), which is also referred to as the charge-voltage converter (CVC), measures an external capacitance value,  $C_{MEAS}$  and provides a differential output voltage proportional to the capacitance (change) to the subsequent ADC. Thereby  $C_{MEAS}$  is connected with both ends to the IC or with one pin to VSS.

The bias current for the stage (CapAmp) can be programmed (using the setup signal *noise\_mode* bit 8 in the *Sensor\_config* memory register 12<sub>HEX</sub>; see Table 16) to allow a trade-off between current consumption and achievable signal to noise ratio (SNR).

The system control unit controls the analog circuitry to perform the measurement types for the external capacitive sensor and internal temperature. The multiplexer selects the signal input to the amplifier, which can be the voltage-converted signals of the external capacitive sensor or the internal temperature reference sensor signal. A full measurement request will trigger an automatic sequence of all measurement types and all input signals.

The gain amplifier (PGA) adjusts the respective signal from the capacitance-to-voltage converter or internal temperature sensor. The ZSSC3230 employs a programmable analog-to-digital converter (ADC) optimized for conversion speed and noise suppression. The programmable resolution from 12 to 18 bits provides flexibility for adapting the conversion characteristics.

The math core accomplishes the auto-zero, span, and 1<sup>st</sup> and 2<sup>nd</sup> order temperature compensation of the measured external sensor signal. The correction coefficients are stored in the nonvolatile memory. The ZSSC3230 supports I2C interface communication for controlling the ZSSC3230, configuration, and measurement result output. An adequate PDM signal for the compensated sensor signal can be provided in Cyclic Measurement Mode at the PDM pin.

Table 5 lists the conversion time of a full corrected and compensated measurement. The temperature measurement always has a 14-bit resolution. The conversion time for the sensor channels includes a full ADC conversion plus auto-zero measurement and the corresponding CVC conversion time for this channel and the respective temperature measurement and math calculation. The 2 noise modes (bit[8] in memory register 12<sub>HEX</sub>) are listed separately.

**Table 5. Conversion Time for Full Temperature Compensated Measurement**

| <i>adc_bits</i> [7:6] |        | ADC Resolution [Bits] | Conversion Time for Full Temperature Compensated Measurement, Typical [ $\mu$ s] |                       |
|-----------------------|--------|-----------------------|----------------------------------------------------------------------------------|-----------------------|
| bit[7]                | bit[6] |                       | <i>noise_mode</i> = 0                                                            | <i>noise_mode</i> = 1 |
| 0                     | 0      | 12                    | 1770                                                                             | 2550                  |
| 0                     | 1      | 14                    | 2310                                                                             | 3850                  |
| 1                     | 0      | 16                    | 3390                                                                             | 6440                  |
| 1                     | 1      | 18                    | 5520                                                                             | 11630                 |

## 6.2 Capacitive Sensor Front-End

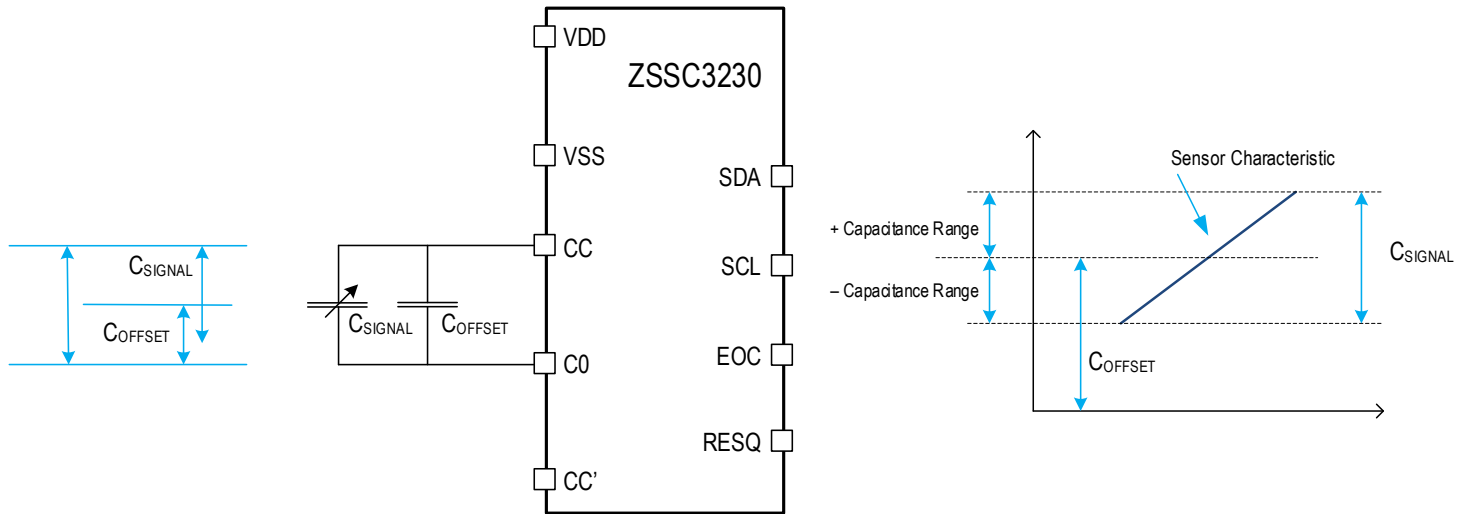
The capacitance amplifier input range ( $C_{RANGE}$ ) must be adjusted to the external capacitance conditions for signal ( $C_{SIGNAL}$ ) and offset shift ( $C_{OFFSET}$ ) as given in Equation 1. See Figure 6 for an illustration of the terms.

$$C_{RANGE} = C_{OFFSET} + C_{SIGNAL} \tag{Equation 1}$$

$C_{OFFSET}$  operates as a zero-shift capacitance to cancel a given offset by the sensor. The offset-shift capacitance must not exceed the selected input capacitance range  $C_{RANGE}$ . For  $C_{OFFSET}$ , the respective configuration must be set up in the EEPROM for the *shift\_cap* parameter (bits[5:0] in memory register 12<sub>HEX</sub>; see Table 16).

The correlating setup for  $C_{SIGNAL}$  must be done in the EEPROM for parameter *cap\_range* (bits[13:9] in memory register 12<sub>HEX</sub>). In Table 16, the respective values are given. These values can be measured in the positive and negative direction, so the effective range of  $C_{SIGNAL}$  will be doubled compared to the *cap\_range* setting. The principle is shown in Figure 6.

**Figure 6. Capacitive Input Signal Conditions**

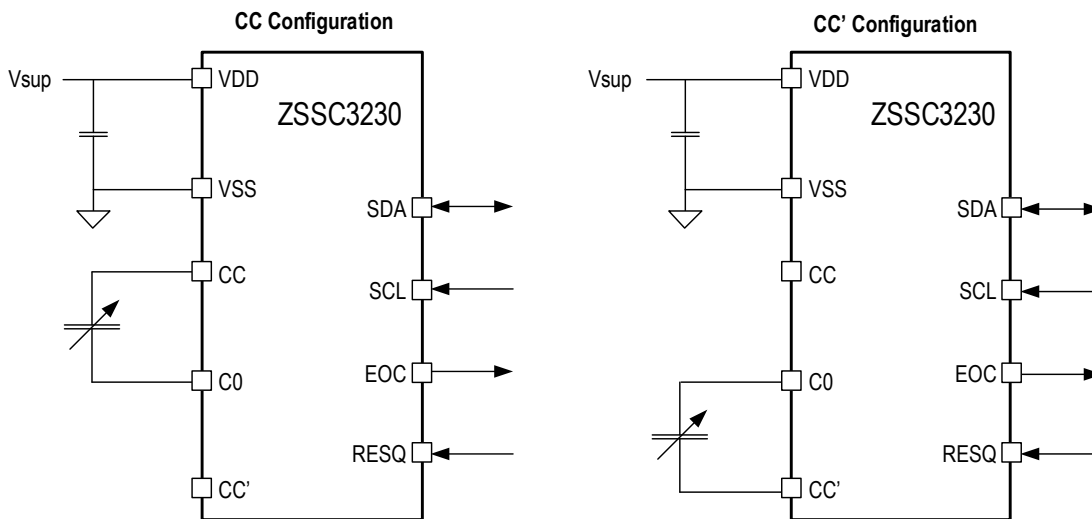


### 6.2.1 Differential Mode

The most relevant measurement mode is the Differential Measurement Mode, with  $C_{MEAS}$  connected between CC and C0 or CC' and C0 so that both ends of the capacitor are connected to the ZSSC3230. For electrical connections, see Figure 7.

For the ZSSC3230 for the Differential Measurement Mode, the configuration must be done in the EEPROM for parameter *sensecap\_type* (bit[15] in memory register 12<sub>HEX</sub>; see Table 16). When the *sensecap\_type* is 0, the differential mode is selected, which is the default configuration.

**Figure 7. Capacitive Input in Differential Mode**



### 6.2.2 Single-Ended Mode

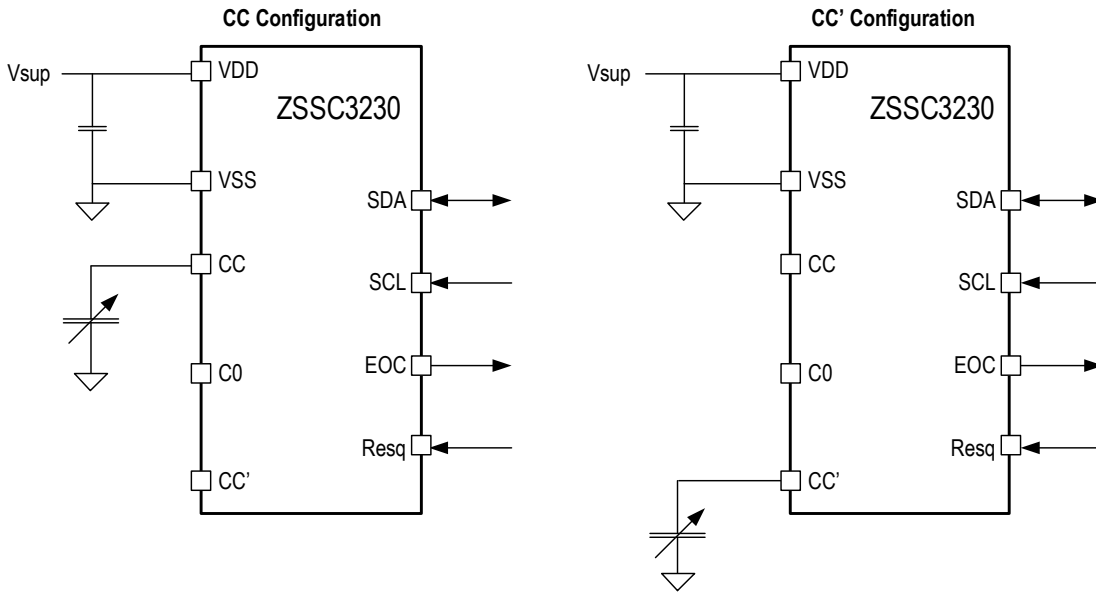
Another measurement mode is the single ended measurement mode, with  $C_{MEAS}$  connected between CC and VSS or CC' and VSS/ground. In this mode C0 is switched to VSS. In this mode only 1 Pin needs to be directly connected to the IC.

Configuring the ZSSC3230 for Single-Ended Input Mode must be done in the EEPROM via the parameter *sensecap\_type* (bit[15] in memory register 12<sub>HEX</sub>; see Table 16). Since the respective bit is defined as “0” in the default configuration for Differential Mode, the bit must be programmed to “1.”

### 6.2.3 Sensor Leakage Compensation

Sensor leakage compensation is an additional option for Single-Ended Mode to enable the sensor element’s leakage current compensation. The leakage current is caused by the sensor element’s parasitic resistance. Enabling this function via the *sensor\_leakage* bit[14] in memory register 12<sub>HEX</sub> leads to loss of dynamic range and a decrease in the SNR. With losing 1-bit effective resolution on leakage compensation, the respective capacitive input range for  $C_{SIGNAL}$  will be doubled compared to the description in section 6.2.

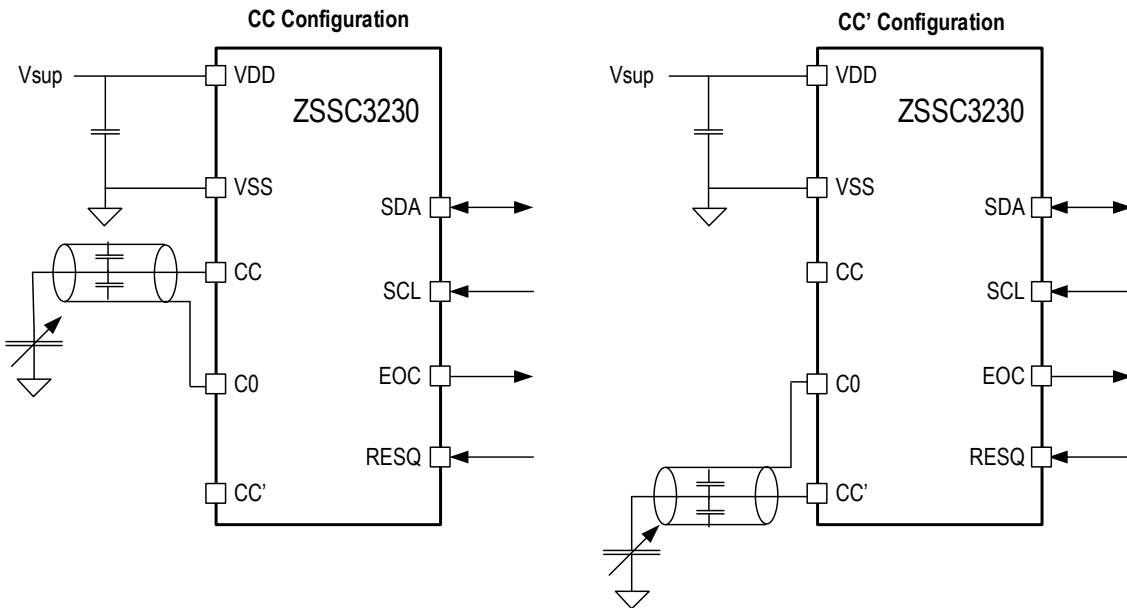
**Figure 8. Capacitive Input in Single-Ended Mode**



**6.2.4 Shield Driver Mode**

The Shield Driver Mode is a special sub-mode for Single-Ended Mode. In this mode, the C0 pin will be forced to the same level as the CC/CC' pin. This pin can be used to drive a shield, so the shield parasitic capacitance does not have an effect on the measurement. The Shield Driver Mode can be enabled by setting the EEPROM parameter *En\_shlddrv* (bit[4] in memory register 19<sub>HEX</sub>) to "1" (see Table 16).

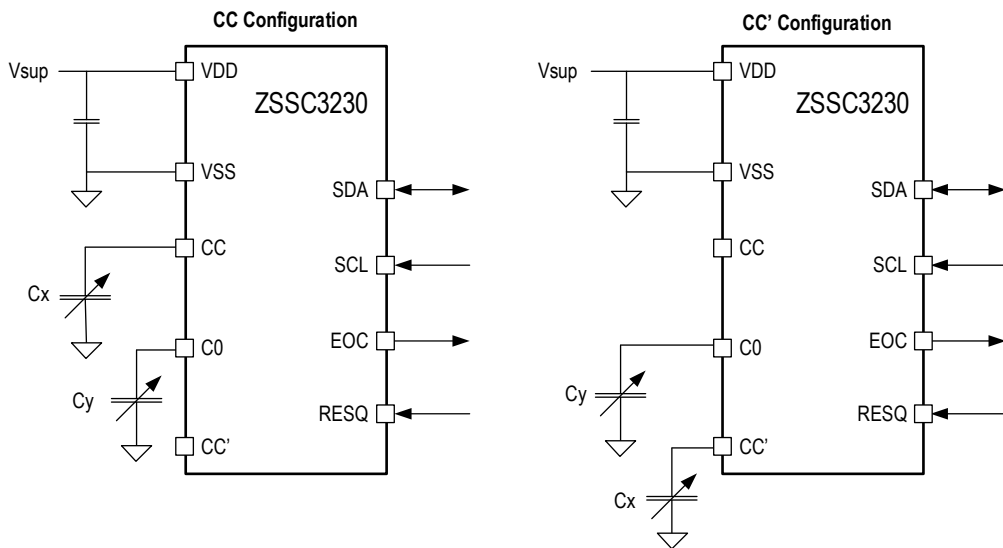
**Figure 9. Shield Driver Mode**



### 6.2.5 Subtraction Mode

The Subtraction Mode is a special sub-mode for Single-Ended Mode. It is activated by setting the *En\_sh2* bit to "1" (bit[3] in memory register 19<sub>HEX</sub>; see Table 16). In this mode, C0 is charged to the opposite reference of the CC/CC' node level. In conversion phase the charge of CC/CC' and C0 are integrated. In this mode, the integrated capacitance corresponds to "Cx-Cy"; thus this mode can provide an additional range extension.

**Figure 10. Subtraction Mode**



### 6.3 Temperature Sensor

The ZSSC3230 provides a PTAT-based internal temperature sensor measurement to allow compensation for temperature effects. The temperature output signal is a differential voltage that is adapted by the amplifier (PGA) for the ADC input. For IC-internal temperature measurements, the respective settings are defined and programmed in the NVM by IDT. The resolution setting for temperature measurements is defined as 14-bit.

### 6.4 Analog to Digital Converter (ADC)

An analog-to-digital converter (ADC) is used to digitize the amplifier signal. To allow optimizing the trade-off between conversion time and resolution, the resolution can be programmed from 12-bit to 18-bit by configuring the parameter *adc\_bits*, (bits [7:6] in memory register 12<sub>HEX</sub>; see Table 16). The ADC processes differential input signals provided by the internal amplifier for sensor measurement and temperature measurement. The application default setting is 16-bit. The corresponding conversion times are listed in Table 6. The conversion time for the sensor channels includes a full ADC conversion as well as the corresponding CVC conversion time for this channel. There are 2 noise modes (selected with bit[8] in memory register 12<sub>HEX</sub>). The listed conversion times are valid for raw measurements including auto-zero compensation.

**Table 6. ADC Resolution and Conversion Times for a Single Analog-to-Digital Conversion with Auto-Zero**

| <i>adc_bits</i> [7:6] |        | ADC Resolution [Bits] | Conversion Time ADC (including CVC), typical [ $\mu$ s] |                       | Conversion Time Temperature, Typical [ $\mu$ s] |
|-----------------------|--------|-----------------------|---------------------------------------------------------|-----------------------|-------------------------------------------------|
| bit[7]                | bit[6] |                       | <i>noise_mode</i> = 0                                   | <i>noise_mode</i> = 1 |                                                 |
| 0                     | 0      | 12                    | 770                                                     | 1550                  | 630                                             |
| 0                     | 1      | 14                    | 1310                                                    | 2850                  | 1040                                            |
| 1                     | 0      | 16                    | 2390                                                    | 5440                  | 1810                                            |
| 1                     | 1      | 18                    | 4550                                                    | 10620                 | 3470                                            |

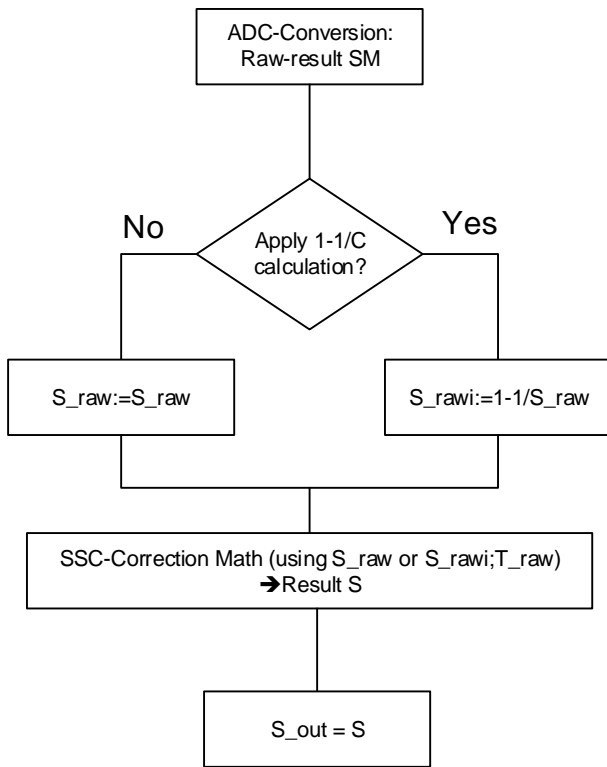


## 6.5 Calibration Math

The data path internally calculates with a 26-bit two’s-complement integer representation. The coefficients in the memory are stored as integers in sign-magnitude representation (1-bit sign + 23-bit magnitude). Each multiplication scales the product by  $2^{23}$ . There is an option to preprocess the data by applying a  $1/C$  algorithm.  $1/C$  is typically used to pre-process transfer characteristics for capacitive pressure sensors. A principle flow is shown in Figure 11.

Internal overflows and underflows are detected and the result is automatically saturated. The saturation is reported in the status byte.

**Figure 11. Principal Compensation Flow**



### 6.5.1 1/C Pre-compensation

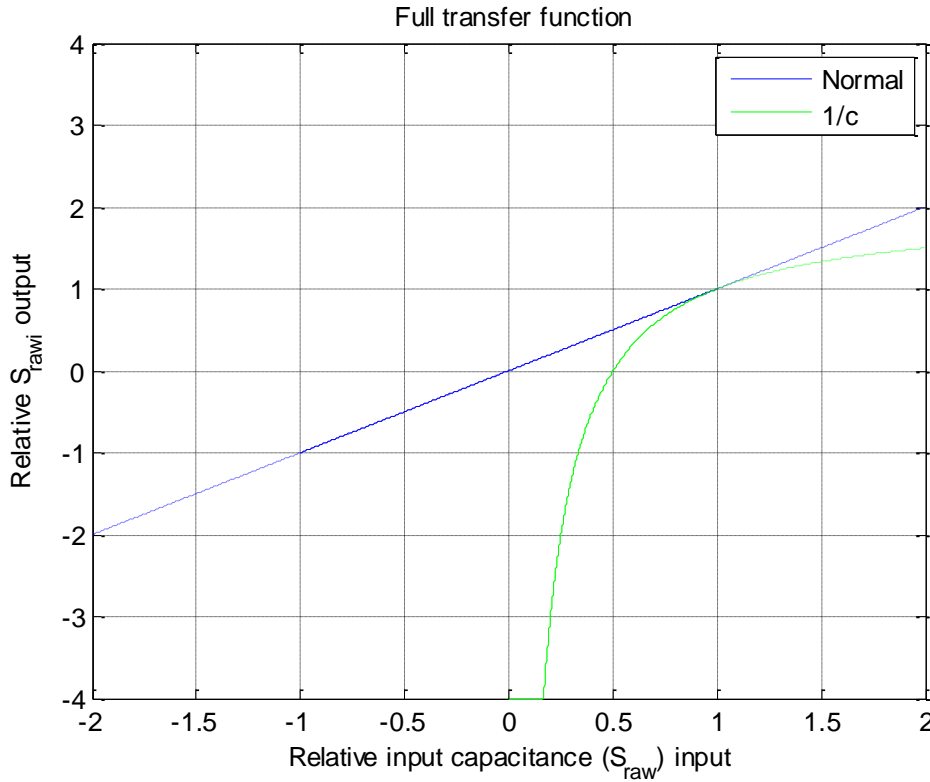
For capacitive pressure sensors, a pre-compensation of the ADC signal might be beneficial. Using this function will help to fit the typical pressure sensor transfer characteristic to matching the second-order compensation input requirements for more accurate compensation results. If the  $1/C$  pre-compensation is activated, it will apply only in Normal Measurement Mode with math compensation, not in RAW measurements using Command Mode. The respective  $1/C$  calculation for determination of calibration coefficients is handled in the respective *calibration.dll*. This feature can be enabled by setting the corresponding bit *siginv* (bit[11] in memory register 02<sub>HEX</sub>; see Table 16). Before the  $1/C$  math is applied, the ADC value of the respective sensor input signal will be inverted.

This leads to the following transfer function for  $S_{raw}$  with the system transfer function that is shown in Figure 12.

$$S_{rawi} = \left[ 2^{24} - \frac{2^{46}}{S_{raw}} \right]_{-2^{25}}^{2^{25}-1} \tag{Equation 2}$$

**Note:** For the application, if a “ $C_{range}/C_{Sens}$ ” inversion will be performed, the shift capacitor must be set to “0.”

**Figure 12. System Transfer Function for 1/C**



**6.5.2 Sensor Signal Compensation Math**

The *SOT\_curve* (bit [15] in EEPROM word 02<sub>HEX</sub>; see Table 16) selects whether second-order equations compensate for sensor nonlinearity with a parabolic or S-shaped curve. The parabolic compensation is recommended.

**Equations for the Parabolic *SOT\_curve* Setting (*SOT\_curve* = 0):**

The coefficients from the memory (23-bit absolute and 1-bit sign; see Table 7) are read into 26-bit-wide registers in the calculation block. The 24-bit-memory coefficients are shifted by two bits so that the MSB of the 24-bit memory coefficient is placed at the MSB of the 26-bit calculation register coefficient.

Simplified:

$$K_1 = 2^{23} + \frac{T_{Raw}}{2^{23}} \cdot \left( \frac{4 \cdot SOT_{tcg}}{2^{23}} \cdot T_{Raw} + 4 \cdot Tcg \right) \tag{Equation 3}$$

$$K_2 = 4 \cdot Offset_S + S_{Raw} + \frac{T_{Raw}}{2^{23}} \cdot \left( \frac{4 \cdot SOT_{tco}}{2^{23}} \cdot T_{Raw} + 4 \cdot Tco \right) \tag{Equation 4}$$

$$Z_{SP} = \frac{4 \cdot Gain_S}{2^{23}} \cdot \frac{K_1}{2^{23}} \cdot K_2 + 2^{23} \tag{Bounded to positive number range} \tag{Equation 5}$$

$$S = \frac{Z_{SP}}{2^{23}} \cdot \left( \frac{4 \cdot SOT_{sensor}}{2^{23}} \cdot Z_{SP} + 2^{23} \right) + Sensor\_Shift \tag{Bounded to positive number range} \tag{Equation 6}$$

### Equations for the S-shaped *SOT\_curve* Setting (*SOT\_curve* = 1):

Simplified:

$$Z_{SS} = \frac{4 \cdot Gain\_S}{2^{23}} \cdot \frac{K_1}{2^{23}} \cdot K_2 \quad \text{Equation 7}$$

$$S = \frac{Z_{SS}}{2^{23}} \cdot \left( \frac{4 \cdot SOT\_sensor}{2^{23}} \cdot |Z_{SS}| + 2^{23} \right) + 2^{23} + Sensor\_Shift \quad \text{(Bounded to positive number range)} \quad \text{Equation 8}$$

Complete:

$$Z_{SS} = \left[ \frac{Gain\_S}{2^{21}} \cdot \left[ \frac{K_1}{2^{23}} \cdot K_2 \right]_{-2^{25}}^{2^{25}-1} \right]_{-2^{25}}^{2^{25}-1} \quad \text{Equation 9}$$

$$S = \left[ \left[ \frac{Z_{SS}}{2^{23}} \cdot \left[ \frac{SOT\_sensor}{2^{21}} \cdot |Z_{SS}| \right]_{-2^{25}}^{2^{25}-1} + 2^{23} \right]_{-2^{25}}^{2^{25}-1} + 2^{23} + Sensor\_Shift \right]_{0}^{2^{24}-1} \quad \text{Equation 10}$$

Where the following representations are valid:

|                     |                                                                                                                                             |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <i>S</i>            | Corrected capacitive sensor reading output via I2C; range: [0 to FFFFFFF <sub>HEX</sub> ]                                                   |
| <i>S_Raw</i>        | Raw capacitive sensor reading from ADC (after auto-zero correction); shifted range to: [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ] |
| <i>Gain_S</i>       | Capacitive sensor gain term; range: [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                                                    |
| <i>Offset_S</i>     | Capacitive sensor offset term; range: [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                                                  |
| <i>Tcg</i>          | Temperature coefficient gain term; range: [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                                              |
| <i>Tco</i>          | Temperature coefficient offset term; range: [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                                            |
| <i>T_Raw</i>        | Raw temperature reading (after AZ correction); shifted range to: [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                       |
| <i>SOT_tcg</i>      | Second-order term for Tcg non-linearity; range: [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                                        |
| <i>SOT_tco</i>      | Second-order term for Tco non-linearity; range: [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                                        |
| <i>SOT_sensor</i>   | Second-order term for sensor non-linearity; range: [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                                     |
| <i>Sensor_shift</i> | Post-calibration, post-assembly offset shift; range: [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                                   |
| $ \dots $           | Absolute value                                                                                                                              |
| $[\dots]_{ll}^{ul}$ | Bound number range from ll to ul; if needed, apply saturation at the limits ll or ul and report overflow/underflow in the status byte       |

### 6.5.3 Temperature Signal Compensation

Temperature is measured internally. Temperature correction contains both linear gain and offset terms as well as a second-order term to correct for any nonlinearities. For temperature, second-order compensation for nonlinearity is always parabolic:

Simplified:

$$Z_T = \frac{4 \cdot Gain\_T}{2^{23}} \cdot (T\_Raw + 4 \cdot Offset\_T) + 2^{23} \quad \text{(Bounded to positive number range)} \quad \text{Equation 11}$$

$$T = \frac{Z_T}{2^{23}} \cdot \left( \frac{4 \cdot SOT\_T}{2^{23}} \cdot Z_T + 2^{23} \right) + T\_Shift \quad \text{(Bounded to positive number range)} \quad \text{Equation 12}$$

Where

|                 |                                                                                                                    |
|-----------------|--------------------------------------------------------------------------------------------------------------------|
| <i>T</i>        | Corrected Temperature reading output via I2C; range [0 <sub>HEX</sub> to 0xFFFFFFFF <sub>HEX</sub> ]               |
| <i>Gain_T</i>   | Gain coefficient for temperature; range [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                       |
| <i>T_Raw</i>    | Raw temperature reading after AZ correction; shifted range to [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ] |
| <i>Offset_T</i> | Offset coefficient for temperature; range [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]                     |
| <i>SOT_T</i>    | Second-order term for temperature source non-linearity; range [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ] |
| <i>T_Shift</i>  | Shift for post-calibration/post-assembly offset compensation [-7FFFFFF <sub>HEX</sub> to 7FFFFFF <sub>HEX</sub> ]  |

**Table 7. Data Format of Calibration Coefficients in Memory**

| Bit Number:         | 23                           | 22             | 21             | 20              | ... | 2                | 1                | 0                |
|---------------------|------------------------------|----------------|----------------|-----------------|-----|------------------|------------------|------------------|
| Meaning, Weighting: | 0 = Positive<br>1 = Negative | 2 <sup>1</sup> | 2 <sup>0</sup> | 2 <sup>-1</sup> | ... | 2 <sup>-19</sup> | 2 <sup>-20</sup> | 2 <sup>-21</sup> |

## 6.6 Output Stages

The ZSSC3230 supports signal output via a PDM output pin and I2C output. Measured values are provided at an I2C output interface and at a pulse-density modulation (PDM) output. The digital interface can be used for configuration and the calibration procedure using the user's computer in order to program a set of calibration coefficients into the on-chip memory.

### 6.6.1 PDM Output Stage

To use the ZSSC3230 in PDM Output Mode, the Cyclic Measurement Mode is required. The ZSSC3230 will not go into Sleep Mode or power-down between measurements. The PDM Output Mode can be enabled via the *PDM\_enable* bit (bit[9] in memory register 02<sub>HEX</sub>; see Table 16). In this case, the PDM output will be started after power-on reset.

Note: If the ZSSC3230 is not used in PDM Output Mode, the PDM pin should not be connected.

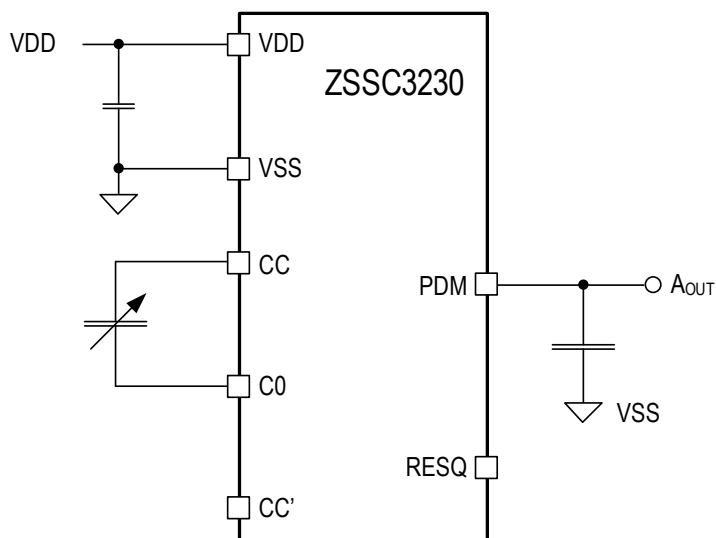
The ZSSC3230 provides a pseudo-analog output of a sigma-delta modulator, i.e. a pulse-density stream, which can be converted into an analog DAC-like output by external low-pass filtering. The PDM signal will be output selectively at the PDM pin. The PDM output is available for the compensated sensor signal. The PDM output is scaled to a 16-bit wide output signal.

When the PDM output is used, an external capacitor must be connected to the PDM output as shown in Figure 13.

**Table 8. Analog Output Performance by External Capacitor Value**

| Filter Capacitance (nF) | Vout Ripple ( $\mu$ V/V) | 0 to 90% Settling Time (ms) | Analog Output Resolution (Bit) |
|-------------------------|--------------------------|-----------------------------|--------------------------------|
| 100                     | 1000.0                   | 2.3                         | 10                             |
| 400                     | 250                      | 9.2                         | 12                             |
| 1600                    | 62                       | 36.8                        | 14                             |
| 6400                    | 16                       | 147.2                       | 16                             |

**Figure 13. PDM Output Configuration**



**6.6.2 I2C Output**

The ZSSC3230 supports an I2C slave interface for digital output operation. The implementation of the interfaces is such that the available commands (see section 6.7.2) and request codes for the ZSSC3230 are the same regardless on the interface type used.

Initially after power-up or reset, the I2C slave address is loaded from the on-chip NVM from the *Slave\_Addr* bits [6:0] in register 02<sub>HEX</sub>; see Table 16). There is a general status byte, which is part of the ZSSC3230’s digital response on READ requests. Every response starts with a status byte followed by the data word. The data word depends on the previous command. It is possible to read the same data more than once if the read request is repeated. The next command invalidates any previous data.

**Table 9. General Status Byte**

| Bit-Number: | 7 | 6        | 5     | 4    | 3 | 2             | 1            | 0               |
|-------------|---|----------|-------|------|---|---------------|--------------|-----------------|
| Meaning:    | 0 | Powered? | Busy? | Mode |   | Memory Error? | ADC Overflow | Math Saturation |

- Bit 7 is intentionally not assigned in order to allow for a 1 bit-length time.
- Bit 6 indicates power: 1 if device is powered, 0 if not powered.
- Bit 5 indicates whether the ZSSC3230 is busy. The data for the last command is not available yet. No new commands are processed if the device is busy. It is “1” if the device is busy.

- Bit 3 and 4 indicate the actual mode of the ZSSC3230: 00 = Normal Operation Mode; 01 = Command Mode; 10 = Test Mode. See Table 10.
- Bit 2 shows whether there has been a memory integrity/error as indicated by whether the checksum-based integrity check passed or failed: 0 if the integrity test passed; 1 if the test failed.
- Bit 1 shows whether there has been an ADC overflow, which is detected if the raw ADC-output value for capacitive measurement exceeded the nominal, digital ADC-output range, depending on the selected ADC resolution. This check is only for the raw results for the capacitive measurement.
- Bit 0 shows the status information regarding ALU saturation. If the last executed command was a measurement request, this bit is 0 if any intermediate value and the final SSC result are in a valid range and no SSC-calculation internal saturation occurred. If the last command was a measurement request, this bit is 1 if an SSC-calculation internal saturation occurred. This bit is also 0 for any non-measurement command.

**Table 10. Mode Status**

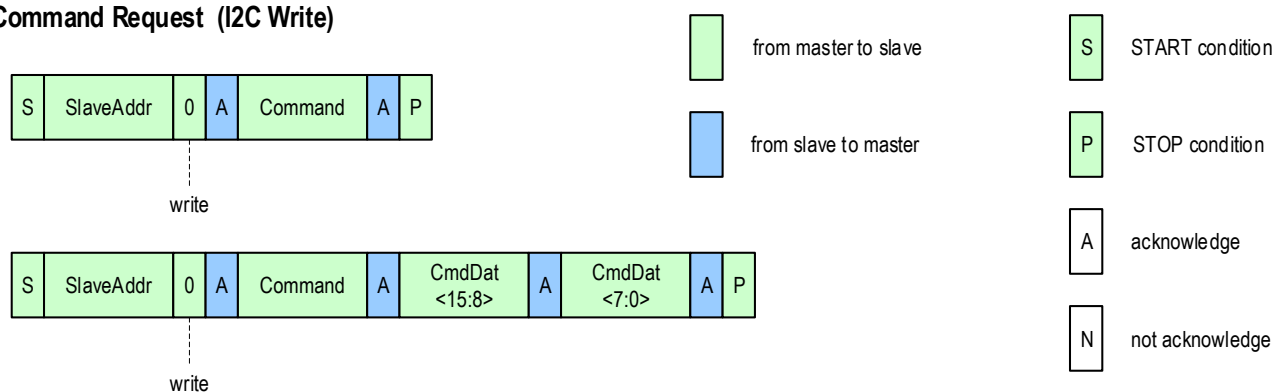
| Status[4:3] | Mode                                                |
|-------------|-----------------------------------------------------|
| 00          | Normal Operation Mode (sleep and cyclic operations) |
| 01          | Command Mode                                        |
| 10          | IDT Reserved for Test Mode                          |
| 11          | IDT Reserved                                        |

The I2C interface is compliant with the *NXP I2C Bus Specification, Rev. 06* (UM10204, 4 April 2014). All modes up to High Speed Mode are supported. Slave address codes 04<sub>HEX</sub> to 07<sub>HEX</sub> must not be programmed to the ZSSC3230 since they are exclusively used for the High Speed Mode. The ZSSC3230 will support 7 bit addressing only.

In I2C Mode, each command is started as shown in Figure 14. Only the number of bytes that are needed for the command must be sent. An exception is the I2C High Speed Mode where 3 bytes must always be sent. After the execution of a command (busy = 0), the expected data can be read as illustrated in Figure 15 or if no data are returned by the command, the next command can be sent. The status can be read at any time as described in Figure 16.

**Figure 14. I2C Command Request**

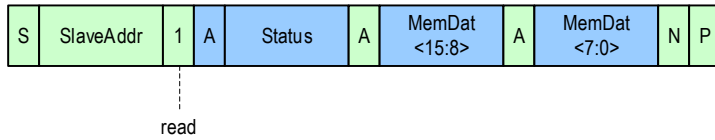
**Command Request (I2C Write)**



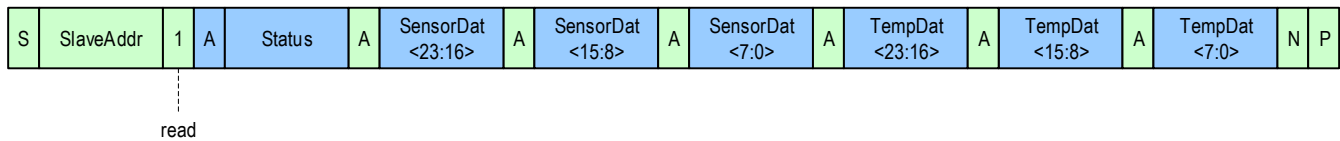
**Figure 15. I2C Read Data**

**Read Data (I2C Read)**

(a) Example: after the completion of a Memory Read command

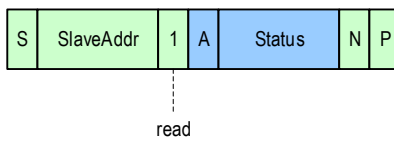


(b) Example: after the completion of a *Measure* command (AA<sub>HEX</sub>)



**Figure 16. I2C Read Status**

**Read Status (I2C Read)**



**Table 11. I2C Interface Parameters**

| Symbol                | Parameter                         | Conditions                                                                                                                                                                                                           | Minimum | Typical | Maximum | Units           |
|-----------------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|---------|-----------------|
| f <sub>SCL</sub>      | Interface clock                   |                                                                                                                                                                                                                      | 0.1     | –       | 3.4     | MHz             |
| D <sub>SPI</sub>      | Duty cycle                        |                                                                                                                                                                                                                      | 33      | –       | 50      | %               |
| V <sub>high,I2C</sub> | Input HIGH level voltage          | Referenced to the external supply voltage V <sub>DD</sub>                                                                                                                                                            | 0.7     | –       | 1.0     | V <sub>DD</sub> |
| V <sub>low,I2C</sub>  | Input LOW level voltage           |                                                                                                                                                                                                                      | 0.0     | –       | 0.3     | V <sub>DD</sub> |
| C <sub>SDA</sub>      | Capacitive load at input pin, SDA | <ul style="list-style-type: none"> <li>100pF ⇔ maximum for Standard and Fast Mode; in High-Speed Mode f<sub>SCL,max</sub> = 3.4MHz</li> <li>400pF ⇔ only in High-Speed Mode, f<sub>SCL,max</sub> = 1.7MHz</li> </ul> | –       | 100     | 400     | pF              |
| I <sub>OL</sub>       | LOW level output current          | V <sub>SDA</sub> =0.4V, Standard and Fast Mode with 400kHz; 400pF load                                                                                                                                               | 3       | 6       | 40      | mA              |

Details for timing and protocol of the ZSSC3230-supported I2C communication in Standard Mode, Fast Mode, and High-Speed Mode are given in the *I2C-Bus Specification, Rev.6, UM10204*.

### 6.6.3 EOC and Output Interrupt Signaling

The EOC pin can be programmed to operate either as a “measurement busy” indicator and end-of-conversion (EOC) transducer, or as a configurable interrupt transducer. The respective basic operation must be programmed into *INT\_setup* bits in the memory (bits[8:7] in NVM register 02<sub>HEX</sub>; see Table 16). One or two 24-bit-quantized thresholds can be programmed (see the *Interrupt Level Setup* memory registers: 13<sub>HEX</sub>, 14<sub>HEX</sub> and 15<sub>HEX</sub>). Depending on the *INT\_setup* selection, the EOC pin provides a logic 1 or logic 0 according to the SSC-corrected measurement result. The respective thresholds are programmed left-aligned in the memory, such that they must be programmed with the threshold’s MSB in the memory register’s MSB, etc. The LSBs of the 24-bit threshold in the memory must be ignored according to the number of bits of the selected ADC resolution (according to *adc\_bits*).

If only the effective end-of-conversion is signaled (*INT\_setup* = 00<sub>BIN</sub>), the EOC signal is pulse of approximately 5μs. The next command will be executed only after this EOC-signaling period.

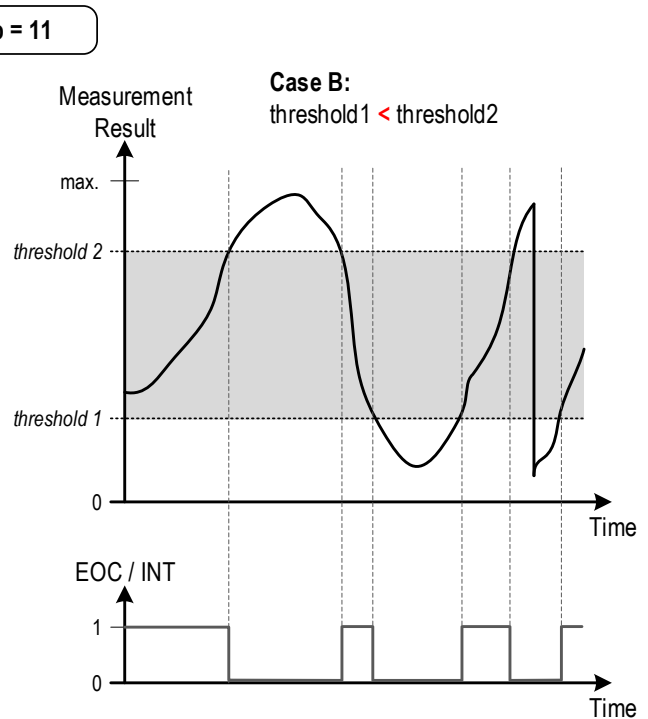
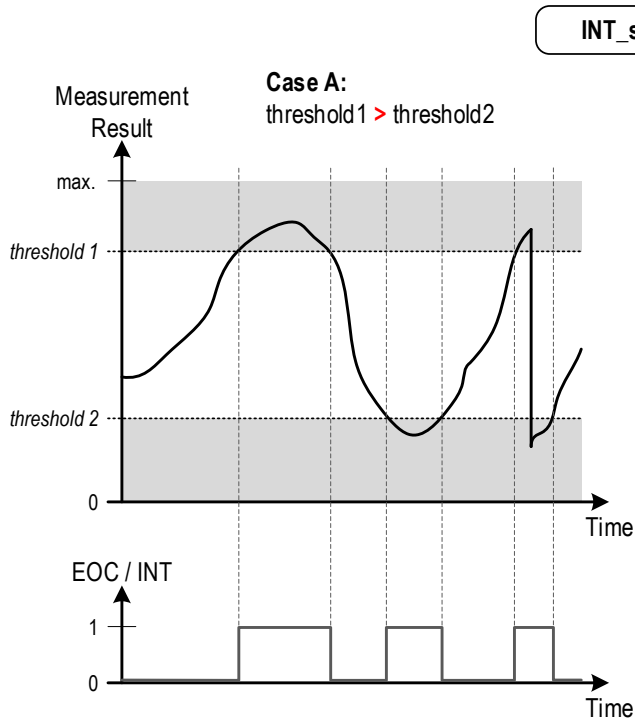
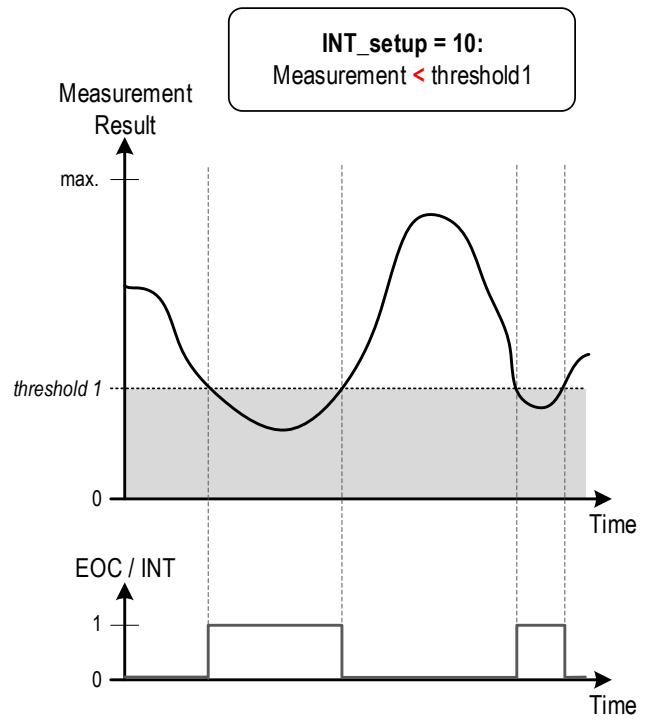
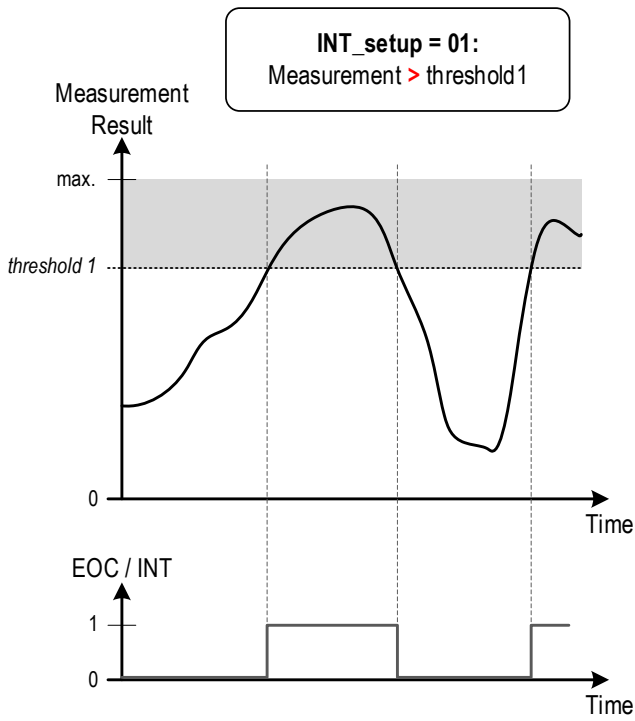
The interrupt functionality is only available for digital values from the SSC-calculation unit. The interrupt feature cannot monitor any type of raw values. The encoding and data format of the interrupt thresholds is the same as for SSC-corrected measurement results (see Table 12).

**Table 12. Data Format of Interrupt Thresholds (TRSH1 and TRSH2)**

| Bit-Number:         | 23             | 22              | 21              | 20              | ... | 2                | 1                | 0                |
|---------------------|----------------|-----------------|-----------------|-----------------|-----|------------------|------------------|------------------|
| Meaning, Weighting: | 2 <sup>0</sup> | 2 <sup>-1</sup> | 2 <sup>-2</sup> | 2 <sup>-3</sup> | ... | 2 <sup>-21</sup> | 2 <sup>-22</sup> | 2 <sup>-23</sup> |



**Figure 17 EOC and Interrupt Thresholds**



## 6.7 Measurement and Output Options

Sensor measurement results of the ZSSC3230 are provided in digital at the I2C interface. This will be the main active interaction path, and it can be combined with the PDM output configuration.

### 6.7.1 Single Measurements: Digital Raw and SSC Results

The ZSSC3230 generates digital raw values, which are processed by the IC-internal math-core generating the SSC-corrected (linearized, temperature-compensated) output signal; see section 6.5.2 for details about SSC math, etc. In addition to the SSC-corrected digital measurement results, the ZSSC3230 can provide raw values with or without SSC correction for evaluation and/or calibration purposes. The respective results are provided at the digital interface as a 24-bit-wide data word. Raw values are LSB-aligned. SSC results are MSB-aligned.

**Table 13. Data Format of Raw ADC Readings**

|                            |           |           |           |           |     |           |           |           |
|----------------------------|-----------|-----------|-----------|-----------|-----|-----------|-----------|-----------|
| <b>Bit-Number:</b>         | <b>23</b> | <b>22</b> | <b>21</b> | <b>20</b> | ... | <b>2</b>  | <b>1</b>  | <b>0</b>  |
| <b>Meaning, Weighting:</b> | $-2^0$    | $2^{-1}$  | $2^{-2}$  | $2^{-3}$  | ... | $2^{-21}$ | $2^{-22}$ | $2^{-23}$ |

**Table 14. Data Format of Corrected SSC Results**

|                            |           |           |           |           |     |           |           |           |
|----------------------------|-----------|-----------|-----------|-----------|-----|-----------|-----------|-----------|
| <b>Bit-Number:</b>         | <b>23</b> | <b>22</b> | <b>21</b> | <b>20</b> | ... | <b>2</b>  | <b>1</b>  | <b>0</b>  |
| <b>Meaning, Weighting:</b> | $2^0$     | $2^{-1}$  | $2^{-2}$  | $2^{-3}$  | ... | $2^{-21}$ | $2^{-22}$ | $2^{-23}$ |

The ZSSC3230 can process and digitize the following signals:

- Direct sensor signal inputs; i.e. perform sensor measurements, *SM*
- Auto-zero signals for the sensor channel, referred to as *AZS*
- Direct temperature signal inputs; i.e. perform temperature measurements, *TM*
- Auto-zero signals for the temperature channel, referred to as *AZT*

The utilization of auto-zero measurements allows inherent compensation for long-term drift effects of the ZSSC3230, such that the risk of lifetime signal degradation for the application and smart sensor is minimized. For the auto-zero measurement, the sensor signal remains the input for the auto-zero measurement with the gain and ADC setups the same as for the original signal measurement, but with swapped inputs and offset configurations of the PGA and ADC such that the following holds for the resulting raw value:

- Sensor raw value with auto-zero:  $S_{raw} = 0.5 * (SM - AZS)$
- Temperature raw value with auto-zero:  $T_{raw} = 0.5 * (TM - AZT)$

Enabling auto-zero measurements is strongly recommended.

The NVM configuration and measurement request commands can be used to select which effective measurements are conducted, processed, and provided at the digital interface. The possible options for a single measurement request and output are the following:

- SSC-corrected sensor readings (requested by the “Measure” command  $AA_{HEX}$ ) generating an output of SSC-corrected, 24-bit sensor data followed by SSC-corrected, 24-bit temperature data.
- Raw sensor measurement with auto-zero correction (requested by the “Raw Sensor Measure” command  $A2_{HEX}$ ) generating an output of raw, 24-bit sensor data.
- Raw temperature measurement with auto-zero correction (requested by the “Raw Temperature Measure” command  $A6_{HEX}$ ) generating an output of raw, 24-bit temperature data.

## 6.7.2 Digital Commands

The availability of commands depends on the active Main Operating Mode: Command, Sleep, or Cyclic Measurement Mode.

**Table 15. Command List**

| Command Code (Byte)                                                                                   | Return                                                                     | Description                                                                                                                                                                                                                                                                                                                                                      | Available in Sleep Mode | Available in Command Mode | Available in Cyclic Measurement Mode |
|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------------------|--------------------------------------|
| 00 <sub>HEX</sub> to 1F <sub>HEX</sub>                                                                | 16-bit data                                                                | <b>Memory Read:</b> Read address 00 <sub>HEX</sub> to 1F <sub>HEX</sub> .                                                                                                                                                                                                                                                                                        | Yes                     | Yes                       | No                                   |
| 20 <sub>HEX</sub> to 3C <sub>HEX</sub> followed by data (0000 <sub>HEX</sub> to FFFF <sub>HEX</sub> ) | –                                                                          | <b>Memory Write:</b> Write data to addresses 00 <sub>HEX</sub> to 1C <sub>HEX</sub> (the NVM-register address is the command minus 20 <sub>HEX</sub> ). Note: If the NVM is locked, write requests are not acknowledged or ignored.                                                                                                                              | Yes                     | Yes                       | No                                   |
| 90 <sub>HEX</sub>                                                                                     | –                                                                          | <b>Calculate NVM Checksum:</b> Calculate the checksum for the NVM and write it to the memory.                                                                                                                                                                                                                                                                    | Yes                     | Yes                       | No                                   |
| A2 <sub>HEX</sub> followed by data 0000 <sub>HEX</sub>                                                | 24-bit raw data                                                            | <b>Raw Sensor Measurement:</b> * Conduct a sensor measurement without SSC correction. The configuration is loaded to the controlling shadow registers from the <i>Sensor_config</i> register in NVM.<br>Note: The auto-zero sensor measurement is also performed.                                                                                                | Yes                     | Yes                       | No                                   |
| A3 <sub>HEX</sub> followed by data SSSS <sub>HEX</sub>                                                | 24-bit raw data                                                            | <b>Raw Sensor Measurement:</b> * Conduct a sensor measurement without SSC correction. The ssss is the user's configuration setting for the measurement provided via the interface. The format and purpose of the configuration bits must be according to the definitions for <i>Sensor_config</i> .<br>Note: The auto-zero sensor measurement is also performed. | Yes                     | Yes                       | No                                   |
| A6 <sub>HEX</sub> followed by data 0000 <sub>HEX</sub>                                                | 24-bit raw data                                                            | <b>Raw Temperature Measurement:</b> * Conduct a temperature measurement without SSC correction. The configuration is loaded to the controlling shadow registers from the <i>extTemp_Config1/2</i> or <i>T_config1/2</i> registers in NVM as well as the <i>SSF1/2</i> registers.<br>Note: Auto-zero-sensor measurement is performed.                             | Yes                     | Yes                       | No                                   |
| A8 <sub>HEX</sub>                                                                                     | –                                                                          | <b>START_SLEEP:</b> Exit Command Mode or Cyclic Measurement Mode and transition to Sleep Mode.<br>Note: The response to Start_Sleep is only the status byte.                                                                                                                                                                                                     | No                      | Yes                       | Yes                                  |
| A9 <sub>HEX</sub>                                                                                     | –                                                                          | <b>START_CM:</b> Enter Command Mode and enable/allow respective commands. This command must be sent as the first command after power-up.                                                                                                                                                                                                                         | No                      | Yes                       | No                                   |
| AA <sub>HEX</sub>                                                                                     | 24-bit SSC-corrected sensor data and 24-bit SSC-corrected temperature data | <b>Measure</b> – trigger a full measurement (auto-zero-sensor, sensor, auto-zero-temperature, temperature) and perform the SSC correction.                                                                                                                                                                                                                       | Yes                     | Yes                       | No                                   |

\* These commands can be used to conduct a measurement without SSC correction; e.g., during smart sensor calibration procedure. No digital correction is performed on the measurement result.

| Command Code (Byte)                                    | Return                                                                     | Description                                                                                                                                                                                                                                             | Available in Sleep Mode | Available in Command Mode | Available in Cyclic Measurement Mode |
|--------------------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------------------|--------------------------------------|
| AB <sub>HEX</sub>                                      | 24-bit SSC-corrected sensor data and 24-bit SSC-corrected temperature data | <b>START_CYC:</b> Enter Cyclic Measurement Mode: continuous measurement cycles, SSC corrections, and automatic, continuous digital output updates.                                                                                                      | Yes                     | Yes                       | No                                   |
| AC <sub>HEX</sub>                                      | 24-bit SSC-corrected sensor data and 24-bit SSC-corrected temperature data | <b>Oversample-2 Measure:</b> * Complete multiple measurements for mean-value generation: 2 full measurements are performed (the same as measurements triggered with AA <sub>HEX</sub> , not cyclic) and the resulting mean value is provided as output. | Yes                     | Yes                       | No                                   |
| AD <sub>HEX</sub>                                      |                                                                            | <b>Oversample-4 Measure:</b> * Complete multiple measurements for mean-value generation: 4 full measurements are performed (the same as AA <sub>HEX</sub> measurements, not cyclic) and the resulting mean value is provided as output.                 | Yes                     | Yes                       | No                                   |
| AE <sub>HEX</sub>                                      |                                                                            | <b>Oversample-8 Measure:</b> * Complete multiple measurements for mean-value generation: 8 full measurements are performed (the same as AA <sub>HEX</sub> measurements, not cyclic) and the resulting mean value is provided as output.                 | Yes                     | Yes                       | No                                   |
| AF <sub>HEX</sub>                                      |                                                                            | <b>Oversample-16 Measure:</b> * Complete multiple measurements for mean-value generation: 16 full measurements are performed (the same as AA <sub>HEX</sub> measurements, not cyclic) and the resulting mean value is provided as output.               | Yes                     | Yes                       | No                                   |
| B0 <sub>HEX</sub>                                      | 16-bit data output<br>0 pass / 1 fail                                      | <b>Broken Chip:</b> Test resistance of corner wire.                                                                                                                                                                                                     | Yes                     | Yes                       | No                                   |
| B4 <sub>HEX</sub>                                      | -                                                                          | <b>Stop PDM:</b> This command can be used to stop the PDM in order to change the PDM enable in NVM. This command does not sent an ack.                                                                                                                  | No                      | No                        | Yes                                  |
| FX <sub>HEX</sub> X followed by data XX <sub>HEX</sub> | -                                                                          | <b>Soft-Reset:</b> Full reset of digital part.<br>Note: Any FX <sub>HEX</sub> command extended by one arbitrary data byte results in the soft reset. This command will not be answered by an acknowledge                                                | Yes                     | Yes                       | Yes                                  |

### 6.7.3 Nonvolatile Memory (NVM)

In the ZSSC3230, the memory is organized in 16-bit wide registers and can be programmed multiple times (approximately 10000). There are 28 x 16-bit registers available for customer use. Each register can be re-programmed. Basically, there are two NVM content sectors:

- Customer Use – Accessible by means of regular WRITE operations: 20<sub>HEX</sub> to 3C<sub>HEX</sub>. It contains the customer ID, interface setup data, measurement setup information, calibration coefficients, etc.
- IDT Use – Only accessible for WRITE operations by IDT. This sector contains specific trim information and is programmed during manufacturing test by IDT; e.g., configurations for the internal temperature sensor are stored there.

\* Use oversample measurements to obtain noise-minimized measurement results in Sleep or Command Mode. With higher oversampling factors, the command execution time increases proportionally.

## 6.7.4 Memory Contents

**Table 16. Memory (NVM) Content Assignments**

| NVM Address                    | Word/Bit Range | Default Setting         | Word/Bit Field Name | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------|----------------|-------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 00 <sub>HEX</sub>              | 15:0           | 0000 <sub>HEX</sub>     | Cust_ID0            | Customer ID byte 0 (combines with memory word 01 <sub>HEX</sub> to form the customer ID).*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 01 <sub>HEX</sub>              | 15:0           | 0000 <sub>HEX</sub>     | Cust_ID1            | Customer ID byte 1 (combines with memory word 00 <sub>HEX</sub> to form the customer ID).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Interface Configuration</b> |                |                         |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 02 <sub>HEX</sub>              | 6:0            | 000 0000 <sub>BIN</sub> | Slave_Addr          | I2C and OWI slave address; valid range: 00 <sub>HEX</sub> to 7F <sub>HEX</sub> (default: 00 <sub>HEX</sub> ).<br>Note: Address codes 04 <sub>HEX</sub> to 07 <sub>HEX</sub> are reserved for entering the I2C High Speed Mode.                                                                                                                                                                                                                                                                                                                                                                                 |
|                                | 8:7            | 00 <sub>BIN</sub>       | INT_setup           | Interrupt configuration, EOC pin functionality:<br>00 End-of-conversion signal<br>01 0-1 transition if threshold1 (TRSH1) is exceeded and 1-0 transition if threshold1 is underrun again<br>10 0-1 transition if threshold1 is underrun and 1-0 transition if threshold1 is exceeded again<br>11 EOC is determined by threshold settings (see section 6.6.3):<br>If (TRSH1 > TRSH2) then EOC/INT (interrupt level) = 0 if (TRSH1 > MEAS ≥ TRSH2) where MEAS is the conditioned measurement result.<br>Otherwise EOC/INT=1.<br>If (TRSH1 ≤ TRSH2) then EOC = 1 if (TRSH1 ≤ MEAS < TRSH2).<br>Otherwise EOC = 0. |
|                                | 9              | 0 <sub>BIN</sub>        | PDM_enable          | Enables PDM-output:<br>0 ⇔ PDM output disabled                      1 ⇔ PDM output enabled<br>If PDM_enable bit is 1, the ZSSC3230 will start after reset without any further command in Cyclic Measurement Mode                                                                                                                                                                                                                                                                                                                                                                                               |
|                                | 10             | 0 <sub>BIN</sub>        | Reserved            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                | 11             | 0 <sub>BIN</sub>        | signv               | Enables input signal inversion ("1-1/C") in conditioning math:<br>0 ⇔ "1-1/C" disabled                      1 ⇔ "1-1/C" enabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                | 14:12          | 000 <sub>BIN</sub>      | CYC_period          | Update period (ZSSC3230 sleep time, except oscillator) in cyclic operation:<br>000 ⇔ 0.0ms (= PDM default)              100 ⇔ 1333ms<br>001 ⇔ 167ms                                      101 ⇔ 2667ms<br>010 ⇔ 333ms                                      110 ⇔ 5333ms<br>011 ⇔ 666ms                                      111 ⇔ Not assigned                                                                                                                                                                                                                                                                  |
|                                | 15             | 0 <sub>BIN</sub>        | SOT_curve           | Type/shape of second-order curve correction for the sensor signal.<br>0 ⇔ parabolic curve                              1 ⇔ s-shaped curve                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

\* For I<sup>3</sup>C operation, this should contain the Legacy Virtual Register "LVR" info: 0x1X ... Index 0; Fast Mode supported.

| NVM Address                           | Word/Bit Range | Default Setting     | Word/Bit Field Name | Description                                                                                                                                                                                                                     |
|---------------------------------------|----------------|---------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Signal Conditioning Parameters</b> |                |                     |                     |                                                                                                                                                                                                                                 |
| 03 <sub>HEX</sub>                     | 15:0           | 0000 <sub>HEX</sub> | Offset_S[15:0]      | Bits [15:0] of the 24-bit-wide sensor offset correction coefficient <i>Offset_S</i> . (MSBs of this coefficient including sign are <i>Offset_S</i> [23:16], which are bits [15:8] in 0D <sub>HEX</sub> .)                       |
| 04 <sub>HEX</sub>                     | 15:0           | 0000 <sub>HEX</sub> | Gain_S[15:0]        | Bits [15:0] of the 24-bit-wide value of the sensor gain coefficient <i>Gain_S</i> . (MSBs of this coefficient including sign are <i>Gain_S</i> [23:16], which are bits [7:0] in 0D <sub>HEX</sub> .)                            |
| 05 <sub>HEX</sub>                     | 15:0           | 0000 <sub>HEX</sub> | Tcg[15:0]           | Bits [15:0] of the 24-bit-wide coefficient <i>Tcg</i> for the temperature correction of the sensor gain. (The MSBs of this coefficient including sign are <i>Tcg</i> [23:16], which are bits [15:8] in 0E <sub>HEX</sub> .)     |
| 06 <sub>HEX</sub>                     | 15:0           | 0000 <sub>HEX</sub> | Tco[15:0]           | Bits [15:0] of the 24-bit-wide coefficient <i>Tco</i> for temperature correction of the sensor offset. (The MSBs of this coefficient including sign are <i>Tco</i> [23:16], which are bits [7:0] in 0E <sub>HEX</sub> .)        |
| 07 <sub>HEX</sub>                     | 15:0           | 0000 <sub>HEX</sub> | SOT_tco[15:0]       | Bits [15:0] of the 24-bit-wide 2 <sup>nd</sup> order term <i>SOT_tco</i> applied to <i>Tco</i> . (The MSBs of this term including sign are <i>SOT_tco</i> [23:16], which are bits [15:8] in 0F <sub>HEX</sub> .)                |
| 08 <sub>HEX</sub>                     | 15:0           | 0000 <sub>HEX</sub> | SOT_tcg[15:0]       | Bits [15:0] of the 24-bit-wide 2 <sup>nd</sup> order term <i>SOT_tcg</i> applied to <i>Tcg</i> . (The MSBs of this term including sign are <i>SOT_tcg</i> [23:16], which are bits [7:0] in 0F <sub>HEX</sub> .)                 |
| 09 <sub>HEX</sub>                     | 15:0           | 0000 <sub>HEX</sub> | SOT_sens[15:0]      | Bits [15:0] of the 24-bit-wide 2 <sup>nd</sup> order term <i>SOT_sens</i> applied to the sensor readout. (The MSBs of this term including sign are <i>SOT_sens</i> [23:16], which are bits [15:8] in 10 <sub>HEX</sub> .)       |
| 0A <sub>HEX</sub>                     | 15:0           | 0000 <sub>HEX</sub> | Offset_T[15:0]      | Bits [15:0] of the 24-bit-wide temperature offset correction coefficient <i>Offset_T</i> . (MSBs of this coefficient including sign are <i>Offset_T</i> [23:16]; i.e., bits [7:0] in 10 <sub>HEX</sub> .)                       |
| 0B <sub>HEX</sub>                     | 15:0           | 0000 <sub>HEX</sub> | Gain_T[15:0]        | Bits [15:0] of the 24-bit-wide absolute value of the temperature gain coefficient <i>Gain_T</i> . (The MSBs of this coefficient including sign are <i>Gain_T</i> [23:16], which are bits [15:8] in 11 <sub>HEX</sub> .)         |
| 0C <sub>HEX</sub>                     | 15:0           | 0000 <sub>HEX</sub> | SOT_T[15:0]         | Bits [15:0] of the 24-bit-wide 2 <sup>nd</sup> -order term <i>SOT_T</i> applied to the temperature reading. (The MSBs of this coefficient including sign are <i>SOT_T</i> [23:16], which are bits [7:0] in 11 <sub>HEX</sub> .) |
| 0D <sub>HEX</sub>                     | 7:0            | 00 <sub>HEX</sub>   | Gain_S[23:16]       | Bits [23:16] including sign for the 24-bit-wide sensor gain correction coefficient <i>Gain_S</i> . (The LSBs of this coefficient are <i>Gain_S</i> [15:0] in register 03 <sub>HEX</sub> .)                                      |
|                                       | 15:8           | 00 <sub>HEX</sub>   | Offset_S[23:16]     | Bits [23:16] including sign for the 24-bit-wide sensor offset correction coefficient <i>Offset_S</i> . (The LSBs are <i>Offset_S</i> [15:0] in register 04 <sub>HEX</sub> .)                                                    |
| 0E <sub>HEX</sub>                     | 7:0            | 00 <sub>HEX</sub>   | Tco[23:16]          | Bits [23:16] including sign for the 24-bit-wide coefficient <i>Tco</i> for temperature correction for the sensor offset. (The LSBs are <i>Tco</i> [15:0] in register 05 <sub>HEX</sub> .)                                       |
|                                       | 15:8           | 00 <sub>HEX</sub>   | Tcg[23:16]          | Bits [23:16] including sign for the 24-bit-wide coefficient <i>Tcg</i> for the temperature correction of the sensor gain. (The LSBs are <i>Tcg</i> [15:0] in register 06 <sub>HEX</sub> .)                                      |
| 0F <sub>HEX</sub>                     | 7:0            | 00 <sub>HEX</sub>   | SOT_tcg[23:16]      | Bits [23:16] including sign for the 24-bit-wide 2 <sup>nd</sup> order term <i>SOT_tcg</i> applied to <i>Tcg</i> . (The LSBs are <i>SOT_tcg</i> [15:0] in register 07 <sub>HEX</sub> .)                                          |
|                                       | 15:8           | 00 <sub>HEX</sub>   | SOT_tco[23:16]      | Bits [23:16] including sign for the 24-bit-wide 2 <sup>nd</sup> order term <i>SOT_tco</i> applied to <i>Tco</i> . (The LSBs are <i>SOT_tco</i> [15:0] in register 08 <sub>HEX</sub> .)                                          |
| 10 <sub>HEX</sub>                     | 7:0            | 00 <sub>HEX</sub>   | Offset_T[23:16]     | Bits [23:16] including sign for the 24-bit-wide temperature offset correction coefficient <i>Offset_T</i> . (The LSBs are <i>Offset_T</i> [15:0] in register 09 <sub>HEX</sub> .)                                               |
|                                       | 15:8           | 00 <sub>HEX</sub>   | SOT_sens[23:16]     | Bits [23:16] including sign for the 24-bit-wide 2 <sup>nd</sup> order term <i>SOT_sens</i> applied to the sensor readout. (The LSBs are <i>SOT_sens</i> [15:0] in register 0A <sub>HEX</sub> .)                                 |

| NVM Address                                               | Word/Bit Range            | Default Setting        | Word/Bit Field Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
|-----------------------------------------------------------|---------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-----------------------|------------------|------------------|------------------|------------------|------------------|---------------|------------------|-------------------|------------------|-------------------|------------------|-------------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|
| 11 <sub>HEX</sub>                                         | 7:0                       | 00 <sub>HEX</sub>      | SOT_T[23:16]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Bits [23:16] including sign for the 24-bit-wide 2 <sup>nd</sup> -order term <i>SOT_T</i> applied to the temperature reading. (The LSBs are <i>SOT_T</i> [15:0] in register 0B <sub>HEX</sub> .)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
|                                                           | 15:8                      | 00 <sub>HEX</sub>      | Gain_T[23:16]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Bits [23:16] including sign for the 24-bit-wide absolute value of the temperature gain coefficient <i>Gain_T</i> . (The LSBs are <i>Gain_T</i> [15:0] in register 0C <sub>HEX</sub> .)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| <b>Measurement Configuration (Sensor_config) Register</b> |                           |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 12 <sub>HEX</sub>                                         | 5:0                       | 00 0000 <sub>BIN</sub> | shift_cap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>Defines the zero shift capacitance ⇔ input offset shift to cancel the static input capacitance of the sensor:</p> <table border="0"> <tr> <td>00 0000 ⇔ no offset shift</td> <td>00 0111 ⇔ 1.75pF</td> </tr> <tr> <td>00 0001 ⇔ 0.25pF</td> <td>00 1000 ⇔ 2.00pF</td> </tr> <tr> <td>00 0010 ⇔ 0.50pF</td> <td>00 1001 ⇔ 2.25pF</td> </tr> <tr> <td>00 0011 ⇔ 0.75pF</td> <td>...</td> </tr> <tr> <td>00 0100 ⇔ 1.00pF</td> <td>11 1101 ⇔ 15.00pF</td> </tr> <tr> <td>00 0101 ⇔ 1.25pF</td> <td>11 1110 ⇔ 15.50pF</td> </tr> <tr> <td>00 0110 ⇔ 1.50pF</td> <td>11 1111 ⇔ 15.75pF</td> </tr> </table> <p>Note: the offset shift capacitance must not exceed the selected input capacitance's range (see <i>cap_range</i>).</p> | 00 0000 ⇔ no offset shift | 00 0111 ⇔ 1.75pF      | 00 0001 ⇔ 0.25pF | 00 1000 ⇔ 2.00pF | 00 0010 ⇔ 0.50pF | 00 1001 ⇔ 2.25pF | 00 0011 ⇔ 0.75pF | ...           | 00 0100 ⇔ 1.00pF | 11 1101 ⇔ 15.00pF | 00 0101 ⇔ 1.25pF | 11 1110 ⇔ 15.50pF | 00 0110 ⇔ 1.50pF | 11 1111 ⇔ 15.75pF |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
|                                                           | 00 0000 ⇔ no offset shift | 00 0111 ⇔ 1.75pF       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
|                                                           | 00 0001 ⇔ 0.25pF          | 00 1000 ⇔ 2.00pF       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
|                                                           | 00 0010 ⇔ 0.50pF          | 00 1001 ⇔ 2.25pF       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00 0011 ⇔ 0.75pF                                          | ...                       |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00 0100 ⇔ 1.00pF                                          | 11 1101 ⇔ 15.00pF         |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00 0101 ⇔ 1.25pF                                          | 11 1110 ⇔ 15.50pF         |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00 0110 ⇔ 1.50pF                                          | 11 1111 ⇔ 15.75pF         |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 7:6                                                       | 00 <sub>BIN</sub>         | adc_bits               | <p>Defines the absolute number of bits for the A2D conversion:</p> <table border="0"> <tr> <td>00 ⇔ 12-bit</td> <td>10 ⇔ 16-bit</td> </tr> <tr> <td>01 ⇔ 14-bit (default)</td> <td>11 ⇔ 18-bit</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 00 ⇔ 12-bit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 10 ⇔ 16-bit               | 01 ⇔ 14-bit (default) | 11 ⇔ 18-bit      |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00 ⇔ 12-bit                                               | 10 ⇔ 16-bit               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 01 ⇔ 14-bit (default)                                     | 11 ⇔ 18-bit               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 8                                                         | 0 <sub>BIN</sub>          | noise_mode             | <p>Select between control sequences for noise-quality vs. energy consumption optimization:</p> <table border="0"> <tr> <td>0 ⇔ Low Current Mode</td> <td>1 ⇔ Low Noise Mode</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0 ⇔ Low Current Mode                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1 ⇔ Low Noise Mode        |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 0 ⇔ Low Current Mode                                      | 1 ⇔ Low Noise Mode        |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 13:9                                                      | 0 0000 <sub>BIN</sub>     | cap_range              | <p>Selection maximum possible external signal capacitance; i.e. the capacitance sensor range (without any offset):</p> <table border="0"> <tr> <td>00000 ⇔ 0.5pF</td> <td>10000 ⇔ 8.5pF</td> </tr> <tr> <td>00001 ⇔ 1.0pF</td> <td>10001 ⇔ 9.0pF</td> </tr> <tr> <td>00010 ⇔ 1.5pF</td> <td>10010 ⇔ 9.5pF</td> </tr> <tr> <td>00011 ⇔ 2.0pF</td> <td>10011 ⇔ 10.0pF</td> </tr> <tr> <td>00100 ⇔ 2.5pF</td> <td>10100 ⇔ 10.5pF</td> </tr> <tr> <td>00101 ⇔ 3.0pF</td> <td>10101 ⇔ 11.0pF</td> </tr> <tr> <td>00110 ⇔ 3.5pF</td> <td>10110 ⇔ 11.5pF</td> </tr> <tr> <td>00111 ⇔ 4.0pF</td> <td>10111 ⇔ 12.0pF</td> </tr> <tr> <td>01000 ⇔ 4.5pF</td> <td>11000 ⇔ 12.5pF</td> </tr> <tr> <td>01001 ⇔ 5.0pF</td> <td>11001 ⇔ 13.0pF</td> </tr> <tr> <td>01010 ⇔ 5.5pF</td> <td>11010 ⇔ 13.5pF</td> </tr> <tr> <td>01011 ⇔ 6.0pF</td> <td>11011 ⇔ 14.0pF</td> </tr> <tr> <td>01100 ⇔ 6.5pF</td> <td>11100 ⇔ 14.5pF</td> </tr> <tr> <td>01101 ⇔ 7.0pF</td> <td>11101 ⇔ 15.0pF</td> </tr> <tr> <td>01110 ⇔ 7.5pF</td> <td>11110 ⇔ 15.5pF</td> </tr> <tr> <td>01111 ⇔ 8.0pF</td> <td>11111 ⇔ 16.0pF</td> </tr> </table> | 00000 ⇔ 0.5pF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10000 ⇔ 8.5pF             | 00001 ⇔ 1.0pF         | 10001 ⇔ 9.0pF    | 00010 ⇔ 1.5pF    | 10010 ⇔ 9.5pF    | 00011 ⇔ 2.0pF    | 10011 ⇔ 10.0pF   | 00100 ⇔ 2.5pF | 10100 ⇔ 10.5pF   | 00101 ⇔ 3.0pF     | 10101 ⇔ 11.0pF   | 00110 ⇔ 3.5pF     | 10110 ⇔ 11.5pF   | 00111 ⇔ 4.0pF     | 10111 ⇔ 12.0pF | 01000 ⇔ 4.5pF | 11000 ⇔ 12.5pF | 01001 ⇔ 5.0pF | 11001 ⇔ 13.0pF | 01010 ⇔ 5.5pF | 11010 ⇔ 13.5pF | 01011 ⇔ 6.0pF | 11011 ⇔ 14.0pF | 01100 ⇔ 6.5pF | 11100 ⇔ 14.5pF | 01101 ⇔ 7.0pF | 11101 ⇔ 15.0pF | 01110 ⇔ 7.5pF | 11110 ⇔ 15.5pF | 01111 ⇔ 8.0pF | 11111 ⇔ 16.0pF |
| 00000 ⇔ 0.5pF                                             | 10000 ⇔ 8.5pF             |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00001 ⇔ 1.0pF                                             | 10001 ⇔ 9.0pF             |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00010 ⇔ 1.5pF                                             | 10010 ⇔ 9.5pF             |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00011 ⇔ 2.0pF                                             | 10011 ⇔ 10.0pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00100 ⇔ 2.5pF                                             | 10100 ⇔ 10.5pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00101 ⇔ 3.0pF                                             | 10101 ⇔ 11.0pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00110 ⇔ 3.5pF                                             | 10110 ⇔ 11.5pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 00111 ⇔ 4.0pF                                             | 10111 ⇔ 12.0pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 01000 ⇔ 4.5pF                                             | 11000 ⇔ 12.5pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 01001 ⇔ 5.0pF                                             | 11001 ⇔ 13.0pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 01010 ⇔ 5.5pF                                             | 11010 ⇔ 13.5pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 01011 ⇔ 6.0pF                                             | 11011 ⇔ 14.0pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 01100 ⇔ 6.5pF                                             | 11100 ⇔ 14.5pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 01101 ⇔ 7.0pF                                             | 11101 ⇔ 15.0pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 01110 ⇔ 7.5pF                                             | 11110 ⇔ 15.5pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |
| 01111 ⇔ 8.0pF                                             | 11111 ⇔ 16.0pF            |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                       |                  |                  |                  |                  |                  |               |                  |                   |                  |                   |                  |                   |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |               |                |

| NVM Address                                                                    | Word/Bit Range | Default Setting     | Word/Bit Field Name | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------|----------------|---------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12 <sub>HEX</sub><br>(Continued)                                               | 14             | 0 <sub>BIN</sub>    | sensor_leakage      | Option to enable sensor element's leakage current compensation (due to sensor element's parasitic resistance) ⇔ leakage cancellation leads to loss of dynamic range and decrease of SNR (loss of 1 bit of effective resolution).<br>The following setups are possible:<br>0 ⇔ no sensor leakage cancellation; full internal dynamic range; full Vref applied to external sensor<br>1 ⇔ sensor leakage cancellation enabled; applied voltage at external sensor of 0.5 * Vref (loss of 1 bit of effective resolution) |
|                                                                                | 15             | 0 <sub>BIN</sub>    | sensecap_type       | Selection of applied (external) sensor capacitance:<br>0 ⇔ "differential" sensor capacitance between C0 and CC (CC') pads<br>1 ⇔ single ended sensor capacitance between VSS and CC (CC') pad; applied voltage at external sensor of 0.5 × Vref (loss of 1 bit of effective resolution)                                                                                                                                                                                                                              |
| <b>Interrupt Level Setup and Post-Calibration (Digital) Offset Calibration</b> |                |                     |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 13 <sub>HEX</sub>                                                              | 15:0           | 0000 <sub>HEX</sub> | TRSH1[15:0]         | Bits [15:0] of the 24-bit-wide interrupt threshold1, <i>TRSH1</i> . (The MSBs for this threshold are <i>TRSH1</i> [23:16], which are bits [7:0] of register 15 <sub>HEX</sub> .)                                                                                                                                                                                                                                                                                                                                     |
| 14 <sub>HEX</sub>                                                              | 15:0           | 0000 <sub>HEX</sub> | TRSH2[15:0]         | Bits [15:0] of the 24-bit-wide interrupt threshold2, <i>TRSH2</i> . (The MSBs for this threshold are <i>TRSH2</i> [23:16], which are bits [15:8] of register 15 <sub>HEX</sub> .)                                                                                                                                                                                                                                                                                                                                    |
| 15 <sub>HEX</sub>                                                              | 7:0            | 00 <sub>HEX</sub>   | TRSH1[23:16]        | Bits [23:16] of the 24-bit-wide interrupt threshold1, <i>TRSH1</i> . (The LSBs for this threshold are <i>TRSH1</i> [15:0], which are bits [15:0] of register 13 <sub>HEX</sub> .)                                                                                                                                                                                                                                                                                                                                    |
|                                                                                | 15:8           | 00 <sub>HEX</sub>   | TRSH2[23:16]        | Bits [23:16] of the 24-bit-wide interrupt threshold2, <i>TRSH2</i> . (The LSBs for this threshold are <i>TRSH2</i> [15:0], which are bits [15:0] of register 14 <sub>HEX</sub> .)                                                                                                                                                                                                                                                                                                                                    |
| 16 <sub>HEX</sub>                                                              | 15:0           | 0000 <sub>HEX</sub> | SENS_Shift[15:0]    | Bits [15:0] of the post-calibration sensor offset shift coefficient <i>SENS_Shift</i> . (The MSBs of <i>SENS_Shift</i> are bits [7:0] of register 18 <sub>HEX</sub> .)                                                                                                                                                                                                                                                                                                                                               |
| 17 <sub>HEX</sub>                                                              | 15:0           | 0000 <sub>HEX</sub> | T_Shift[15:0]       | Bits [15:0] of the post-calibration temperature offset shift coefficient <i>T_Shift</i> . (The MSBs of <i>T_Shift</i> are bits [15:8] of register 18 <sub>HEX</sub> .)                                                                                                                                                                                                                                                                                                                                               |
| 18 <sub>HEX</sub>                                                              | 7:0            | 00 <sub>HEX</sub>   | SENS_Shift[23:16]   | Bits [23:16] of the post-calibration sensor offset shift coefficient <i>SENS_Shift</i> . (The LSBs of <i>SENS_Shift</i> are in register 16 <sub>HEX</sub> .)                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                | 15:8           | 00 <sub>HEX</sub>   | T_Shift[23:16]      | Bits [23:16] of the post-calibration temperature offset shift coefficient <i>T_Shift</i> . (The LSBs of <i>T_Shift</i> are in register 17 <sub>HEX</sub> .)                                                                                                                                                                                                                                                                                                                                                          |



| NVM Address                   | Word/Bit Range | Default Setting     | Word/Bit Field Name | Description                                                                                                                                                                               |
|-------------------------------|----------------|---------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Configuration Register</b> |                |                     |                     |                                                                                                                                                                                           |
| 19 <sub>HEX</sub>             | 1:0            | 00 <sub>BIN</sub>   | CC_pin_selection    | Defines which pin is used for measurement (CC and/or CC'):<br>00 ⇔ no input<br>01 ⇔ CC<br>10 ⇔ CC'<br>11 ⇔ CC and CC'                                                                     |
|                               | 2              | 0 <sub>BIN</sub>    | Dither              | Enable/disable digital dithering to improve EMI performance:<br>0 ⇔ No dithering                      1 ⇔ Dithering enabled                                                               |
|                               | 3              | 0 <sub>BIN</sub>    | En_sh2              | Enable Subtraction Mode in grounded mode (see section 6.2.5):<br>0 ⇔ Disabled                          1 ⇔ Enabled                                                                        |
|                               | 4              | 0 <sub>BIN</sub>    | En_shlddrv          | Enable active shield drive at the C0 pin (see section 6.2.4):<br>0 ⇔ Disabled                          1 ⇔ Enabled                                                                        |
|                               | 5              | 0 <sub>BIN</sub>    | Dyn_imp             | Enables higher drive current in analog front end, which will be needed if the sensor range is much smaller than the shift capacitor:<br>0 ⇔ Disabled                          1 ⇔ Enabled |
|                               | 6              | 0 <sub>BIN</sub>    | Test_cap            | Enables an internal reference sensor capacitor of approx. 2pF in parallel to sensor input:<br>0 ⇔ Disabled      1 ⇔ Enabled                                                               |
|                               | 15:7           |                     | Reserved            | IDT lot tracking information; can be overwritten and used as free space for customer use.                                                                                                 |
| 1A <sub>HEX</sub>             | 15:0           | 0000 <sub>HEX</sub> | Reserved            | IDT lot tracking information; can be overwritten and used as free space for customer use.                                                                                                 |
| 1B <sub>HEX</sub>             | 15:0           | 0000 <sub>HEX</sub> | Reserved            | IDT lot tracking information; can be overwritten and used as free space for customer use.                                                                                                 |
| 1C <sub>HEX</sub>             | 15:0           | 0000 <sub>HEX</sub> | CRC                 | Generated checksum (CRC) for whole memory through a linear feedback shift register (LFSR); Signature is checked upon power-up to ensure memory content integrity                          |

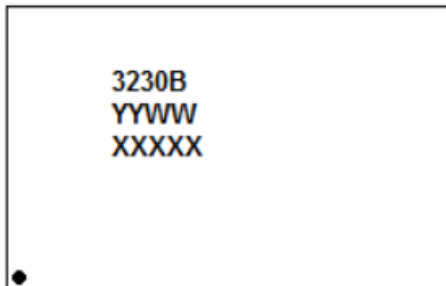
The NVM-consistency checksum is calculated (IC-internally for the whole NVM) using the polynomial:  $x^{16} + x^{15} + x^2 + 1$ . The checksum verification is only realized directly after  $V_{DD}$  power-on. If the checksum is successfully verified, then the "Memory Error" status bit is set to 0<sub>BIN</sub>.

## 7. Package Outline Drawings

The package outline drawings VFQFPN package are appended at the end of this document and are accessible from the link below. The package information is the most current data available.

<https://www.idt.com/document/psc/24-vfqfpn-package-outline-drawing-40-x-40-x-090-mm-body050mm-pitchepad-245-x-245-mm-nlg24p1>

## 8. Marking Diagram



1. Line 1 is the truncated part number.
2. Line 2 – “YYWW” are the last two digit of the year and week that the part was assembled.
3. Line 3 – “XXXXX” denotes assembly lot number.

## 9. Ordering Information

| Orderable Part Number | Description and Package                                | MSL Rating     | Carrier Type | Temperature  |
|-----------------------|--------------------------------------------------------|----------------|--------------|--------------|
| ZSSC3230BC1B          | Dice on 304µm wafer no inking                          | Not applicable | Wafer Box    | -40 to 85°C  |
| ZSSC3230BC2B          | Dice on 725µm wafer no inking                          | Not applicable | Wafer Box    | -40 to 85°C  |
| ZSSC3230BI1B          | Dice on 304µm wafer no inking                          | Not applicable | Wafer Box    | -40 to 125°C |
| ZSSC3230BI2B          | Dice on 725µm wafer no inking                          | Not applicable | Wafer Box    | -40 to 125°C |
| ZSSC3230BC5B          | Dice on 304µm wafer with inking                        | Not applicable | Wafer Box    | -40 to 85°C  |
| ZSSC3230BC6B          | Dice on 725µm wafer with inking                        | Not applicable | Wafer Box    | -40 to 85°C  |
| ZSSC3230BI5B          | Dice on 304µm wafer with inking                        | Not applicable | Wafer Box    | -40 to 125°C |
| ZSSC3230BI6B          | Dice on 725µm wafer with inking                        | Not applicable | Wafer Box    | -40 to 125°C |
| ZSSC3230BC3R          | 4 × 4 mm <sup>2</sup> PQFN                             | MSL1           | 13" Reel     | -40 to 85°C  |
| ZSSC3230BI3R          | 4 × 4 mm <sup>2</sup> PQFN                             | MSL1           | 13" Reel     | -40 to 125°C |
| ZSSC3230BI3W          | 4 × 4 mm <sup>2</sup> PQFN                             | MSL1           | 7" Reel      | -40 to 125°C |
| ZSSC3230KIT           | ZSSC3230 Evaluation Board with USB Cable and 5 Samples |                |              |              |

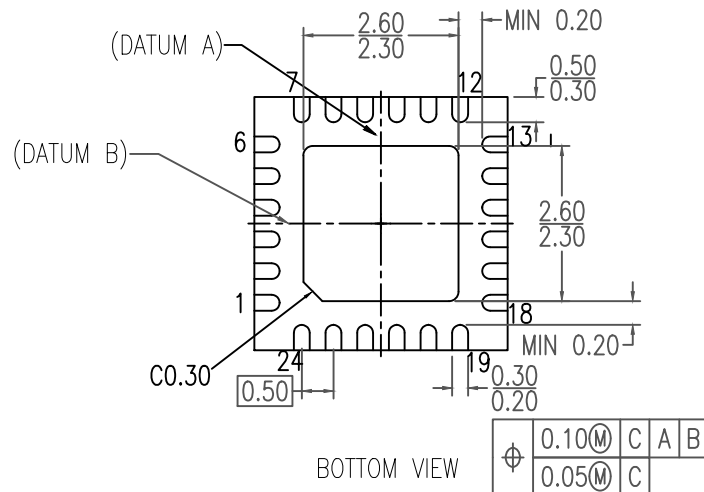
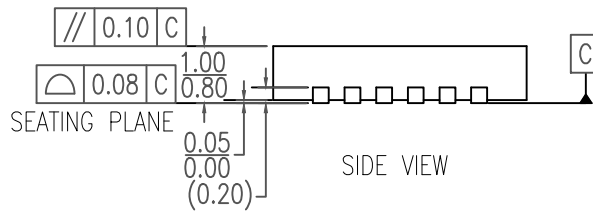
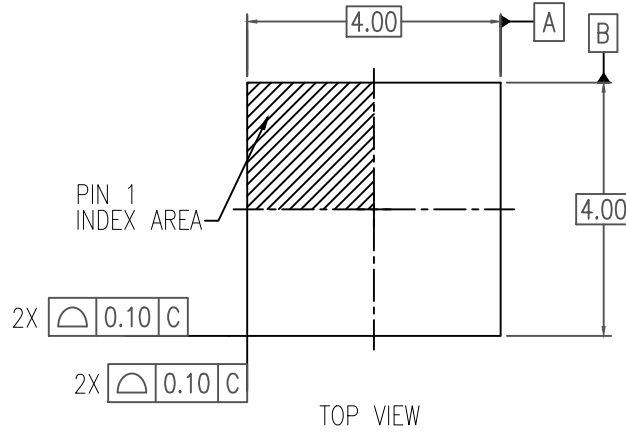
## 10. Glossary

| Term  | Description                                                                                        |
|-------|----------------------------------------------------------------------------------------------------|
| A2D   | Analog-to-Digital                                                                                  |
| ACK   | Acknowledge (interface's protocol indicator for successful data/command transfer)                  |
| ADC   | Analog-to-Digital Converter or Conversion                                                          |
| AGND  | Analog Ground                                                                                      |
| AZ    | Auto-Zero (unspecific)                                                                             |
| AZS   | Auto-Zero Measurement for (External) Sensor Path                                                   |
| AZT   | Auto-Zero Measurement for (External or Internal) Temperature Path                                  |
| CLK   | Clock                                                                                              |
| CVC   | Charge-Voltage Converter                                                                           |
| DAC   | Digital-to-Analog Converter or Conversion                                                          |
| EOC   | End of Conversion                                                                                  |
| FSO   | Full Scale Output (value in percent relative to the ADC maximum output code; resolution dependent) |
| HVAC  | Heating, Ventilation, and Air Conditioning                                                         |
| LFSR  | Linear Feedback Shift Register                                                                     |
| LSB   | Least Significant Bit                                                                              |
| MSB   | Most Significant Bit                                                                               |
| MSL   | Moisture Sensitivity Level                                                                         |
| NACK  | Not Acknowledge (interface's protocol indicator for unsuccessful data/command transfer)            |
| NVM   | Nonvolatile Memory                                                                                 |
| OpAmp | Operating Amplifier                                                                                |
| PGA   | Programmable Gain Amplifier                                                                        |
| POR   | Power-On Reset                                                                                     |
| PSRR  | Power Supply (Disturbance) Rejection Ratio                                                         |
| PTAT  | Proportional to Absolute Temperature                                                               |
| S     | SSC-Corrected Sensor Readout / Result                                                              |
| SM    | Sensor Measurement                                                                                 |
| SNR   | Signal to Noise Ratio                                                                              |
| SOT   | Second-Order Term                                                                                  |
| SSF   | Smart-Sensor Function (specific NVM registers)                                                     |
| T     | SSC-Corrected (additional) Temperature Readout / Result                                            |
| TC    | Temperature Coefficient                                                                            |

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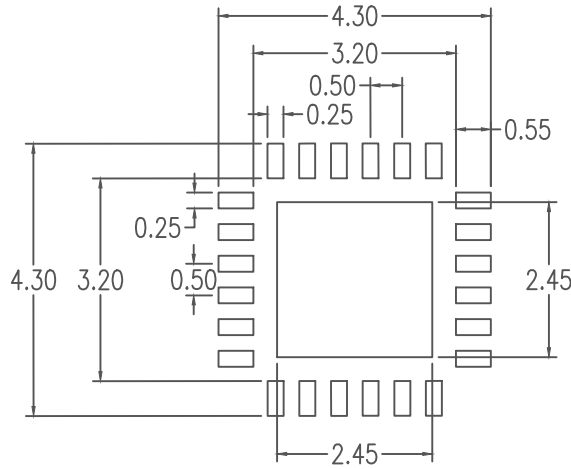
## 11. Revision History

| Revision Date      | Description of Change                                                                                                                                                  |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| October 15, 2019   | <ul style="list-style-type: none"><li>▪ Values updated for Power-up conditions</li><li>▪ Conditions updated for equations for the S-shaped SOT_curve setting</li></ul> |
| September 10, 2019 | Initial release.                                                                                                                                                       |



NOTES:

1. DIMENSIONING AND TOLERANCING CONFORME TO ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS.



RECOMMENDED LAND PATTERN DIMENSION

NOTES:

1. ALL DIMENSIONS ARE IN MM. ANGLES IN DEGREES.
2. TOP DOWN VIEW, AS VIEWED ON PCB.
3. LAND PATTERN RECOMMENDATION PER IPC-7351B GENERIC REQUIREMENT FOR SURFACE MOUNT DESIGN AND LAND PATTERN.

| Package Revision History |         |                                                           |
|--------------------------|---------|-----------------------------------------------------------|
| Date Created             | Rev No. | Description                                               |
| Sept 9, 2016             | Rev 01  | Add Chamfer on Epad                                       |
| Sept 13, 2018            | Rev 02  | New Format, Recalculate Land Pattern Change QFN to VFQFPN |