Internal Oscillator Compensation Functions

1. Introduction

To compensate the internal oscillator, the Texas Instruments factory takes measurements of the internal oscillator and temperature sensor. It then calculates a reference point for the temperature sensor and oscillator trim and calculates an oscillator trim slope. The trim slope can be used to adjust the oscillator fine trim as the temperature sensor reading moves away from that of the reference point.

The reference point for the internal oscillator consists of two pieces of data. The first is the temperature sensor reading at that point. The second is the oscillator trim values to get 10.0MHz at that temperature. This trim itself is composed of two parts: the fine trim and the coarse trim. Only the fine trim will be adjusted by the compensation procedure. The coarse trim remains the same no matter what temperature the device is at.

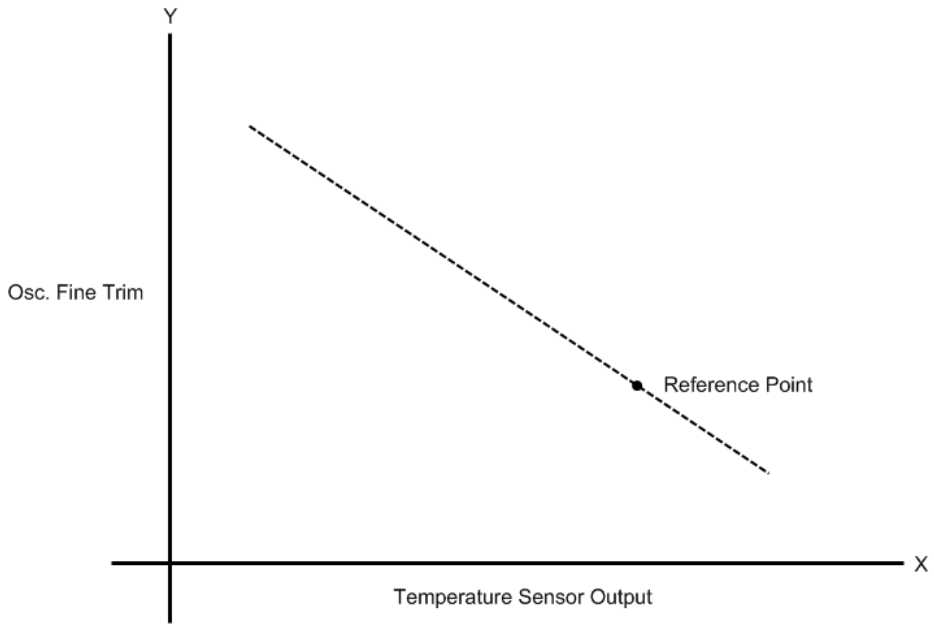
The oscillator compensation slope contains the information needed to adjust the oscillator fine trim from the reference fine trim as the temperature moves away from the reference temperature. This slope has the units of oscillator fine trim steps / ADC codes (temperature sensor output).

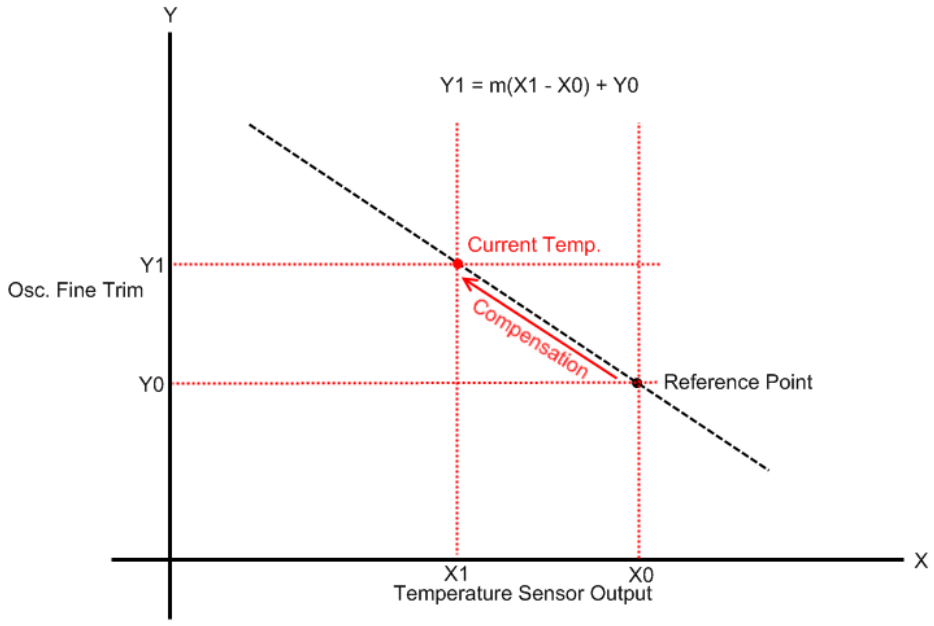
If X is considered to be the temperature sensor reading and Y is considered to be the oscillator fine trim, then the basic oscillator compensation equation is

$$Y_1 = m(X_1 - X_0) + Y_0$$

Where:
Y_1 is the oscillator fine trim at the current temperature
Y_0 is the oscillator fine trim at the reference temperature
X_1 is the temperature sensor reading at the current temperature
X_0 is the temperature sensor reading at the reference temperature
m is the oscillator compensation slope, which is $\frac{\text{change in oscillator fine trim}}{\text{change in temperature sensor reading}}$

This is equivalent to a line with equation Y = mX + b:


Y
Osc. Fine Trim
Reference Point
X
Temperature Sensor Output


Y
Y1 = m(X1 - X0) + Y0
Current Temp.
Y1
Osc. Fine Trim
Compensation
Y0
Reference Point
X
X1
X0
Temperature Sensor Output

2. Oscillator Compensation Functions Available in the Header Files and Peripheral Examples Package

2.1 OTP Functions

The following functions in *DSP<Device>_OscComp.c* are programmed in OTP and return variables stored in OTP used for oscillator compensation.

Function Call: getRefTempOffset()
OTP address: 0x3D7EA2
Returns: Reference Temperature Offset
This is the temperature sensor reading of the reference point for oscillator compensation.

Function Call: getOsc1FineTrimOffset()
OTP address: 0x3D7E93
Returns: Oscillator 1 Fine Trim Offset
This is the fine trim of the reference point for oscillator 1. This is the fine trim required to get 10.0MHz when the temperature sensor reads the value of "High Temperature Offset".

Function Call: getRefTempOffset()
OTP address: 0x3D7EA2
Returns: Reference Temperature Offset

Function Call: getOsc2FineTrimOffset ()
OTP address: 0x3D7E9C
Returns: Oscillator 2 Fine Trim Offset
This is the fine trim of the reference point for oscillator 2. This is the fine trim required to get 10.0MHz when the temperature sensor reads the value of "High Temperature Offset".

Function Call: getOsc1FineTrimSlope()
OTP address: 0x3D7E90
Returns: Oscillator 1 Fine Trim Slope
This is the slope of the oscillator temperature characteristic determined by the factory for internal oscillator 1. Units are oscillator fine trim steps / ADC codes (temperature sensor output). This variable is stored as a Q0.15 fixed point number – e.g. if the slope = -0.04, then this value is stored as $-0.04*(2^{15}) = -1311$. Note that this will require us to use fixed point math to compensate the oscillator.

Function Call: getOsc2FineTrimSlope()
OTP address: 0x3D7E99
Returns: Oscillator 2 Fine Trim Slope
This is the slope of the oscillator temperature characteristic determined by the factory for internal oscillator 2. Units are oscillator fine trim steps / ADC codes (temperature sensor output). This variable is stored as a Q0.15 fixed point number – e.g. if the slope = -0.04, then this value is stored as $-0.04*(2^{15}) = -1311$. Note that this will require us to use fixed point math to compensate the oscillator.

Function Call: getOsc1CoarseTrim()
OTP address: 0x3D7E96
Returns: Oscillator 1 Coarse Trim
This is the coarse trim to always use for oscillator 1 when doing oscillator compensation.

Function Call: getOsc2CoarseTrim()
OTP address: 0x3D7E9F
Returns: Oscillator 2 Coarse Trim
This is the coarse trim to always use for oscillator 2 when doing oscillator compensation.

2.2 Oscillator Compensation User Functions

The following functions use the ADC temperature sensor sample as a parameter and update the internal oscillator coarse and fine trim value while compensating for temperature. These functions can be called directly via user application code.

Function Call: Osc1Comp(int16 sensorSample)
This function uses the temperature sensor sample reading to perform internal oscillator 1 compensation with reference values stored in OTP.

Function Call: Osc2Comp(int16 sensorSample)
This function uses the temperature sensor sample reading to perform internal oscillator 2 compensation with reference values stored in OTP.