无线通信实验在线开放课程

主讲人：吴光 博士

广东省教学质量工程建设项目


Казахстан
Улаанбаатар
Монгол улс
齐齐哈尔市
哈尔滨市
乌鲁木齐市
伊犁州
长春市
Бишкек
通辽市
四平市
札幌市
Кыргызстан
喀什地区
北京市
朝阳市
조선민주주의인민공화국
呼和浩特市
唐山市
Тоҷикистон
沧州市
吕梁市
石家庄市
西宁市
济南市
대한민국
日本
兰州市
西安市
كابل
اسلام آباد
汉中市
中国
徐州市
福岡市
成都市
重庆市
上海市
لاہور
پاکستان
Delhi
नेपाल
长沙市
铜仁市
毕节市
温州市
Jaipur
Lucknow
邵阳市
昆明市
贵阳市
臺北市
کراچی
泉州市
Ahmedabad
বাংলাদেশ
南宁市
India
Kolkata
Hà Nội
မြန်မာ
海口市
ประเทศลาว
Mumbai
Hyderabad
ရန်ကုန်
ประเทศไทย
Manila

Lab 2: Pre-Labs and AM

(Basic)

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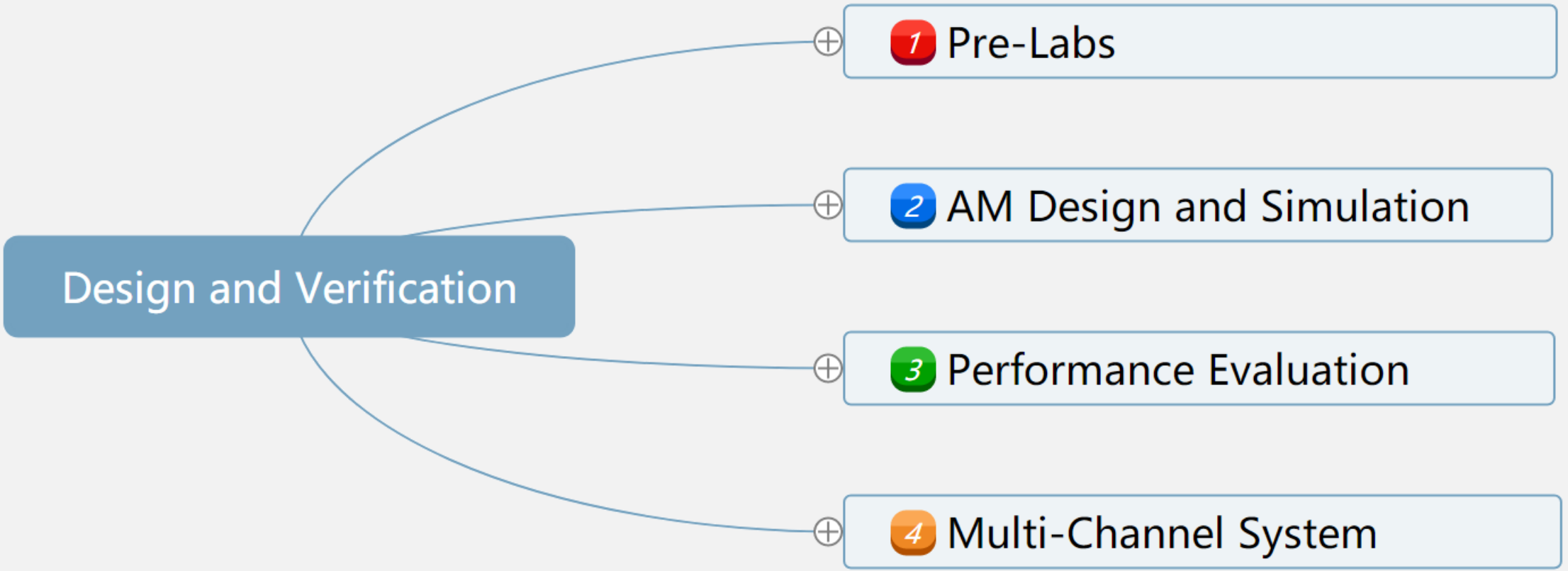
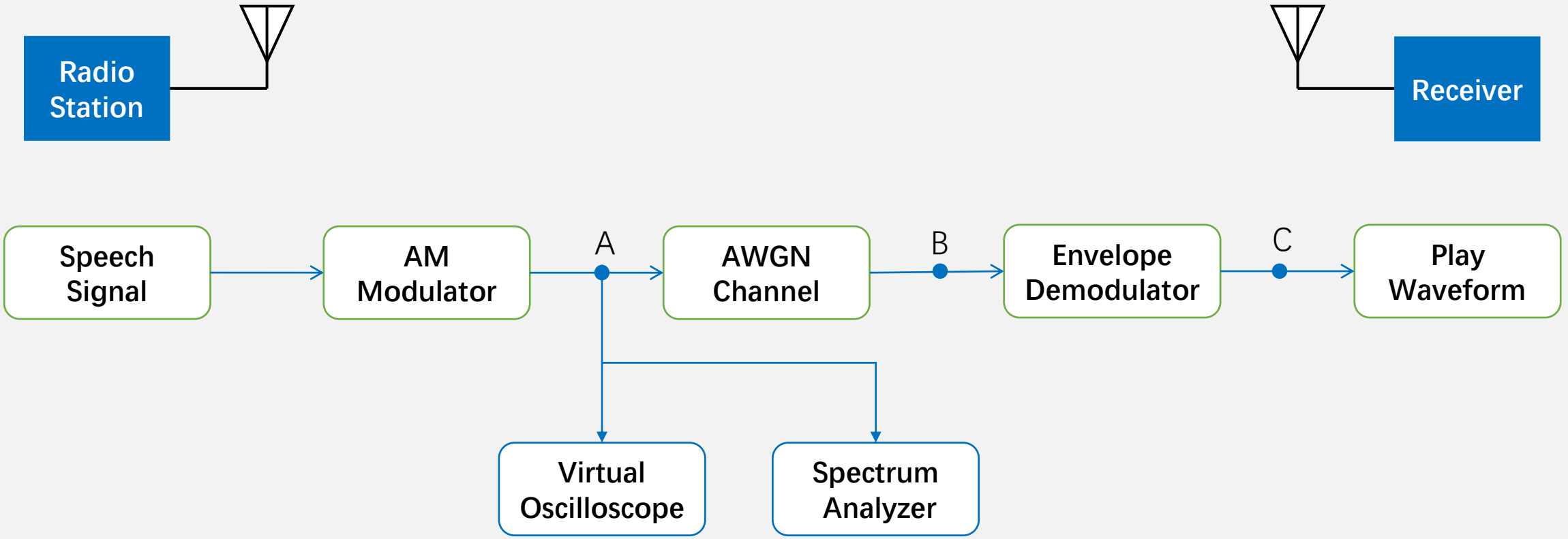
Rethinking and Redesign


Design and Verification
1 Pre-Labs
2 AM Design and Simulation
3 Performance Evaluation
4 Multi-Channel System

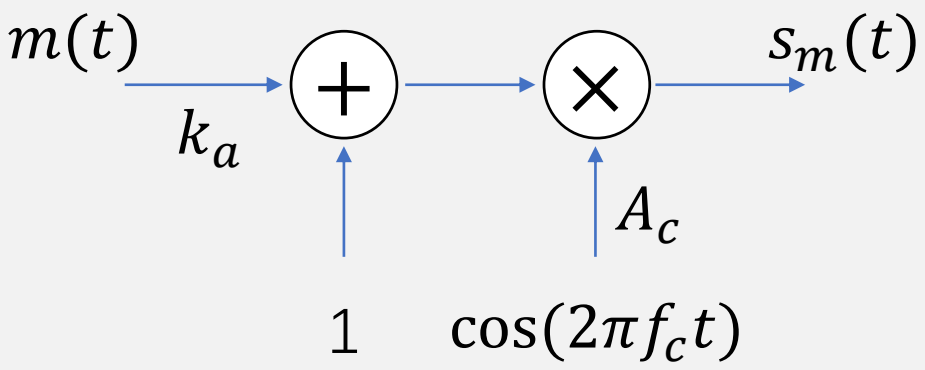
Demo: Amplitude Modulation

Simulation Model of AM System



Pre-Lab: AM Mathematical Model

Modulator



Sensitivity

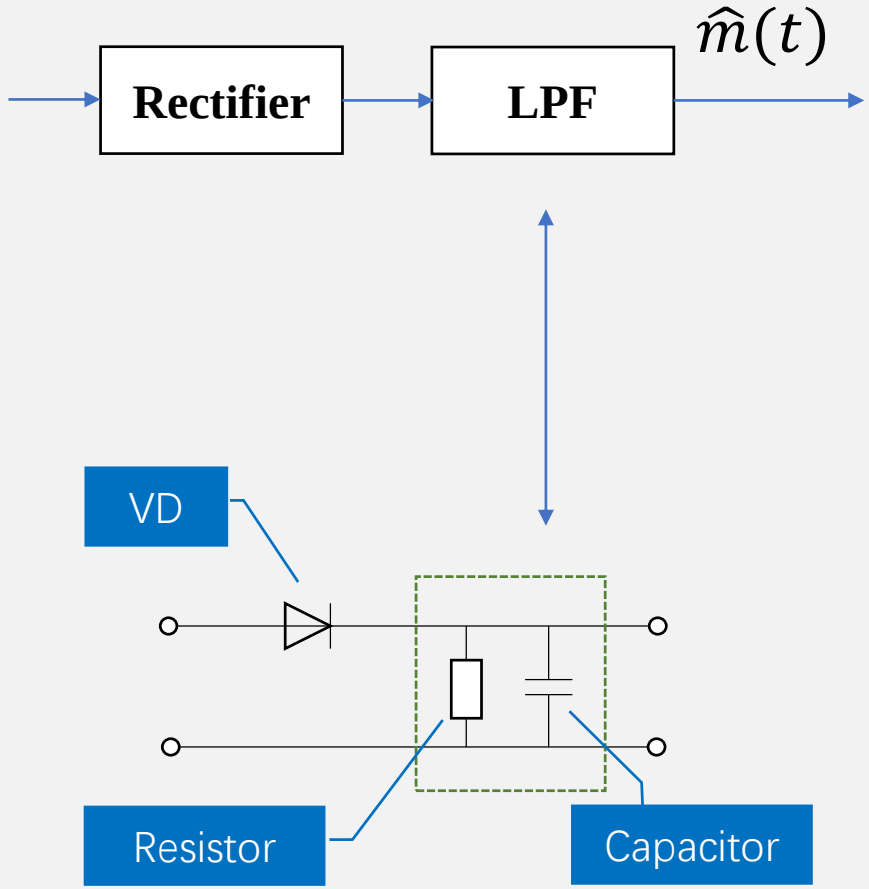
sin(2*pi*fm*t)

Carrier

$$s_m(t) = A_c\big(1 + k_a m(t)\big)\cos(2\pi f_c t)$$

Baseband

Demodulator

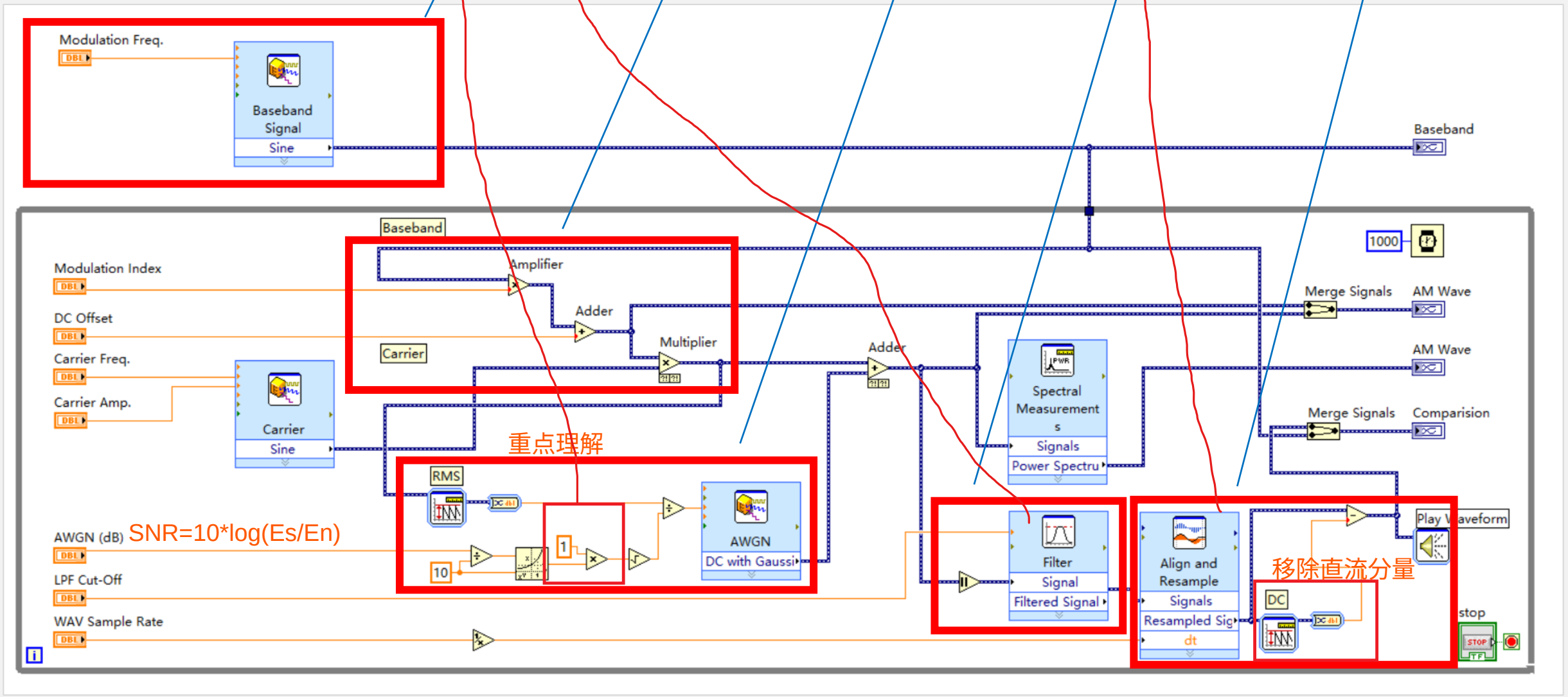


幅度响应尽量为门函数
相位响应尽量保持线性，保证系统的时不变性

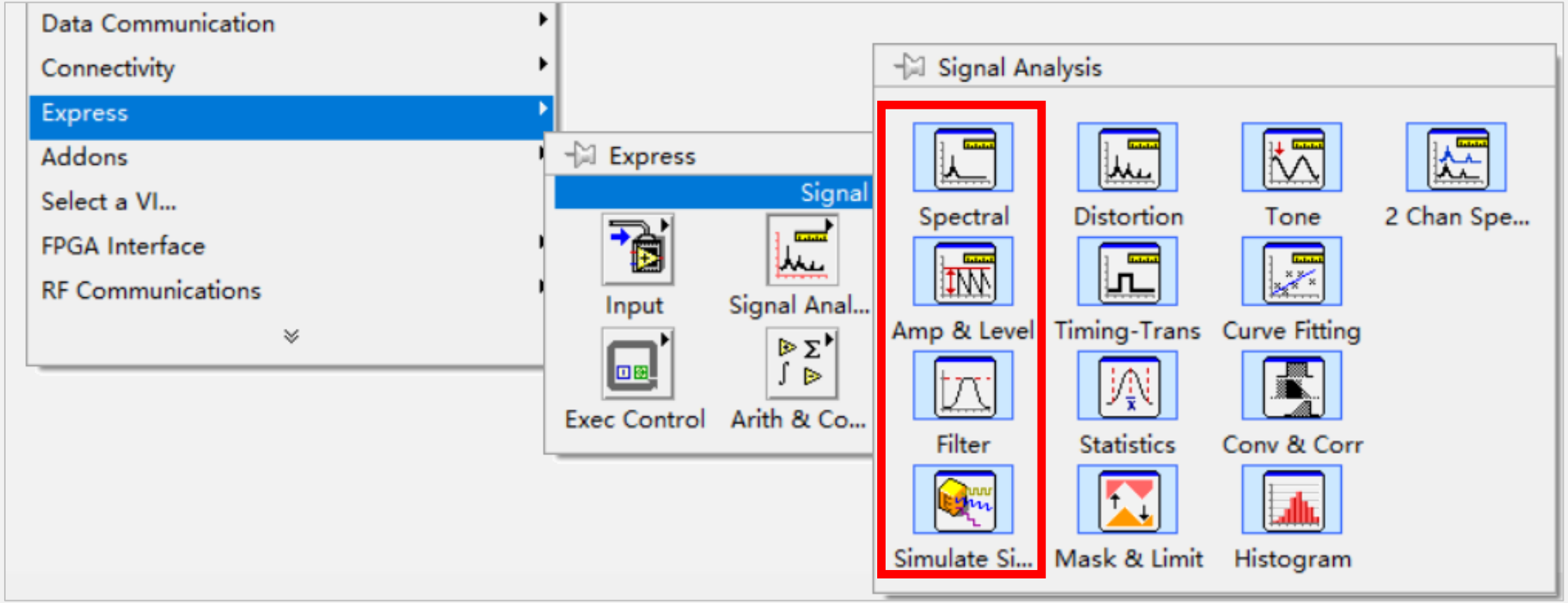
对波形进行重采样，以便声卡播放

Baseband | Modulator | AWGN | Demodulator | Play wave

不乘以1也可以
如果考虑复信道，则要乘以2

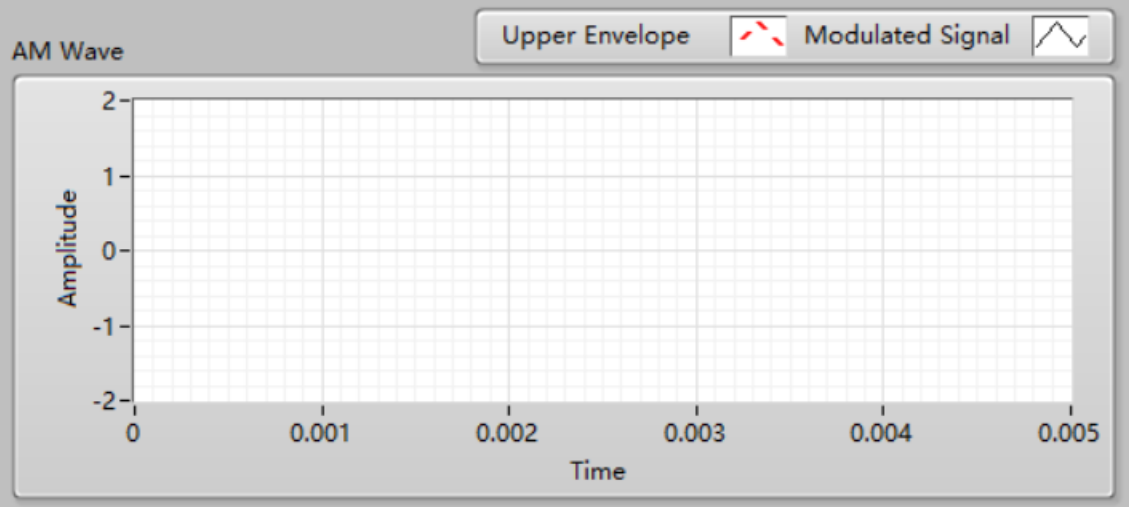


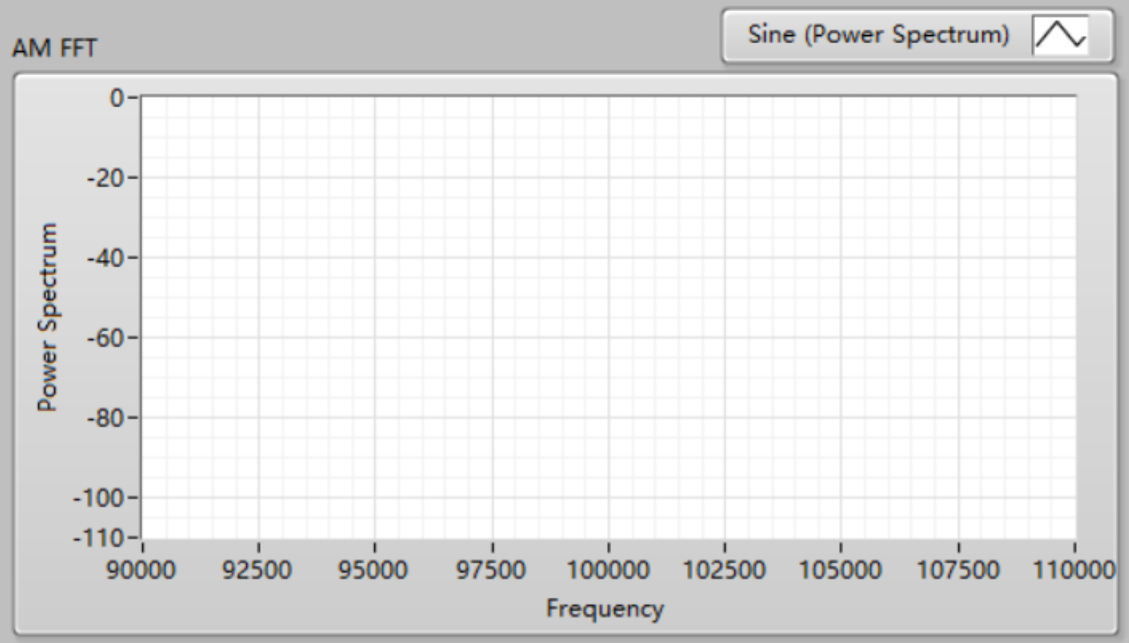
Blocks for Programming

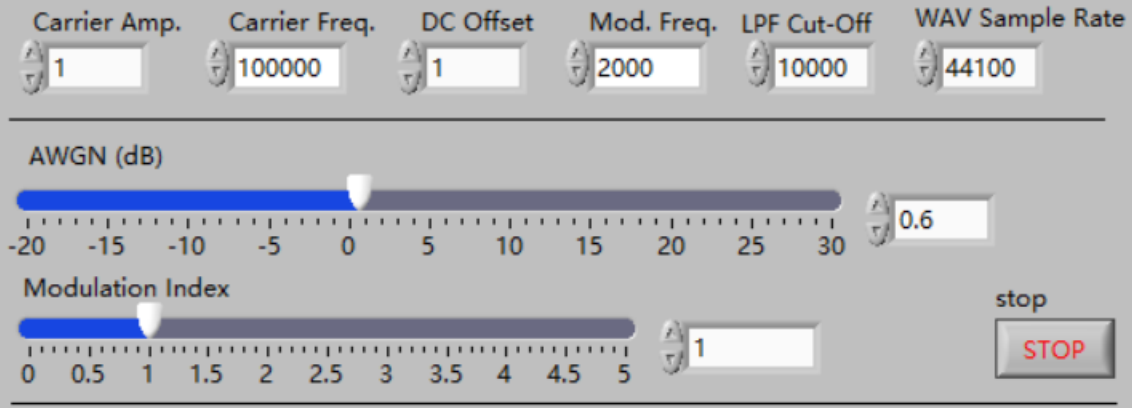


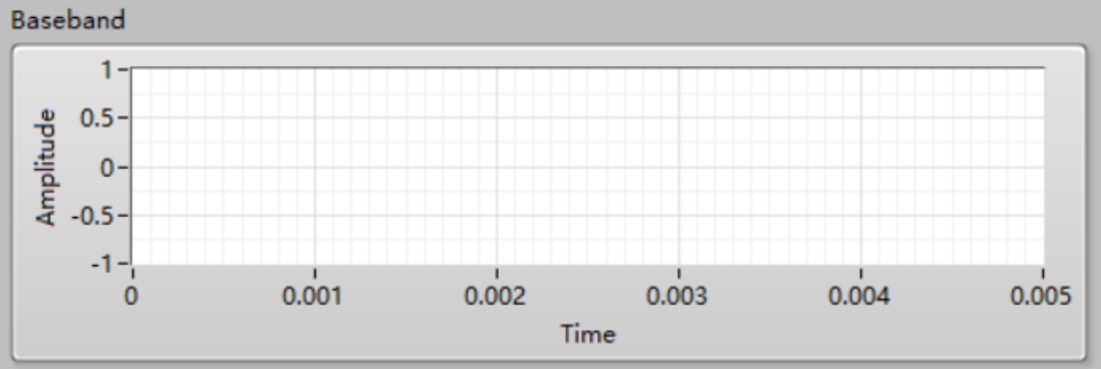
Exercise: Amplitude Modulation

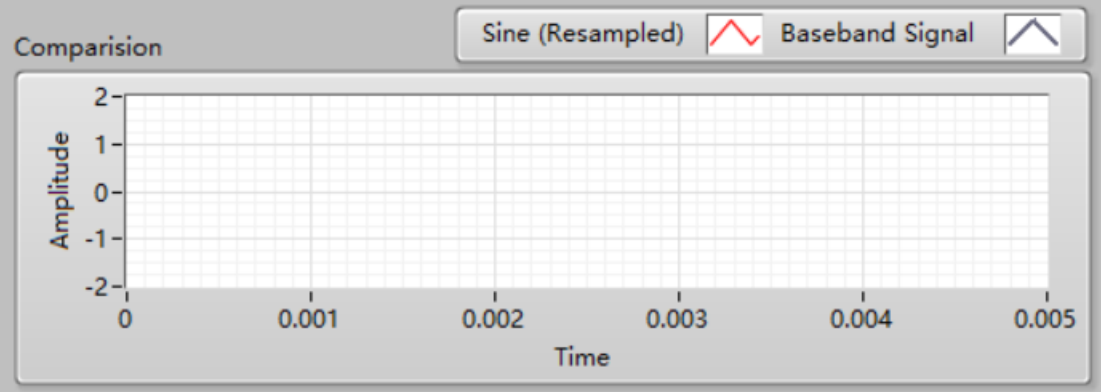
Amplitude Modulation

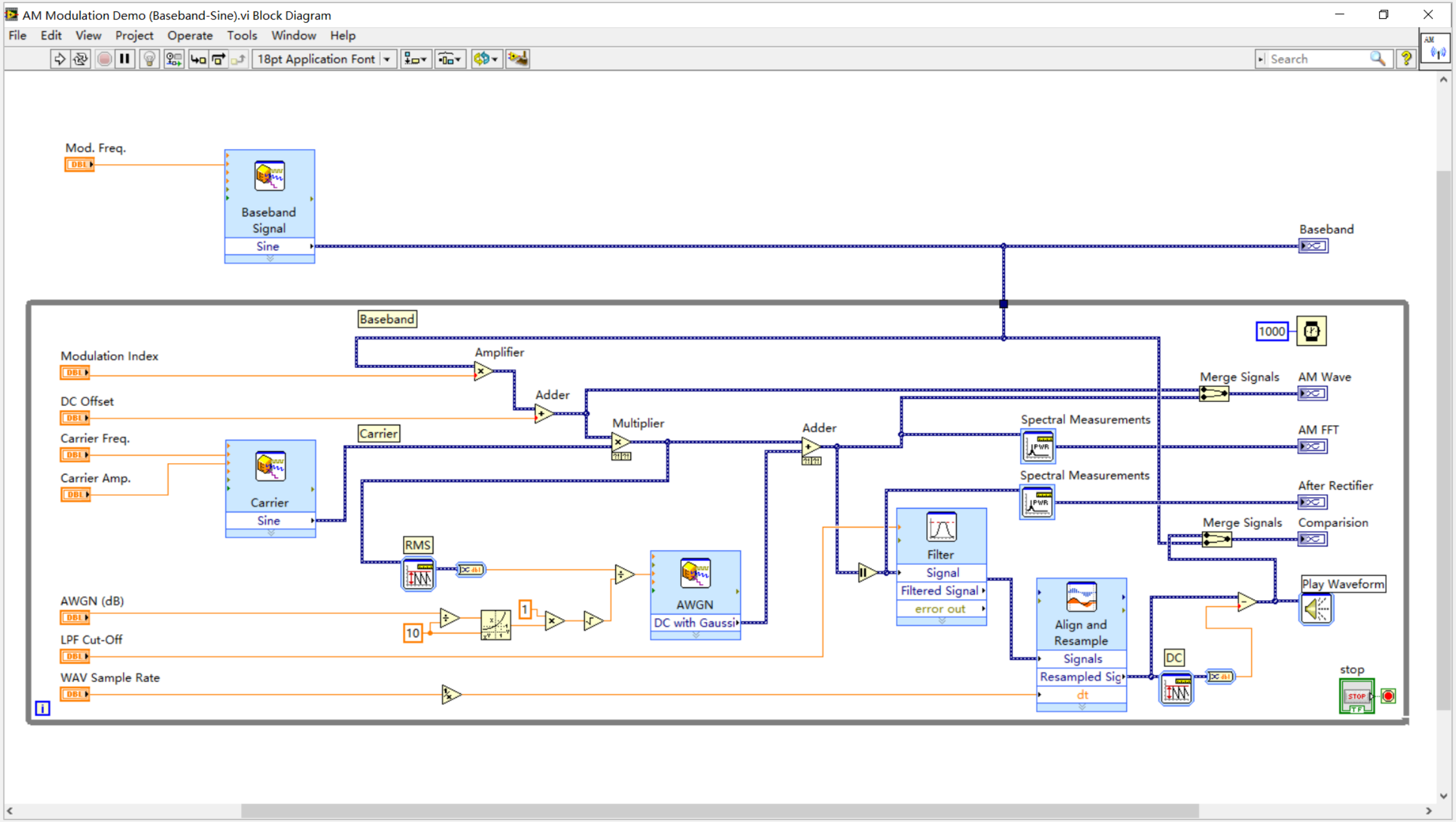








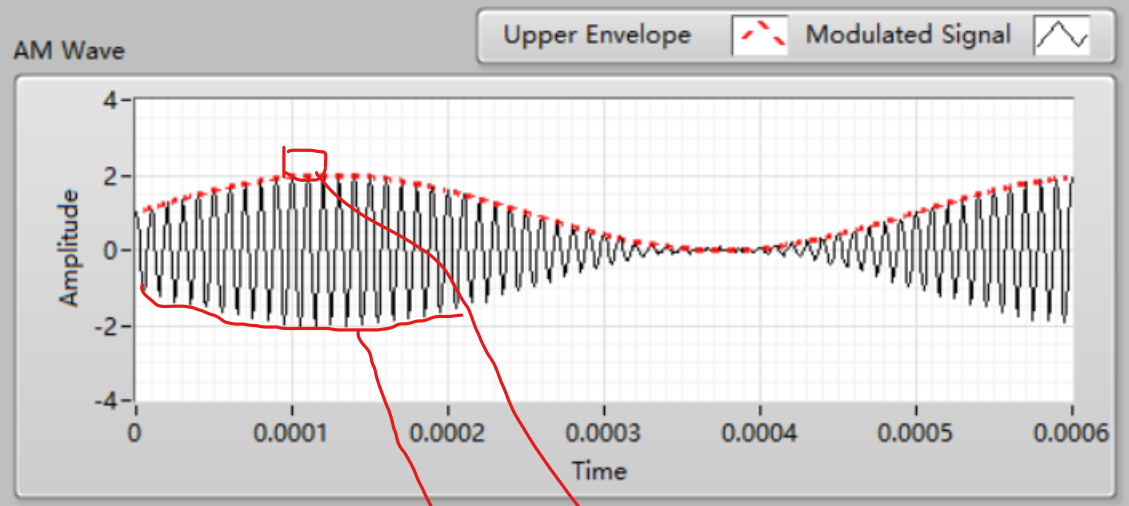


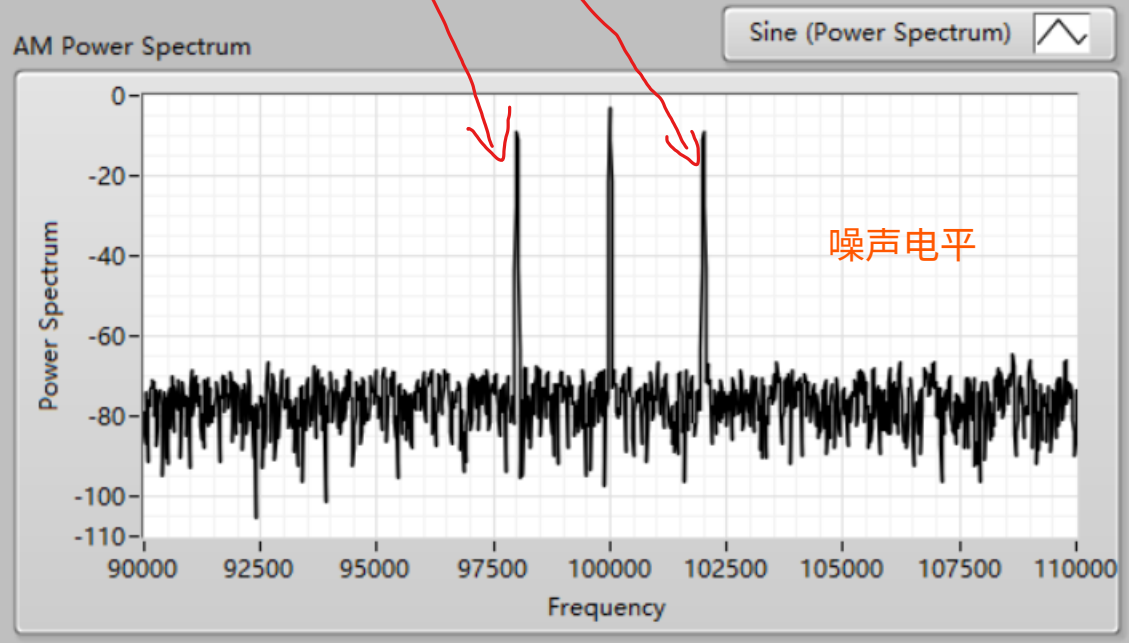

AM Modulation Demo (Baseband-Sine).vi Block Diagram
File Edit View Project Operate Tools Window Help
18pt Application Font
Search
Mod. Freq.
Baseband Signal
Sine
Baseband
Baseband
Modulation Index
DC Offset
Carrier Freq.
Carrier Amp.
Amplifier
Adder
Multiplier
Carrier
Carrier
Sine
Adder
1000
Merge Signals
AM Wave
Spectral Measurements
AM FFT
Spectral Measurements
After Rectifier
Merge Signals
Comparision
RMS
Filter
Signal
Filtered Signal
error out
Play Waveform
AWGN (dB)
LPF Cut-Off
WAV Sample Rate
AWGN
DC with Gaussi
10
1
Align and Resample
Signals
Resampled Sig
dt
DC
stop
STOP
TF

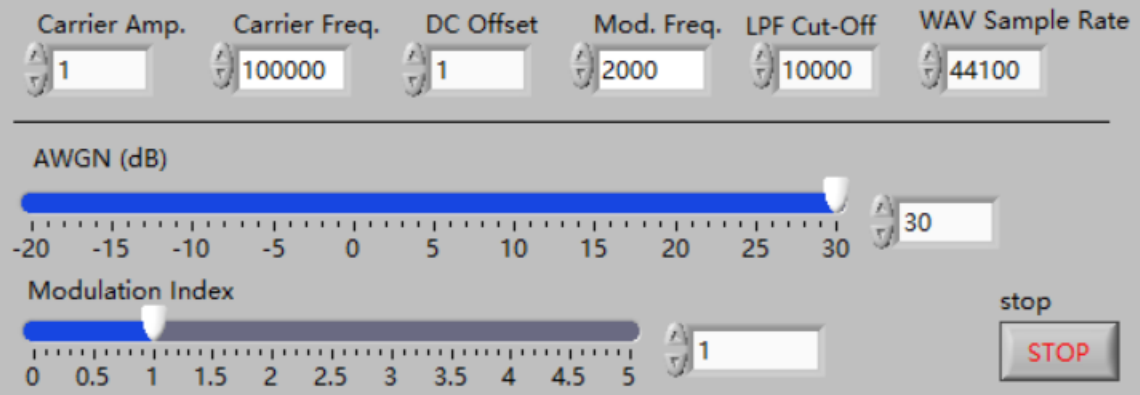
在射频信号中，更多是从频域上分析

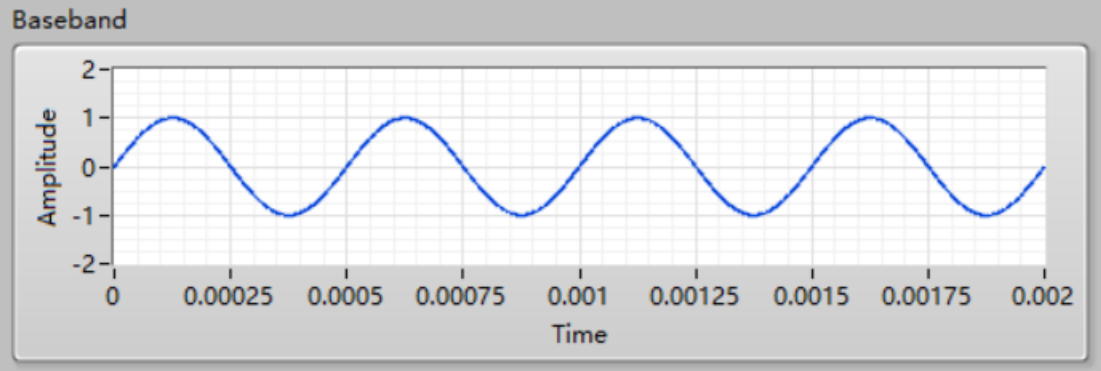
作业结果

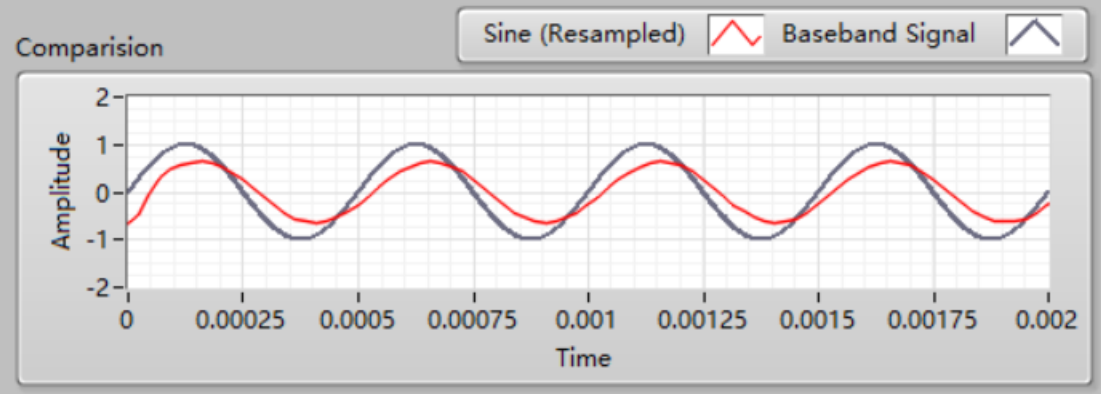
Amplitude Modulation

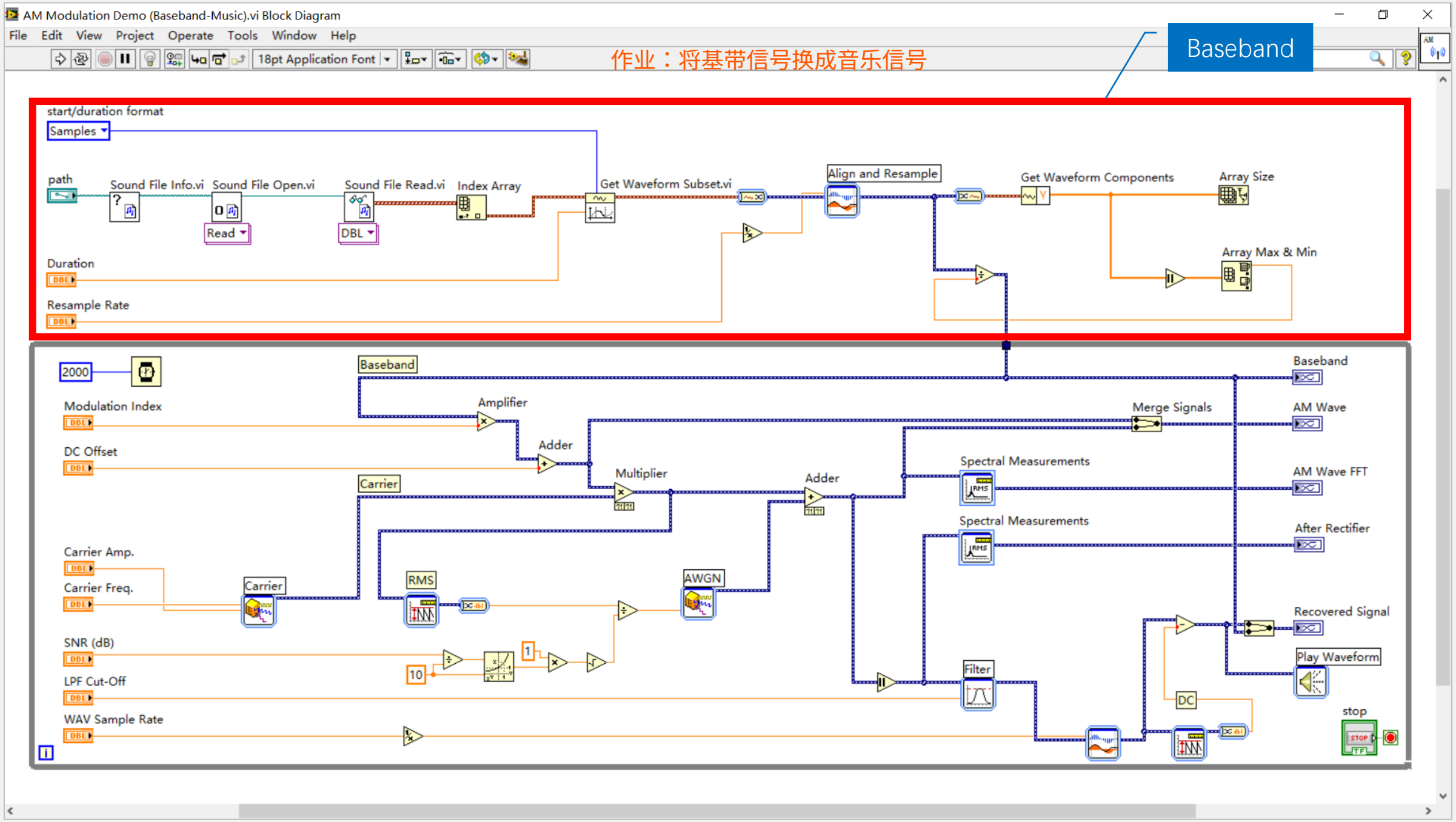











AM Modulation Demo (Baseband-Music).vi Block Diagram
File Edit View Project Operate Tools Window Help
18pt Application Font
作业：将基带信号换成音乐信号
Baseband
start/duration format
Samples
path
Sound File Info.vi
Sound File Open.vi
Read
Sound File Read.vi
DBL
Index Array
Get Waveform Subset.vi
Align and Resample
Get Waveform Components
Array Size
Array Max & Min
Duration
Resample Rate
2000
Baseband
Modulation Index
Amplifier
Adder
DC Offset
Multiplier
Carrier
Merge Signals
Spectral Measurements
Adder
AM Wave FFT
Spectral Measurements
After Rectifier
Carrier Amp.
Carrier Freq.
Carrier
RMS
AWGN
Recovered Signal
SNR (dB)
10
1
Play Waveform
LPF Cut-Off
Filter
DC
WAV Sample Rate
stop

Exercise: Sound File Read

Amplitude Modulation

path

D:\File\mozart.wav

Duration

44101

WAV Sample Rate

44100

Carrier Amp.

1

Carrier Freq.

100000

DC Offset

1

Resample Rate

1000000

LPF Cut-Off

10000

SNR (dB)

-20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50

30

Modulation Index

0 0.5 1 1.5 2 2.5 3

1

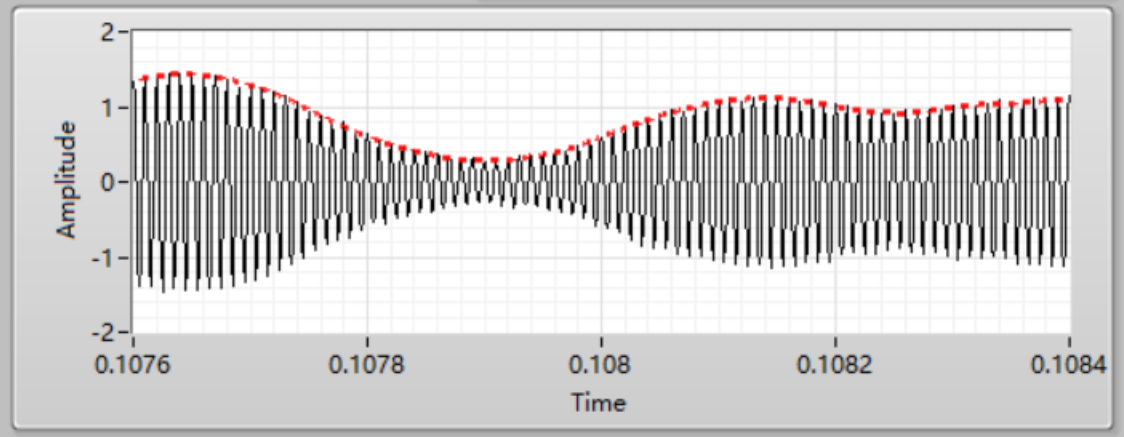
stop

STOP

AM Wave

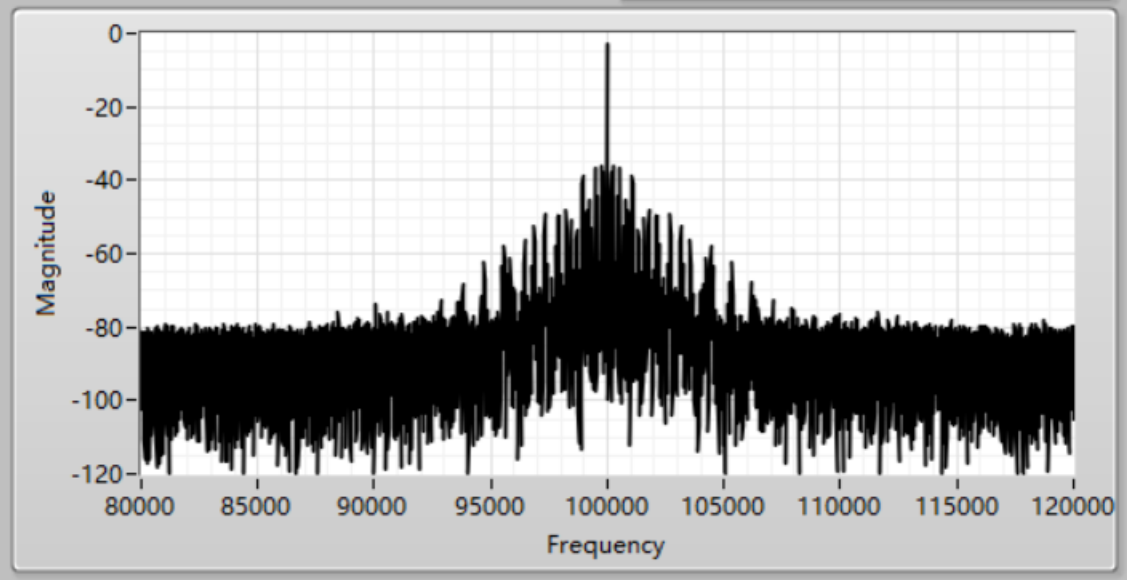
Upper Envelope

Modulated Signal

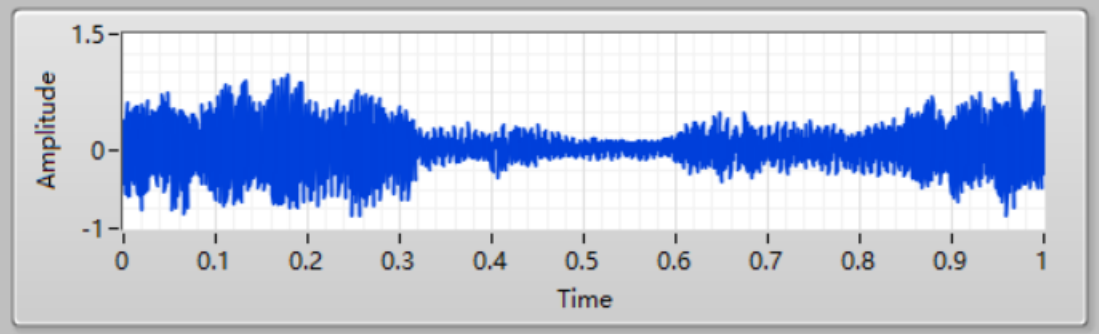


AM Wave FFT

Modulated Signal (FFT - (RMS))



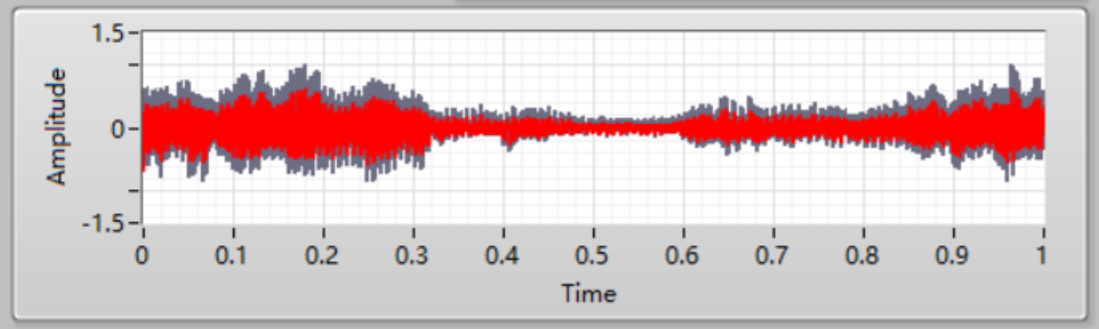
Baseband



Recovered Signal

Recovered Signal

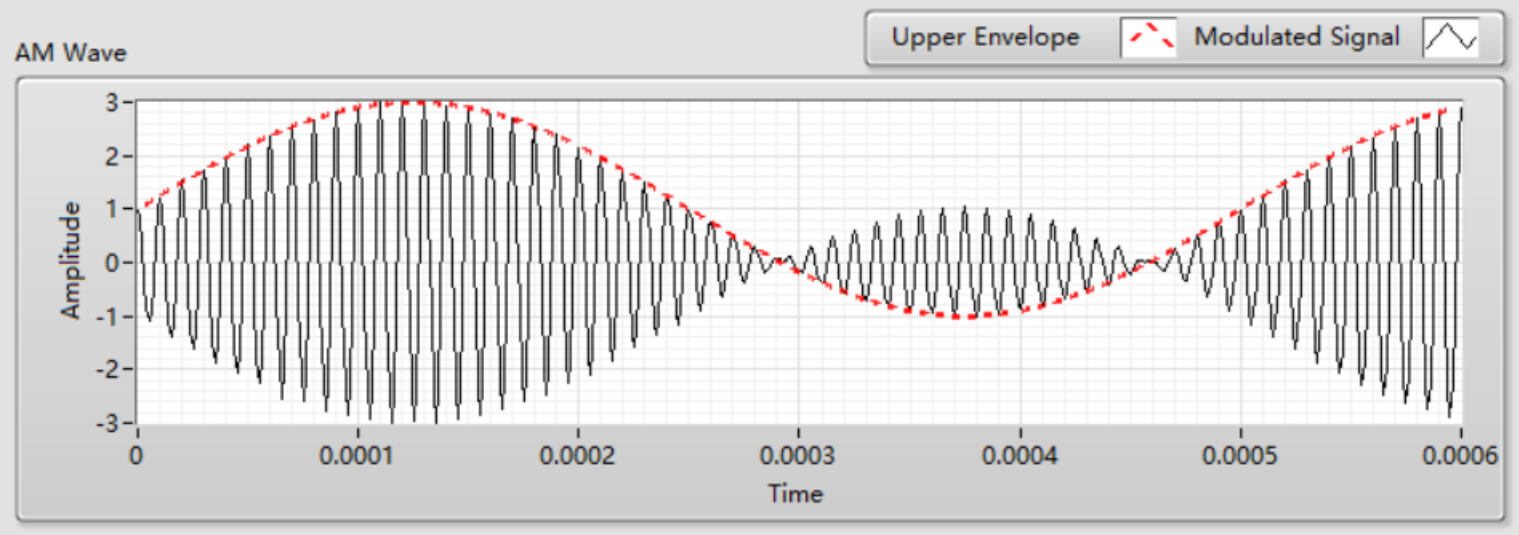
Baseband Signal

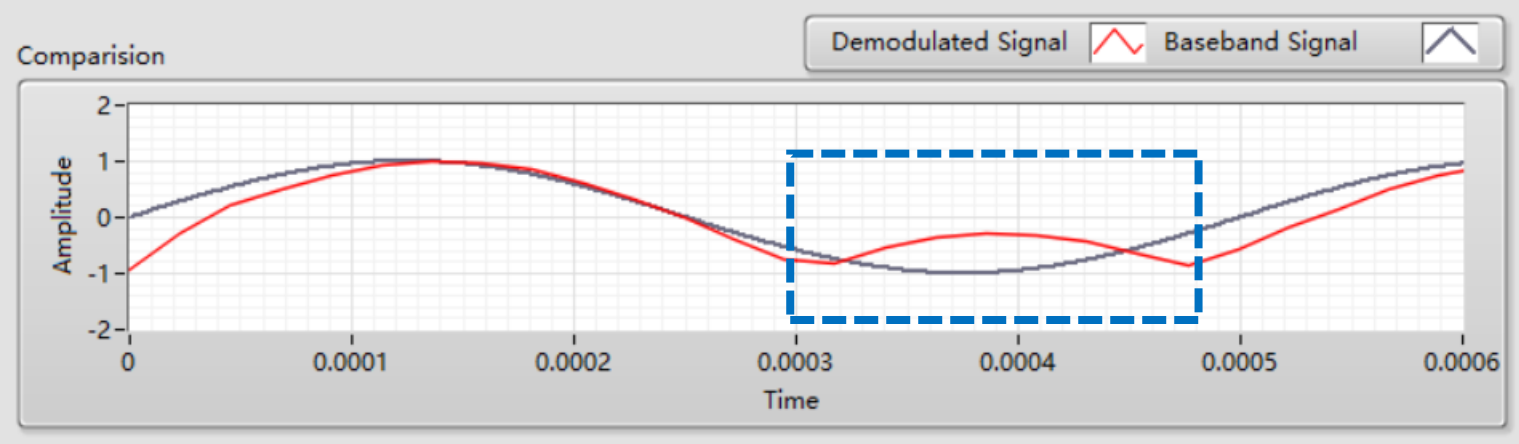


Demo: Performance Evaluation

Performance Evaluation-Over modulation

过调制





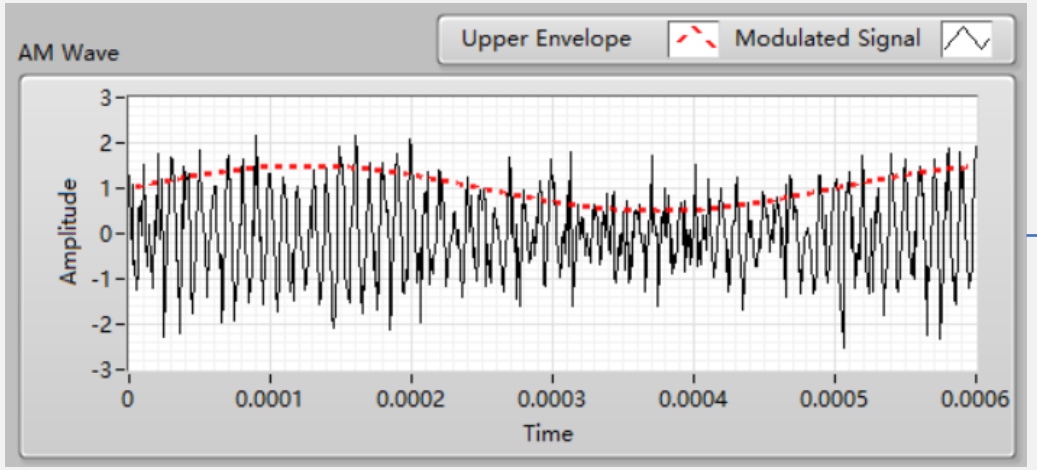
Modulation Index: 2

SNR(dB): 30 dB

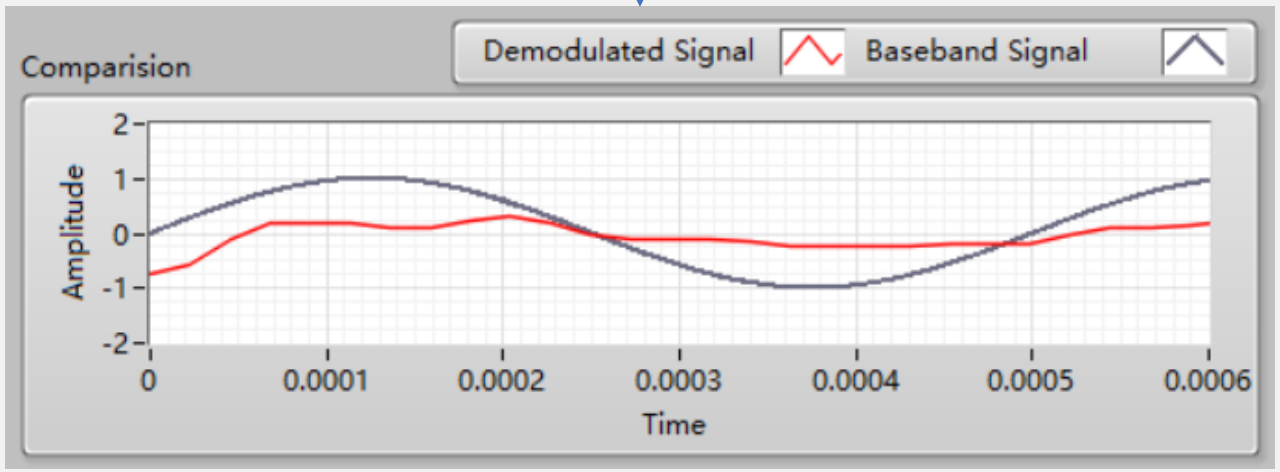
LPF Cutoff Frequency: 10 kHz

Demo: Performance Evaluation

Performance Evaluation-AWGN

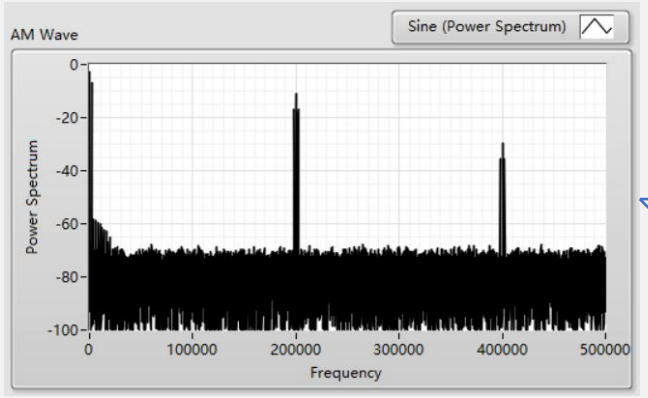


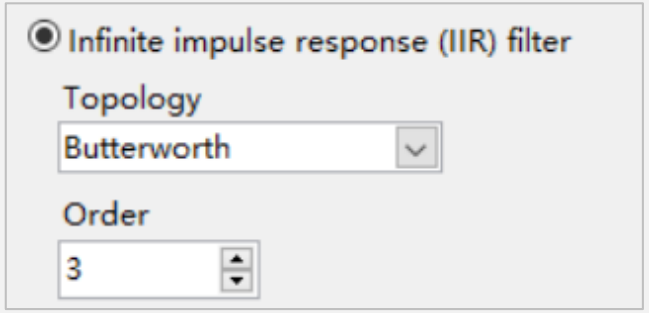
SNR(dB): 0 dB

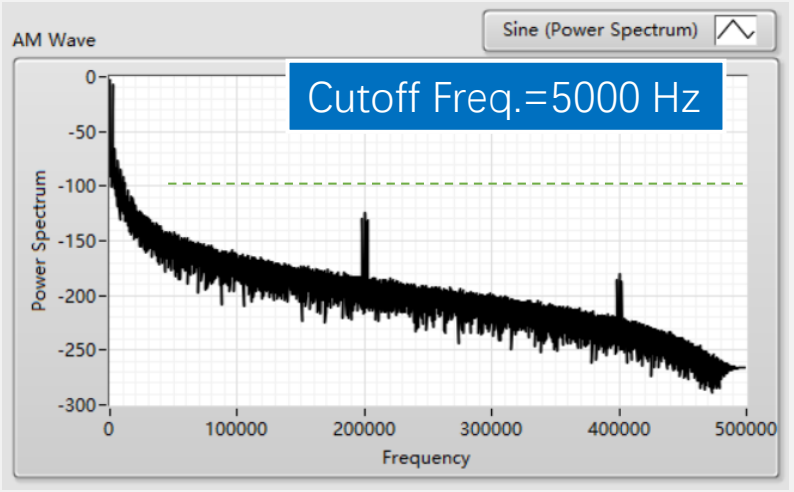


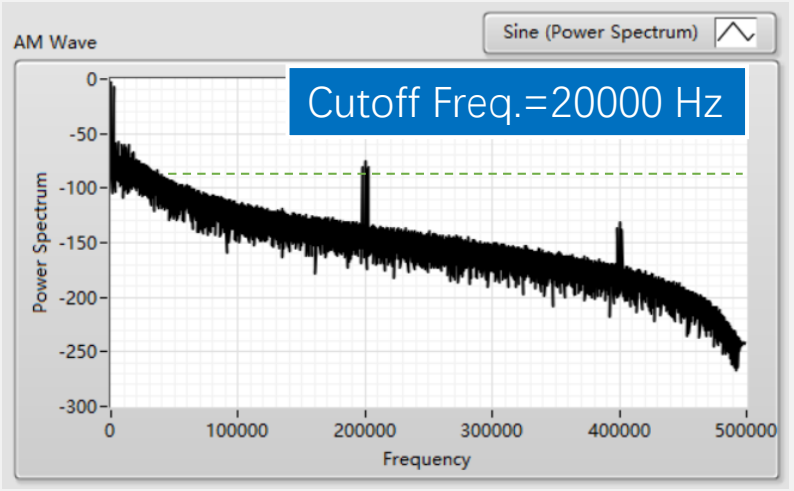
Demo: Performance Evaluation

Performance Evaluation-Cutoff Frequency

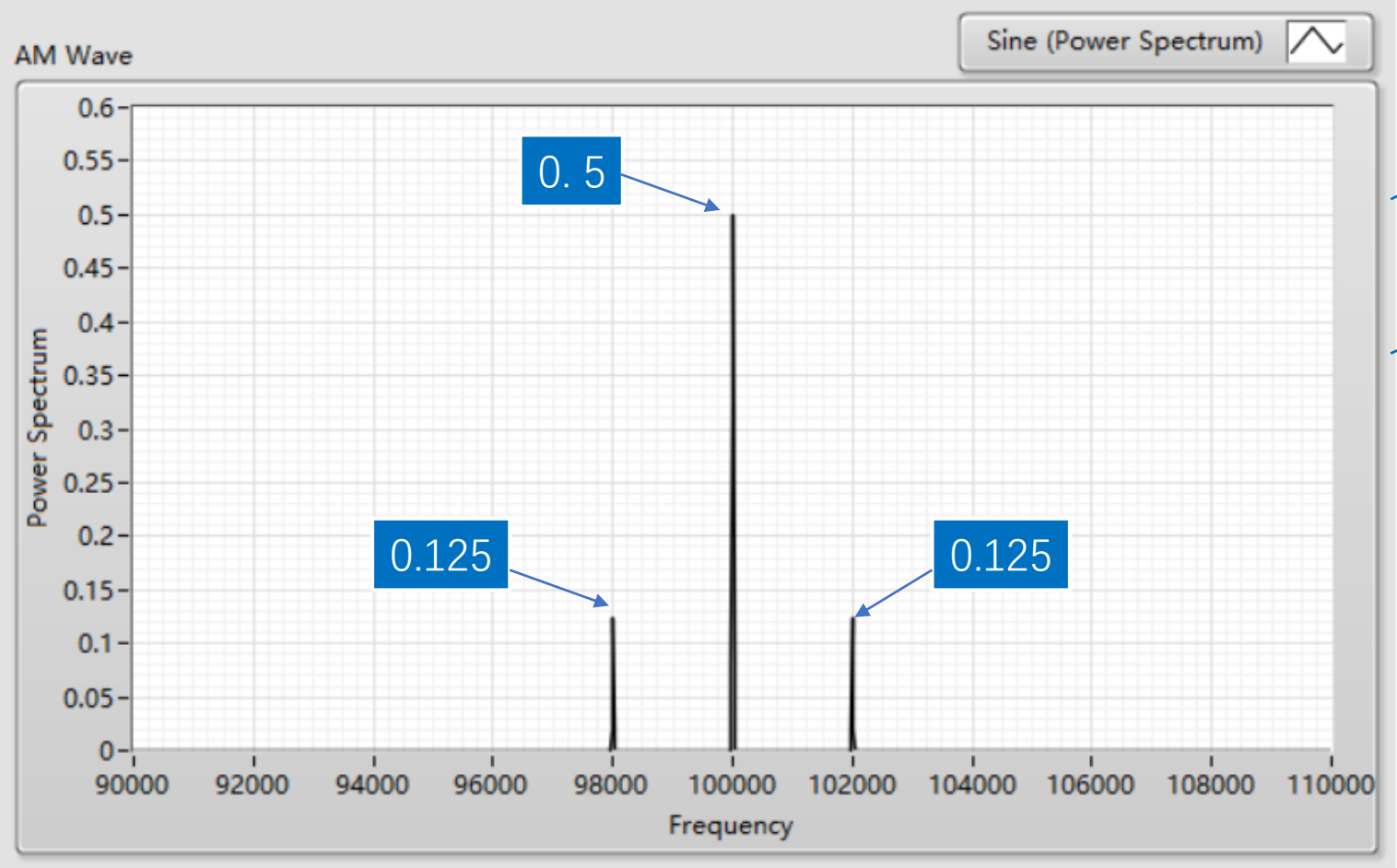








Performance Evaluation-Power and Spectrum



Power Efficiency ≤ **1/3**

Bandwidth=**4000Hz**

如何去提高功率效率和宽带效率？

1、如何去调试这个系统？理论基础，测量工具
2、分析系统性能，获得更好的效果

- Question ？