Research on the application of multi band filtering technology in PD detection

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Abstract. in order to in the process of partial discharge detection identification and removal of interference signal, general inspector can also be simple, fast to complete the complex field interference signal processing, studies a kind of automatic of the local discharge detection signal and interference identification analysis device. Through the automatic control signal processing device (smart filter module) and digital filtering algorithm to deal with multi band filter on the signal to interference and improve the detection signal to noise ratio, to ensure that the accuracy of the test data.

Key words. Partial discharge, interference identification, multi band filtering, signal to noise ratio.

1. Research background and significance

Field interference signal identification and removal, is always a difficult point in the process of partial discharge detection, the device automatically of the local discharge detection signal and interference identification and analysis, through the automatic control signal processing device (smart filter module) and digital filtering algorithm to process the signal to interference, improve the detection signal to noise ratio, to ensure that the accuracy of the test data.

The device can reduce partial discharge detection of high voltage electrical equipment to the technical personnel skill requirements, enable ordinary inspectors can also be simple and quick to complete the complex field interference signal processing, help to improve the high voltage electrical equipment bureau put the online detection of the work efficiency and accuracy.

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2. Design scheme

Intelligent control module with automatic input of background signal and standard discharge waveform analysis, intelligent search effective detection band, and automatic control simulation of multiple filters in the filter matrix according to the requirement of the combination, the input signal processing, also can be taken using a digital filter to filter.

Finally the signal output is processed to the PD detection system.

In the intelligent interference processing software also provides digital filtering algorithm, in order to make up for the deficiency of analog filter. There are threshold filtering method based on FFT and finite impulse response filter software, adaptive filtering algorithm, wavelet transform frequency windowing method. Can according to different environment bring interference to select different filtering algorithms.

3. design principle

Partial discharge intelligent jammer processor with digital and analog mixed on-site filtering interference signals, so as to improve the signal to noise ratio. The complexity of the detection field noise determines the interference signal is not likely to exist only in the range of the frequency of a single, as shown in the figure below, interference field tend to in detection frequency sub band and with the Bureau of the discharge signal without fixed amplitude frequency and phase relationships.
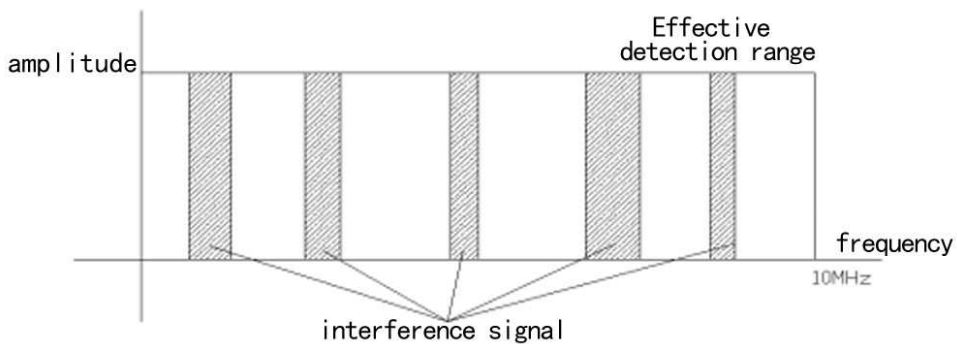

Fig. 1

And the existing filter generally high pass, low pass and band pass three, and each can only be processing a single band signal. Refer to the diagram is not difficult for us to find, using conventional filter can certainly to filter the interference, but also greatly reduce the effective detection frequency bands.

(1)Low pass filter processing results

A low pass filter is an electronic filter that allows the signal to pass below the cutoff frequency, but above the cut-off frequency of the signal can not be passed.
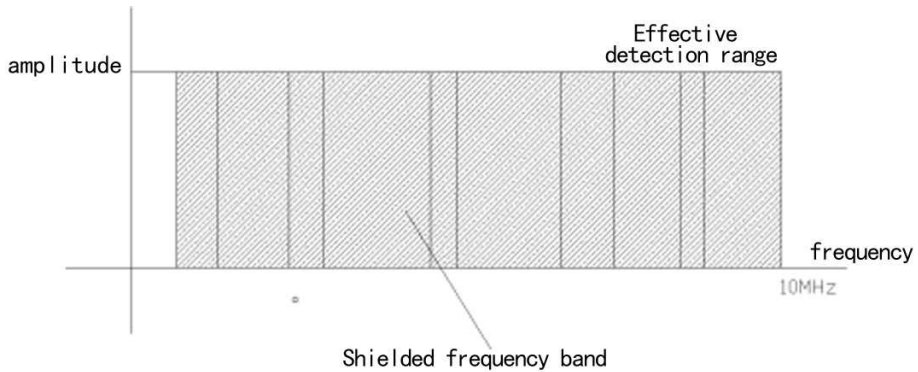
3.1. Geometry of the plate

Fig. 2

(2)High pass filter processing results

High pass filter, also known as the low cut filter, low resistance filter that allows higher than a cutoff frequency by, and can greatly decrease the lower frequency of a filter. It removed the signal of low frequency components or said to remove the low frequency interference.
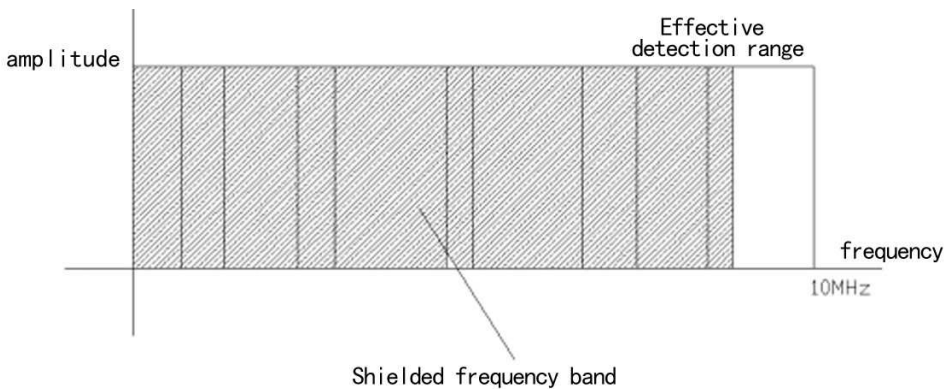

Fig. 3

(3)Band pass filter processing results

Band pass filter is a device that allows the wave of a certain frequency band to pass through other frequency bands, such as the RLC oscillation loop, which is an analog bandpass filter.

For this situation, it is necessary to design a capable of simultaneous removal of matrix filter interference signals of multiple frequency bands, as shown below, the matrix of the filter consists of a large number of filter and combined switch, work by the combination switch free combination, at the same time, the detection in multiple frequency bands for processing.
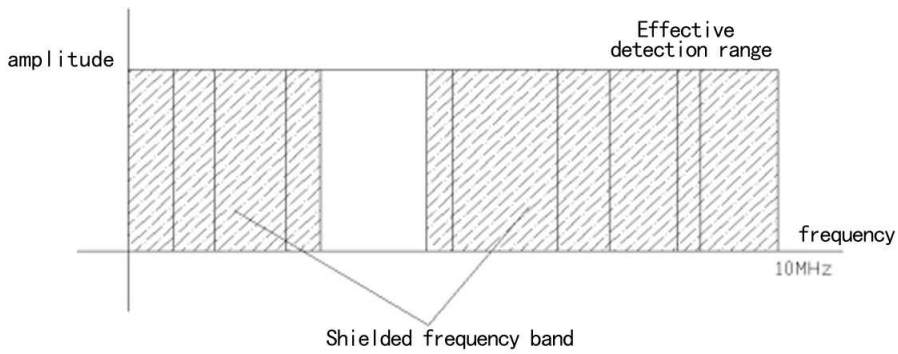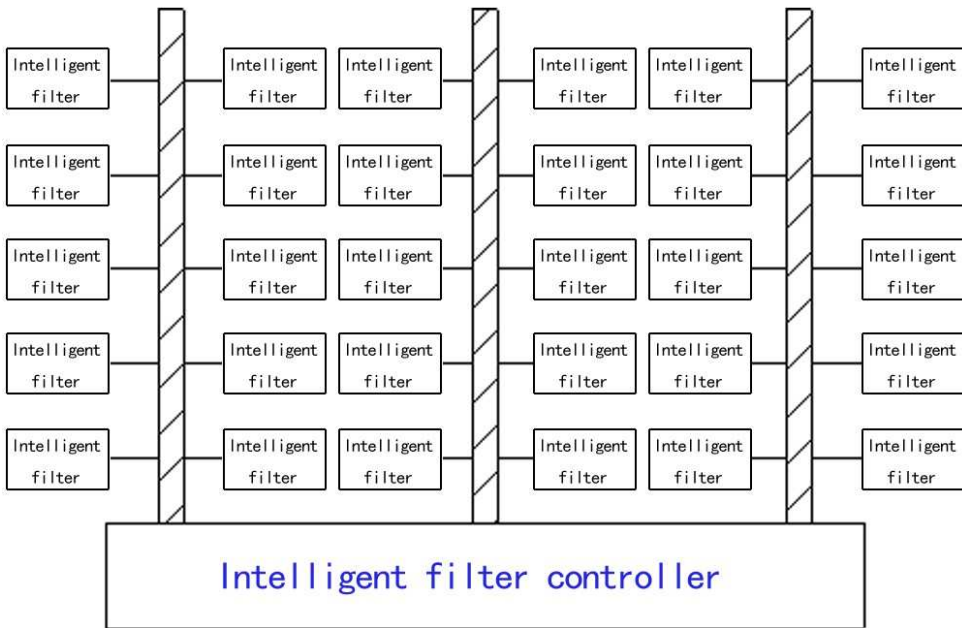
Fig. 4

Fig. 5

(4)Adaptive filter

Conventional filter only specific performance, for the input signal and according to the characteristics of the filter, produces the corresponding output, namely, first, the weight coefficient of the filter, and decide corresponding output value. However practical application is often in turn requires that the requirements of the output filter is clear, and filter characteristics cannot be known in advance, such applications must rely on adaptive filtering technique.

The adaptive filter is a closed loop system, the input signal in a can be programmed filter is filtering or weighted, an output signal is obtained, it and the

required reference signal C (n) compared, error signal C (n), the signal to refresh the processor of the right coefficient, thus changing the output the value, make it close to the reference signal, to reduce the error. In this system, the frequency response of the processor or the transfer function can be changed into adaptive, it can let the signal through, and the other signal to be suppressed.

Adaptive noise cancellation is adaptive filter of the use of a containing noise and useful information of the signal x (n) is added to the input end, from another source signal obtained correlated noise c (n) is added to the processor input end, and the processors have such impulse response, namely from the input signal x (n) by subtracting the interference component reaches the minimum, the output of the system feedback to the FIR filter, according to the principle of least square method at any time adjust the filter coefficients, allowing the system to the total output power reaches the minimum.

An adaptive filter, the weights can be according to an adaptive algorithm to constantly modify, make the system impulse response can satisfy a given performance criterion. Generally speaking, adaptive filter has two independent parts, a according to the ideal model for the design of the filter, an adaptive algorithm to adjust the coefficients of the filter, filter performance meet the requirements.

(5)Principle of matrix filter

The use of matrix filter, can be processed at the same time for multiple frequency bands, the use of the detection process as shown below, this will be able to maximize the effective detection of the frequency band.
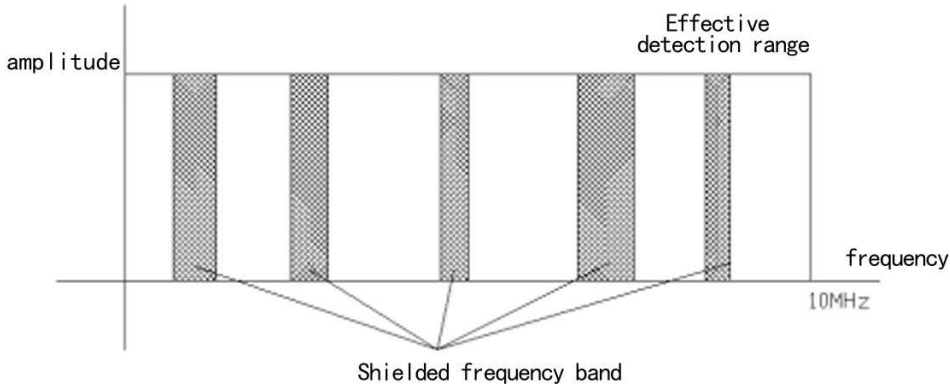

Fig. 6

Digital filter we use a high-speed DA, AD card and digital filtering algorithm to complete, the specific steps are as follows:

Through a high-speed A / D sampling card, sensor to collect the analog signals into digital signals, process the collected digital signal through a variety of algorithms, to further filter the interference. Finally, the interference filtering after the digital signal through D / a conversion into analog signal output.

1)Threshold filtering method based on FFT

FFT threshold filtering method using PD signals of small amplitude and energy distribution in frequency domain is average, the interference signals (such as narrow
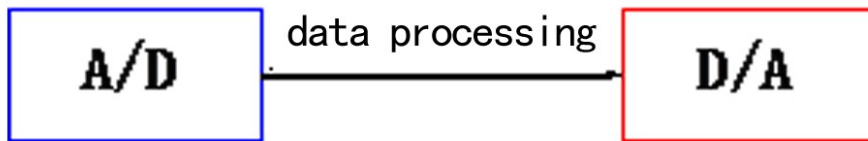
Fig. 7

band interference) amplitude is large and in the frequency domain energy is relatively concentrated in the characteristics and using threshold linear method or threshold curve method in the frequency domain, the PD and interference signal to distinguish.

2)Finite impulse response filter

FIR from.FIR linear finite impulse response (FIR) filter has two main features, one is the type filter is always stable, the second is the type filter can be designed to ensure that the signal through the filter without distortion filter amplitude frequency response to points, can be divided into low pass, high pass, band pass, band stop and all pass filtering method not only can eliminate periodic narrowband interference, but also can remove part of the white noise interference. But due to the application of FIR filter order requirements higher, computation time is too long, and the frequency band range determined in advance, and only applicable to specific site conditions, when the scene of the carrier wave communication interference frequency change, we must change the filter.

3)Adaptive filtering technique

Adaptive digital filter is to estimate the statistical characteristics of the input signal and adjust the corresponding parameters of the input signal, So that a cost function to achieve the minimum value, its essence is the use of noise and the signal has a different degree of correlation through the noise to improve the signal to noise ratio.

4)Wavelet transform

The method has the advantages of strong noise suppression ability, small signal distortion of PD, simple algorithm and short calculation time, and can effectively extract the PD signal from the white noise interference.

4. Software implementation

Intelligent jamming processing software is based on Windows operating system, VC environment developed. Simple operation interface can display real-time sensor receives interference signal waveform of time domain and frequency domain waveform; a square wave amplitude, adjusting the frequency and, after joining square wave and adding square wave before the frequency characteristics of the interface; signal after multi processor intelligent interference of time-domain interface charac-

teristic and frequency characteristic of the interface display.

5. Concluding remarks

The device realizes the interference signal of high-voltage equipment of partial discharge detection and filtering processing function. Using high-speed processing chip, precision electronic components, digital filtering technology, matrix filter, multi band Window interference processing a variety of techniques to remove the interference signal. Multi band filter, filter matrix by numerous filter and a combination switch, work by the combination switch free combination, can simultaneously on multiple detection band processing. To solve the limited at home and abroad Pindai detection method, maximum guarantee effective detection band.

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