Adaptrum TV White Space Demonstration System

1. System description

Adaptrum White Space Demonstration System is an integrated hardware and software development system that allows effective exploration, design, evaluation, and demonstration of cognitive radio/dynamic spectrum access technologies. As shown in Figure 1, key components of the development platform include:

1. A wide-band high dynamic-range RF transceiver operating over the frequency range 400 – 1000 MHz, which can be modified to operate over the frequency range 100 – 1000 MHz.
2. An FPGA-based hardware development board with integrated high-speed ADCs and a high-density FPGA where the baseband and protocol-layer functions can be implemented.
3. Matlab-based integrated development environment (IDE) where CR hardware functions are controlled using Matlab GUI and Matlab scripts.

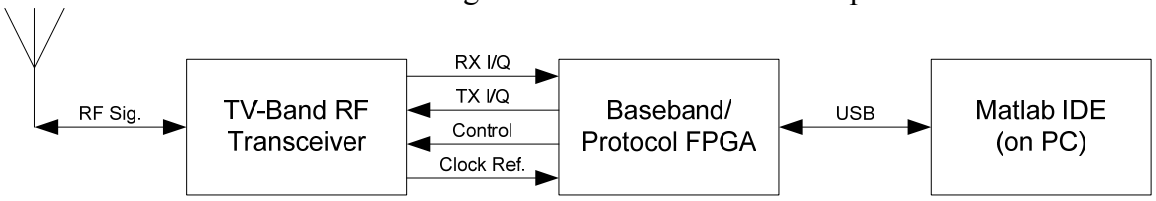

Figure 1: Adaptrum TV-band CR Development Platform.

The wide-band RF transceiver supports carrier frequency from 400 to 1000 MHz with 30 MHz signal bandwidth. The transceiver employs a novel 2-step heterodyne up/down conversion architecture to achieve a spur-free dynamic range (SFDR) of more than 70 dB. Table 1 shows the key transceiver specifications.

Carrier frequency tuning range	400 – 1000 MHz (Extendable to 100 – 1000 MHz)
Minimum tuning step size	1 MHz
1 dB baseband signal bandwidth	30 MHz
Noise Figure	3.5 dB
SFDR	70+ dB
Image rejection	80+ dB
Maximum RX input power	30 dBm
RX gain control range	52.5 dB total 30 dB in 0.5 dB steps (IF) 22.5 dB in 1.5 dB steps (Baseband)
Maximum TX output power	1 W (with external power amplifier)
TX gain control range	30 dB in 0.5 dB steps
Supply	12 V, ~350 mA
I/Q connections	RF input: SMA female RX baseband I/Q output: 2 x SMA female TX baseband I/Q input: 2 x SMA female Reference clock output: SMA female Control: 2 x 40-pin header

Table 1: Adaptrum white space demonstration system RF transceiver specifications.

The baseband signal processing and protocol-layer functions are implemented on a high-density FPGA on a hardware development board with integrated high speed ADCs and DACs.

ADC	Dual, 12-bit, 125 MHz
DAC	Dual, 14-bit, 165 MHz
PC interface	USB 2.0 daughter card
Transceiver interface	RX I/Q input: 2 x SMA female TX I/Q output: 2 x SMA female Reference clock input: SMA female Control: 2 x 40-pin header

Table 2: Adaptrum white space demonstration system FPGA board specifications.

2. Experimental results

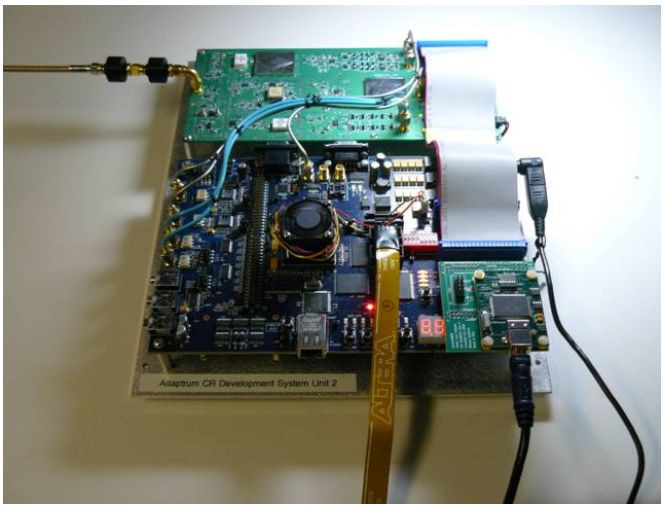

Figure 2: Lab picture of Adaptrum CR prototype system.

Figure 2 shows a lab picture of the prototype system which includes the RF transceiver board and the FPGA board. A similar unit has been submitted to FCC for white space device testing [1]. The system is capable of reliably sensing ATSC and NTSC signals at very low detection threshold. Figure 3 shows measured sensitivity curves for DTV (ATSC) signal sensing using the prototype system. Detailed description of the DTV sensitivity measurement can be found in [2].

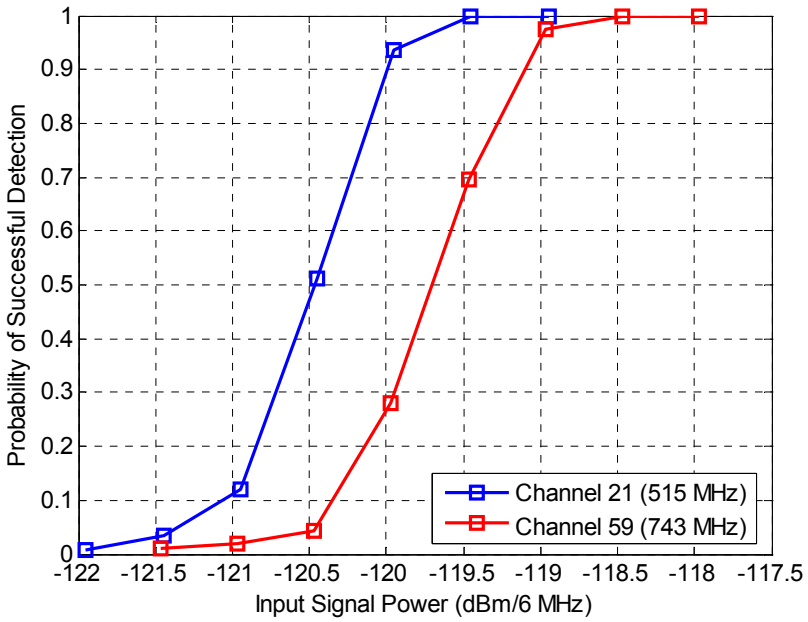

Figure 3: Measured ATSC spectrum sensing results.

The system is capable of generating OFDM signal with arbitrary bandwidth from 0.5 MHz to 18 MHz at any carrier frequency from 400 MHz to 1000 MHz. Through a combination of intelligent baseband signal processing and careful RF transmit chain frequency and gain planning, the system produces a very clean wideband RF signal with < -60 dBc out of band emission as shown in Figure 4.

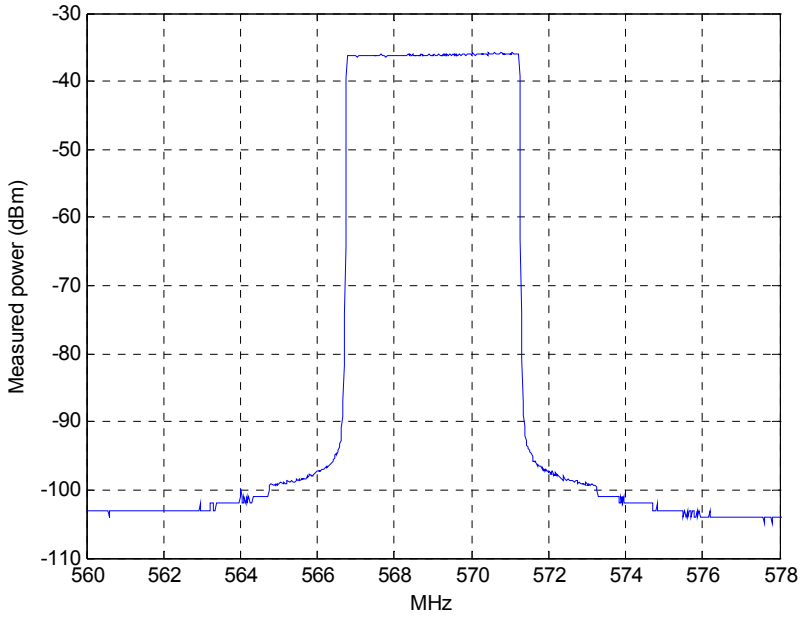

Figure 4: Device transmit spectrum. TV channel 30, center frequency 569 MHz, OFDM signal bandwidth 4.5 MHz.

In addition to sensing and transmission for TV white space testing, the system is also used for wireless microphone beacon generation and detection. Figure 5 shows the outdoor measurement setup for wireless microphone beacon detection and Figure 6

shows the measured beacon detection range. Detailed description of the wireless microphone beacon testing can be found in [3].

Figure 5: Wireless microphone beacon detection setup.

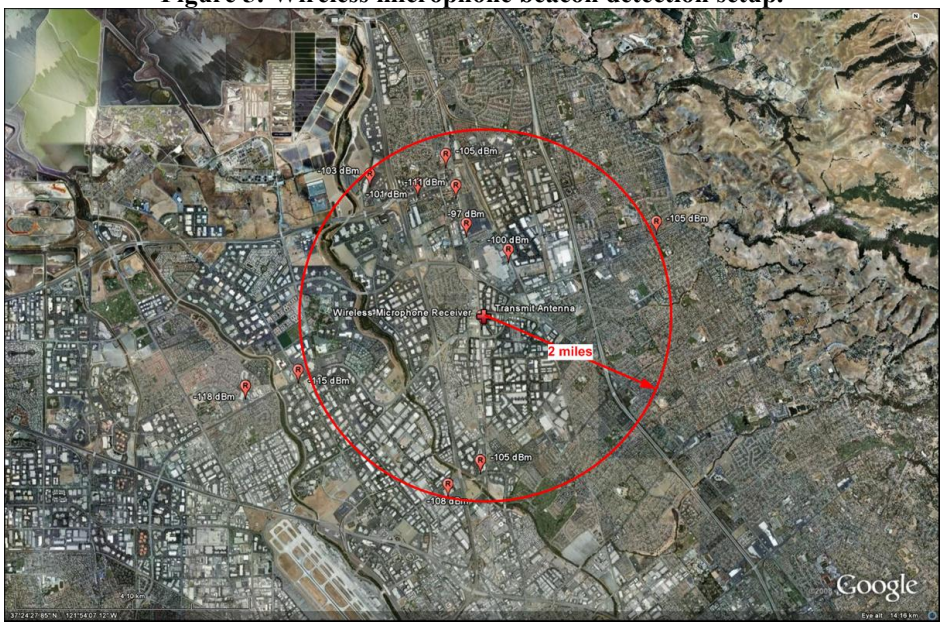

Figure 6: Beacon range measurement results.

References

1. http://www.fcc.gov/oet/projects/tvbanddevice/Welcome.html
2. http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6519821091
3. http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520047209