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AX8052 Oscillator Calibration

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APPLICATION NOTE

Introduction

The built−in Fast RC (FRC) and Low Power (LP) oscillators offer many benefits, such as low current consumption, and fast start−up and shut−down. After applying factory calibration, they offer a frequency accuracy in the order of 1−2%.

Accuracy may be improved by calibrating these oscillators against a crystal reference frequency source. All circuits involving a radio transceiver feature an accurate frequency reference. Furthermore, the built−in crystal or low power crystal oscillator may also be used as calibration frequency source.

The AX8052 contains circuitry that can calibrate the FRC and LP oscillators autonomously, without software intervention. These circuits work similarly to a digital phase locked loop (PLL). They slave the oscillators to the reference frequency, as long as calibration and the reference clock source is enabled.

This raises the question of when the calibration is “good enough”. The example code of this application note compares measured oscillator periods against the reference periods, and signals end of calibration as soon as the measured period is no more than 0.2% for the FRC and 0.4% for the LP oscillator off for four consecutive measurements.

Code Overview

The code assumes an AX8052F143; however, it will work also on other Axsem SOC with straightforward code changes.

The function calibrate_oscillators implements the setup of oscillator calibration, and the monitoring of the terminating condition.

The variables frcmaxerr and lpmaxerr hold the maximum allowed deviation of the measured period compared to the reference period in order to consider the oscillator calibrated. This is set to 0.2% for the FRC and 0.4% for the LP oscillator.

frccalcnt and lpcalcnt count the number of “good” periods and thus serve to implement the terminating condition.

ax5043_rclk_enable switches on the radio’s crystal oscillator, enables clock routing from the radio to the microprocessor, and sets the divider ratio to two to the power of its argument.

This application note’s code requires the user to set the define XTALFREQ to the frequency of the radio’s crystal (in Hz). The macro XTALDIV then selects a divider that ensures the resulting frequency (macro XTALFRQDIV) is no higher than 20 MHz.

To set up the AX8052 calibration logic registers, the code uses the macro setup_osc_calibration_const from the header file libmfosc.h. This macro should only be fed with constants; it compiles to very efficient code, with all register contents computed at compile time. If the frequencies are not known at compile time, the routine setup_osc_calibration may be used.

Calibration register set−up is followed by checking the revision of the AX8052, and possibly apply workarounds for silicon errata.

The main loop of the calibration routine checks the OSCCALIB register to see whether the frequency tuning word of the FRC or LP oscillator has been updated. If so, it reads the last measured period, and compares it to the limits determined above, and updates the counter accordingly. If the terminating condition is met, the loop is exited.

At the end, oscillators are switched off and the workarounds are cleaned up.

Defining USE_INTERRUPT implements the same algorithm using the clock management interrupt, instead of the in−line version.

Conclusion

This application note presented example code for calibrating the AX8052 FRC and LP oscillators against a reference frequency, specifically the radio’s crystal oscillator.

The application code may be modified as follows:

- monitoring the termination of the calibration is only needed if this information is actually used by the application code
- FRCOSCKFILT and LPOSCKFILT may be reduced to reduce oscillator phase noise at the expense of calibration speed

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