MRS2015 /6th International Workshop on Magnetic Resonance

A multi-channel SNMR instrument with integrated broadband and narrowband filter

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SUMMARY

To date the main multi-channel surface NMR instrumentation is GeoMRI system internationally. It can accomplish the MRS signal detecting and acquisition by adaptive noise cancellation technology and 1D/2D imaging technology. However, the GeoMRI system has a bandwidth of approximately 10 kHz. Althrough it shorten the dead time to some extent, it limited the application range of MRS instrument because of the channel saturation in the case of high environmental and cultural noise (e.g. Power line noise, mines and tunnel detection environment). For solving this issue, we designed the signal conditioning circuit integrating broadband and narrowband filter which has a bandwidth of approximately 300Hz. The narrow-band filter of low coefficient of rectangular was used to suppress amplifier saturation in noisy environment. In addition， by adjusting the programmable gain amplifier, the signal conditioning circuit can be set to broadband mode which could shorted the dead time of the instrument. Therefore, the application mode of MRS system iscould be changed according to the different environment situations.

INTRODUCTION

Because of the characteristics of non-invasive and direct detection of groundwater, MRS is widely applied in water resources survey. However, due to MRS signal is extremely weak, it can be affected by environmental disturbance, and the SNR is low, so these brought a lot of problems in application and inversion accuracy. Recent years, the multi-channel systems developed by USA, Germany, France, such as GeoMRI，NUMIS-poly, they can realize the data processing in high noise environment through the methods such as reference channel cancellation. But in the environment that noise is extremely high, the amplifier become saturated, we can't acquire valid MRS data, and implement noise cancellation.

In this paper, we design the multi-channel combination MRS system of broadband and narrowband that can be applied in different detection environment. The successful development of the system is meaningful for the application in urban environment, coal mine and tunnel.

METHOD AND RESULTS

The structure diagram of SNMR system is shown in figure 1. The system had separated transmitter and receiver loops and generated timing of transmitter and receiver by controller which give a synchronization signal to acquire signals and current PC communicates with other modules by RS485 bus and signal data transmitted over the network bus that make sure the transmission speed and 24bit A / D acquisition card with four synchronous channels guarantee the accuracy of the collection. The signal conditioning circuit Integrating broadband and narrowband filter shown in figure 2, high voltage relay, transient suppression diode, resonant capacitance and low noise preamplifier are the common circuit. The range of resonant capacitance is 0.1uF to 18.3uF, The gain of low noise preamplifier is 29.5dB. Theband pass of filter is 1.5kHz to 3.2kHz. When the environment noise below 100 mVpp, the signal conditioning circuit can work normally ,then, go through the band-pass filter which consist of eight order high-pass filter and eight order low-pass filter to make sure gain flatness and low coefficient of rectangular is 4.03.If the noise in pass-band is small, we will select broadband mode, otherwise, the narrowband mode is used. The narrowband filter's coefficient of rectangular is less than 2 by using switched capacitor filter which is easy to adjust the center frequency and quality factor, then through the programmable gain amplifier, enter the acquisition card.

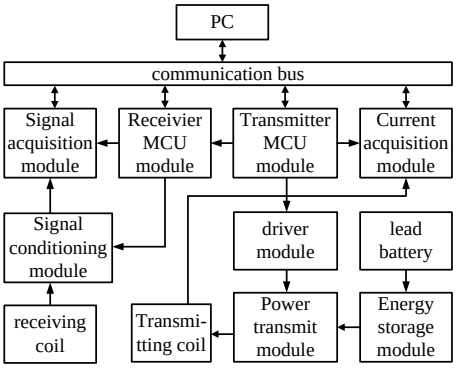

Figure 1. The structure diagram of SNMR system.

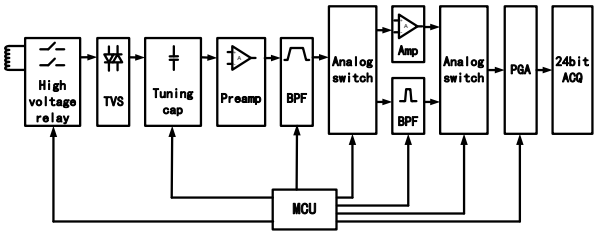

Figure 2. The structure diagram of signal conditioning circuit Integrating broadband and narrowband filter.

Figures and Tables

The multi-channel system was shown in Figure 4. The results of field experiment using this system in shaoguo Town Changchun City Jilin Province in China shown in figure 5 and figure 6. The magnetic field is 54720nT and the frequency of MRS signals is 2330Hz. The figure 5 shown the result of broadband mode and figure 6 shown the result of narrowband mode.

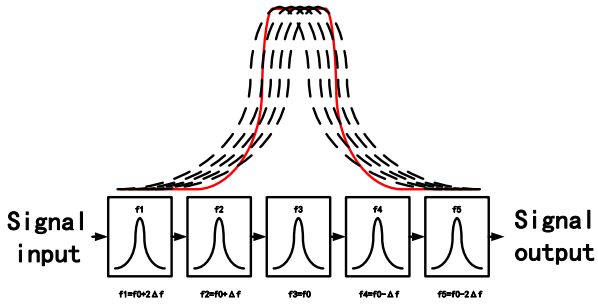

Figure 3. The narrow-band filter of low coefficient of rectangular.

Figure 4. A multi-channel SNMR instrument with integrated broadband and narrowband filter.

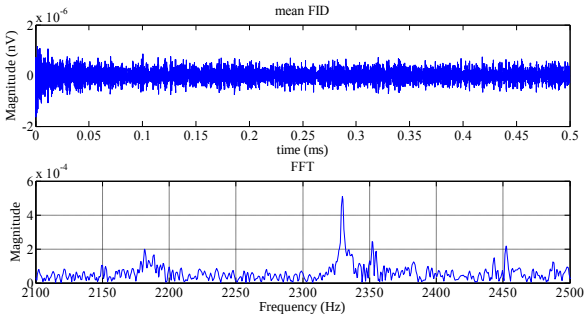

Figure 5. The signal of broadband Amplitude.

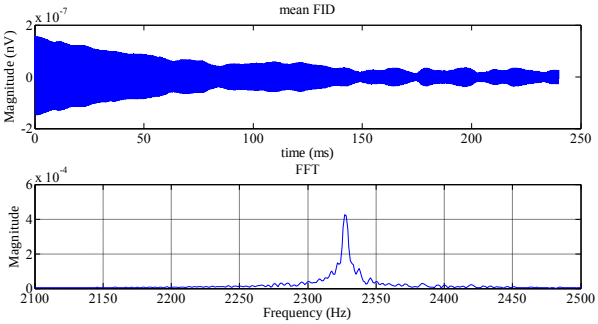

Figure 6. The signal of narrowband Amplitude.

CONCLUSIONS

In the paper, we provide the structure diagram of SNMR system Integrating broadband and narrowband filter and the design method of narrowband filter, then we designed the SNMR system. The field experiment in shaoguo Town, Changchun City Jilin Province proved its ability to adapt to the complex environment. In the following research, we will apply it into the disaster water monitoring of mine or tunnel, expand its application scope further.

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