

## High Data Rate ENG Systems Using VSB Modulation

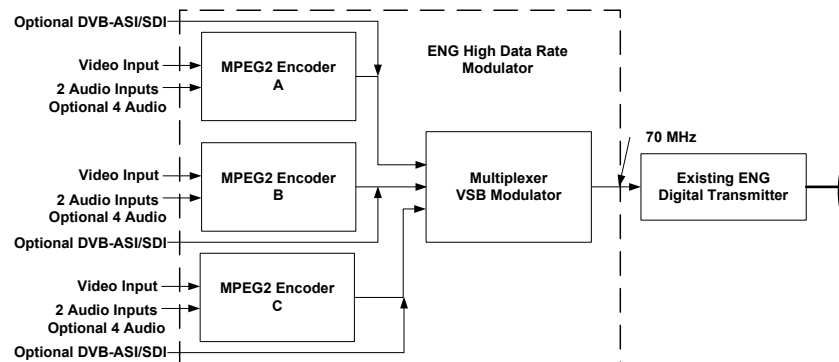
### Multiple Video Digital ENG Systems

#### *Features:*

- High Data Rate Digital ENG System
- Single or Multiple Video/Audio
- Optional DVB-ASI or SDI Inputs/Outputs
- Video Encoding 4:2:2 and 4:2:0
- Video Low Delay Mode < 100 msec
- Occupies < 12 MHz bandwidth at 2 GHz with Data Rates to 58 Mbps
- Occupies < 25 MHz bandwidth at 7 GHz with Data Rates to 80 Mbps
- ATSC VSB Modulation with Superior FEC
- Robust Adaptive Equalization
- Switchable Bandwidths 12, 17 and 25 MHz for Flexible Operation between 2, 7 and 13 GHz
- Ideal for Multiple DMA Area Operation
- Operates with any ENG Digital Radio
- Small, Compact and Low Cost.

#### *Advantages of the VSB Modem:*

- High Data Rates over 12 MHz BW
- Data Rates to 80 Mbps
- Multiple Video Channels over a Single ENG Microwave Link
- Ideal for Component HDTV
- Low Cost and Small Size
- Resilient to Multi-Path



**Block Diagram of the Three Video  
ENG System**

#### **Description:**

Nucomm ENG-VSB-HDLM Modem Series. The High Data Rate 70 MHz VSB Digital Mode is another innovative Nucomm product designed specifically for Digital ENG operation. When attached to a digital ENG transmitter such as the Nucomm Digital Newscaster ENG truck transmitter, the system can simultaneously transmit a variety of signals within the new FCC 2 GHz 12 MHz bandwidth as well as standard 25 MHz bandwidths. This includes:

- Single Broadcast quality video/audio program
- Up to Three Broadcast quality video/audio programs
- Very high data rate HDTV
- Multiple carriers configuration

The ENG-VSB-HDL Modem’s versatile operation is ideal for systems that must operate in multiple 2GHz DMA areas, switch between the 12 and 17 MHz bandwidths and still be able to operate in the 7 and 13 GHz band with bandwidth up to 25 MHz.

By using advanced digital ATSC modulation and error correction techniques, the ENG VSB-HDL system easily transmit as much as 58 Mbps of error free data within new FCC 2 GHz 12 MHz of bandwidth channel plan. The receiver demodulator utilizes fifth generation very powerful and robust ATSC adaptive equalization techniques. As new more robust generation chip sets are developed, any of the Nucomm VSB Demodulator can be upgraded.

The VSB-HDL technology has been successfully used for several years to transmit ATSC digital HDTV signals through single and multi-hop digital microwave systems. In several ENG applications using 8VSBT modulation with a 6 MHz bandwidth, high multi-path ENG shots were successfully obtained where analog could not get through.

**Modes of Operation:**

The ENG VSB-HDL Modem can be configured to operate in a number of modes and at varying data rates depending on the application. The trade off are between data rate, signal bandwidth and receiver threshold levels. These various modes are shown in Table 1:

Table 1 VSB Modulation Modes

Type Modulation	Maximum Data Rate	Signal Bandwidth	Receive Threshold
2VSB	5 Mbps	3 MHz	-90 dBm
2VSB	10 Mbps	6 MHz	-84 dBm
8VSBT	10 Mbps	3 MHz	-87 dBm
8VSBT	20 Mbps	6 MHz	-84 dBm
8VSBT	30 Mbps	9 MHz	-82 dBm
8VSB	29 Mbps	6 MHz	-78 dBm
8VSB	40 Mbps	9 MHz	-76 dBm
2 Carrier 8VSB	58 Mbps	12 MHz	-75 dBm
2 Carrier 8VSB	80 Mbps	18 MHz	-73 dBm

The ENG VSB-HDL modem is supplied in four model configurations. This includes

- Single Carrier – One Video Input
- Single Carrier – Two Video Input
- Single Carrier – Three Video Input
- Dual Carrier – One Video/DVB-ASI/SDI Input/Output with Data Rates to 58 Mbps
- Dual Carrier – Two Video/DVB-ASI/SDI Inputs/Output with Data Rates to 29 Mbps/Channel
- Dual Carrier – Three Video/DVB-ASI/SDI Inputs/Output with Data Rates to 17 Mbps/Channel

Various options are available include:

- Different input configurations
- Different maximum data rates
- Different bandwidths

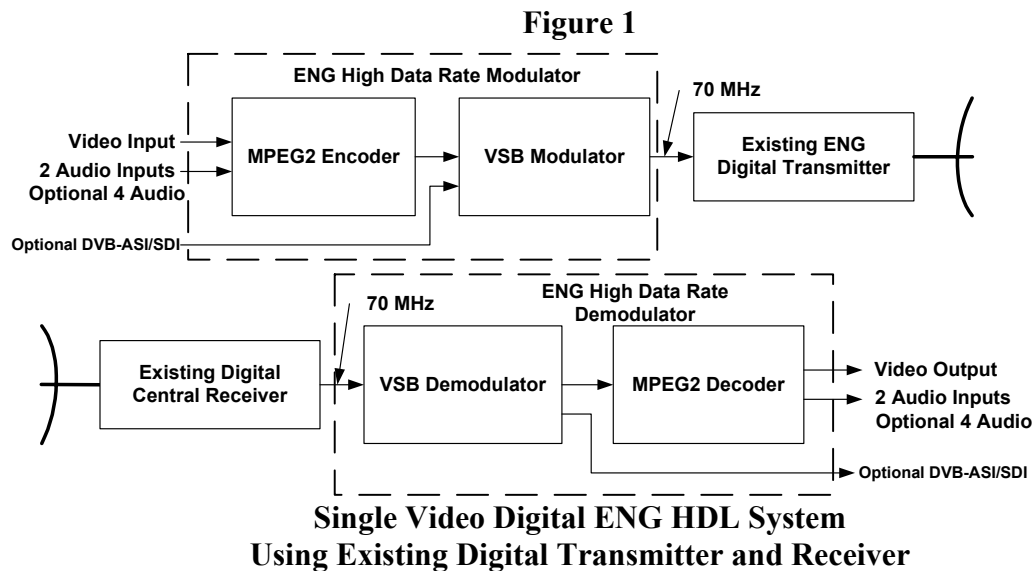
- Four audio inputs per video
- Universal power supply for AC & DC operation
- Rugged weatherproof case
- Internal Test Generator with 16 character ID

Data rate, bandwidth and modulation modes are front panel selectable. The various modes of operation are discussed in more detail below.

**Single Video System:**

Figure 1 shows a block diagram of the single carrier, single video input modem. The modem accepts one composite video and up to four analog audio signals. An MPEG2 encoder encodes the video and audio to either 4:2:2 or 4:2:0. The encoder's output transport stream is then converted to a VSB 70 MHz IF signal with a bandwidth of 3, 6, or 9 MHz with data rates from 5 Mbps to 40 Mbps as determined by the front panel controls. The 70 MHz IF signal is up-converted to the desired RF frequency and power level by the digital transmitter. Alternately, the MPEG2 encoder can be replaced by a DVB-ASI/SDI input signal. With a narrow signal bandwidth, as shown in Figure 3 and 4, multiple signals can be simultaneously transmitted within the 12 or 25 MHz bandwidth either from a single transmitter or from independent non-collocated transmitters. To accommodate this mode of operation, the 70 MHz modem out frequency is synthesizer controlled over +/- 12.5 MHz range in 0.5 MHz steps. Therefore the modems output can be set from 58.5 MHz to 82.5 MHz. Figure 3 and 4 shows the output spectrum of the 3 and 6 MHz wide modulation signals centered at 70 MHz.

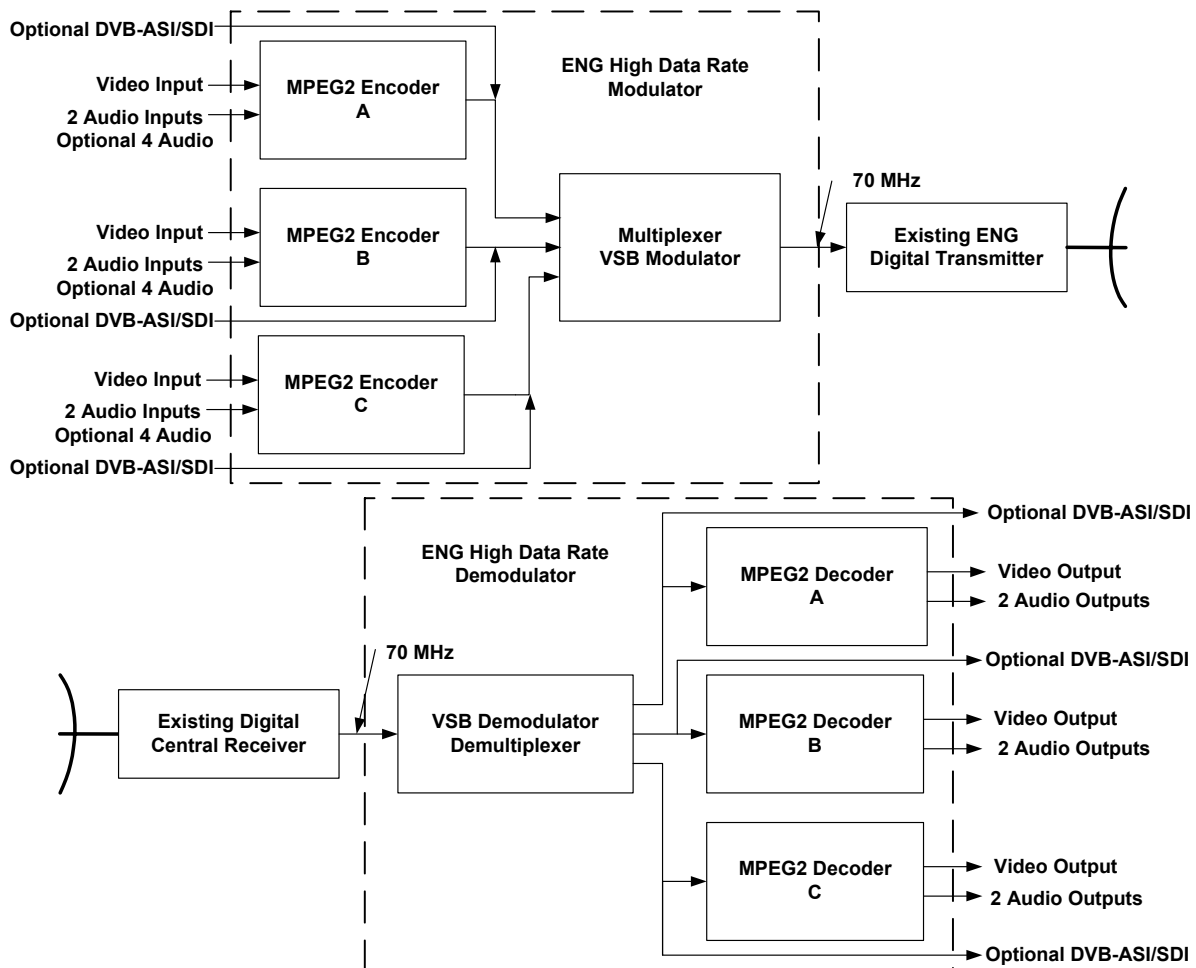
The single carrier VSB modems data rate can be set between 5 Mbps to 40 Mbps as shown in Table 1. In the 5 Mbps mode, the output bandwidth is 3 MHz and the modulation mode is 2VSB. In the 40 Mbps mode, the output bandwidth is 9 MHz and the modulation mode is 8VSB. Although the maximum data rate and resulting bandwidth of the modem is set, the modem will automatically accept any input data rate up to the maximum input data rate for that mode.



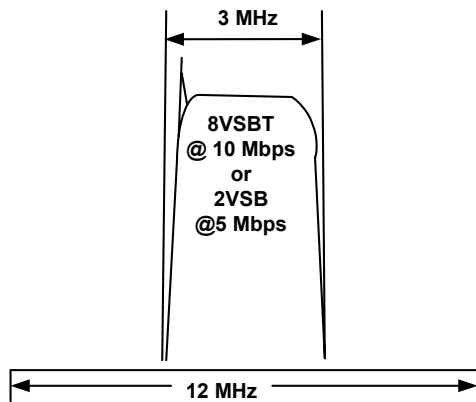
**Three Input Video System:**

Figure 2 shows a block diagram of the single carrier, triple video input modem. The modem simultaneously accepts three independent, composite, video signals with up to four analog audio inputs each. The three MPEG2 encoders encode the video and audio to either 4:2:2 or 4:2:0. The encoders outputs are multiplexed into a single transport stream then converted to a VSB 70 MHz IF signal with a bandwidth of 3, 6, or 9 MHz as determined by the front panel controls. The 70 MHz IF signal is up-converted to the desired RF frequency and power level by the digital transmitter. Alternately, the MPEG2 encoder can be replaced by a DVB-ASI/SDI input signal. With a narrow signal bandwidth, multiple signals can be simultaneously transmitted within the 12 or 25 MHz bandwidth either from a single transmitter or from independent non-collocated transmitters. To accommodate this mode of operation, the Modem 70 MHz output frequency is synthesizer controlled over +/- 12.5 MHz range in 0.5 MHz steps. Therefore the modems output can be set from 58.5 MHz to 82.5 MHz. Figure 3 and 4 shows the output spectrum of the 3 and 6 MHz wide modulation signals centered at 70 MHz.

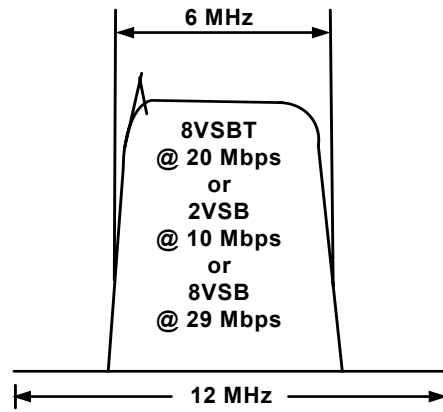
When the maximum data rate of the VSB modem is set, the modem will automatically accept any input data rate up to that maximum data rate. The combined data rate of the two MPEG2 encoders cannot exceed this data rate.



**Figure 2**  
**Triple Video Digital ENG HDL System**  
**Using Existing Digital Transmitter and Receiver**



**Figure 3**  
**RF Spectrum of 3 MHz BW**  
**VSB Signal**



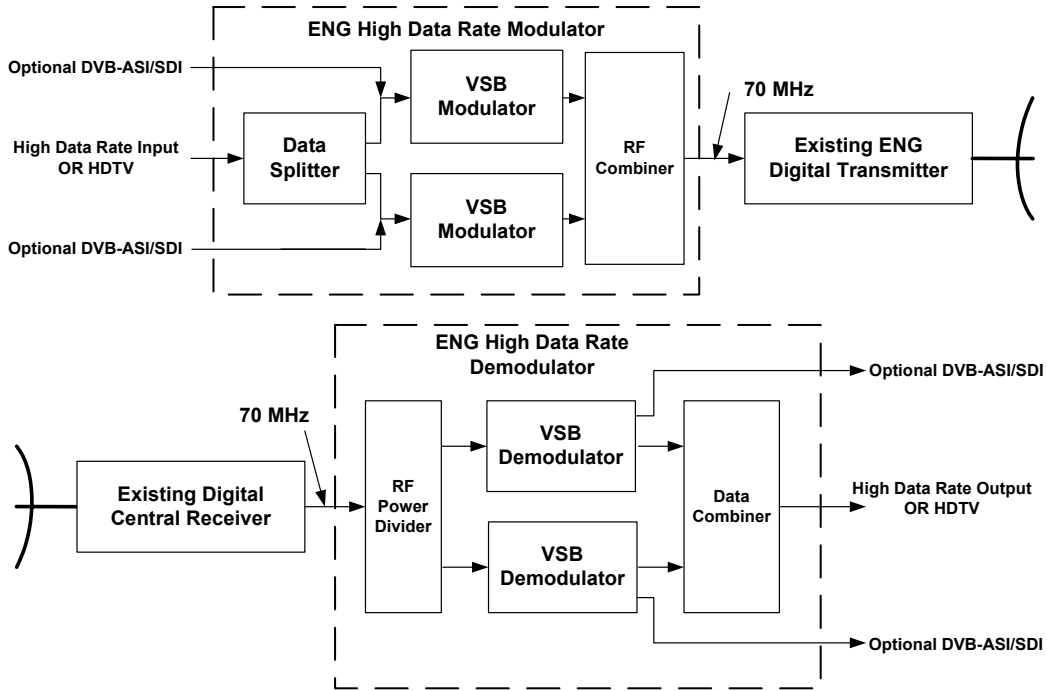
**Figure 4**  
**RF Spectrum of 6 MHz BW**  
**VSB Signal**

**Multi-Carrier System:**

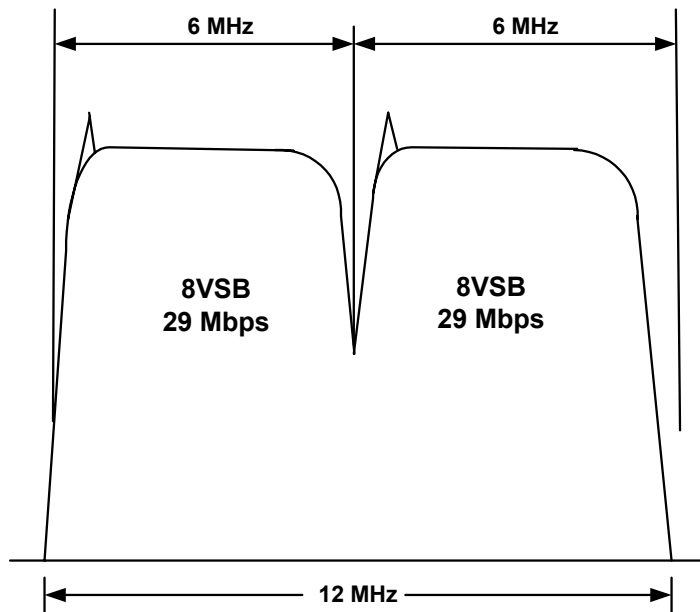
Figure 5 shows a block diagram of the dual carrier VSB modem. This configuration is used when the required data rate exceeds 40 Mbps. Typically this configuration would be for the transmission of component HDTV. The high data rate signal is split packet by packet into alternate paths. One packet is sent to Modulator A and the next to Modulator B and so on. Each data stream is then converted to a VSB IF signal with a bandwidth of 9 MHz. Modulator A outputs with a center frequency of 60.5 MHz. Modulator B outputs at 79.5 MHz, for a total bandwidth of 20 MHz and a total of 80 Mbps. For operation in a 12 MHz bandwidth, 8VSB modulation would be used with a 6 MHz bandwidth per carrier. This yields a 58 Mbps data rate that fits within 12 MHz as shown in Figure 6

The ENG VSB-HDL modem receiver demodulator splits the incoming signal into two paths. Each path is demodulated, error corrected and outputted to the data combiner. The data combiner outputs the original single high data rate stream. As in the case of the single carrier modem, the input data rate can be at any rate up to the 80 Mbps. That is the VSB modem is variable rate automatically adjusts for rates less than its maximum data rate.

At the Central Receiver site, the ENG VSB Demodulator connects to the receiver's Baseband output. No other modification is required. Composite video plus two audios are outputted. Optionally DVB-ASI/SDI output is available as well as the optional second channel. By turning on the ENG transmitters audio sub-carriers, conventional analog operation is easily restored.



**Figure 5**  
**Dual Carrier VSB Modulator**  
**for Data Rates greater than 40 Mbps**



**Figure 6**  
**RF Spectrum of Two 8VSB Signals**  
**at 29 Mbps Data Rate each**  
**for a Total Rate of 58 Mbps**