# Sharing crystal with a MCU

## 1. Preface

This white paper gives guidelines on how a crystal can be shared between an nRF transceiver from Nordic Semiconductor and an external micro controller unit (MCU). The nRF24L01 has been used as an example in this paper, and all data have also been taken from the datasheet of this device. In case other nRF devices are to be used, all necessary data can be found in the corresponding datasheet.

## 2. Crystal from MCU used to feed nRF24L01

In this setup the MCU controls the startup of crystal, feed the clock to nRF device, and also specify most of the crystal requirements. This is the recommended setup, due to the advantages listed at the end of this chapter.

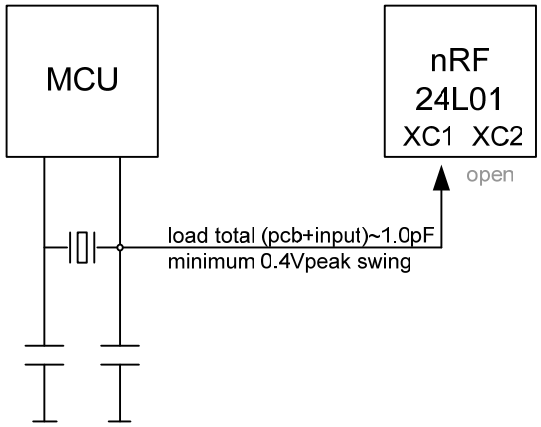


*Figure 1: MCU feed nRF24L01.*

The nRF24L01 crystal oscillator is amplitude regulated. To achieve low current consumption and also good signal-to-noise ratio when using an external clock, it is recommended to use an input signal larger than 0.4 V-peak. When clocked externally, XC2 is not used and must not be connected.

The input signal must not have amplitudes exceeding any rail voltage, but any DC voltage within this is OK. Exceeding rail voltage will excite the ESD structure and the radio performance is degraded below specification.

When the MCU drives the nRF24L01 clock input, the requirement of load capacitance $C_L$ is set by the micro controller only. The frequency accuracy of ±60 ppm[1] is still required to get a functional radio link. The nRF24L01 will load the crystal by 0.5pF at XC1 in addition to the PCB routing.

[1] This data is nRF24L01 specific, and must be checked if other nRF devices are to be used.

Advantages with this kind of setup

- MCU can control startup of crystal oscillator.
- MCU will ensure large signal (> 0.4 V-peak) from crystal.
- $C_L$ can be chosen freely dependent on MCU requirements.
- Low current consumption in standby mode (due to > 0.4V-peak).

| Requirements | MCU | nRF24L01 |
|---|---|---|
| Frequency | | 16 MHz[1] |
| Tolerance | | ±60 ppm[1] |
| $C_{L\ max}$ | X | |
| $C_{O\ max}$ | X | |
| $ESR_{\ max}$ | X | |

*Table 1: Crystal requirements set by which device (figure 1).*

## 3. Crystal from nRF24L01 used to feed MCU

In this setup the nRF24L01 controls the crystal startup, feed the MCU clock, and also set all requirements to crystal specifications.

The nRF device needs to be set in power up mode before the crystal oscillator starts. This means that the MCU must be able to do this before it gets the clock from the nRF device.

This is not a recommended setup. There are no advantages with this kind of setup.

## 4. Conclusion

The advantages of sharing a crystal with a MCU are fewer components and smaller PCB board, which means lower cost to bill of materials. Also it's possible to use a crystal with other specifications, by feeding the clock from a MCU.

A MCU can be used to feed clock to the nRF24L01, however the opposite is not recommended. This is mainly due to the fact that the nRF24L01 is by default in powerdown mode, and needs to be configured with power up bit[2] high, before it will startup it's crystal oscillator.

[1] This data is nRF24L01 specific, and must be checked if other nRF devices are to be used.
[2] This is nRF24L01 specific, and other nRF devices might have power up as an input pin.

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White paper. Revision Date: **2006-05-15**.

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