Handheld DVB-T Digital TV with An Automatic Antenna Selection Method for Mobile Reception

Chua-Chin Wang[1,2], *Senior Member, IEEE*, Gang-Neng Sung[1], Jie-Yu Liao[1], Jason Chang[2], and Ron Hu[2]

Abstract — *A handheld DVB-T TV with a 3.5" LCD panel for mobile entertainment is presented in this work. A dual-board design is used in such a TV receiver. An MPEGII hardware decoder is included to decode the received signals and generate crystal clear terrestrial broadcast DVB-T DTV programs. In addition, an automatic antenna signal detection method is proposed to determine which of the build-in telescopic antenna or an external antenna is selected to deliver the received signal depending on the quality of the received signals individually. Field trials proved that the TV receiver works perfectly at a signal strength -80 dBm with a moderate mobile speed.*

Keywords : DVB-T, mobile TV, handheld, sensitivity, wireless network

I. INTRODUCTION

DVB-T digital TV receivers compliant with ETS 300 744 DVB-T standard are particularly designed for resistance of Doppler effects when the receivers are in a mobile scenario, e.g., moving in a vehicle or walking in a park. Particularly, ever since the booming of cellular phones and iPODs, personal A/V entertainment electronics has attracted lots of spotlight. Thus, two major problems appear when engineers try to design DVB-T handheld digital TVs (DTV) : the power consumption and the antenna reception quality. The former problem unavoidably leads to another difficulty : how to efficiently dissipate the generated heat in an expectedly small TV set ? The second problem is the reception of the DVB-T signals for the handheld TVs is not consistently stable. For instance, when a person enjoys his TV programs while walking from a park into a building, the reception becomes bad mainly due to the multi-path effect, [1], [2], [3]. Although the quality of the received signals can be enhanced by utilizing a so-called "diversity technique" with two antenna/demodulator frontend [4], the power consumption as well as the heat dissipation problems become even worse. The reason is that the power consumption of the extra NIM (network interface module), composed of a COFDM demodulator, an RF frontend and other discretes, is large. In this work, we propose an automatic antenna selection method by continuously monitoring the reception quality of two antennas, i.e., one build-in telescopic antenna and one attachable antenna. The proposed method has been proved on a handheld DVB-T TV to possess -80 dBm sensitivity at a 50 km/hr moving speed.

[1] : C.-C. Wang, G.-N. Sung, and J.-Y. Liao are with Dept. of Electrical Engineering, National Sun Yat-Sen University, Kaohsiung, Taiwan.
[2] : C.-C. Wang, J. Chang, and R. Hu are with Asuka Semiconductor Inc., Hsinchu, Taiwan.
[§] : This work is partially supported by National Science Council under grant NSC 94-2213-E-110-022 and NSC 94-2213-E-110-024.

II. HANDHELD DVB-T TV DESIGN

An overview of the proposed handheld DVB-T TV receiver is shown in Fig. 1.

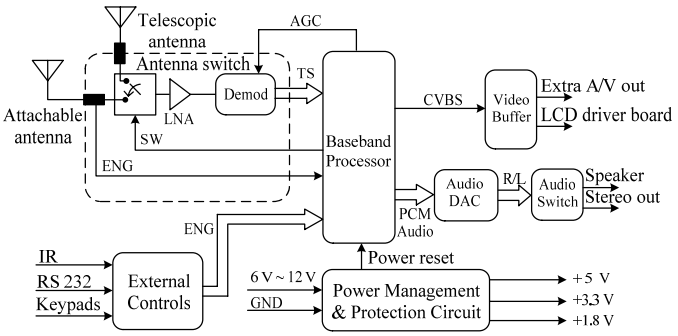

Fig. 1. Overview of the proposed handheld DVB-T TV

A. Automatic Antenna Selection in FrontEnd Circuitry

The build-in telescopic antenna (ANT0) is coupled to port 0, which is deemed as the default antenna (ANTF). Port 1 is reserved for an attachable external antenna (ANT1) which is mainly for indoor or stationary reception usage. Referring to Fig. 1, if ANT1 is not present, the ENG is low, the baseband controller set SW=0 to select ANT0 as the input to the COFDM demodulator. Notably, the COFDM demodulator converts the received signal into an MPEG2 transport stream (TS). By contrast, as soon as ANT1 is engaged at port 1, ENG is pulled high to trigger the automatic antenna selection mechanism in the baseband processor.

The automatic antenna selection method, as shown in Fig. 2, is summarized as follows.

1. Q0 and Q1 denote the BER (or PER) quality of the received signals from ANT0 and ANT1, respectively. Meanwhile, E0 and E1 represent the power of the received signals from ANT0 and ANT1, respectively. QF and EF are, respectively, the signal quality and power of ANTF.
2. th1, th2, th3, and th4 are different user- or designer-defined thresholds. They can be programmed in the system firmware depending on the usage or areas.
3. Two major performance indices are signal quality (Q, BER) and signal strength (E, power). The priority is the former one in our method. It is why the comparison of the quality is earlier than that of the strength in Fig. 2. (S05 ~ S12)
4. Periodically monitoring the signal quality and power of the selected antenna is required in order to avoid that the TV is

stuck at a poor antenna. (S14~S16 in Fig. 2)

5. The handling of unexpected interrupts must be considered, too. For instance, accidental detach of ANT1 or battery power low. (S15 in Fig. 2).

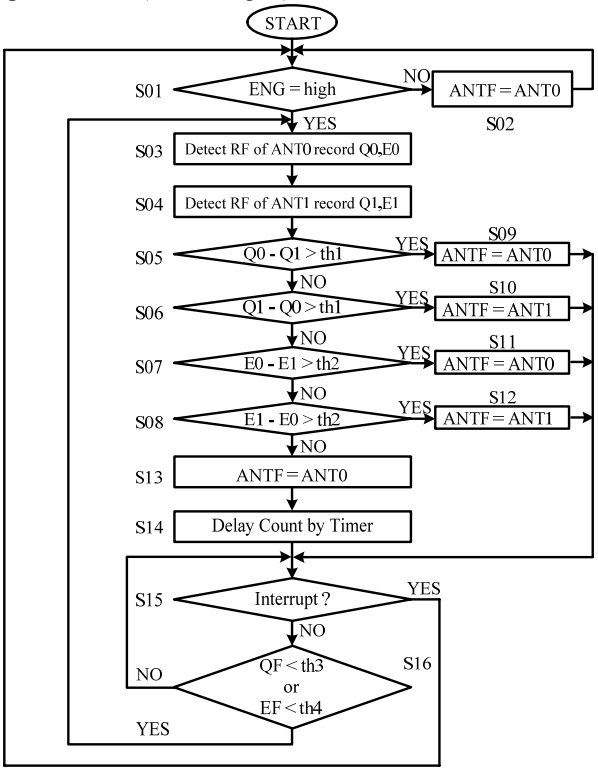

Fig. 2. The proposed automatic antenna selection method

B. Baseband Processor and Peripherals

The baseband processor is the core of the entire receiver. It accepts external control commands, including IR (infrared), RS232, and keypads, to carry the following major functions.

- decode the selected TS by an embedded MPEG2 decoder
- convert the selected programs into a CVBS signal by an embedded video encoder
- control all of the peripherals, including video buffers, switches, etc., by an embedded 8-bit micro-controller
- monitor the power supply variations and the ENG signal from port 1 to determine whether the automatic antenna selection method is invoked or not.

Notably, an extra CVBS output is included such that the handheld DVB-T TV can be turned into a home-use STB (set-top box) by connecting its CVBS output to a home TV with large display.

III. IMPLEMENTATION AND FIELD TRIAL

The proposed handheld DVB-T TV, has been fabricated and field trialed in Hannover, Germany during CeBIT 2006 (March 2006) as shown in Fig. 3. The attachable external antenna is shown in Fig. 4. The overall characteristics of the proposed handhand DVB-T TV are summarized in Table I.

Fig. 3. Outlines of the handheld DVB-T TV

Fig. 4. The attachable external antenna

TABLE I
CHARACTERISTICS OF THE HANDHELD DVB-T TV

Outlines	135mm (L) x 85mm (W) x 35mm (D)
Weight	150g, (300g with battery)
LCD panel resolution	3.5", 480(W)x 234(H)
Frequency range	145.1MHz ~ 862 MHz
RF input impedance	75 Ohm
Channel bandwidth	6/7/8 MHz
Input signal range	-20dBm ~ -80dBm
Demodulation	QPSK, 16-QAM, and 64QAM
Input voltage	6V ~ 12V DC
Sensitivity	-80 dBm
Highest car speed	≦ 50 Km/hr
Power consumption	4.5 W (operating time > 2.5 hrs)

REFERENCES

[1] S.L. Linfoot, R.S. Sherratt, "Analysis of a DVB-T compliant receiver simulation under various multipath conditions," IEEE Trans. on Consumer Electronics, vol. 46, no. 1, pp. 201-206, Feb. 2000.

[2] S.L. Linfoot, R.S. Sherratt, "Correcting for local oscillator phase offset in a DVB-T compliant receiver under multipath conditions," IEEE Trans. on Consumer Electronics, vol. 46, no. 2, pp. 306-312, May 2002.

[3] F. Sanzi, J. Speidel, "An adaptive two-dimensional channel estimator for wireless OFDM with application to mobile DVB-T," IEEE Trans. on Broadcasting, vol. 46, no. 2, pp. 128-133, Jun. 2000.

[4] C .-C. Wang, T.-J. Lee, H. K. Lo, S.-P. Lin, and R. Hu, "High-sensitivity and high-mobility compact DVB-T receiver for in-car entertainment," IEEE Trans. on Consumer Electronics, vol. 52, no. 1, pp. 21-25, Feb. 2006.