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TECHNICAL NOTE

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Embedding Temperature Information in the ADXL202's PWM Outputs

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Introduction

The ADXL202 is a low cost, low power, complete 2-axis accelerometer with a measurement range of ± 2 g. The outputs are digital signals whose duty cycles (ratio of pulsewidth to period) are proportional to the acceleration in each of the 2 sensitive axes.

Many cases exist where it's important to know the temperature of the ADXL202. Sometimes temperature information is required for control or data logging requirements (as in data loggers used to monitor how articles are handled in shipping), or for high precision tilt sensors applications (for temperature compensation of the zero g drift of the accelerometer). Since no A to D converter is required when using the ADXL202's duty cycle outputs, it is preferable to have some means of acquiring temperature information digitally as well.

This application note outlines a simple method of embedding the temperature information from a TMP36 voltage output temperature sensor in the duty cycle acceleration output of the ADXL202. No A to D converter is required, and no additional I/O is necessary.

Basic Principle of Operation

The duty cycle output period is proportional to the current flowing through Rset. The voltage at the T2 pin is typically 1.25 V. So for the recommended range of Rset resistor (125 KΩ to 1.25 MΩ) the current is 1 to 10 µA. Normally Rset is connected between the T2 pin and ground, but any noise free voltage source between 0 and 1.25 V is acceptable.

In figure 1 a TMP36 voltage output temperature sensor is connected to Rset.

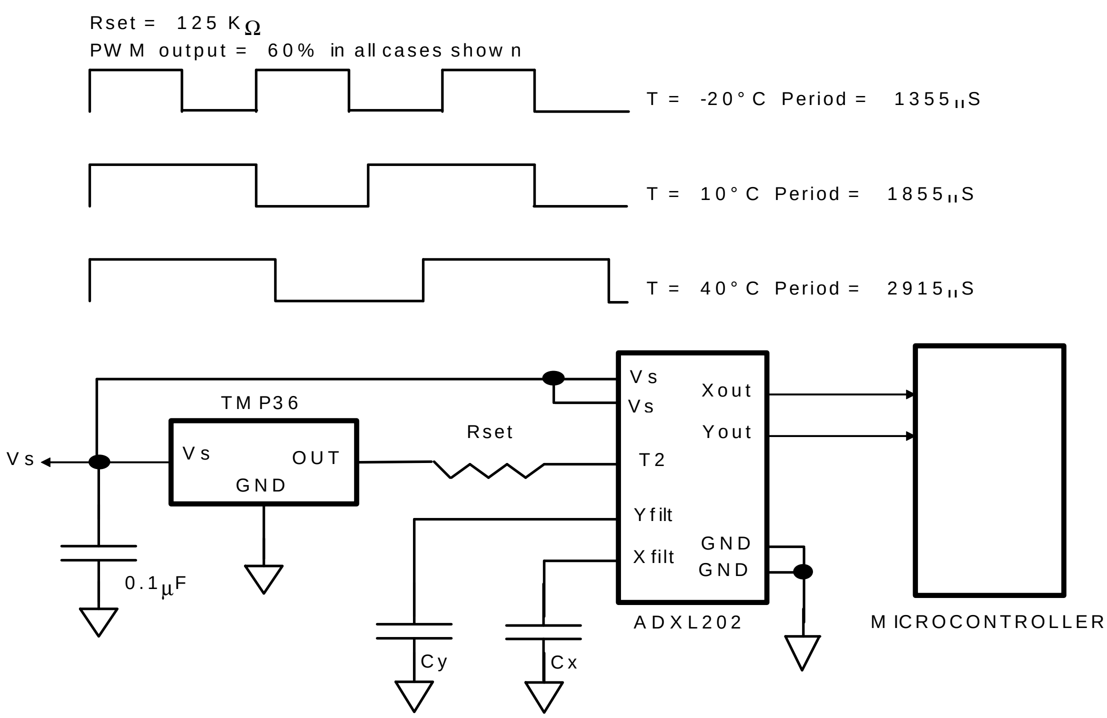

Figure 1. Using a Temperature Sensor to Embed Temperature Information into the Acceleration Duty Cycle Output of the ADXL202

The TMP36 has an output voltage of:

$$Vr = 0.75 + (0.01 \times T) \text{ Volts}$$

where T=temperature in °C

Over a range of -40 to 70°C, the output is 0.1 to 1.2 V. The resulting current is:

Irset = (1.25 - Vr) / Rset = (1.25 / Rset) - (Vr - Rset)

Using a 125 KΩ resistor for Rset, the current is 9.2 to 0.4 μA over the -40 to 70°C temperature range.

In most applications the period need not be measured every cycle (this is discussed thoroughly in the "Using the ADXL202 Duty Cycle Output" application note) . Since temperature change is normally a low speed phenomenon, this will not effect the accuracy of the temperature measurements. Measuring the period a few times per second should be more than sufficient.

A subroutine used to determine the temperature from the T2 period must be added to the user's firmware. Since the change in T2 is not completely linear over temperature, the subroutine's complexity will vary in proportion to the temperature accuracy required. Table 1 shows the typical T2 period versus temperature. Using a simple calculation of:

Temperature = (1735 μS - T2 μS) / 26

Where temperature is in °C and T2 is in μS. This technique will result in temperature readings that are accurate to ±5.5°C over a range of -20 to 40°C. If more accurate temperature readings are required, a simple look-up table can be used. Alternatively, both the initial constant (1735) and the divisor (26) may be modified for higher accuracy over a narrower temperature range.

TEMPERATURE (°C)	**T2 (IN μSec)**	**CALCULATED TEMP. (°C)**
-30	1250	-18.7
-25	1300	-16.7
-20	1355	-14.5
-15	1420	-12.1
-10	1490	-9.4
-5	1565	-6.5
0	1650	-3.3
5	1740	0.2
10	1855	4.5
15	1980	9.5
20	2110	14.4
25	2280	21
30	2450	27.5
35	2660	35.6
40	2915	45.5
45	3230	57.5
50	3620	72.5

Table 1. T2 versus Temperature for the circuit in Figure 1