AN-904
APPLICATION NOTE
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"microSP" Technology Eval-boards

Experience and refine your "IoT" wireless expertise

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Abstract

The Eval EVT17S3 and EVR27A boards have been designed for tests and experiments on the SPT17S3 and SPR27S3 modules, the two basic modules, transmitter and receiver, designed for "microSP" technology. In addition to the individual tests on the two modules, the two boards, used together, allow a whole series of experiments in the "wireless" sector in particular to understand and analyze the problems that can be encountered in "Internet of Things" applications.

The EVT17S3 and EVR27A Evaluation Boards .

The combined use of the two boards with the SPR27S3-D2 module in reception and the SPT17S3-D2 module in transmission allows a first understanding of the advantages offered by the "Short Pulse" "microSP" technology in "IoT" networks. Subsequent experiments can then be conducted to investigate issues typical of the propagation of radio waves, the control of disturbances and interferences or even for tests on the antennas. One of the problems encountered in the design of a wireless sensor, especially if its dimensions are only a few centimeters, is precisely to ensure that the antenna radiates all or almost all the RF power.
The two modules are programmed with the "D2" software, which, besides being usable for general use, has above all a "demo" function.

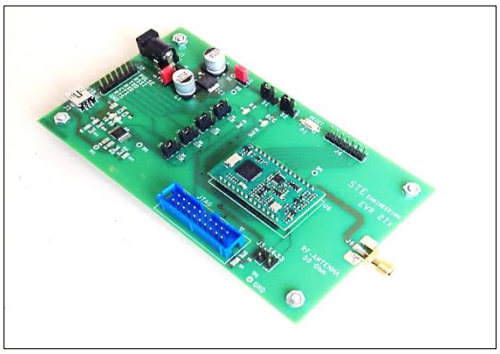


Fig.1 – The EVR27A Rx Evaluation Board with the SPR27S3-D2 Receiver.

Note 1 - The SPR27S3-D2 receiver ("D2" programmed) can be enabled, with the EVR27A S1 and S2 jumpers, to coding the received data from the UART both as a string of "Hex" characters and as "ASCII" characters, to be displayed as plain text on a Terminal Emulator ("HyperTerminal" or "TeraTerm" as an example, see Figure 3). In a practical test, this facility allows to see the received data and also to immediately read and evaluate signal and noise intensity.

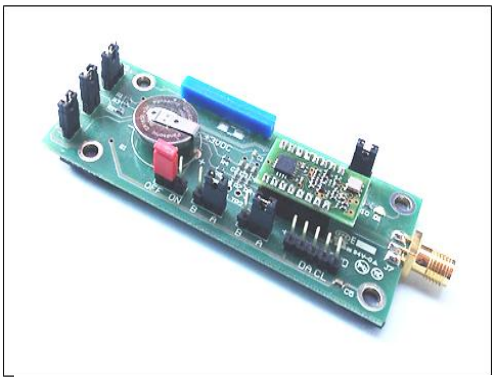


Fig.2 – The EVT17S3 Tx Evaluation Board with the SPT17S3-D2 "microSP" Tx module.

Note 2 - The EVT17S3 was instead designed to perform data transmission tests in conjunction with a "D2" programmed transmitter. The SPT17 Tx module to work must be interfaced with one or more sensors specific to the application for which it is intended. The "D2" version is programmed for 3 On/Off inputs plus an analog input : on the EVT17S3 two "Jumpers" and a "Reed" contact are provided for the three on/off contacts plus a separate input for voltage measurement.
The SPT17S3-D2 also provides an output for a Led indicator (Tx Led) and two inputs (S1 and S2 Selector) to choose four different operating modes with different times for the "Heartbeat" transmission and the measurements sampling.

The EVR27A Eval-board can therefore be used generically also with receivers with a program other than "D2". The EVT17S3 is specific for use in conjunction with the Tx EVT17S3-D2 module: it can however be used with appropriate modifications for other types of applications and with other sensors/alarms. For example, to realize "Test Fixtures" at an early stage of production.

(1) The “Basic” Demo Kit

The "Demo Kit" consists of the two Evaluation Boards, the SPT17S3-D2 and SPR27S3-D2 Tx and Rx modules, and two 1/4 wave 434 MHz rubber antennas (STE n.195020). The two modules are programmed with the "D2" software and therefore the Kit is immediately operational and tests and experiments can begin.

In Figure 3 a PC with the help of a Terminal Emulator (Teraterm) displays the messages received from the SPT17S3-D2, including the values of "Signal" strength and "Noise" level present on the radio channel. The "Noise" represents the "on-channel" noise level (background noise plus interference) as sampled and measured immediately before reception and decoding of a valid message.

Fig. 3 – Transmit and receive messages with the "Basic" Demo Kit

(2) Receiver waveforms of a “PPM” message

The EVR27A Demo-board allows you to view the three main waveforms at the output of the "microSP" receiver on an oscilloscope.

a) The **"RSSI"** signal is the IC2 peak detector output and allows analyzing the received signal intensity and its envelope. Especially on weak signals and in the presence of noise or interference, it is possible to detect distortions in the RSSI signal.

b) The **"Pulse"** signal, at a logic level, allows analyzing any faulty reconstructions of the pulse frame.

“RSSI” and “Pulse” are available on the J2 connector of the board.

c) The **"Rx out"** signal is instead taken directly from the “TP2” test point of the receiver.

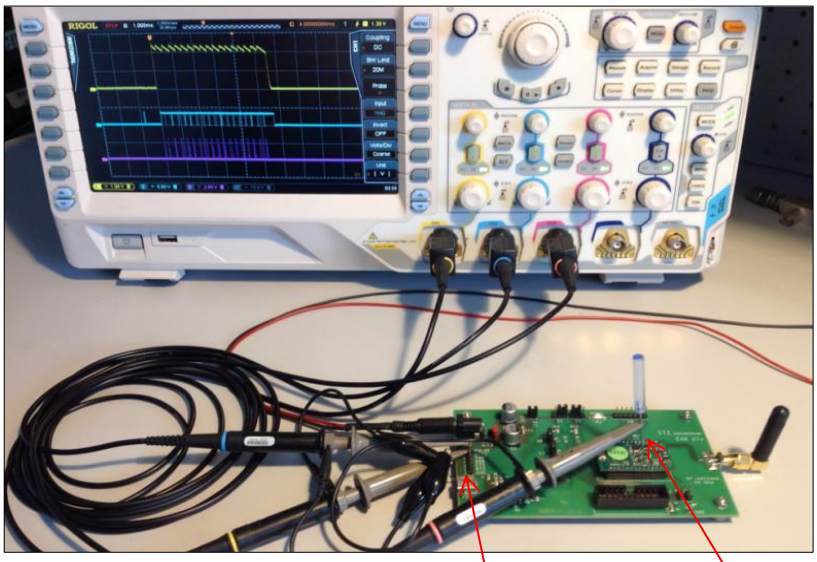


Fig. 4 – “RSSI”, “Pulse” and “Rx out” waveforms

"Rx out" is what the receiver actually "sees" on the radio channel. Unlike "RSSI", which represents the peak value of the signal integrated with its time constant, on TP2 you can view the signals "on air", so in addition to the RF pulses from "microSP" transmitters, also interference, broadband noise, transient pulses, etc.

Receiver TP2 Test point and the Rx Output signal

“RSSI” and “Pulse” waveforms on J2 connector

(3) “Pulse” and "Pulse Frame" waveforms

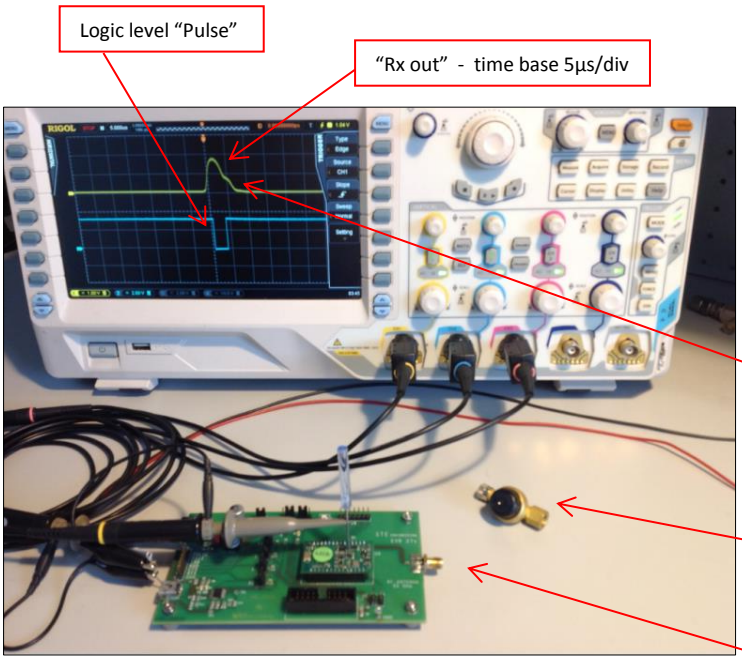


Fig. 5 - One singledemodulated pulse

"Rx out", the RF demodulated signal at the receiver output, allows to display a complete "Frame" of pulses (Fig.6), but also a single "Pulse" (Fig.5). Possible reception anomalies can therefore be highlighted, anomalies due for example to multiple reflections, disturbances on the radio channel or sudden changes of the RF level during a message.

Notice how the falling edge of the pulse is "stretched" in passing through the receiver. This is due to the impulse response of the "SAW" filter, to the filter "group-delay" and related pass-band "ripple". The trigger point of the Rx adaptive slicer is very near to the top of the pulse and it is not influenced by the falling edge shape.

The one shown is one of the pulses transmitted by a BST1712 "TPMS" valve.

No antenna on the Eval-board: the BST1712 is close enough and an antenna would pick up too much noise making it difficult to trigger the rising edge of the pulse.

(4) Take a look at the radio channel …..

"Rx out"
A pulse "Frame". A decrease in the level of the impulses towards the end of the message can be noticed: this is typically an indication of battery towards the end of life.

“Pulse”
No consequences in the "Adaptive Slicer" output.

The receiver picks up interference before and after the message, but without affecting the decoding process.

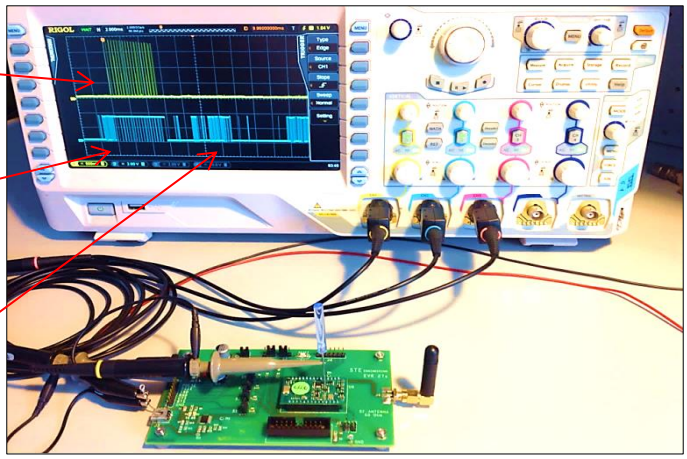


Fig. 6 - “Rx out” , “Pulse” and noise .

(5) Localize “Noise” sources

In addition to picking up noise through the antenna, the Eval-board can be used to detect suspicious sources of noise capable of reducing the effective sensitivity of the receiver.
A coax cable terminated with a "Loop" (Fig.7) and connected to the antenna input can help to locate noise generated by fast logic or in particular by "Switch-mode" power supplies or DC / DC converter.

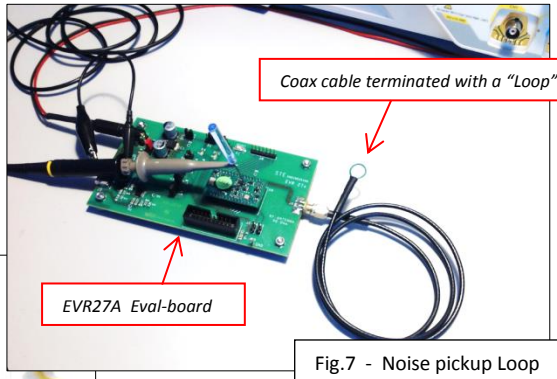


Fig.7 - Noise pickup Loop

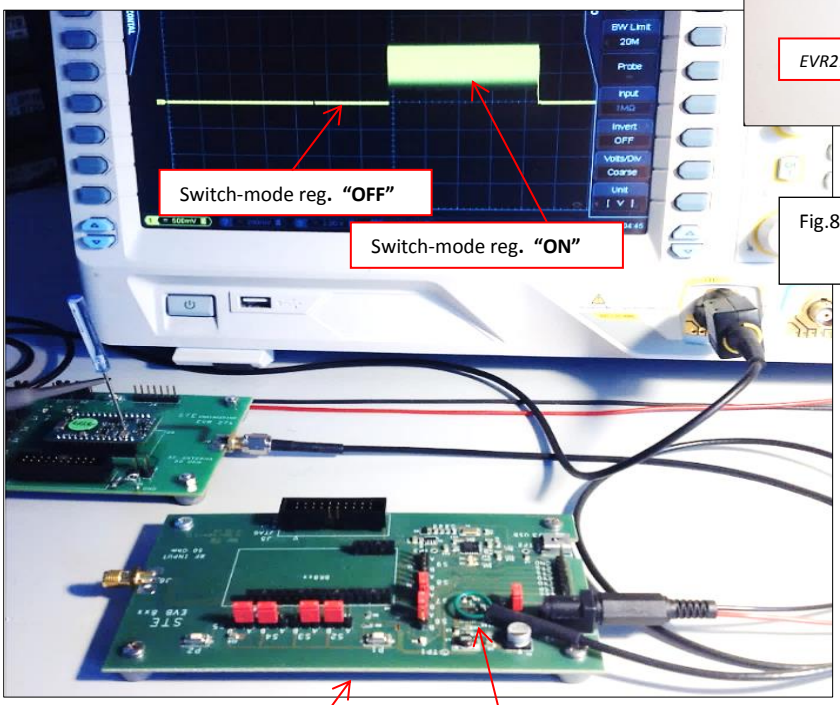


Fig.8 - Noise from a “Swich-mode” DC/DC converter

In this example of “Noise” detection, the Eval-board EVR27A with the SPR27S3 receiver is used as a Spectrum Analyzer.
A Spectrum Analyzer in "Zero span", on the frequency of 434.350 MHz and with a BW of 300 kHz. Once the noise source has been identified, be it on-board or external, it is possible to adopt countermeasures or appropriate shielding.

Interference and noise are often the cause of insufficient performance in a wireless network.
The tests described in paragraphs (5) and (6) and performed with the Eval-boards obviously do not exclude that in many cases more sophisticated instruments are necessary. The disturbances can be present on the air, coming from external sources and detected by the antenna (par.4) or generated on board and usually more difficult to eliminate (par.5). The Eval-boards can be a valid aid, in the design phase of an "Access Point" or "Gateway" and in general in a "WSN" project.
And above all in making the designer aware of the problem of radio interference.

A more detailed discussion on the "Noise" and "Interference" problems is reported in the AN-906 Application Note which has precisely the subtitle "EMI and EMC Design".

(6) - Radio Waves Propagation and Antennas

As described in paragraph (1) the two Eval-boards communicate with each other and with a Terminal Emulator program they display the "RSSI" signal received and "Noise" on a PC. The RSSI level can also be displayed and measured on an oscilloscope (par.2). Therefore it is possible to carry out propagation tests and measurements of radio waves attenuation from obstacles. An "RSSI" mapping can also be created of the area where the "WSN", the Wireless Sensor Network, will be built.
In these tests it is also possible to evaluate the characteristics and efficiency of antennas, both as radiation on the EVT17S3, and as reception on the EVR27A. In the following example (Fig.9) the efficiency of four typical antenna was measured: a classic 1/4 wave "Rubber" antenna, a "Helical" and a "Ceramic" antenna and a "Vertical Loop" magnetic antenna. In this test the reference transmitter was an SPT17S3-D2 mounted on the EVT17S3 and positioned at a suitable distance (about 30m in-building).

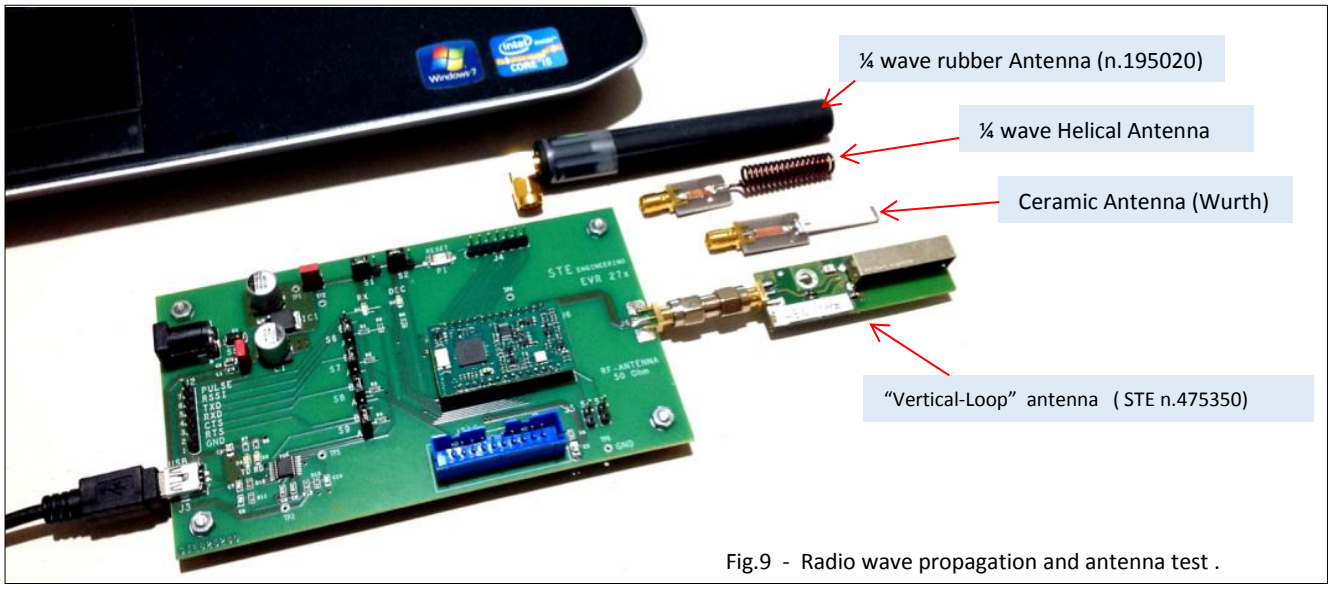
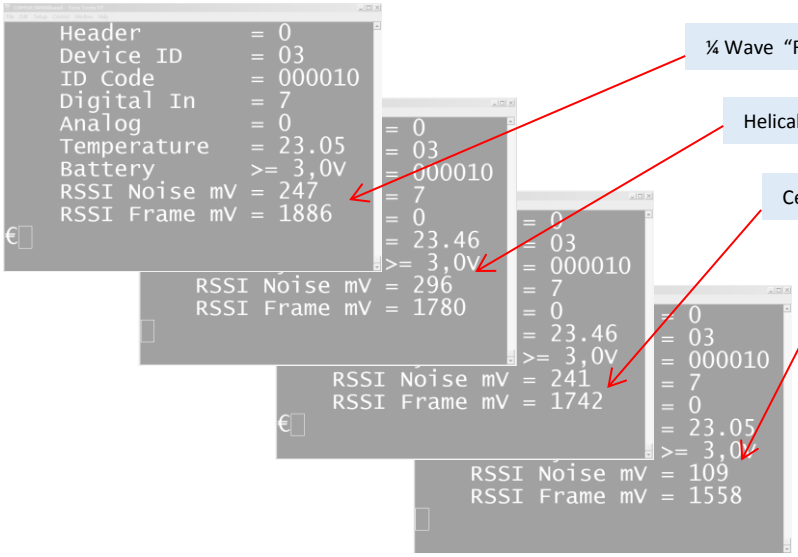


Fig.9 - Radio wave propagation and antenna test .



¼ Wave "Rubber" - RSSI=1886 mV Noise=247mV

Helical antenna - RSSI=1780 mV Noise=296mV

Ceramic antenna - RSSI=1742 mV Noise=241mV

Loop antenna - RSSI=1558 mV Noise=109mV

As expected, the best performance is from the "Rubber" antenna, certainly for its size and therefore for the largest capture area.
The "Noise" level is quite high and comes from the PC and the USB cable. It is interesting to note that the "Loop" antenna has a slightly smaller RSSI, but a decidedly much smaller "Noise".

This test example is only to show the use of the "Basic" Demo Kit in the difficult approach to the theory and practice of antennas.
The first three, in different forms, are all quarter wave antennas and need a ground reference: the EVR27A is at a frequency of 434 MHz a good ground reference. The "Loop" antenna has the advantage of not needing the ground plane.
An in-depth discussion of antennas is in the AN-905 Application Note.