Monthly Report of Baseband Receiver Software

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I. RF Hardware Connection

A. Lab Capability

Previously, the transmission and reception of the baseband signal is connected using an audio cable. The audio cable carries baseband analog signals between the sound cards of two PCs. A few WAND Lab instruments can up- and down-convert the baseband signal to and from the radio-frequency (RF) band, and assist the software receiver to analyze the data off-line. The Agilent E4438C ESG Vector Signal Generator can up-convert an arbitrary (finite) complex baseband signal with a carrier from 250 KHz to 6 GHz. The Agilent 89441A Vector Signal Analyzer can process signals from DC to 2.650 GHz, and demodulate them with standard schemes.

Eventually, we want our baseband signals to be up-converted, transmitted and received by the antennas through a wireless channel, down-converted to baseband, and sampled and processed by our software receiver in real-time. In a primitive experiment, we generate a baseband BPSK signal using MATLAB, and store the data in the memory of the Signal Generator. The signal is then up-converted with a carrier of 2.4 GHz. The RF output of the Signal Generator and the RF input of the Signal Analyzer are connected directly through a cable (Fig. 1). The Signal Analyzer down-converts and demodulates the BPSK signal to verify the transmission.

B. Up Conversion via Agilent E4438C ESG Vector Signal Generator

A baseband BPSK signal waveform is generated using MATLAB and transferred to the Agilent E4438C ESG Vector Signal Generator through LAN. The intended sample rate of the transferred data is 44.1 KHz, i.e. a BPSK signal of symbol rate 29.4 KHz with pulse-shaping roll-off factor $\beta = 0.5$. The Signal Generator up-converts the baseband signal to 2.4 GHz, and outputs the RF signal with an amplitude of -5 dBm.

Facts: The Agilent Signal Generator is an effective means to up-convert a complex (I and Q) baseband signal. It can process an arbitrary waveform. However, the data is read into the instrument memory all at once before the RF hard-key can be turned on to start radio transmission. The data transfer and control signalling are quite slow through LAN. In the experiment, it took about 20 minutes for a data block of 18874368 sample points. Once data in memory, the RF signal is sent repeatedly. Therefore,

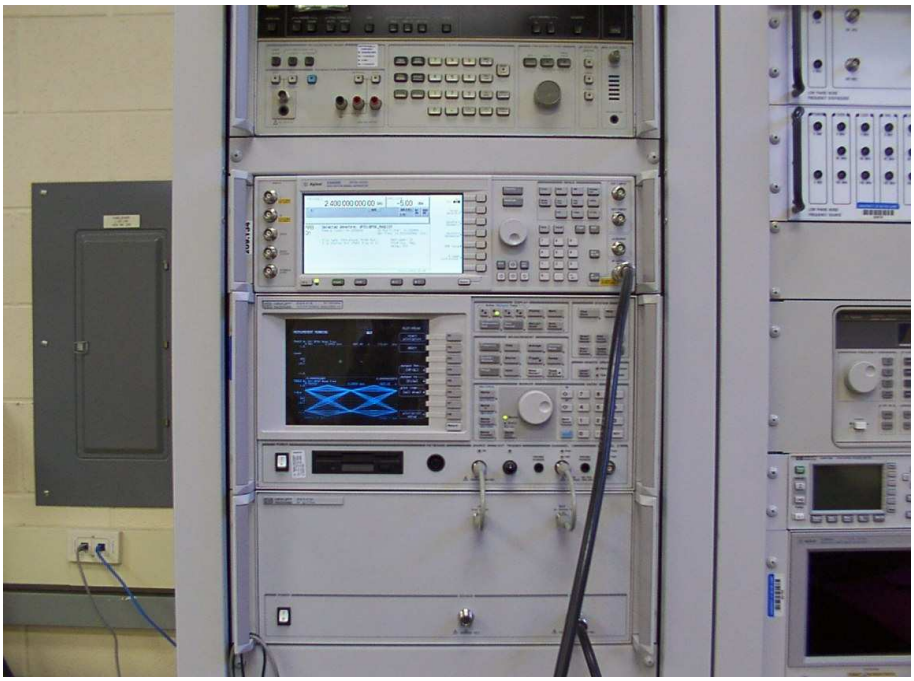

Fig. 1. Hardware Connection: Agilent E4438C ESG Vector Signal Generator and 89441A Vector Signal Analyzer.

we need to ensure the smoothness when connecting the head and tail of the BPSK waveform for correct demodulation. The repeated data can be used for BER calculation, but not for real-time communication.

C. Demodulation via Agilent 89441A Vector Signal Analyzer

The RF signal (carrier 2.4 GHz) is fed into the Agilent 89441A Vector Signal Analyzer. The Signal Analyzer down-converts and demodulates the BPSK signal. Fig. 2 and Fig. 3 are the screen shots of the demodulation display. In Fig. 2, the spectrum is centered at 2.4 GHz, with a span slight more than 44.1 KHz. The figure also shows the baseband BPSK signal waveform. In Fig. 3, the eye-diagram and symbol constellation appear almost perfectly without channel noise.

Facts: The RF section of the Signal Analyzer can down-convert the RF signals to IF band of 5 MHz, but there is no baseband output from the instrument. The amount of baseband waveform that can be saved to file is limited.

II. Proposed Work

1) When it arrives, we can use the Tektronix WCA280A Portable Wireless Communication Analyzer to down convert RF signals and save baseband waveforms to file. Then we can test our software receiver by demodulating the captured baseband signals off-line.

2) Replacing the cable link with a wireless channel between the RF output of the Signal Generator and the RF input of the Signal Analyzer (Possible antenna and connector purchase)

3) Experimenting RF up and down conversion for real-time applications (Possible RF evaluation module purchase)

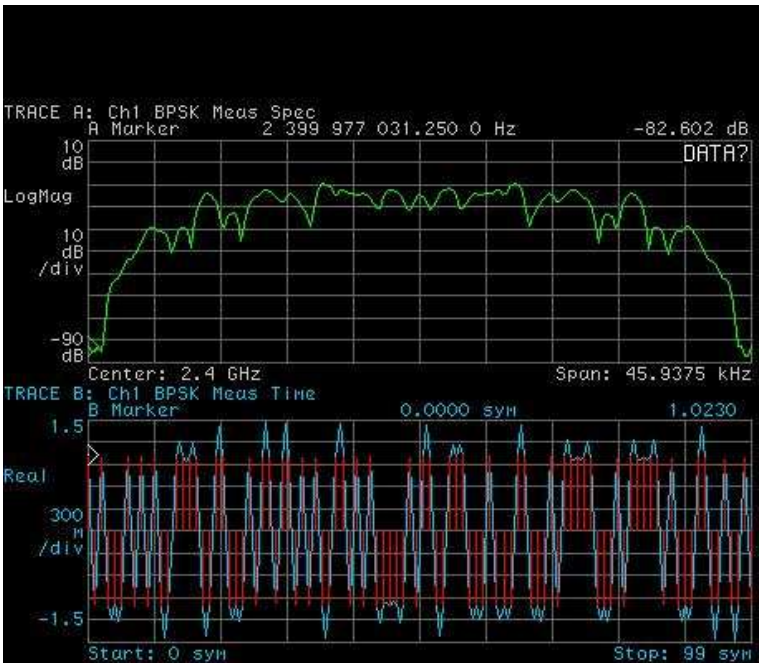

Fig. 2. BPSK Signal Spectrum and Waveform.

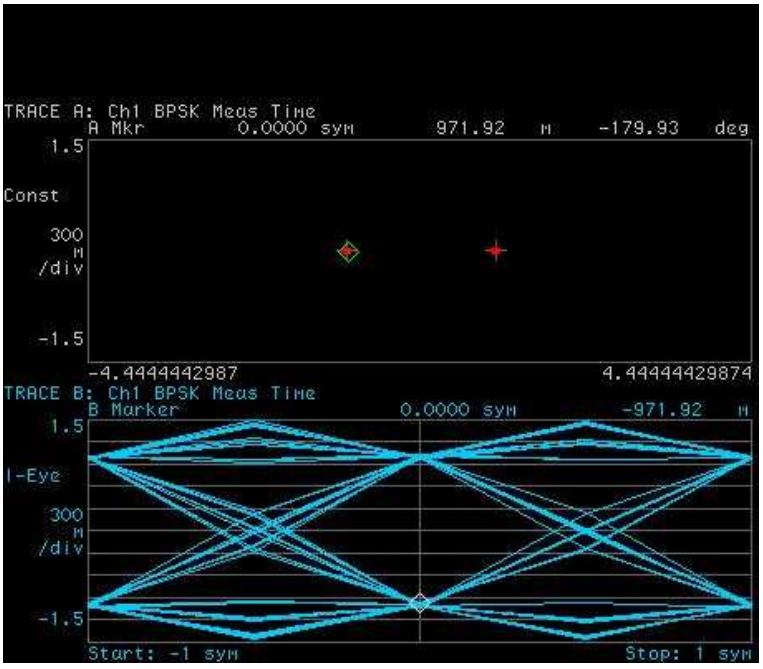

Fig. 3. BPSK Symbol Constellation and Eye Diagram.