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APPLICATION NOTE 3830

MAX2141 XTAL Port Interface Recommendations

Jun 23, 2006

Abstract: This application note describes recommendations for the MAX2141 XM satellite-radio receiver's XTAL port interface circuitry. The 257Ω worst-case negative resistance of the MAX2141's XTAL port input guarantees oscillation startup with the crystals currently approved by XM Radio. Selection of the series capacitor value is also described.

Introduction

There are two important [MAX2141](#) XTAL port interface considerations: ensuring oscillator startup and optimizing the oscillation frequency. These considerations are discussed below, along with a brief operational overview of the MAX2141 XM Satellite Radio Receiver.



[Click here](#) for an overview of the wireless components used in a typical radio transceiver.

Operational Overview

The MAX2141 is a complete low-power receiver designed for XM satellite-radio applications. As the functional block diagram shows (**Figure 1**), the receiver includes self-contained RFAGC and IFAGC loops. Channel selectivity is achieved by an external SAW filter and by the on-chip lowpass filters. An integrated fractional-N synthesizer allows fine frequency steps, enabling the implementation of a software AFC loop.

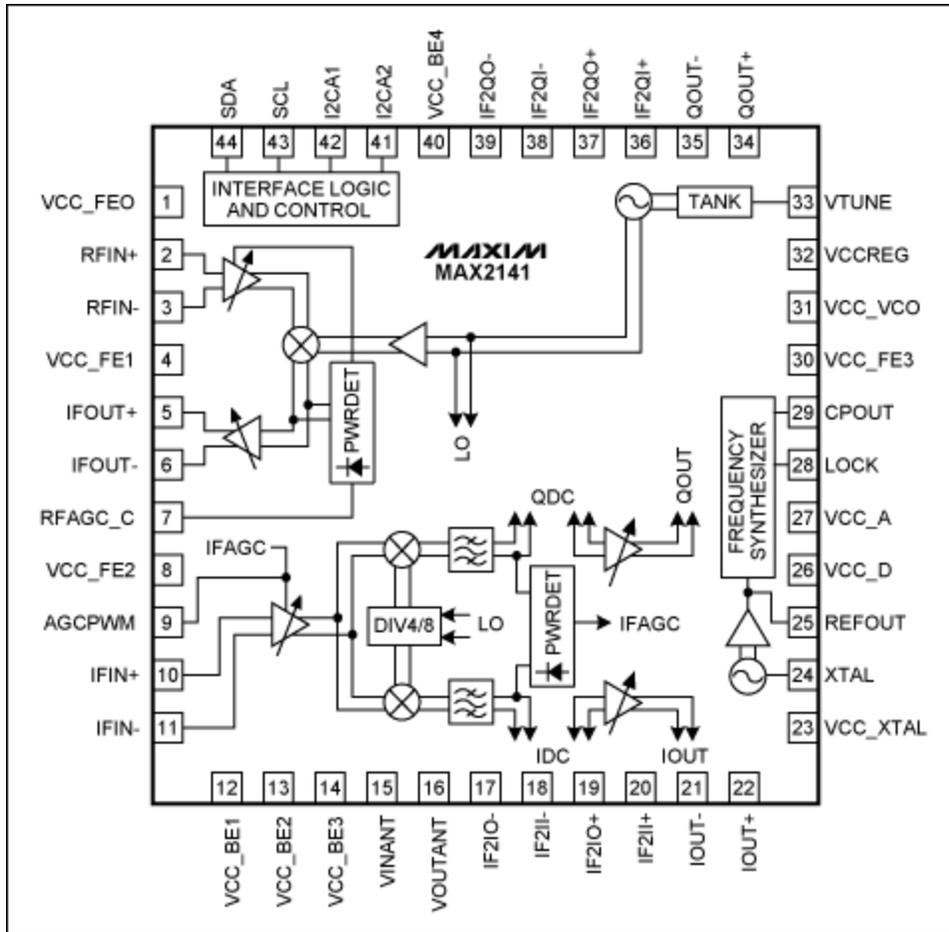


Figure 1. Schematic of the MAX2141 functional block diagram.

Negative Resistance and Oscillator Startup

It is essential that an oscillator start oscillating under all possible startup conditions. To guarantee this, the minimum series negative resistance of the MAX2141 XTAL port at startup must be greater than the maximum ESR of the crystal.¹

Figure 2 shows that the nominal, simulated MAX2141 negative resistance of the XTAL input at startup is 1159Ω at 23.92MHz. The worst-case process state, temperature, and supply-voltage simulation results show a negative resistance of 257Ω at 23.92MHz (**Figure 3**). The maximum ESR of the recommended crystal (Suntsu SCX123-23.920MHz) is 60Ω, which matches the maximum currently allowed by XM. As the worst-case negative resistance is 4.3 times larger than the maximum crystal ESR, oscillator startup is guaranteed for all conditions.

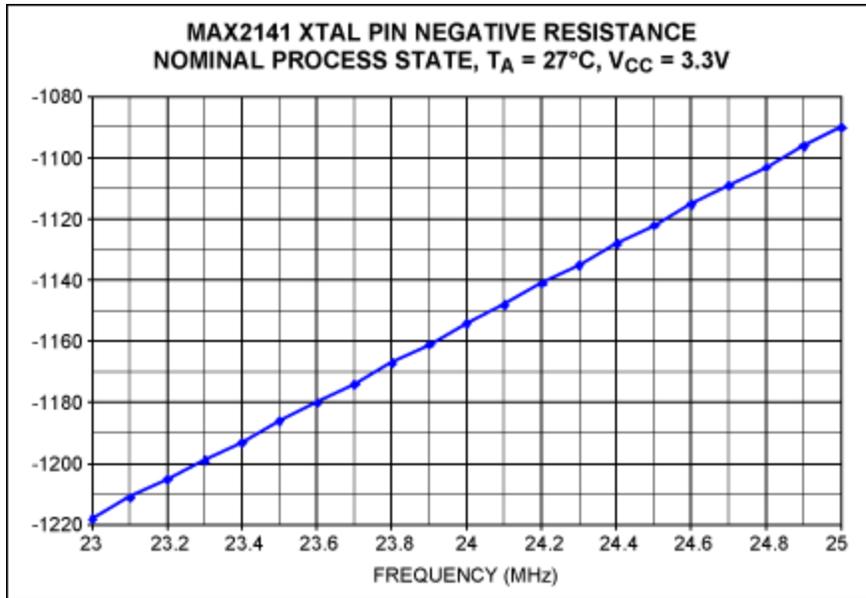


Figure 2. Simulated MAX2141 XTAL pin negative resistance for nominal process, temperature, and supply voltage.

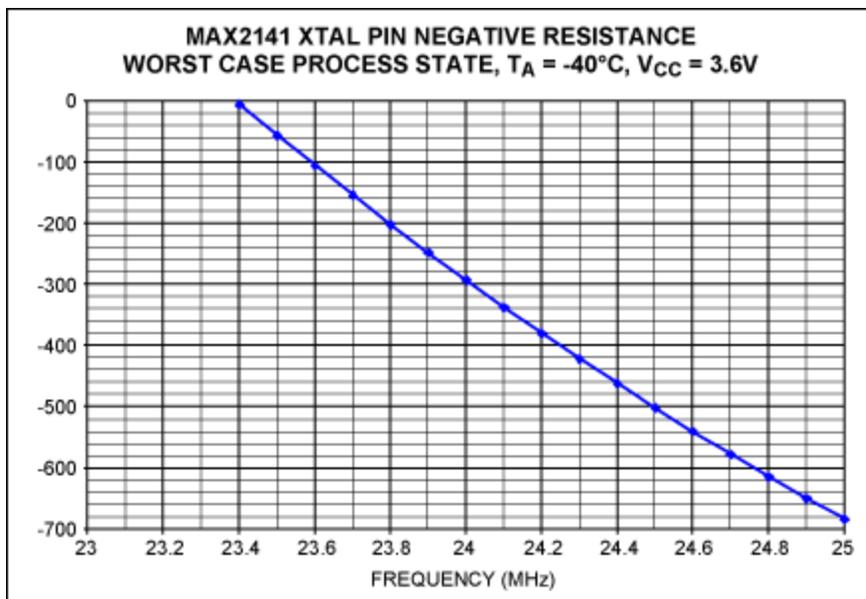


Figure 3. Simulated MAX2141 XTAL pin negative resistance for worst-case process, temperature, and supply voltage.

Selection of Series Capacitor Value

The Suntsu SCX123-23.920MHz crystal requires a parallel load capacitance of 12pF. The MAX2141 XTAL port input provides this required load capacitance when parasitic capacitance is tuned out by the capacitor C1. See **Figure 4**. The optimal value of C1 (100pF, Murata GRM1885C1H101J) is chosen to fine-tune the oscillation frequency.

A similar approach can be used for alternate crystals, such as the 23.920MHz version of the KSS CX-

96F.

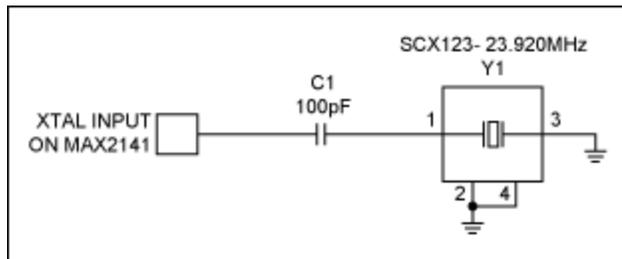


Figure 4. Typical external circuitry for the MAX2141 XTAL port.

Conclusion

Oscillator startup is guaranteed for all conditions when a crystal with maximum ESR of 60Ω or lower is connected to the MAX2141 XTAL port. The Suntsu SCX123-23.920MHz crystal is recommended. Capacitor C1 is optimized to fine-tune the oscillation frequency.

Reference

¹Boyles, John W. "The Oscillator as a Reflection Amplifier: an Intuitive Approach to Oscillator Design," Microwave Journal, June 1986, pp 83–98.

Related Parts

[MAX2141](#)

Low-Power XM Satellite Radio Receiver

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