Course 9: Modems

Agenda

- Introduction
- AM modems
- FM modems

Introduction

- Definition(s) (from the web)
  - A device that converts digital data into analog signals and vice-versa for transmission over a telephone line.
    www.mobileedge.co.uk/jargon/jargon.htm
  - Equipment that converts between digital data and audio tones for transmission and reception over analog channels.
    www.thesaudi.net/vsat/vsat-glossary.htm
  - A device used that you connect to your computer and phone line to the internet.
    www.mantis.biz/glossary
  - A device named from an amalgam of the words modulator and demodulator. A modem will modulate an outgoing binary bit stream to an analog carrier, and demodulate an incoming binary bit stream from an analog carrier.
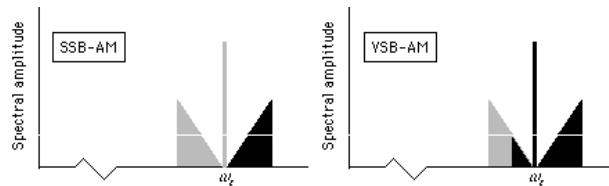   www.wtcs.org/snmp4tpc/jton.htm

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AM modems

- Modems using amplitude modulation
- Transmission made in the bandwidth of a primary group (60-108KHz)
- Transmission speeds: 48, 56, 64, 72 kbps
- The modems use, in general, SSB-AM or VSB-AM
- CCITT V.35: less-used, allows synchronous and asynchronous transmission at 48Kbps

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7200 bps VSB-AM modem

- ## It uses VSB-AM
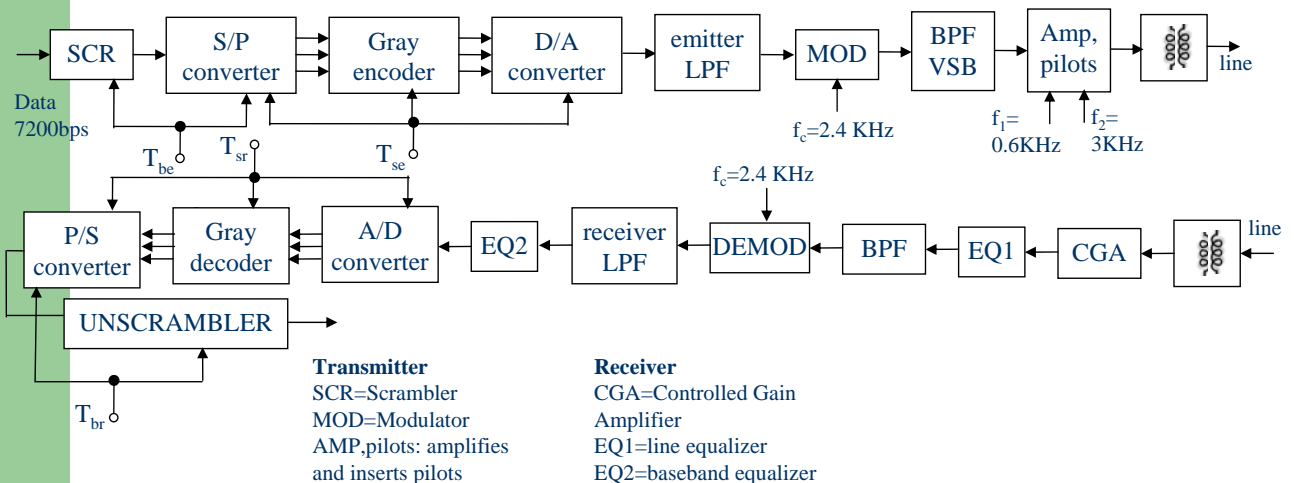 - VSB –AM transmits the whole upper side-band from the spectrum and part of the lower-sideband
  - 25% more bandwidth consumption than in SSB-AM

- ## Modulation speed of 2400 Baud, carrier frequency of 2400 Hz

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7200 bps VSB-AM modem's scheme

SCR → S/P converter → Gray encoder → D/A converter → emitter LPF → MOD → BPF VSB → Amp, pilots → line

Data 7200bps

T_{be} T_{sr} T_{se}

f_c=2.4 KHz

f_1= 0.6KHz f_2= 3KHz

f_c=2.4 KHz

P/S converter ← Gray decoder ← A/D converter ← EQ2 ← receiver LPF ← DEMOD ← BPF ← EQ1 ← CGA ← line

UNSCRAMBLER

T_{br}

Transmitter
SCR=Scrambler
MOD=Modulator
AMP,pilots: amplifies
and inserts pilots

Receiver
CGA=Controlled Gain
Amplifier
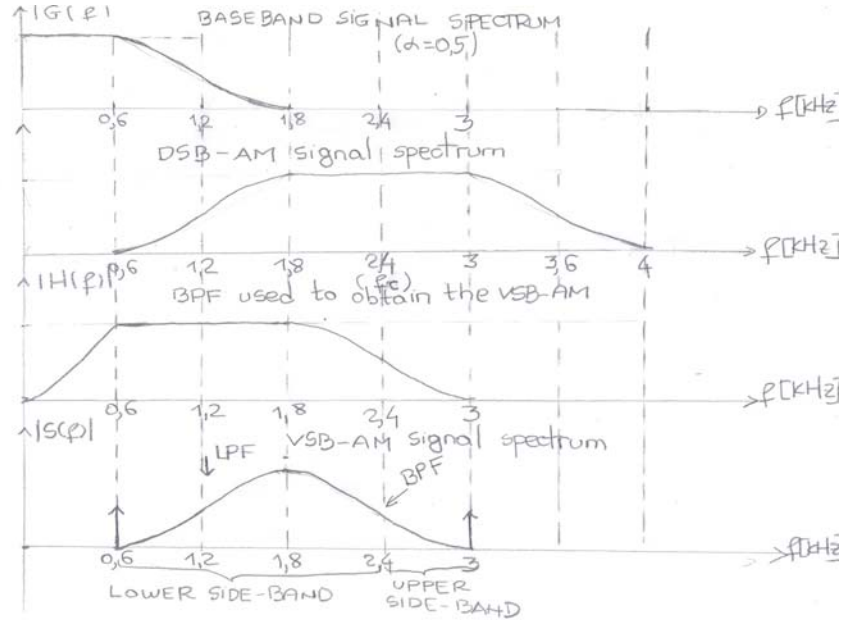EQ1=line equalizer
EQ2=baseband equalizer

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Comments on the previous scheme: the transmitter

- The carrier frequency is f_c=2400 Hz and the modulation speed is V_m=2400 Baud
- The data rate is D=$3V_m$=7200 bps (each symbol carries 3 bits, therefore 8 amplitude levels are used)
- Two clock signals needed: 7200 Hz (bit clock) and 2400 Hz (symbol clock, derived from the bit clock)
- The LPF (raised-cosine with a roll-off factor of 0.5) used after the D/A conversion shapes the baseband signal
- The analog baseband signal modulates the carrier and a DSB-AM signal is obtained
- The BPF is used to obtain the VSB-AM signal
- The signal is amplified to the required level and two pilots are inserted (600 Hz and 3KHz)
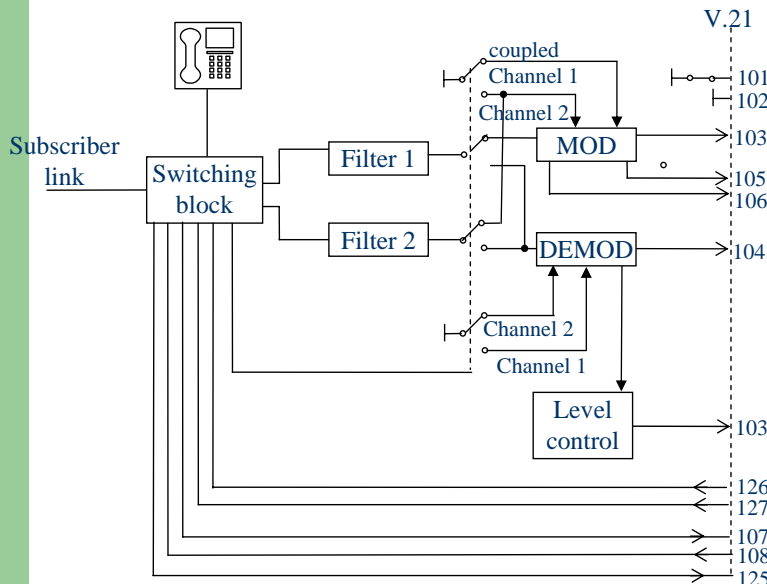
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Comments on the previous scheme: the receiver

- The CGA maintains a constant level of the received signal
- An equalizer (EQ1) compensates the frequency characteristic of the transmission channel
- A baseband equalization is performed too (EQ2)
- A/D: The signal is sampled and a decision is made on the received signal level (out of the 8 possible amplitude levels)
- The receiver clock signal (2400 Hz) is synchronized from the two pilots

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Comments on the previous scheme: VSB-AM signal generation

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V.21 FM modem

	Interchange circuit	
Number	Designation	
102	Signal ground or common return	
103	Transmitted data	
104	Received data	
105	Request to send	
106	Ready for sending	
107	Data set ready	
108/1	Connect data set to line	
108/2	Data terminal ready	
109	Data channel received line signal detector	
125	Calling indicator	
126	Select transmit frequency	

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V.21 modem parameters

- FM modem, with frequency division duplex transmission
- Data rate: 300bps
- The lower channel:
  - Used by the calling modem
  - Frequency: 1080 Hz, frequency shift 100 Hz
  - 1180 Hz signal represents "0", 980 Hz signal represents "1"
- The upper channel
  - Used by the modem which is called
  - Frequency: 1750 Hz, frequency shift 100 Hz
  - 1850 Hz signal for "0", 1650 Hz for "1"
- Tolerated frequency error: 6 Hz
- Asynchronous transmission

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V.21 modem description

- Switching block
  - Link set up and release
  - Channel control
  - Tone generation (2100 Hz)
- The filters separate the channels
- The switching between the channels can be made by the switching block or can be commanded by the terminal (circuits 126 and 127)
- The transmission is full duplex

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