**Lab 3：DSB-AM Modulation System**

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| **Introduction:**  **1.Basic principles of DSB-AM modulation/demodulation**  Double sideband (DSB) modulation is a type of amplitude modulation (AM) that produces a modulated waveform with two symmetrical sidebands on both sides of the carrier frequency, resulting in a spectrum that is symmetrical about the carrier frequency. In DSB modulation, the carrier wave is suppressed, and only the two sidebands containing the modulating information are transmitted.  In coherent demodulation, a local oscillator is used to generate a signal that is at the same frequency and phase as the carrier wave. This signal is then mixed with the received modulated signal, resulting in a product signal that contains the modulating information.  **2.LabVIEW Express Module:**   * **Frequency Multiplier Module:**   The Frequency Multiplier module in LabVIEW Express is used to multiply the frequency of a given input signal by a specified factor. It operates by generating a signal that is the input signal multiplied by the desired frequency factor. This module is particularly useful in signal processing applications where a signal needs to be upconverted or downconverted to a different frequency range.   * **Passband Filter Module:**   The Passband Filter module in LabVIEW Express is used to filter a signal within a specific frequency range, allowing only frequencies within the passband to pass through while attenuating frequencies outside of the passband. This module is particularly useful in communication systems for signal filtering and demodulation. It can be configured as a low-pass, high-pass, band-pass, or band-stop filter. Phase Locked Lo   * **Phase Locked Loop Module:**   The Phase Locked Loop module in LabVIEW Express is a control system that is used to synchronize the phase and frequency of an input signal with a reference signal. It operates by comparing the phase and frequency of the input signal with the reference signal and generating a feedback signal to adjust the phase and frequency of the input signal. This module is particularly useful in communication systems for carrier recovery and frequency demodulation.  **Lab results & Analysis:**  **1.DSB-AM modulation/demodulation simulation**  **Block Diagram:**  The block diagram of a typical AM modulation and demodulation system is as follows:  Signal Source --> Signal Modulator --> Modulator --> Amplifier --> Antenna (Channel)  Antenna (channel) --> amplifier --> detector --> band-pass filter --> speaker or signal output   1. **Single Tone Test**   As finished on lab class, the program is as below:  **descript**  **descript**  Compared to last experiment, we used a bandpass filter this time and the parameter of this filter is showed in the next test. And what makes it different is that we use a lowpass filter whose low cut off frequency is 100hz.  **3.Music Test**  After playing the music file provided to us by the teacher, the result of DSB is carried out as shown.  **descript**  descript  In this experiment, we set the resampling rate at 1,000,000 and the duration is 44100. Then import the address of the voice file into the block diagram's path. And we used convert form DDT to single waveform and convert single wave form to DDT.There are some parameter we uesd: Carrier Freq is 100000 and Mod. Freq is 2000 LPF Cut-off is 10000 and WAV Sample Rate is 44100. And we know that the low cut off frequency and high cut off frequency of the bandpass filter is 199000hz and 201000hz.  We also can found in the spectrum of this experiment, there is no carrier wave's component.  And the figure of it is symmetrical.  **4.Factors Affecting DSB-AM Modulation System**  **The performance of an DSB-AM modulation system is affected by several factors, some of the main ones are as follows:**   * **Carrier frequency:** The carrier frequency should be selected carefully to ensure that it is within the bandwidth of the modulated signal. If the carrier frequency is too low or too high, it may result in distortion or loss of the modulated signal. * **Modulation index:** The modulation index determines the level of modulation and affects the amount of power in the sidebands. If the modulation index is too low, the modulated signal may not be detectable, while if it is too high, it can cause overmodulation and distortion. * **Frequency response of the system:** The frequency response of the system, including the transmitter, channel, and receiver, can affect the quality of the modulated signal. Any filtering or attenuation can impact the amplitude and phase of the modulated signal. * **Noise:** Noise can be introduced in the transmission and reception process, which can affect the signal-to-noise ratio (SNR) and the quality of the modulated signal. * **Interference:** Interference from other sources can also affect the quality of the modulated signal. It is essential to ensure that the system is shielded from external sources of interference. * **Bandwidth of the system:** The bandwidth of the system should be large enough to accommodate the modulated signal and avoid signal distortion or loss. * **Nonlinear distortion:** Nonlinear distortion can be caused by the nonlinear characteristics of the transmitter, channel, and receiver components. It can cause signal distortion, harmonic generation, and intermodulation.   **5.Advantages and Disadvantages of AM Modulation System and Its Value**  **Advantages:**   * DSBAM has a relatively simple demodulation process compared to other forms of amplitude modulation such as conventional AM and SSB. * It is bandwidth-efficient, as it does not require additional bandwidth for the transmission of a carrier signal. * The receiver requires less complexity, as it only needs to extract the amplitude modulation envelope to recover the original message signal. * It is commonly used in low-frequency applications, such as audio and instrumentation systems.   **Disadvantages:**   * DSBAM is not suitable for long-distance transmission because of the high attenuation of high-frequency components in the transmission medium. * The carrier signal can cause radio frequency interference (RFI) to other communication systems that share the same frequency band. * The receiver must be perfectly tuned to the carrier frequency, otherwise, the signal will not be recovered accurately.   **Value:**  **AM radio broadcasting:** One of the most common and widespread applications of DSB-AM modulation is in AM radio broadcasting. AM radio stations use DSB-AM modulation to transmit audio signals over long distances, allowing listeners to tune in to their favorite radio programs from anywhere within range of the broadcast signal.  **Television broadcasting:** DSB-AM modulation is also used in some analog television broadcasting systems, although this technology is being phased out in favor of digital broadcasting methods.  **Military communications:** DSB-AM modulation has been used for military communications, particularly during World War II, when it was used to transmit voice and Morse code messages over long distances.  **Industrial automation:** DSB-AM modulation is sometimes used in industrial automation applications, such as remote control of machinery and equipment. In these applications, DSB-AM modulation can be used to transmit control signals over long distances, allowing operators to remotely control machines and equipment from a central location.  **6.Design and Realization of Multi-channel DSB-AM Modulation System**  **System design:**  **Input:** Use Labview file reading to input multiple sound signals into the program.  **Carrier signal generation:** use the waveform generator module in LabVIEW to generate  multiple sine wave signals as carrier signals, and the frequencies correspond to different  modulation frequencies. Because the bandwidth of the wav file stipulates that each carrier  frequency interval is 20kHz.  **Modulation signal generation:** Use the amplitude modulation module in LabVIEW to modulate  each sound signal with the corresponding carrier signal.  **Synthesis of modulated signals:** Multiple modulated signals at different frequencies are  synthesized into the same time-domain signal through an adder.  **Output signal:** output the modulated signal.  **LabVIEW Program:**  The am modulation system used in the course is reused here to transmit two sinusoidal signals. As can  be seen from the front panel, one is 100kHz and the other is 200kHz. Then merge them together  through a merge signal module, superimpose a Gaussian noise and then demodulate. The demodulation  implementation in the course directly uses a low-pass filter, or traditional coherent demodulation can  be used. For the first sinusoidal signal, we continue to use the demodulator in the class; for the second  sinusoidal signal, we use a bandpass filter with a starting frequency greater than 100kHz and a cutoff  frequency less than 200kHz.  It can be seen from the front panel that although the sinusoidal signals demodulated by comparison 1  and 2 have the same waveform, but the frequency is different (the scale of the x-axis is different)  **descript**  **Front Panel:**  **descript**  **descript** | |
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