8-VSB Course

About the Author
The SBE 8-VSB course is written by Douglas W. Garlinger, CPBE, 8VSB, CBNT. Mr. Garlinger is a Fellow in the Society of Broadcast Engineers and a Trustee of the Ennes Educational Foundation Trust. Doug received the SBE Broadcast Engineer of the Year Award in 2002 and was selected SBE Educator of the Year in 1994. Doug was the Director of Engineering of Indiana-based LeSEA Broadcasting Corporation for 23 years and has served as the RF Engineering Manager at Mt. Wilson for NBC owned-and-operated stations KNBC-TV, KVEA-TV and KWHY-TV. Doug is also the author of the SBE Introduction to DTV RF (published by SBE in 1998; out of print) and the co-author of the SBE Television Operator's Certification Handbook, 7th Edition.

Introduction
The purpose of the SBE 8-VSB course is to give the student an overview of the 8-VSB system from end to end, providing all the basic information he or she will need to understand the nature of 8-VSB modulation and to recognize deficiencies in the transmitted signal. This information will be invaluable in installing, maintaining and operating a digital television transmitter facility. Much of the material contained in this course will aid the student in his or her efforts to obtain the SBE 8-VSB Certification.

Course Description
The Advanced Television Systems Committee (ATSC) developed the 8-VSB standard to permit the transmission of HDTV pictures or multiple SDTV channels within the same 6 MHz channel spectrum that had been occupied by an NTSC analog channel. The DTV signal is transported to the 8-VSB transmitter exciter as an MPEG-2 bitstream with a data rate of 19.39 Mbit/s, sometimes referred to as 19.4 Mbit/s. Most television exciters accept this input signal as a SMPTE 310M signal.

The primary focus of the SBE 8-VSB Course is RF transmission and the process employed to transform the 19.39 Mbit/s transport signal into a signal suitable to modulate the transmitter. The course will also touch briefly on some of the important elements in the transport stream, such as video compression, picture formats, Active Format Description, PSIP and Dolby AC-3 audio.

Course Content
1. Introduction to 8-VSB
2. 8-VSB Overview
3. Video Compression
4. DTV Audio
5. Active Format Description
6. PSIP
7. 8-VSB Signal and Channel Occupancy
8. The 8-VSB Transmitter Part 1 (Data Processing)
9. The 8-VSB Transmitter Part 2 (Modulator and Filtering)
10. 8-VSB Spectral Display and Mask
11. 8-VSB Transmission Monitoring
12. 8-VSB Receiver
13. Television Power
14. DTV Service Areas

Enrollment Information
SBE Member Price:  $99
Non-Member Price:  $139
8-VSB Overview

The transmitted 8-VSB signal is a modulated analog carrier whose RF envelope varies with the data modulation. The polarity and eight specific levels of I-component amplitude during each clock period of the I-signal are used to symbolize 3 bits of digital data. There are four positive levels (+7, +5, +3 and +1) and four negative levels (-7, -5, -3 and -1). The clock rate for the 8-VSB signal is 10.762 MHz, or 10,762,238 symbols each second. This is often referred to as a symbol rate of 10.76 Megasymbols per second or a symbol period of 92.9 nanoseconds.

At 3 bits per symbol, the symbol rate of 10.76 MHz would appear to permit 8-VSB data transmission at the rate of 32.28 Mbit/s per second. More than one third of this data is used for data synchronizing signals and forward error correction (FEC). The 8-VSB transmitter and the 8-VSB receiver together form a 19.39 Mbit/s one-way modem.

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The 8-VSB receiver can produce a perfect picture in the presence of a high noise floor. The Carrier-to-Noise (C/N) threshold of data errors for the 8-VSB RF signal is specified at 15 dB. The received 8-VSB picture will either be "studio quality," or the 8-VSB receiver will sense an excessive "bit error rate" in the received data signal. If the bit error rate is excessive, the received picture will begin to display pixelization or a "freeze frame." This sudden loss of the received signal is called the cliff effect.

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The primary focus of this 8-VSB Course is RF transmission and the process employed to transform the 19.39 Mbit/s transport signal into a signal suitable to modulate the transmitter. However, before getting deeply into that subject we are going to touch briefly on some of the important elements in the transport stream, such as video compression, picture formats, Active Format Description, PSIP and Dolby AC-3 audio.

Detailed technical specifications of the DTV standards are set forth in documents prepared by the Advanced Television Services Committee (ATSC); these documents can be downloaded from the Internet at www.atsc.org/standards/.

Transport

The FCC adopted a DTV standard based on the 188-byte MPEG-2 international data packet standard.

A division of the International Standards Organization (ISO) known as the Moving Picture Experts Group (MPEG) has established various standards for the transport of digital data. The MPEG-2 video standard, also known as the ISO/IEC IS 13818-2, was established as an International Standard in November 1995. The MPEG-2 standard defines four levels and five profiles. The ATSC DTV standard is compliant with MPEG-2 MP@HL (Main Profile @ High Level).

In digital systems, the term coding is used to describe the technique used for overcoming adverse characteristics of the transmission channel. The term compression describes the technique used to reduce the required data rate in the transport system.

A specific fixed-data-length version of MPEG-2 was selected as the DTV standard. The DTV transport system was designed to be compatible with the internationally accepted 188-byte MPEG-2 data packet standard. A fixed-length data packet offers many
advantages when multiple services are being delivered to the 8-VSB receiver. The contents of each data packet are identified in the packet headers (see Figure 1.1). The first byte of information in the four-byte "Link" header is used for data synchronization.

The 188-byte MPEG-2 data packets are formed by multiplexing individual packetized elementary streams (PES). The Stream ID in each PES identifies the type of data in the PES packet (e.g. video, audio, or data). Other PES information is contained in the Header codes as shown on Figure 1.2. PES length can vary, with the upper limit extending to 65,536 bytes (64k). For data transport, data in the variable-length PES packets are packaged into fixed length 188-byte MPEG-2 packets.

It is beyond the scope of this text to detail the characteristics of this MPEG-2 data. It is important to understand, however, that the 188-byte MPEG-2 digital bitstream uses a compression technique that allows the broadcast of a High Definition Television picture or multiple Standard Definition Television Signals within the 6 MHz of spectrum allocated to a single NTSC channel. An uncompressed HDTV signal may require a bit rate over 1 Gbit/s. Since the ATSC 8-VSB RF system is limited to 19.39 Mbit/s, a significant amount of digital compression is required.

What is the symbol rate of the 8-VSB signal?
- 5.38 Megasymbols per second
- 10.76 Megasymbols per second
- 3.579545 Megasymbols per second
- 15,734.2 Megasymbols per second

What is the data rate of an 8-VSB transmission?
- 10.76 Mbit/s
- 92.9 Mbit/s
- 19.39 Mbit/s
- 15 Mbit/s