Semiconductors

TN06003

LPC900 Mechanical stress on resonator

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Technical note

1. Introduction

This document provides additional information about using a (external) resonator together with the LPC9xx. It discusses special considerations where the resonator is subject of mechanical stress.

2. Mechanical stress

A ceramic resonator is a piezoelectric transducer. It converts electrical energy in force and force in electrical energy. The resonator mechanically vibrates at a resonant frequency in response to an electrical potential applied by the LPC9xx oscillator circuitry. When the resonator is subject of external mechanical stress an electrical current is generated. This charges the load capacitors and creates a differential voltage across X1 and X2 pins of the micro. The voltage is proportional to the transient force that was applied to the resonator. The increase of the differential voltage will cause small pulses, generated by the buffer, when the voltage is larger than the hysteresis of the input buffer. These pulses can be a too high frequency input for the micro. The behaviour is unpredictable then.

3. Precautions

a. Mechanical protection

Flexible leads can be a solution to protect the resonator.

b. Code protection

Watchdog

The watchdog can be used to reset the microcontroller when the program is running out of range. The LPC9xx watchdog has a separate watchdog oscillator.

NOP instruction

Filling the not used program memory with NOP (0x00) instruction and a jump to address 0 on the end of the program memory will also minimize execution of wrong instructions.

c. Circuitry modification

Feedback resistor

The feedback resistor of the LPC9xx oscillator is between of 1.3 and 2 Mohm to reduce the power consumption. However this value might be a problem for mechanical stress phenomenon. The customer has to qualify the external feedback resistance to minimize the differential voltages caused by the mechanical stress of the resonator. The value must be large enough for a correct startup of the oscillator but low enough to absorb the energy caused by the mechanical stress of the resonator. The application notes under reference can be helpful to find the right value.

Bias resistor

It’s important that the neutral bias point of the oscillator is in the middle of the linear region of the oscillator. It is advisable to use a bias resistor from X1 to Vss. In general a value of 1.2Mohm is enough for the oscillator in “high frequency” mode (see data sheet). Lower values seem to have a positive effect on the mechanical stress. However this can cause a bad startup in relation to temperature. Tests show that a bias resistor of 560k ohm is on the edge of the correct operating domain.

PHILIPS

Bias resistor/feedback resistor combination

Tests show that a bias resistor of 1M2 ohm and feedback resistor of 47k ohm is a good combination for the Murata CSTCV12.0MTJ0C4 resonator and the LPC936 in HF oscillator mode.

The best is to ask the resonator manufacturer for a good working combination of Load capacitors /bias resistor and feedback resistor. For optimal resistance against mechanical stress a feedback value on the lower side of the advised value range is recommended.

4. Remark(s)

The remarks are also valid for MF and LF mode of the LPC9xx oscillator however we did not test mechanical stress on the resonator in these modes.

5. References

a. Info Internet

b. Application note AN10289, LPC900 external crystal start-up

c. Application note AN96103, X-tal oscillators on 8-bit microcontrollers

d. Application note AN97090, Oscillators on 8 bit microcontrollers(2)