THE RESEARCH ON THE HSP50214 PDC CHIP APPLYING TO FDM TELEMETRY SYSTEM

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ABSTRACT

The content of this paper is putting forward an idea that applies the software radio technique to the subcarrier demodulation of frequency divided multiplexing telemetry system. Firstly, the article explains the basic thought and application of the software radio. It introduces the main function and the use of the programmable downconverter in HSP50214/ HSP50216. Secondly, it discusses the merit and shortcoming about the method of the subcarrier demodulation of frequency divided multiplexing telemetry system in common use. Finally, the article aims at ± 7.5% proportion

bandwidth FM subcarrier channels that in common use in the military standard, introducing HSP50214/HSP50216 programmable downconverter in achievement of design and simulation result. The main problems in the design are discussed and a conclusion obtained.

KEYWORDS

Programmable Downconverter, Frequency Divided Multiplexing Telemetry, Software Radio

THE DIGITIZED TECHNOLOGY OF THE SIMULATION SYSTEM ----SOFTWARE RADIO

With the development of digital signal processing technology, computer technology and large-scale integrated circuit (LSI) technology, a lot of systems that were realized by analog circuit will be replaced by digitized technology gradually. Developing fast software radio technique is a typical example. The software radio is the application based on radio station originally. Its central idea is to construct a hardware platform in common use with opening, standardization and modularization. It will achieve the various kinds of function by software, for example, frequency band, modulate type, data form, encrypt mode, communication protocol and so on. It makes broadband A/D and D/A converter closed to the antenna as much as possible, in order to develop the high flexibility and open radio communication system of new generation. Because of many reasons, such as speed of the device, the ones that can realize now are still just after intermediate frequency.

In the radio communication field, more and more systems adopt the software radio technique in High-Tech fields, such as mobile communication, military communication, electronic warfare, digital TV, etc. Among radio telemetry and remote control field, it pays close attention to the software radio technique too, but the application is not enough. The telemetry receiver based on PC bus of digital microwave, which is adopted by HSP50214 of Intersil Company, is a very good example that the software radio is used in telemetry field [2].

In fact, with the development of software radio technique, its application range isn't only limited to radio station, but can utilize software radio technique to realize the function instead of analog technique in other fields. This paper is just one of them, its main idea is that it intend to apply HSP50214/16 which is applied in the subcarrier demodulation of a frequency divided multiplexing(FDM) telemetry system, that is, to use the digital discrimination in subcarrier demodulation.

PRIMARY FUNCTION OF HSP50214/HSP50216

The implementation of the software radio can mainly be realized in three ways: DSP，FPGA/CPLD, and special chips.

The advantage of using DSP is flexible to realize and easy to change algorithms. The disadvantage is the slow speed and it can not be used in many situations where highly real-time is required. The advantage of using FPGA/CPLD is fast and easy to change the function. But because of the integrated level and other problems, many complicated functions can not be realized in a single chip. The advantages of using special chips are high speed, highly integrated. The disadvantages are lack of flexibility and difficult to alter functions. The method adopted in this paper is the third one above-mentioned, that is, adopt HSP50214 special-purpose chip.

Digital down frequency conversion and demodulation is one of the main technologies in software radio. There are many varieties of digital down frequency converter among them. At present, the most advanced and powerful one is the HSP50214/HSP50216 of Intersil Company.

A. Main Function of HSP50214B

There are three Primary functions of HSP50214B:

(1) Digital down conversion: Including local numerical control oscillator (NCO) and digital mixer, it can move center frequency of useful signal to zero frequency. The resolution in frequency of the NCO is high and the single carrier is easily selected in digital channel of broad band

(2) Low pass filter: it can filter signal out of the band and acquiring useful signal. HSP50214B programmable FIR filter also can be designed for the matching filter.

(3) Sample rate conversion: In order to process the following signal, the sample rate can be reduced. Because decimation factor is broadly in range of change, the digital channel for broad or narrow band can be designed, as well as high processing gain is acquired.

B. Main Application of HSP50214B

Digital software radio receiver for single channel
Base station for FDM system
Base station for TDM system
Base station for CDMA mobile communication
Demodulation: AM, ASK, FM, FSK, PM, PSK
Again sampling filter and interpolation filter
Resolution ratio of 14bit in processing

SUMMARY OF FDM DEMODULATION SYSTEM

The method for subcarrier demodulation of FDM generally is divided into three kinds. The first is

phase locking discriminator. The characteristic of method is narrow bandwidth, losing lock possibly and small volume. The second is average in pulse. Generally, the average in positive and negative pulses are adopted, which characteristic is that bandwidth is wide, linearity is pretty good and not losing lock, but the volume is large. We mostly adopt this way among the application of telemetry equipment formerly. For example, this way are always adopted in FDM telemetry system in U.S.A. and China. The third is the digital discriminator, in which there are two kinds of methods actually. One is digital phase locking loop, another is lookup table or calculating.

The phase locking loop and lookup table in the digital discriminator can be referred to the list of references [3] and [5]. The digital discriminator mentioned in the paper is different from two ways above. It adopts HSP50214B of Intersil Company which use Digital Programmable Down converter to realize the function of subcarrier demodulation.

DESIGN SCHEME OF FDM SYSTEM USING HSP50214B AND CALCULATION OF PRIMARY PARAMETER

According to the telemetry standard of U.S.A. and China, FDM telemetry system can be divided into proportional bandwidth (PBW) FDM telemetry system and constant bandwidth (CBW) telemetry system. The paper takes proportional bandwidth FDM system as an example to illustrate the design, the standards of 15% proportional bandwidth is shown as table 1. There are 25 channels in all.

Table 1: The ±7.5% subcarrier channel of proportional bandwidth FM

Channel	Centre frequency (Hz)	Channel	Centre frequency (Hz)
1	400	14	22,000
2	560	15	30,000
3	730	16	40,000
4	960	17	52,500
5	1,300	18	70,000
6	1,700	19	93,000
7	2,300	20	124,000
8	3,000	21	165,000
9	3,900	22	225,000
10	5,400	23	300,000
11	7,300	24	400,000
12	10,500	25	560,000
13	14,500		

A. Synthetical Design of FDM Demodulation Part

The frequency of receiver is S band. Because of being limited by the device performance, it is difficult to process the radio frequency sampled directly. On reserving software radio in common use,

flexible and open, it has adopted that the scheme of digital intermediate frequency. The structure block diagram of the whole system is as Figure. 1 shows.

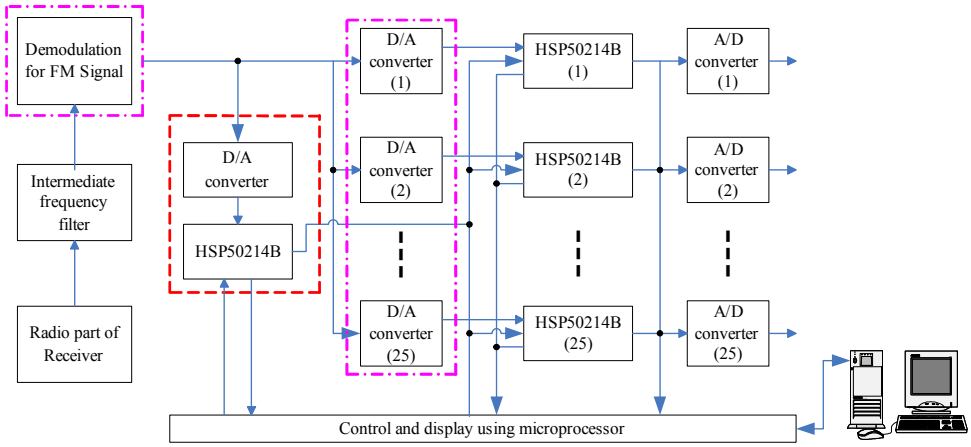

Figure. 1 Block diagram of FDM receiver system

Considering reliability, it is best to design an independent board for each channel of FDM demodulation. If considering the volume, it is also can designed that 2 or 4 channel into one board. A HSP50216 includes 4 channel digital down converter and demodulator. So HSP50214B in Figure. 1 can be replaced by HSP50216, but its each channel can be set up and controlled separately.

The design of subcarrier demodulator can be synthetically designed with digital receiver and the existing receiver can also be utilized. There are two kinds of methods to compose the system. One is using HSP50214B to carry out the first FM demodulation, outputs from the intermediate frequency of the receiver, and then the demodulated digital parameter is sent directly to each channel of the subcarrier demodulator without A/D converting, in order to carry out the second FM demodulation. The other is to output from behind the video demodulation of the receiver, and then enters each channel of the A/D converter.

HSP50214B is a general device, and the primary application is for the receiver, so the speed of the frontal data processing can be reached to 65 MSPS, there will have lots of redundancy to subcarrier. The speed of A/D converter is slower than the receiver and the cost reduces much more at the same time.

The digital signal after the subcarrier demodulation can be sent into computer to store or process directly, it can also be passed through the A/D converter to display at the same time.

B. Design of Digitized Subcarrier Demodulation Unit

This unit is the core part of the subcarrier demodulation, which mainly complete the frequency

movement (to move subcarrier signal to zero intermediate frequency) and the demodulation of FM signal. The control circuit of microprocessor should offer to the command of set up frequency and bandwidth for the digital subcarrier demodulation unit. Specially, we can store setting format of different standards in advance according to different commands, such as the different standard of proportional bandwidth and constant bandwidth. According to the needs of user, it also can be set that non-standardized for each channel separately. The hardware system of digital subcarrier demodulation unit shows in Figure. 2

When sampling a radio signal with very high frequency, it dose no good to increasing the quantifying SNR if the sampling frequency is too low. So the sample rate of band-pass should be selected as high as possible, in order to make the instantaneous sample bandwidth as wide as possible. But with the increasing of sample rate, another question is that the speed of dataflow after sampling is too high, it causes signal processing speed not to match. Especially, some calculation amount of synchronous demodulation algorithms is heavy. It is difficult to realize the real-time processing to mass datum. So the dataflow must be lowered after A/D converting. CIC and HB filters of HSP50214B are the high efficient filters which apply to decimation.

Because what be processed is to the subcarrier, the frequency processed is lower than radio frequency. The highest frequency of proportional bandwidth is 560 KHz in this paper, and the one of constant bandwidth is only 3.84 MHz. So it can be used to the theorem of low pass sampling directly instead of band-pass.

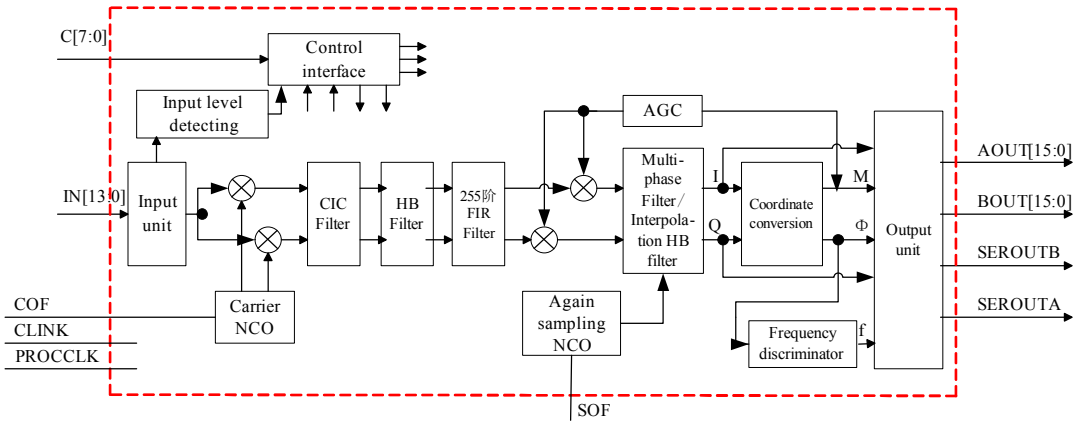

Figure.2 The hardware structure of digital subcarrier demodulation unit

A fewer decimation are only needed after sampling. The demodulation of FM signal can be accomplished in two steps. Firstly, the phase is gotten by transform rectangular coordinate into polar coordinates. Secondly, the frequency is gotten by differencing the phase.

The highest and the lowest subcarrier channel can be used to explain the principle of subcarrier demodulation. The central frequency of the highest subcarrier is 560 KHz and the NCO frequency of

HSP50214B is set as 560 KHz, then, the orthogonal local oscillators cos($_0$n) and sin($_0$n) are both multiplied by the input signal sequence and centre frequency is moved to zero frequency. The result of simulation is shown in Figure. 3.

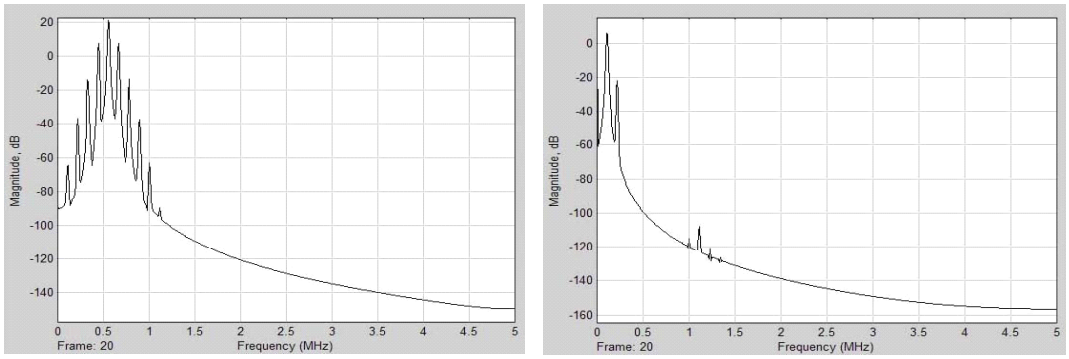

Figure.3 560KHz digital downconverter of subcarrier channel

Similarly, when frequency is 400Hz, the result is shown in Figure 4.

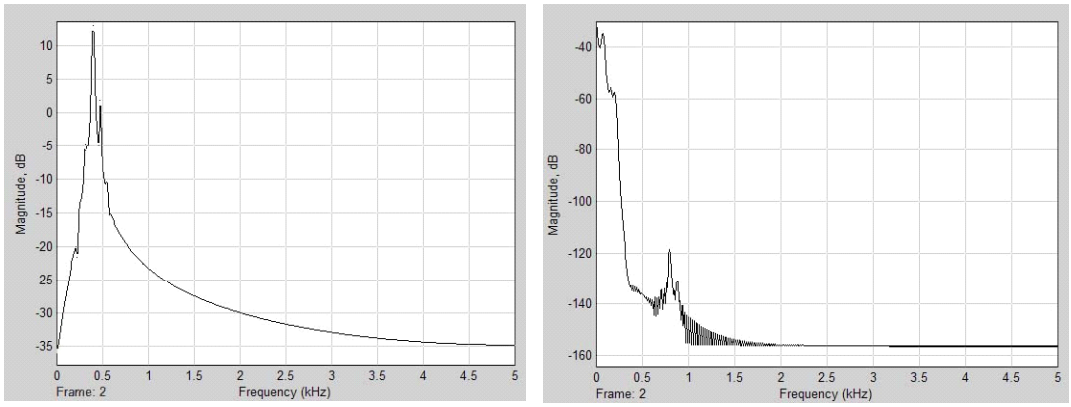

Figure.4 400Hz digital downconverter of subcarrier channel

CONCLUSION

The central idea of this paper is to apply software radio method into subcarrier demodulation of the FDM telemetry system. Specifically, we use HSP50214/HSP50216 as the core module of demodulation to realize the demodulation of the FDM telemetry system. Author has used HSP50214 to realize the demodulation for FM signal in IF of the telemetry receiver. About subcarrier demodulation of the FDM telemetry system, Author only simulate it in Sinmulink/Matlab after scheme designing.

The scheme in this paper has **5** advantages: The first is less peripheral chips, it can be realized by using HSP50214/HSP50216 and a few peripheral chips; The second is stable frequency, while the center frequency of devices using discrete components will drift as the changing of temperature; The third is high precision, the internal process precision of HSP50214 is 14-bit, which is far beyond the analog method; The fourth is this chip is programmable, so it is easy to use and can be repeatedly designed; The fifth is that the debugging is no need, as the working process is digital; The last advantage is that the digital signal can be input to computer directly for processing.

The calibration of FDM telemetry system is an important problem. Before FDM demodulation system working, the signal generator utilizing DDS is used to accomplish calibration of system. This function can be designed as a part of demodulation.

The work needs to be done is how to acquire and send the multiple digital parameters into computer after demodulation.

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