

Using an External 32 kHz Clock to Drive a CC254x Chip

Fredrik Kervel

ABSTRACT

The purpose of this application report is to show how an external CMOS clock can be connected to the crystal pins of the CC2540/41 chip. Note that the results presented in this document are intended as a guideline only.

Contents

1	Introduction	2
2	Application Circuit	2
3	Clock Signal Requirements	3
4	References	5

List of Figures

1	Application Circuit	2
2	32.768 kHz Oscillator Functioning When Driven Using an External Clock	4
	32.768 kHz Oscillator Functioning When Driven Using an External 0 – 300 mV Clock Over Various Operating Conditions	5

List of Tables

1	Capacitors Used for Driving CC2540/41 With an External Clock	2
2	Clock Signal Requirements	3

Bluetooth is a registered trademark of Bluetooth SIG, Inc. All other trademarks are the property of their respective owners.

1



www.ti.com

1 Introduction

The CC254x family of devices has two types of 32.768 kHz oscillator: an RC oscillator and a crystal oscillator. The RC oscillator requires less current and no external crystal. However, it has lower accuracy than the crystal oscillator.

The *Bluetooth*[®] low energy timing accuracy requirements means that the RC oscillator cannot be used if the CC2540/41 chips were to be used with power modes. Hence, a crystal oscillator is used. However, there is an approach by which an external 32 kHz clock can be used to drive the crystal oscillator. Thereby, allowing you to get rid of the 32.768kHz crystal.

2 Application Circuit

When driving the CC2540/41 with an external 32.768 kHz clock, make sure to capacitively couple the external clock signal to the P2_3/XOSC32K_Q2. Ground the P2_4/XOSC32K_Q1 pin via cap C321. For more details, see Table 1.

Table 1. Capacitors Used for Drivin	g CC2540/41 With an External Clock
-------------------------------------	------------------------------------

Component	Description	Value
C331	32-kHz clock AC couple capacitor	100 nF
C321	Grounding capacitor for XOSC32K_Q1 pin	100 pF



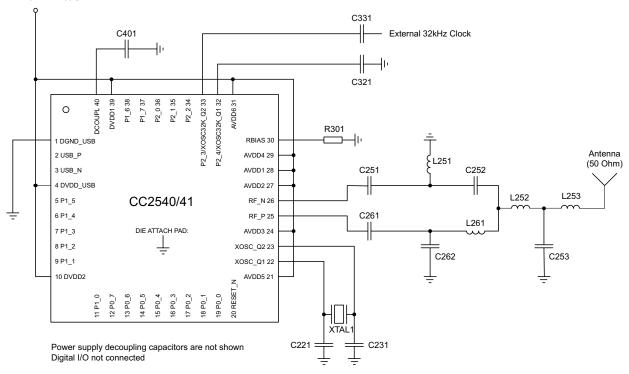


Figure 1. Application Circuit

2



www.ti.com

3 Clock Signal Requirements

There are two recommended alternatives for driving the crystal oscillator from an external clock source. Either a 0 – VDD signal can be used, or alternatively a signal with lower amplitude. The requirements for these signals are shown in the table below. If generating a lower amplitude signal through a resistive divider it is recommended to keep the total resistance in the range $50k\Omega - 100k\Omega$.

The clock signal duty cycle should be 50%. While square wave signal is typically used, it is not a requirement, and it is not a problem using a more sinusoidal clock signal.

The clock requirement applies to the signal before the AC couple capacitor, C331, as shown in Figure 1. When using a lower amplitude clock signal, the oscillator will apply a DC bias which can be observed by measuring on the Q2 pin. This bias level will vary with operating conditions, but will typically be around 0.55 V, as can be seen in Figure 3.

From the application circuit shown in Figure 1, the 32.768 kHz crystal oscillator circuit operation is verified by simulating the conditions where the XOSC32K_Q2 pin is driven with the clock through C331. Figure 2 shows the external and internal clock when the clock signal amplitude is equal to the supply voltage, in this case 3.0 V. Figure 3 shows the external and internal clock as well as the signal on the Q2 pin. The input clock signal amplitude is 300 mV, and the simulation is performed over operating conditions (temperature = -40° C, 25°C and 85°C; supply voltage = 2.0 V, 3.0 V and 3.6 V) and process variations.

Amplitude Either Operating Range: 0 – VDD		Operating Range: 0 – VDD
Or Operating Range: 0 – 200/400 mV		Operating Range: 0 – 200/400 mV
Absolute min/max (as defined in data sheet): -		Absolute min/max (as defined in data sheet): -0.3 V / VDD + 0.3 V
Duty Cycle		min: 45%, max: 55%

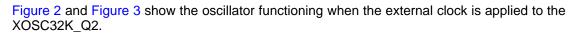
Table 2. Clock Signal Requirements

3



Clock Signal Requirements

www.ti.com



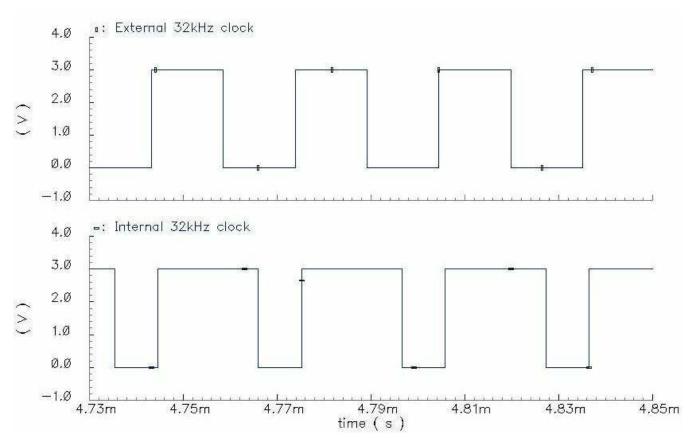


Figure 2. 32.768 kHz Oscillator Functioning When Driven Using an External Clock

www.ti.com

External 32 kHz clock lk divided∟ 320-[300-250-200 V (mV) 150 100-50.0-0 -50.0-7.25 7.3 7.35 time (ms) Clock signal on Q2 pin 1.1-<mark>92</mark>-1.0 .9-.8-S .7 .6-.5-.4 .3 7.25 7.35 7.3 time (ms) Internal 32kHz clock 4.0-3.5 3.0-2.5-S^{2.0} >1.5 1.0 .5-0-- 5 7.25 7.3 7.35 time (ms)

Figure 3. 32.768 kHz Oscillator Functioning When Driven Using an External 0 – 300 mV Clock Over Various Operating Conditions

4 References

- CC2540F128, CC2540F256 2.4-GHz Bluetooth® low energy System-on-Chip Data Sheet (SWRS084)
- CC2541 2.4-GHz Bluetooth[™] low energy and Proprietary System-on-Chip Data Sheet (SWRS110)
- CC253x System-on-Chip Solution for 2.4-GHz IEEE 802.15.4 and ZigBee® Applications User's Guide (SWRU191)



Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (August 2012) to A Revision		Page
•	Updates were made to Section 3	3

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have *not* been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products Audio Amplifiers Data Converters DLP® Products	www.ti.com/audio amplifier.ti.com dataconverter.ti.com www.dlp.com	Applications Automotive and Transportation Communications and Telecom Computers and Peripherals Consumer Electronics	www.ti.com/automotive www.ti.com/communications www.ti.com/computers www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	TI E2E Community	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconne	ctivity	

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265 Copyright © 2016, Texas Instruments Incorporated