Application Note: Manual Offset Nulling of ADXL345

INTRODUCTION

The ADXL345 is factory calibrated to minimize 0-g offset error. Due to additional stresses associated with mounting and soldering, additional 0-g offset error may be introduced by the end-of-line assembly. To further reduce this error, the ADXL345 has been designed with user programmable registers to manually calibrate any additional error. The purpose of this application note is to describe the method to manually null offset error while using the ADXL345.

PROCEDURE

To correct for offset variation in the ADXL345, begin by placing the part such that the axis to be calibrated is parallel with the Earth's surface, or orthogonal to the Earth's gravitational field. The output should then be sampled and the samples, in LSBs, should be averaged. The number of samples depends on the Bandwidth(BW) or Output Data Rate(ODR), as the Root-Mean-Squared(RMS) noise increases as the BW increases. If samples are taken for a fixed period of time, for example 0.25 – 1.0 seconds, the number of samples would automatically increase with the BW, filtering the noise at the output. A shorter time interval can be used; however, if the number of samples is not sufficient the noise will impact the offset nulling procedure. Figure 1 a simulation of the effects of noise on the accelerometer output and how averaging can yield a true offset value.

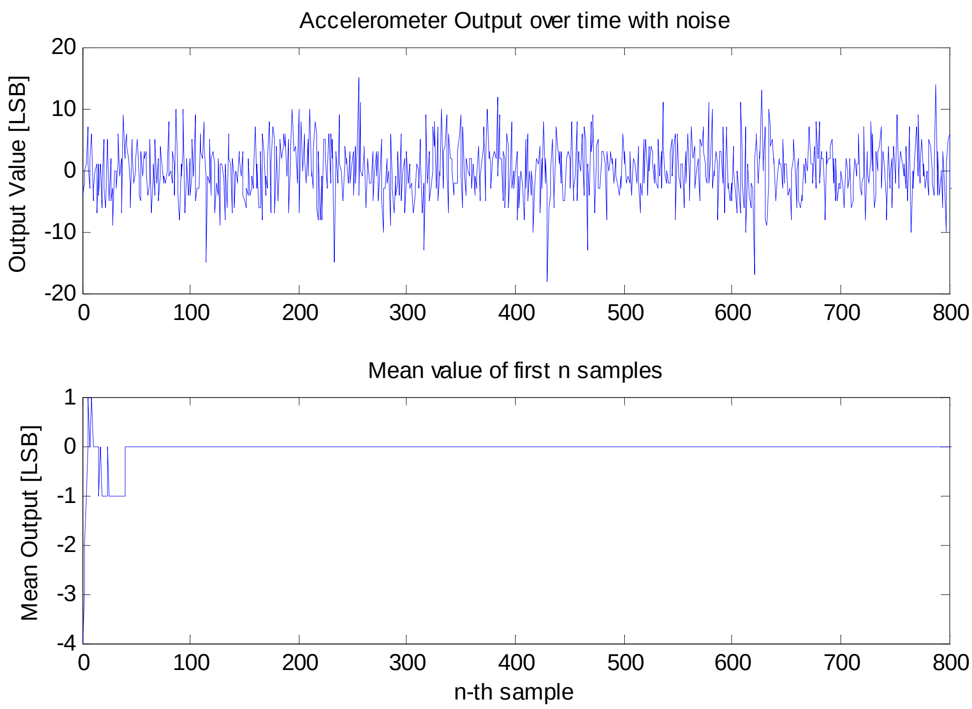

Fig. 1. Effects of filtering accelerometer output to obtain true offset value

The registers for manual offset adjustment on the ADXL345 are registers **0x1E**, **0x1F** and **0x20** for X-axis, Y-axis and Z-axis respectively. The values are two's complement and acceptable values are between -128 to +127. The scale factor for each LSB in the offset register corresponds to 4 LSBs of acceleration or 15.6 mg.

With the output offset determined for the axis of interest, the appropriate offset register should be programmed to account for undesirable offset. For example, if the offset was determined to be +13 LSBs of acceleration, the offset register would need to be programmed with a value -4 to minimize residual offset. Likewise, if the offset was measured as -19 LSBs of acceleration, the offset register would be programmed with a value of +5 to minimize remaining error.

Conversion of a positive number to two's complement is the same as conversion to standard binary. Conversion of a negative number is done by adding 2^N to the value, where N is the number of bits in the sequence, eight(8) for the ADXL345. Examples of converting a positive and negative number are shown below:

Example 1:	+5	→	00000101_2	→	0x05		
Example 2:	-4	→	-4 + 256 = 252	→	11111100_2	→	0xFC

If it is desirable that all three axes be calibrated, the device must be placed in a minimum of two positions, since only two axes at most will be in a 0-g field at any given time. Two axes can be calibrated in the first position and then the remaining axis would be placed into 0-g field and calibrated.

If repositioning the component is not an acceptable alternative, two axes can be well calibrated and some assumptions can be made about the third axis to obtain a rough calibration. It can be assumed that the output sensitivity is well calibrated to the typical value of 3.9 mg/LSB, which corresponds to a count of 256 LSBs in a 1-g field. By averaging the output of the third axis parallel to Earth's gravity, a 1-g field, the difference between the averaged output and the expected 256 LSBs can be used to calibrate the output in a manner similar to when the axis of interest is in a 0-g field. For example, if the measured output is 237, the difference would be -19 LSBs and the offset register would be programmed as shown in Example 1.