Design of a Multi-Style Vector Modulation Interference System

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Abstract. In order to solve the impact of the interference system on different connected devices and generate a variety of interference patterns, this paper proposes a multi-style vector modulation interference system design. The interference signal generated by the multi-style vector modulation interference device is amplified by power and sent. The sub-band antenna, the antenna selects the interference direction under the control of the servo turntable and the control system, implements effective interference to the receiving equipment, reduces economic costs, and meets actual needs. The multi-style vector modulation interference system is composed of interference antenna, power amplifier, servo turntable and control system, communication interference equipment and related accessories. When the system detects the signal, the operating frequency, modulation mode, spectrum width, and other related signal parameters of the interference station are determined through analysis. Then the controller uses the modulator to select the best interference mode and select the frequency to the corresponding position. The high-frequency oscillating signal is used to modulate the interference transmitter, and the interference signal is amplified to the required power by the power amplifier. Finally, the energy is transmitted through the transmitting antenna. The servo turntable is rotated to drive the interference antenna to target the interference object to implement precise interference.

1. Communication Interference Equipment
The main function of communication interference equipment is to generate vector modulation signals of multiple modulation styles to form interference to communication receiving equipment. The communication interference equipment is mainly composed of four functional sub-modules, such as a baseband signal generator module, a local oscillator signal generation module, an IQ modulation module, and an amplitude control simulation. Application software installed in the zero slot controller) to complete the module's working parameter configuration and status monitoring.

1.1 Baseband Signal Generator Module
The baseband signal generator module is used to generate a variety of baseband modulation signals required by the system. Its principle block diagram is shown in Figure 1. According to the control instructions of the host computer, the corresponding analog signal generation protocol is called to generate the corresponding baseband signal, which is divided into I channels. Send to the DA digital-to-analog conversion circuit after Q and Q. The digital analog signals are converted into positive and in-phase, negative in-phase, positive inversion, and negative inversion differential analog signal outputs by digital-to-analog conversion circuits. The trigger channel uploads the trigger signal input and output to the host computer through the trigger conditioning circuit.
1.2 Local Oscillator Signal Generation Module

The local oscillator signal generation module generates a broadband microwave signal of 250KHz-20GHz, which is used by the system. Its implementation principle is shown in figure 2. In order to obtain the local vibration signal with better index, the multi-loop phase lock scheme is adopted in the design. The local oscillator main loop outputs the local oscillator signal of 10GHz-20GHz, which is divided into high and low frequency bands through the frequency division circuit. On the other side, the local oscillator signal of 1GHz-1.25ghz is output, which is mixed with the input 1GHz point frequency signal to produce the low frequency signal of 250KHz-250MHz. After the two signals reach the switch circuit, the output of the first circuit is synthesized.

1.3 IQ Modulation Module

IQ modulation module implements vector modulation signals in all frequency bands, and its implementation principle is shown in figure 3. The direct path mainly regulates the power of the input local oscillator signal and outputs it directly. In IQ modulation circuits, the need to pass the local oscillator signal amplifier fixed and adjustable attenuator and segmented filter control to satisfy the IQ modulation chip power requirements of the input signal, at the same time, the baseband signal of input to receive IQ modulation pathway, the IQ of modulated signals through the gain control circuit to adjust its output power to satisfy the requirement of the final output signal. The upper computer and FPGA communicate with each other. When the input signals are at different frequencies and powers, orthogonal compensation data and linear adjustment data are called to ensure the quality of IQ output signals. Through the control of the switch, the pass-through channel and IQ modulation channel are switched and the segmented filtering function is completed.
1.4 Amplitude Control Module

The amplitude control module is used to extend the output power range of the vector modulation signal. Its implementation principle is shown in Figure 4. It is mainly composed of VPX bus interface circuit, FPGA control circuit, power supply filter circuit, microwave circuit and ALC amplitude stabilization control loop. The input vector modulation signal is filtered and amplified by the modulation filter amplification component to realize the signal filtering and amplification function, and then output through the process-controlled attenuator. At the same time, a signal is coupled to the directional coupler and the coaxial detector is used to input the ALC signal to the control circuit. The control signal is fed back to the modulation filter amplifier component to achieve stable signal output.

2. Power Amplifier

The power amplifier is mainly used for power amplification of the interference radio frequency signal to meet the power requirement of the interference effect. The power amplifier uses a solid state form, and the specific performance indicators are:

(1) Working frequency: meet the requirements of related equipment;
(2) Working voltage: AC 220V ± 10%, 50 / 60Hz;
(3) Output power: 10W;
(4) Maximum input power: 5dBm;
(5) Gain: 47dB;
(6) Working temperature range: 0 °C - + 40 °C
(7) Power flatness: ± 3dB;
(8) Second harmonic: -15dBc typ;
(9) Out-of-band clutter: -50dBc.

3 Interfering Antenna
Because the frequency band covered by the interference device is relatively wide, it is difficult to
design an antenna that can cover the short-wave to microwave frequency range, and the cost is
relatively expensive. In order to facilitate the realization of the project, the antenna is divided into
frequency bands.
(1) Short-wave frequency band (1.5MHz ~ 30MHz), use short-wave passive omnidirectional antenna.
(2) Ultra-short wave frequency band (30MHz ~ 300MHz), choose ultra-short wave direction finding
antenna.
(3) In the microwave frequency band (300MHz ~ 6GHz), a broadband horn antenna is selected.

4. Servo Turntable Control System
The main function of the servo turntable control system is to control the attitude of the antenna
mounted on the servo turntable to control the attitude of the servo turntable, so that the antenna can
track the target and implement interference.

The electrical control part of the antenna attitude servo system is mainly composed of three parts:
power amplification, angular position measurement system and controller.

4.1 Controller
The controller is a digital controller. The main task is to collect the angular position signal of the shaft
system output by the angle measurement circuit, and compare it with the given target position to
obtain the angular position error. The control algorithm obtains a control signal for the interference
antenna, and uses this signal to control the power amplifier circuit to drive the motor to drive the
rotating shaft to rotate at the desired speed and direction. Due to the advantages of large storage
capacity, fast processing speed, and multiple software support, the digital controller is completed by a
PC.

4.2 Angular Position Measurement System
The task of the angular position measurement system is to measure the current position of the
interfering antenna shaft system, and to properly process the angular position through an angle
measurement circuit, and convert it into a digital signal that can be received by a digital controller.

The basic working principle of an angle measuring system composed of a resolver and a shaft angle
converter is a resolver based on electromagnetic induction, which is a precision micro-control motor.
Its external structure is similar to that of a wound asynchronous motor, and consists of a stator and a
rotor. In essence, it is a transformer that can be rotated. The primary and secondary windings of this
transformer are placed on the stator and rotor, respectively. The degree of electromagnetic coupling
between the primary and secondary windings is related to the rotor angle, so the output voltage of the
rotor windings is also related to the rotor angle. With this feature, the angle change can be measured,
and the servo system can be controlled to rotate as required.

4.3 Power Amplification
The power amplification link is the driving part of the servo system. It is mainly responsible for
amplifying the control signals output by the digital controller, and then driving the torque motor to
drive the antenna body to rotate toward the target until the antenna can accurately track the target. In
fact, this link can be seen as driven by errors, that is, the error between the target position (the azimuth
or elevation of the target) and the actual position of the antenna (the azimuth or elevation of the
antenna at this moment) is corrected by a given control law. Then, the power amplification circuit
performs power amplification, and then drives the DC torque motor with the antenna as a load in the
direction of reducing the above error until the error reaches zero.
5. Conclusion
The multi-style vector modulation interference system adopts analog design, which has good universality and scalability. In addition, the control system controls the turntable to realize the automatic tracking adjustment of the antenna to the target, which greatly improves the interference effect and the system adapts to the practical use of interference. Yes, it has a wider application prospect.

6. References
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