Digital ENG Using the Analog Coder System

Digital Video/Audio Over an Existing ENG Analog System

Features:

- Operates in the New 2 GHz FCC Frequency Plans
- No Modification to Existing Analog System
- Video Encoding 4:2:0 and 4:2:2
- Low delay mode < 100 msec.
- Single, Dual or Triple channel Video
- Optional DVB-ASI or SDI Inputs/Outputs
- Variable Data Rates to 18 Mbps for 12 MHz BW
- Variable Data Rates to 36 Mbps for 25 MHz BW
- Operates at Full Analog Output Power
- Uses ATSC FEC and Robust Adaptive Equalization
- Better Performance than Analog Modulation
- -84 to –90 dBm Threshold Performance
- Small Low Cost Add-on Module to Existing Analog System

Advantage of the ENG Analog Coder

- Digital Over an Existing Analog Link
- 15 Mbps in 12 MHz Bandwidth
- Up to Three Videos in 12 MHz BW
- Threshold better than Analog

Description:

The ENG Analog Coder is another innovative Nucomm product that makes the conversion to the new FCC 2 GHz plan simple easy and inexpensive. Adding the ENG Analog Coder to existing Analog ENG equipment enables up to three Video plus 4 Audio/channels to be digitally transmitted within the new 12 MHz wide 2 GHz bandwidth channels. Four Video channels can be passed through existing 25 MHz bandwidths at 7 and 13 GHz with superior performance. Each video channel can have up to four audio channels. Optionally, any one of the video channels can be replaced with a DVB-ASI or SDI input. Unlike digital transmitters that must back the RF output power down by 3 to 5 dB, the existing analog transmitter with the ENG Analog Coder operates at full analog output power levels.

In modifying existing analog radios to the new FCC plan, the frequency synthesizer is typically configured with a frequency plan switch. This enables the equipment to be easily switched between the two frequency plans. When an existing Analog ENG system is configured with the ENG Analog Coder, the system can be switched between the present 17 MHz frequency plan and the new FCC 2 GHz plan with the flip of a single switch. Since the ENG Analog Coder bandwidth occupies less than 12 MHz it operates equally as well on both channel plans. Thus, when moving from one DMA to another the system is easily reconfigured.

Modes of Operation:

The ENG Analog Coder uses a form of multi-level ATSC modulation coding and forward error correction. A combination of reed Solomon and Trellis coding is used in accordance with the ATSC standard. The demodulator and decoder use powerful and effective ATSC chip sets that have robust adaptive equalization. Table 1 below lists the type of modulation used and the

resultant data rates and occupied bandwidths for an analog system using the ENG analog Coder. Also shown is the receiver threshold level at which the "Cliff Effect" occurs.

Table 1 VSB Modulation Modes

Type Modulation	Maximum Data Rate	Signal Bandwidth	Receive Threshold
2 level	5 Mbps	8 MHz	-90 dBm
2 level	9 Mbps	12 MHz	-84 dBm
8 level T	9 Mbps	8 MHz	-87 dBm
8 level T	18 Mbps	12 MHz	-84 dBm
8 level	14 Mbps	8 MHz	-78 dBm
8 level	25 Mbps	12 MHz	-76 dBm

The T indicates when Trellis coding is used.

The receiver threshold level for 8 Mbps in an 8MHz bandwidth is –90 dBm. At this level both video and audio are noise free. Using conventional analog modulation, comparable receive levels would typically –80 dBm. (Analog threshold of existing equipment as defined at a S/N =35 dB is –85 dBm. However the video is very noisy and the audios are hardly usable)

Single Video System:

A block diagram of the single video ENG Analog Coder is shown in Figure 1. It consists of a Broadcast Quality MPEG2 4:2:0/4:2:2 encoder/decoder that can operate with delays less than 100 msec. The Nucomm field proven proprietary digital-to-baseband spectrum efficient converter (Patent Pending) follows the encoder.

The baseband output from the ENG Analog Coder is inputted to the baseband input of **any existing analog** FM modulated ENG transmitter. No modification of the transmitter is required other than turning off the audio sub-carriers. The total data rate for 12 MHz bandwidth operation is 18 Mbps using 8 level T modulation. For 25 MHz bandwidth operation the maximum data rate is 36 Mbps using 8 label modulation. Operating using the 2 level mode at a data rate of 5 Mbps in an occupied bandwidth of 8 MHz give a threshold improvement of 3 dB over 8level T. The input data rate is full variable up the maximum setting.

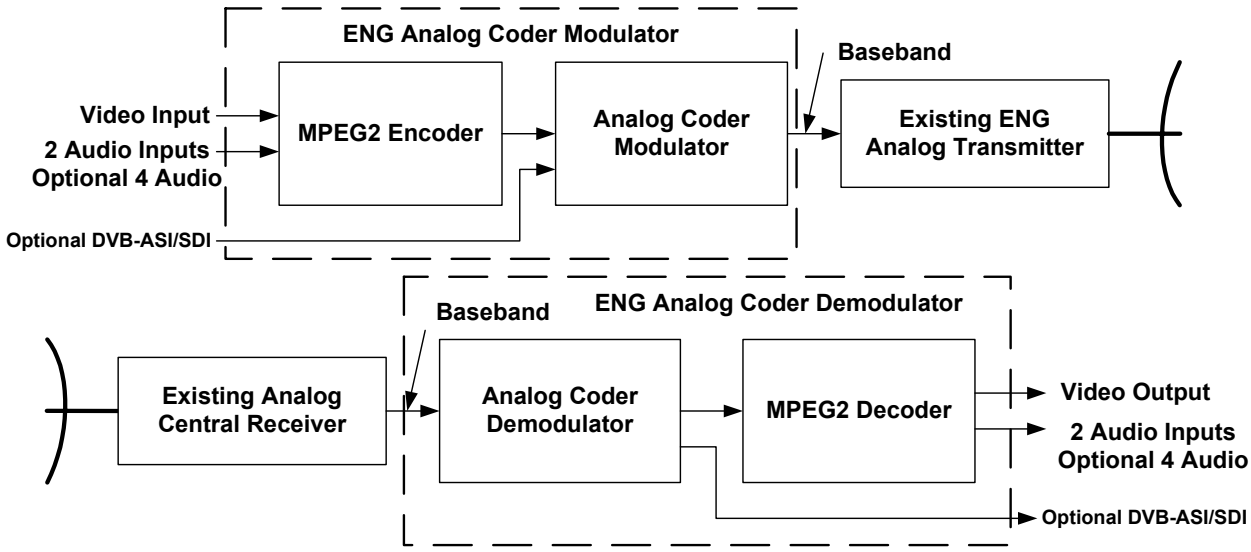

Figure 1

Block Diagram of a Single Video Digital ENG System
Using Existing Analog Transmitter and Receiver

The RF spectrum is shown in Figure 3. The spectrum is well within new FCC 2 GHz 12 MHz bandwidth.

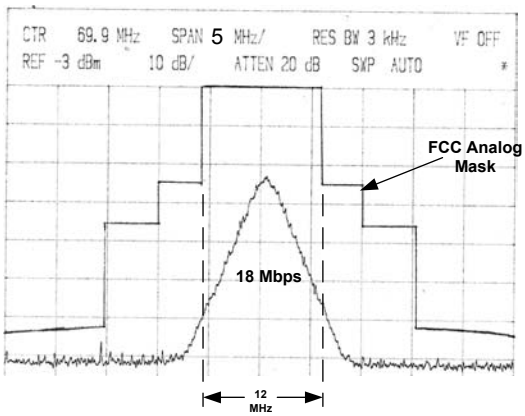

Figure 2
Spectrum of the ENG Analog Coder
With Three Videos
in a 12 MHz Bandwidth

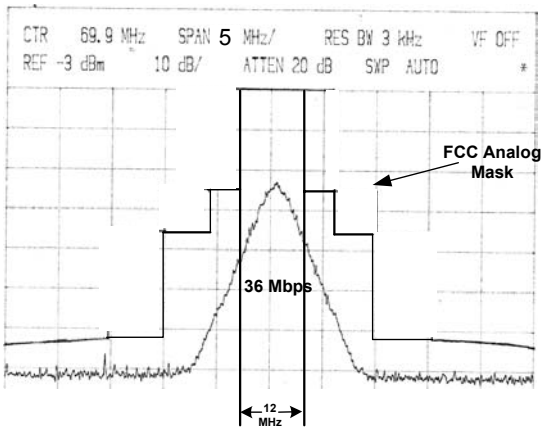

Figure 3
Spectrum of the ENG Analog Coder
With 4 Videos
in 25 MHz Bandwidth

Three Input Video System:
Figure 4 shows a block diagram of the three-input ENG Analog Coder system. For the three Video channel systems operation, each encoder would operate at 6 Mbps data rate for a total data rate of 18 MHz and use 8 level T modulation. The system will occupy 12 MHz of bandwidth.

At the Central Receiver site, the ENG Analog Coder Demodulator connects to the receivers Baseband output. No other modification is required. Composite video plus two audio channels are outputted. Optionally DVB-ASI output is available as well as the optional three channels. To change the system back to conventional analog operation, simply turn back on the audio sub-carriers. The analog video and audio from the Central Receiver is outputted from the conventional analog outputs.

By using advanced digital ATSC error correction techniques, the ENG Analog Coder is able to easily transmit as much as 18 Mbps of error free data within the new FCC 2 GHz 12 MHz of bandwidth channel plan. The receiver demodulator utilizes 5th generation very powerful and robust ATSC adaptive equalization techniques. As new more robust generation chip sets are developed, the Analog Coder Demodulator can be up-graded.

The Analog Coder technology has been successfully used for several years to transmit ATSC digital HDTV signals with data rates up to 27 Mbps through single and multi-hop analog microwave systems. In one application, the ATSC digital 19.39 Mbps signal plus a T1 channel was passed through a 24 repeater system with no degradation in performance. See the *Report on field tests using the Nucomm Analog Coder Modulator/Demodulator ATSC Transport System with Nurad 70-Series Analog Microwave equipment* and *The "Analog Coder" HDTV Digital Transmission Over*

an Analog Microwave Link. Both papers are available on Nucomm's web site at www.nucomm.com.

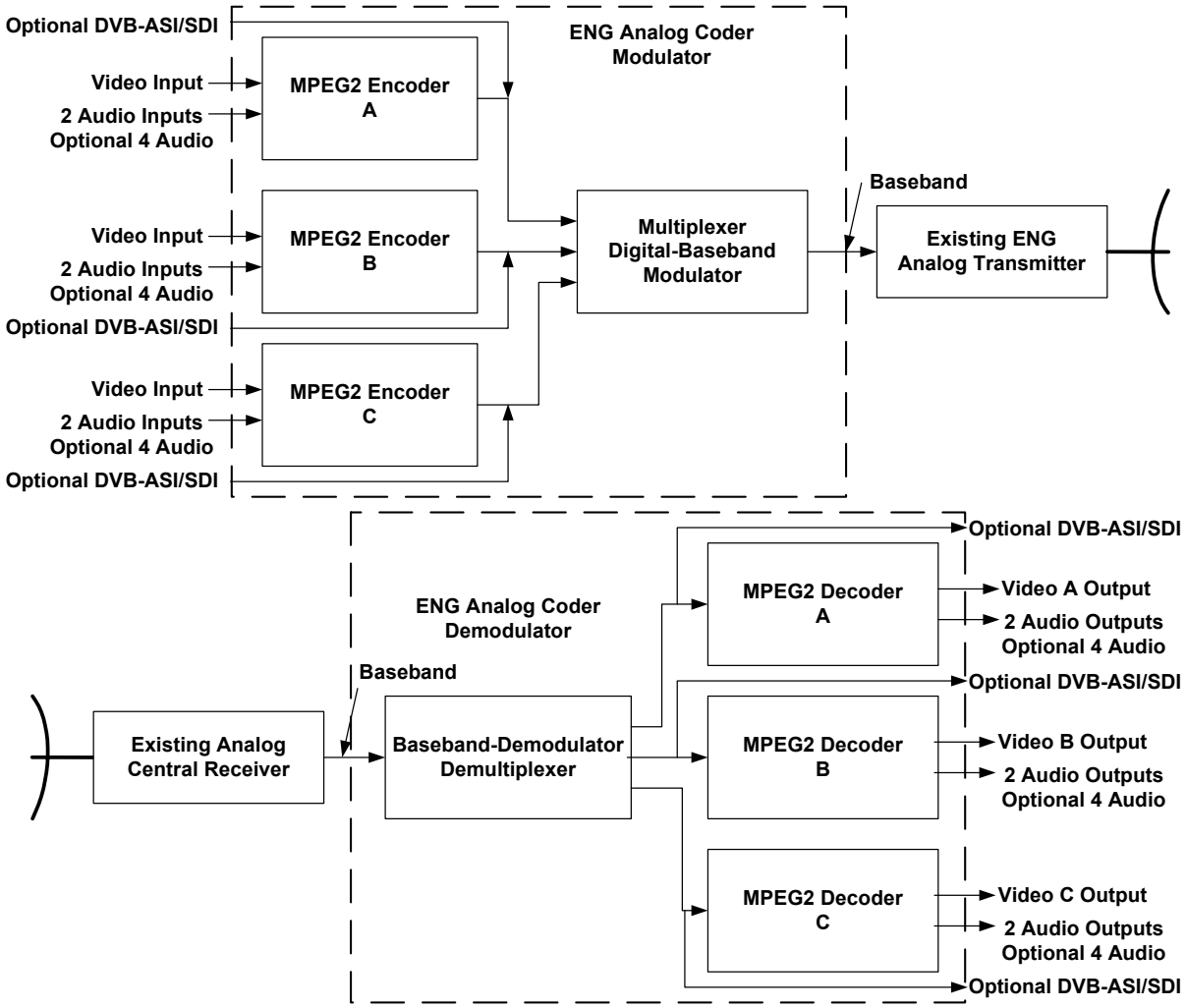

Figure 4
Block Diagram of a Triple Video Digital ENG System
Using Existing Analog Transmitter and Receiver