

KeeLoq RX application over S2-LP

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Main components	
S2-LP	Ultra-low power, high performance, sub-1 GHz transceiver
STEVAL-FKI433V1	Sub-1 GHz transceiver development kit based on S2-LP
NUCLEO-L152RE	STM32 Nucleo-64 development board with STM32L152RE MCU, supporting Arduino and ST morpho connectivity
STM32L152RET6	Ultra-low-power 32-bit MCU ARM®-based Cortex®-M3 with 512 Kbytes Flash, 80 Kbytes SRAM, 16 Kbytes EEPROM, LCD, USB, ADC, DAC

Purpose and benefits

This design tip explains how to implement a KeeLoq receiver over S2-LP, which allows bit-by-bit real-time decoding of the packets received.

Description

The complete list of the hardware (HW) prerequisites is the following:

- Receiver node (one unit): 1 *STEVAL-FKI433V1 Sub-1 GHz transceiver development kit based on S2-LP*.
- Transmitter node: 1 KeeLoq compliant remote e.g. CHJ-7787K, or as alternative 1 STEVAL-IKR002V3: SPIRIT1 433 MHz low data rate transceiver, which can simulate a remote control transmitting KeeLoq encoded packets.
- System setup:
 - 1 laptop/PC with Windows® 7/8.
 - 3 or more USB type A to Mini-B USB cables for connecting and supplying power to the 3 or more STM32 Nucleo boards.

The complete system is shown in Figure 1 and 2.

Figure 1. RX node, KeeLoq compliant



Figure 2. TX node, KeeLoq compliant based on SPIRIT1 evaluation kit STEVAL-IKR002V3



Software prerequisites

- STM32 Nucleo ST-LINK/V2-1 USB driver
- A serial terminal emulator (e.g. Tera Term)
- KeeLoq firmware example for RX node available on request through local marketing/sales representative.

Solution description

The software implementation aims to decode KeeLoq encoded packets by sampling the signal and interpreting every bit separately, taking into account that the KeeLoq protocol interprets the data by triples of bits, where 110b (6 dec) encodes a zero and 100b (4 dec) encodes one.

The S2-LP is configured with a channel filter of 200 kHz in order to be compatible with the widest number of remotes which may have a different/drifted carrier frequency.

The S2-LP outputs the received demodulated data to a general purpose IO pin, using the direct GPIO mode so that the MCU can decode the data and rebuild the digital information.

Based on the KeeLoq protocol, each packet has a 66-bit transmission code and is composed by two parts. One part has a 34-bit fixed code (28-bit serial number, 4-bit button code, 2-bit status) and the second part has a 32 bit encrypted portion.

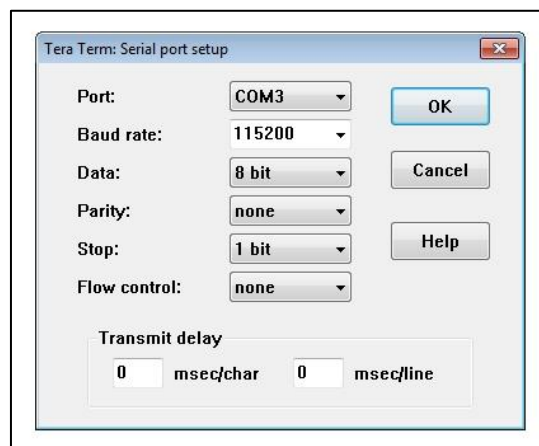
The sensitivity obtained with the S2-LP configuration used in this implementation is about -108dBm (considering a 1%BER) as can be seen by the chart in Figure 4.

As a transmitter, the SPIRIT1 has been used with an automatic routine that changes the frequency along the range 433.9 MHz \pm 87 kHz and the power level.

The application running on the RX node (S2-LP) sends the fixed (unencrypted) part of the received packet out to the serial interface. In order to display this information, the terminal emulator should be configured as follows (in the pictures below, the setup for Tera Term is shown):

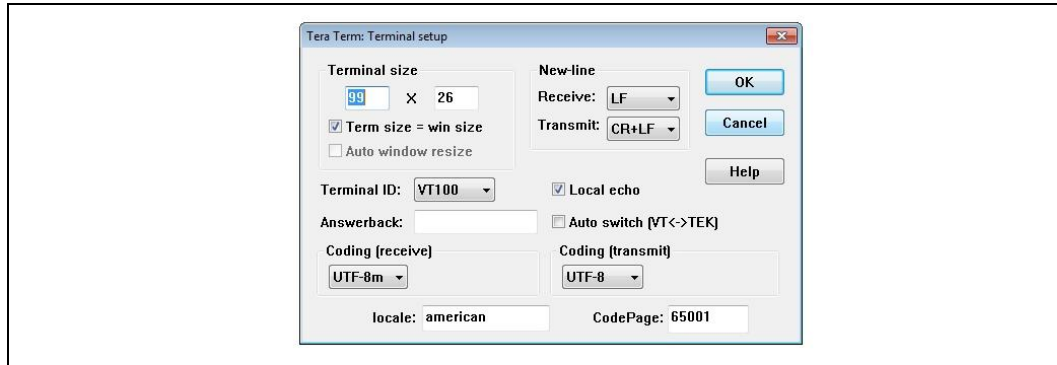
- Click on “Setup” and “Serial port...” to configure the parameters as shown in Figure 3. Note that the COM port must match the one assigned by Windows to the receiver node.

Figure 3. Serial port setup



- Click on “Setup” and “Terminal...” to configure the parameters, as shown in Figure 4.

Figure 4. Terminal setup



As soon as the RX node gets the packets, it displays the data on the terminal, as illustrated in Figure 5.

Figure 5. Terminal emulator output on the RX node board

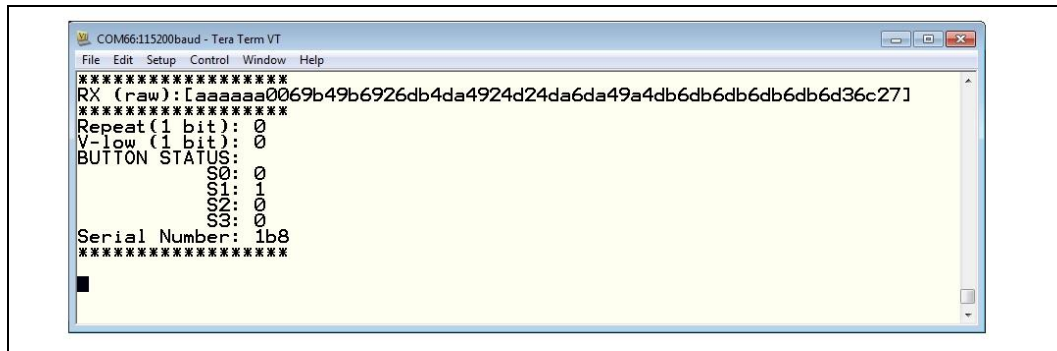
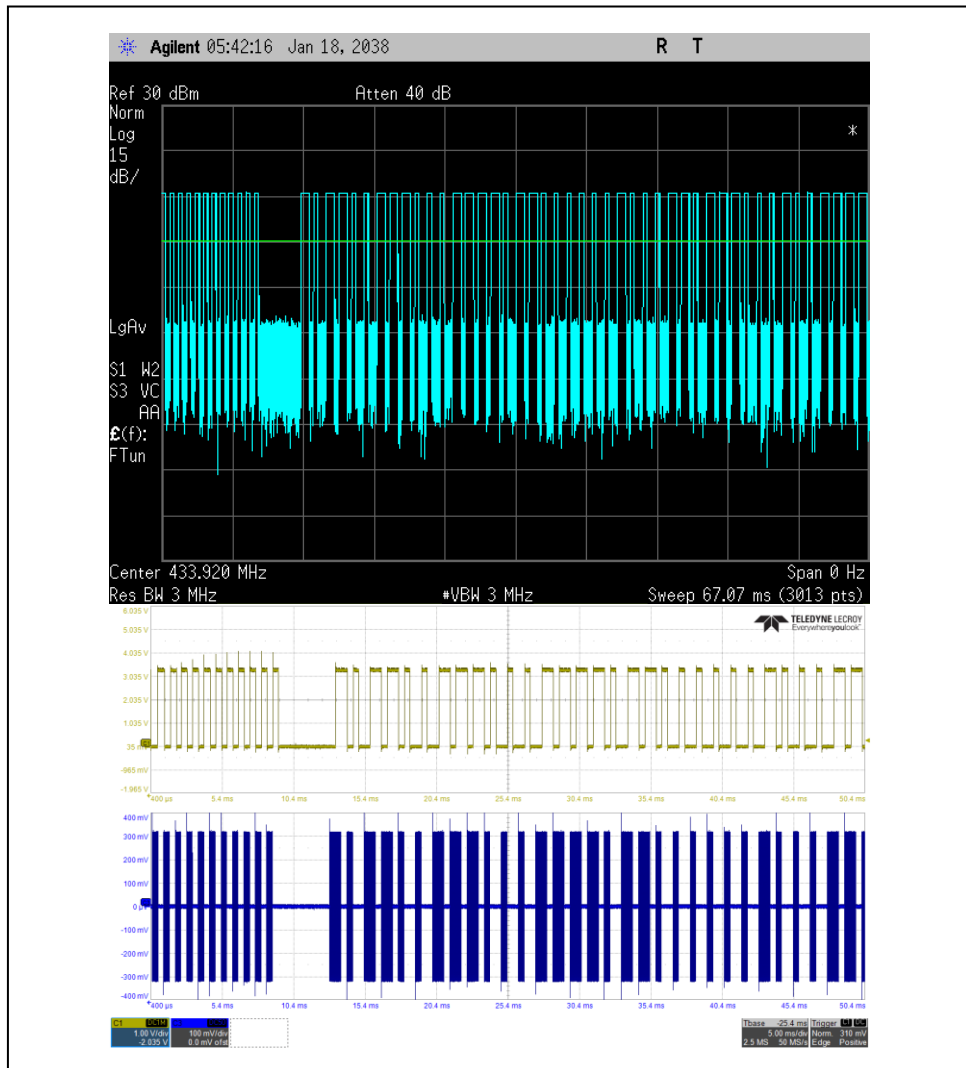


Figure 6. Spectrum analyzer and oscilloscope view



Support material

Related design support material
STEVAL-FKI433V1: Sub-1 GHz transceiver development kit based on S2-LP
STEVAL-FKI433V1 board schematics
STEVAL-FKI433V1 gerber files
STSW-S2LP-DK: Evaluation SW package based on S2-LP
NUCLEO-L152RE: STM32 Nucleo-64 development board with STM32L152RE MCU
Documentation
Datasheet: S2-LP, Ultra-low power, high performance, sub-1 GHz transceiver
User manual UM2149: Getting started with the S2-LP development kits
User manual UM1724: STM32 Nucleo-64 board
Application note AN4947: PCB design guidelines for the S2-LP transceiver
Application note AN499: Using the S2-LP transceiver under FCC Title 47 Part 15 in the 430-470 MHz band

Revision history

Date	Version	Changes
07-Dec-2017	1	Initial release

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