Preliminary

SENSOR PLATFORMS

SSP1235

HDD Rotational Vibration Correction

Adaptive feed-forward RV control for HDD applications

Rotational Vibration: The Problem

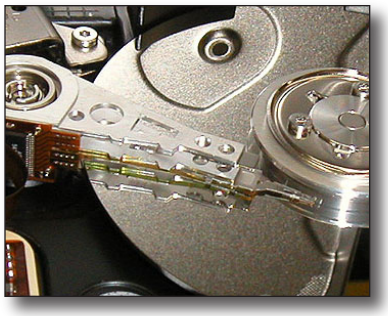
Increasing drive densities are forcing narrower track pitch. With shrinking track pitch, sensitivity to external forces is becoming even more important. Now, even small external rotational forces can push a hard disk drive (HDD) head off track. In the future, with 1TByte drives, the problems will only get worse.

The current solution has been to use simple accelerometer based solutions for the Rotational Vibration (RV) problem. These "first generation solutions" require calibration, and are sensitive to environmental changes, as sensors age and drive mechanics drift. These solutions require discrete op-amp buffers with numerous external components to amplify the small sensor signals. They require fast ADC's to convert the accelerometer signals into the digital domain, where dedicated DSP algorithms run in real time to provide the proper correction signal. Any latency and the corrections will arrive too late. Development of these algorithms is non-trivial and consumes critical bandwidth from the host DSP.

SSP1235: The Next Generation

Sensor Platforms has developed a cost effective, innovative solution to solve the HDD RV problem: adaptive feed-forward correction.

As in the first generation solutions, we use a pair of linear accelerometers, placed parallel to each other on the main HDD circuit board. The SSP1235 has two specially designed low-noise, high gain analog front-ends that amplify the signals from the linear accelerometers. The signal from each accelerometer is then corrected with its proper calibration coefficient, and the two linear signals are then compared to generate a rotational acceleration signal.



With the rotational acceleration signal, the SSP1235 can tell the HDD the amount of rotational vibration it is experiencing. This means the HDD can correctly adjust the position of the read-write head in real-time as the vibration is happening. This is called a feed-forward signal and it lets the HDD appear to "anticipate" the rotational vibration. It means the R/W head will stay on track far more often. And this means better data throughput — and happier customers!

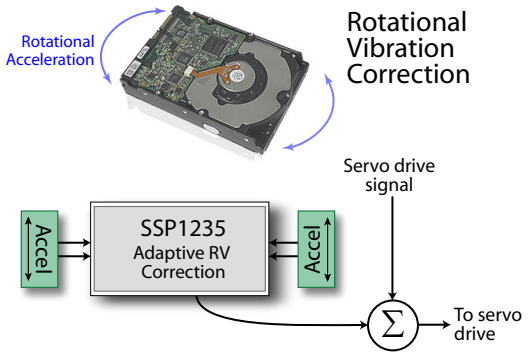


Diagram #1: The SSP1235 RV Correction ASIC. The SSP1235 reads the HDD rotational acceleration signal and generates a correction signal. This signal sums directly into the analog servo drive lead. The SSP1235 autonomously calibrates the accelerometer gains each time the unit spins up and continuously as it operates.

Adaptation

The most remarkable part of the SSP1235 is its ability to self-calibrate. The chip uses available HDD properties to measure changes in the mechanical system. The result is used in a proprietary algorithm to adapt the gain of each accelerometer. This means the SSP1235 can self-calibrate each accelerometer every time the drive is spun-up and continuously over time. The result is the removal of a significant calibration cost during manufacturing and the fact that uncalibrated accelerometers can now be used. It also means that a number of drift mechanisms can now be corrected for: thermal sensitivity of the accelerometers, mechanical stiffness of the PCB, loosening screws, to name only a few.

A "drop-in" solution

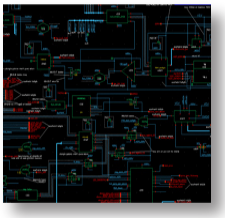
The SSP1235 is a drop-in solution requiring few external components and no software programming. It is a "linear" (analog / mixed-signal) IC implementation that does **not** require a Digital Signal Processor (DSP), analog-to-digital converters (ADCs) or digital-to-analog converters (DACs). The distinct advantage of Sensor Platforms is that our expertise in analog circuit design means that we can design smaller, simpler, lower-power chips than their digital equivalents.

The SSP1235 make designs simpler. It eliminates manufacturing calibration and works to continuously optimize the feed forward correction due to changing environmental and mechanical conditions.

SSP1235

HDD Rotational Vibration Correction

Adaptive feed-forward RV control for HDD applications



Real-time response

Latency, or phase delay, is a critical parameter in feed-forward systems. Latency degrades the effectiveness of feed forward RV cancellation since the corrections arrive after they are needed, and can even amplify the effect of the vibration (if the corrections arrive out-of-phase). The analog design of the SSP1235 is superior to a digital DSP solution. Digital implementations introduce latency and require fast dedicated processing as well as fast ADCs and DACs. One of the great benefits of the SSP1235 is that it is a completely standalone solution and consumes no bandwidth from the host DSP.

Benefits

The SSP1235 is a sophisticated mixed-signal chip implemented primarily with analog circuits for reduced size and superior performance. This chip contains all the required gain, filtering, signal processing and algorithms necessary to solve the HDD RV problem. Inputs to the chip include the accelerometer signals, power / ground and a few external resistors. Output is taken from the SSP1235 and couples a feed forward correction signal directly into the drive's servo loop.

The SSP1235 provides flexibility in programming key parameters directly though a combination of external resistor values as well as pin straps. No SPI or I2C communications to the chip are necessary. Once set during the development phase, these components and straps do not change in production. The SSP1235 requires no programming, nor any change to the drive's firmware.

Key Product Specifications:

- Supply voltage range: 2.25 V to 3.6 V
- Input filter -3dB cut off range:
  7 kHz to 15 kHz ± 30% part to part
- Minimum Logic High Level = 1.7 V
- Operates with piezo electric accelerometers with signals as low as 0.3 picocoulombs/g and as large as 1.2 picocoulombs/g
- Built in "seek detector" disables adaptation when read head is greater than ±10% off track (threshold is adjustable)
- Seek detector can be over ridden by external "seek input" logic signal
- Low power SLEEP mode input pin (SLEEP current <1ua)
- Operating temperature: -10 to +80 degrees C
- Available in packages (TBD) or in bare die.

Sensor Platforms, Inc.

SPI is a fabless semiconductor company, located in San Jose, California, that provides standard and custom mixed signal IC solutions to sensor manufacturers and system integrators. We are unique because we understand the needs of the interface IC not only from a mixed signal IC perspective, but also from the level of the system and the sensor. Our unique combination of expertise in mixed-signal analog IC design, sensor knowledge, and system level application requirements enable us to add value at each stage of sensor application deployment, from sensor specific analog blocks to DSP and algorithm engines to embedded firmware.

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