Interfacing CC1100 - CC2500 to the MSP430

By Giuseppe Mazzoleni

Keywords

- *MSP430*
- *CC1100*
- *CC1100E*
- *CC1101*
- *CC2500*
- *Application Example*
- *Interfacing CC1100 using SPI*
- *MSP430 with SmartRF04®EB*
- *Library for CC1100 and CC2500*

1 Introduction

The purpose of this design note is to show how to interface the CC1100/CC1101/ CC1100E/CC2500EM with the MSP430F1xx/41x family. An example shows the interconnection between the CC1100/CC2500 transceiver and the MSP430F169. The simple protocol is adapted from the TI software libraries [1] [2]. The software handles the transceiver configuration, the MCU configuration, and a basic RF communication protocol. The hardware consists of an MSP-FET430 Development Tool from Texas Instruments equipped with an MSP430F169 MCU. The kit can be connected to the CC1100/CC1101/CC1100E/CC2500 hosted on the SmartRF®04EB from Texas Instruments. An auxiliary node must be used to implement and test the RF protocol. The software, which is available from the TI web pages [2], is compatible with the IAR C/C++ compiler and the MSP-GCC compiler from GNU. Any device within the MSP430 family can be used with this library due to hardware abstraction. Similarly, any SPI capable interface module within the MSP430 family is supported by the library.

Table of Contents

2 Abbreviations

ADC	Analog to Digital Converter
DK	Development Kit
DMA	Direct Memory Access
EB	SmartRF®04EB evaluation board
EM	Evaluation Module
FLASH	Non-volatile memory for storing of, mainly, program code
GDO	General Data Output
GPIO	General Purpose Input/Output pin
MCU	Micro Controller Unit
RAM	Random Access Memory
SCLK	Serial Clock
SPI	Serial Peripheral Interface
SVS	Supply Voltage Supervisor
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
USI	Universal Serial Interface

3 Description

The example introduced here exploits two MSP430F169 microcontrollers connected to the CC1100/CC1101/CC1100E/CC2500 transceivers. The microcontrollers and the transceivers are interfaced through a MSP-FET430 socket module [3], a SmartRF®04EB, and the CC1100/CC2500 EMs. Two nodes are required to establish a half duplex RF link. The two evaluation boards together with the related two evaluation modules are included in the associated DK [4]. A complete example project is provided with the library. The purpose of this project is to demonstrate the use of the library together with the Chipcon/Texas Instruments DK. It is intended to provide a boost in the development of MSP430/CCxxxx-based products but is not a comprehensive guide to using the CC1100/CC1101/CC1100E/CC2500. An overview of the connection schema is depicted in Figure 1.

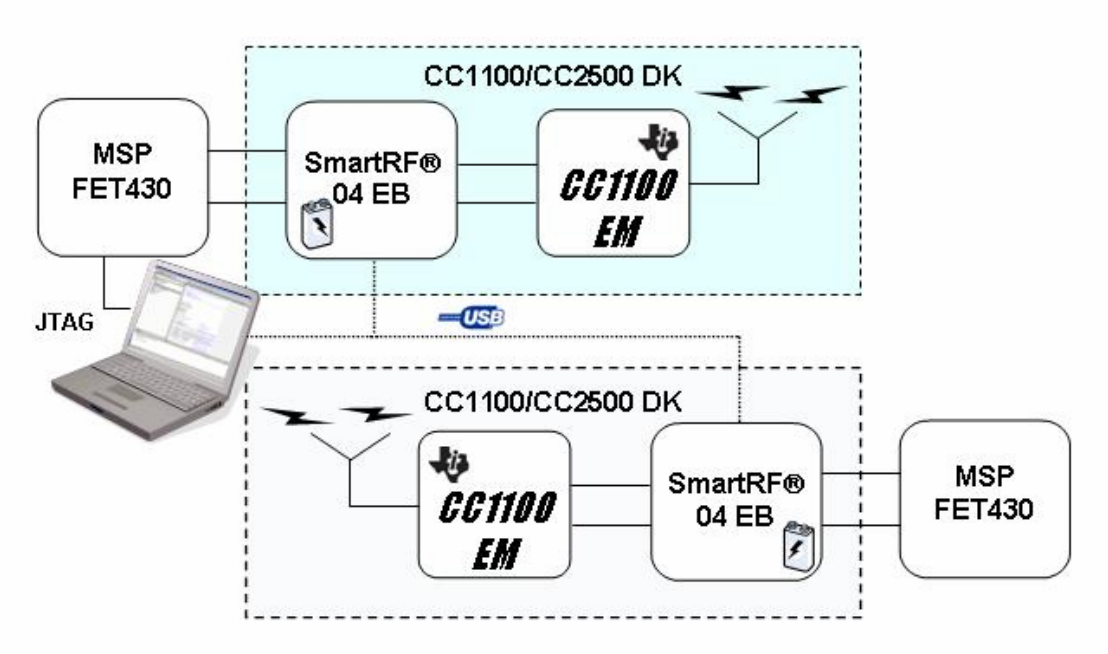

Figure 1. Bidirectional RF link, MSP430, SmartRf04®EB, and CC1100CC1101/CC1100E/CC2500 EM

4 Hardware

The MCU chosen for the design is the MSP430F169 [5]. This MCU has several peripherals; it integrates 12-bit analog to digital converter (ADC12) with built-in voltage reference and temperature sensor, dual 12-bit D/A converter, and two universal serial synchronous/asynchronous communication interfaces. This enables easy interface to various sensors directly. In addition to the peripherals, this device features 60Kbytes of Flash program memory, 2Kbytes of RAM, and DMA to support quite complex wireless networking protocols. There is a wide choice of drop in replacement MSP430 derivatives that can be used on this hardware platform based on the end applications and memory requirements. Some compatible devices are listed in Table 1. It must be pointed out that this controller has processing and memory capacity which exceeds the requirement of the software example, so this software could execute on smaller microcontrollers.

Part Number	Flash	RAM	GPIO	ADC	Other Peripherals
MSP430F156	24 KB	1 KB	48	12-bit SAR	2 DAC 12, Analog Comparator, DMA, SVS
MSP430F168	48 KB	2 KB	48	12-bit SAR	2 DAC 12, Analog Comparator, DMA, Hardware Multiplier, SVS
MSP430F149	60 KB	2 KB	48	12-bit SAR	Analog Comparator, Hardware Multiplier
MSP430F148	48 KB	2 KB	48	12-bit SAR	Analog Comparator, Hardware Multiplier
MSP430F167	32 KB	1 KB	48	12-bit SAR	2 DAC 12, Analog Comparator, DMA, Hardware Multiplier, SVS
MSP430F1611	48 KB	10 KB	48	12-bit SAR	2 DAC 12, Analog Comparator, DMA, Hardware Multiplier, SVS
MSP430F147	32 KB	1 KB	48	12-bit SAR	Analog Comparator, Hardware Multiplier
MSP430F2011	2 KB	128 B	10	Slope	Analog Comparator, Timer UART
MSP430F2013	2 KB	128 B	10	Slope	Analog Comparator, Timer UART USI for SPI

Table 1. Some MSP Microcontrollers Suitable for this Type of Application

The microcontroller can be programmed using a JTAG module, MSP430FET, available from TI [3]. The SmartRF®04EB is used as a motherboard for the CC1100EM in this example, interfacing the MSP430F169 and the CC1100 radio transceiver. The motherboard (EB) is populated with 0-ohm resistors which connect the signal lines from the EM to the USB MCU and the various peripherals on the EB board. The 0-ohm resistors must be removed to isolate the USB MCU from the EM selectively for all the signals. The signal lines can then be controlled by for instance another MCU development board (MSP-FET430) by connecting to the I/O connectors (P11 I/O_B and P10 I/O_A). The I/O connectors bring out all the signals from the EM connectors. These connectors make it easy to attach additional external circuitry using a ribbon cable to connect a prototyping board (see Figure 2 and Figure 3). The following describes which signals are routed to the external headers (P10 and P11). In order to activate the connection between the prototyping board and the transceiver EM a set of six signals is required (refer to Table 2; highlighted light blue rows). In addition, the prototyping board can also exploit the supply voltage provided by the SmartRF®04 motherboard (3.3V, highlighted light yellow rows). The SmartRF®04EB can be powered in several different ways; DC, USB, or battery powered. Please refer to the DK user guide [4] to obtain more details about the power supply configuration.

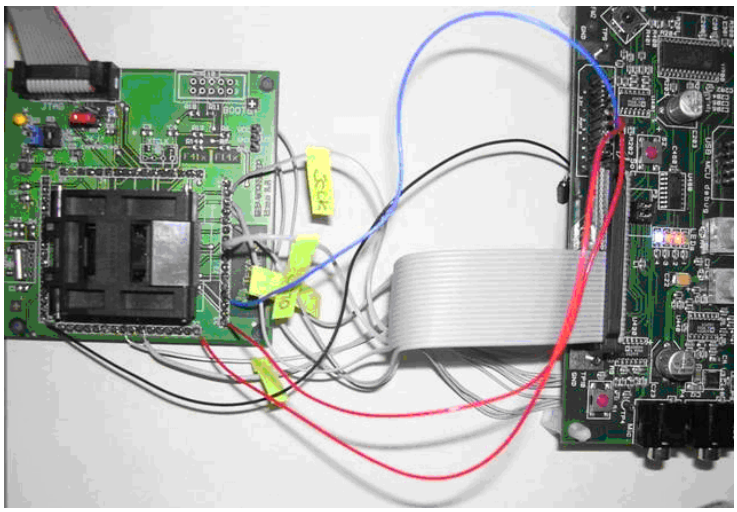

Figure 2. Basic Connection MSP430 and the SmartRF®04EB connectors

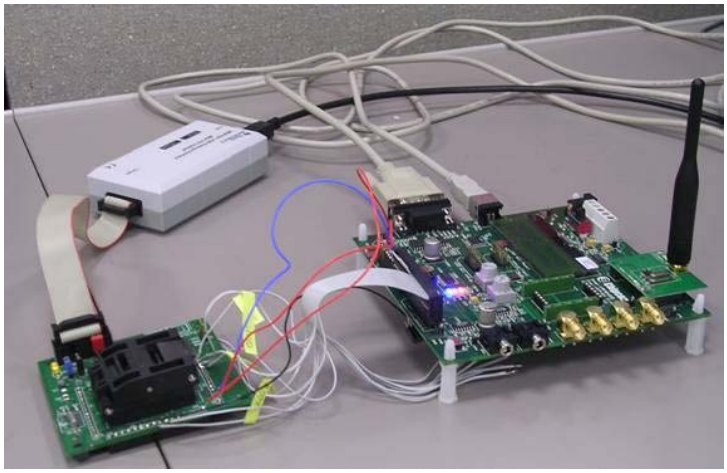

Figure 3. System overview; Connection of the MCU with the EM through the EB

P10 I/O Connector A		P11 I/O Connector B	
PIN	**Function**	**PIN**	**Function**
1		1	
2		2	
3	Mic input	3	+3.3V
4	+3.3V	4	LED4
5	+3.3V	5	LED1
6		6	CC25XX/CC11XX GDO0
7	Push button	7	Audio output
8		8	CC25XX/CC11XX GDO2
9	RS-232 RD	9	LED2
10		10	SDA (LCD display)
11	RS-232 TD	11	LED3
12		12	SCL (LCD display)
13	RS-232 RTS	13	CC25XX/CC11XX CSn
14		14	
15	Joystick push, RS-232 CTS	15	CC25XX/CC11XX SCLK
16		16	
17	Joystick	17	CC25XX/CC11XX SI
18		18	GND
19	Potmeter	19	CC25XX/CC11XX SO/GDO1
20	GND	20	GND

Table 2. I/O Connector A and B Pin Out

Table 3 summarizes which 0-ohm resistors must be removed in order to isolate the selected signal from the USB MCU which governs the SmartRF®04EB motherboard. The signals, which directly interface the external prototyping board to the EM are highlighted.

Signal Name	Resistor	Function
SO/GDO1/MISO	R117	SPI MISO SO/GDO1
SCLK	R115	SPI Serial clock
LED3	R113	LED3 (yellow), active low
LED_4	R120	LED4 (Blue), active low
JOY	R106	Joystick input (analogue coded voltage)
LED2	R111	LED2 (Red), active low
LED1	R110	LED1, (Green), active low
POT	R107	Potmeter input
JOY_PUSH	R112	Joystick pushed
PWM_OUTPUT	R105	PWM audio output
BUTTON_PUSH	R101	Button pushed
MIC_INPUT	R104	Audio input
SCL	R124	I2S clock (for LCD)
SDA	R123	I2S data (for LCD)
GDO2/DC	R122	Transceiver/transmitter GDO2.
GDO0/DD	R121	Transceiver/transmitter GDO0.
UART_RD	R102	UART RD
UART_TD	R103	UART TD
CS/SS	R114	SPI slave select signal
MOSI	R116	SPI MOSI signal; Transceiver/Transmitter SI

Table 3. Peripherals Connections on SmartRF®EB

The MSP430 communicates with the CC1100 via the SPI bus on USART1. Table 4 shows port pin connections and the signal names.

MSP430 pin name	Signal Name	SmartRF04®EB Peripherals
P1.0/TACLK	LED1	LEDs (optional)
P1.1/TA0	LED2	
P1.2/TA1	LED3	
P1.3/TA2	LED4	
P1.4/SCLK	Push button	S1 Button (optional)
P1.5/TA0	Joystick Push / CTS	Joystick (optional) / Flow Control
P6.0/A0	Joystick	
P2.4/CA1/TA2	CC25XX/CC11XX GDO0	CC1100/CC2500 EM
P2.6/ADC12CLK/DMAE0 SFD	CC25XX/CC11XX GDO2	
P5.3/UCLK1	CC25XX/CC11XX SCLK	
P5.2/SOMI1	CC25XX/CC11XX SO/GDO1	
P5.1/SIMO1	CC25XX/CC11XX SI	
P5.0/STE1	CC25XX/CC11XX CSn	
P3.1/SIMO0/SDA	SDA (LCD display)	SMBus LCD (optional)
P3.3/UCLK0/SCL	SCL (LCD display)	
P3.4/UTXD0	RS-232 TD	RS232 level shifter (optional)
P3.5/URXD0	RS-232 RD	

Table 4. MSP430 Pin and Corresponding Signal Name on the SmartRF®EB

5 CC1100/CC1101/CC1100E/CC2500

The MSP430 configures and controls the CC1100/CC1101/CC1100E/CC2500 via a high speed SPI bus. Other signals to and from the CC1100/CC1101/CC1100E/CC2500 are required to successfully acquire packets from the RF transmission. Please refer to CC1100/CC1101/CC1100E/CC2500 documentation for more information about the signal definitions and their usage [5], [6], [7], and [8].

6 Software

The software developed for the MSP430F169 microcontroller is written for the IAR MSP430 C-compiler. Configuration of the CC1100/CC1101/CC1100E/CC2500 is performed using general I/O pins and the MSP430's SPI interface. The demo application is simple: pressing a switch on one board causes a corresponding LED on another board to toggle. The demo application makes use of the GDO0 output on the CC1100/CC1101/CC1100E/CC2500, configuring it to assert when a sync word is received and de-assert when the complete packet is received. Please follow the guidelines defined in the referred documentation [1] (Adapting the Demo Project to Other Hardware) in order to adapt the software to your own prototype board. The related code can be downloaded from the TI web site [2].

7 References

[1] MSP430 Interface to CC1100/CC2500 Code Library, Technical document (slaa325.pdf)

[2] MSP430 Interface to CC1100/CC2500 Code Library, Associated code files (slaa325.zip)

[3] MSP-FET430 FLASH Emulation Tool, User's Guide (slau138.pdf)

[4] Mixed Signal Microcontroller, Data sheet (msp430f169.pdf)

[5] CC1100 Single-Chip Low Cost Low Power RF-Transceiver, Data sheet (cc1100.pdf)

[6] CC2500 Single-Chip Low Cost Low Power RF-Transceiver, Data sheet (cc2500.pdf)

[7] CC1101 Single-Chip Low Cost Low Power RF-Transceiver, Data sheet (cc1101.pdf)

[8] CC1100E Single-Chip Low Cost Low Power RF-Transceiver, Data sheet (cc1100E.pdf)

8 General Information

8.1 Document History

Revision	Date	Description/Changes
SWRA116A	2009.03.12	Removed logo from header. Added CC1101 and CC1100E.
SWRA116	2006.10.06	Initial release.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI 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 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DLP® Products	www.dlp.com	Broadband	www.ti.com/broadband
DSP	dsp.ti.com	Digital Control	www.ti.com/digitalcontrol
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Military	www.ti.com/military
Logic	logic.ti.com	Optical Networking	www.ti.com/opticalnetwork
Power Mgmt	power.ti.com	Security	www.ti.com/security
Microcontrollers	microcontroller.ti.com	Telephony	www.ti.com/telephony
RFID	www.ti-rfid.com	Video & Imaging	www.ti.com/video
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265