

EIA-608 and EIA-708 Closed Captioning

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In NTSC and SMPTE 259M digital system, captions are encoded onto line 21 of the Vertical Blanking Interval (VBI). The captioning standard is defined by EIA-608B. For HD-SDI EIA-708B, space is provided in the SMPTE 292M serial digital bit stream to encode captions, typically on line 9. Three HD caption transport protocols are currently used: SMPTE 334M, SMPTE 333M, and Grand Alliance protocol.

Closed Captioning is the process of electronically encoding television speech in such a way that, although it is invisible to the regular viewer, a decoder in the television set (or a special set top box) can decode the spoken word and display it as text in the picture area. The encoding process relies on an operator translating the speech into written text. In the NTSC and SD-SDI television system in North America, the captioning data is transmitted in the vertical interval, outside the normal viewing area of the picture. A new method of encoding has been created for HDTV, and will be described later in the paper.

For NTSC, SD-SDI, and HD-SDI closed captioning, the spoken word may be translated into captions either in real time, or off-line for transmission later. Real time live translation relies on a skilled stenographer, to type captions along with the speaker and send the data via modem to the Closed Caption Encoder. Until quite recently, off-line captioning had been carried out using video tape machines, but the advent of compression and non linear editing techniques now enables the work to be accomplished much faster using suitable hardware and software, such as ProCAP.

The Federal Communications Commission

The Television Decoder Circuitry Act of 1990, requires that all television sets sold in the USA with screens 13" or larger, shall contain decoding circuitry enabling the display of closed captioned material. With the introduction of digital television, the Federal Communications Commission is proposing new rules to ensure that closed captioning services be maintained on the new digital receivers.

In 1997, the Federal Communications Commission adopted rules that require an increasing amount of captioned programming over an eight-year transition period, with 100% of all new non-exempt programming required to be captioned by January 1, 2006.

NTSC Closed Captioning

In the NTSC television format, line 21 in the vertical blanking interval (VBI) has been allocated to carry closed captioning information. In the television station, an NTSC closed captioning encoder is used to place the data on line 21. At home, either a recent model television, or a special set top decoder, may be used to decode the closed captions and key the text onto the screen. Both fields of the NTSC signal may be used for this purpose (see Figure 1).

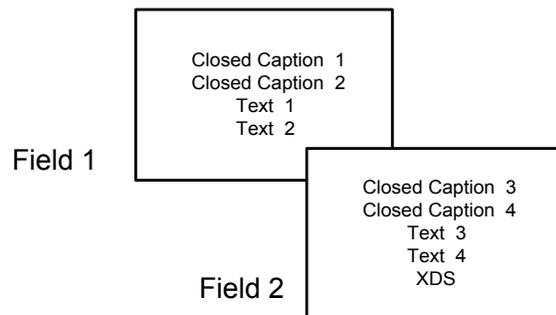


Figure 1 - Line 21 Closed Captions

Field 1 carries two Caption Channels CC1 and CC2 and two Text Channels T1 and T2. Field 2 carries additional Caption Channels CC3 and CC4, Text Channels T3 and T4 and Extended Data Services (XDS) data. (Captions and text may be placed on either field whereas XDS data is restricted to Field 2). Each field can contain only two characters at one time (16 bytes). In NTSC there are 60 fields per second, so the whole system can transmit a total of $2 \times 60 = 120$ characters per second. Text and XDS information only change occasionally, whereas captions change constantly.

Captions may be displayed in “Roll Up”, “Paint on” or “Pop Up” modes. Roll Up mode was designed to facilitate comprehension of message during live events. Captions are wiped on from the left and then roll up as the next line appears underneath. 1, 2, 3 or 4 lines typically remain on the screen at the same time. In Paint On mode, a single line of text is wiped onto the screen, remains there briefly and then disappears. Pop Up mode is less distracting than the first two methods, but the complete sentence must be pre-assembled off screen. It is then “popped” onto the screen as a completed message at the appropriate time. In all modes, captions may be positioned at different locations on the screen.

Text may occupy half a screen or the whole screen. XDS data can include Time of Day, Program Name, Program Rating based on the TV Parental Guidelines and the Transmission Signal Identifier (TSID).

SD-SDI Closed Captioning

Television facilities operating in the Serial Digital Interface (SD-SDI) 601 standard, also use line 21 to carry the closed caption information. SD-SDI 601 closed caption encoders perform a similar function to NTSC closed caption encoders, except that the video signal being passed is component digital. It is important to preserve this format, as the majority of viewers still have NTSC receivers. When converting the SD-SDI signal to NTSC, most encoders add 7.5 IRE setup to all lines including line 21. The EIA 608 waveform specification, however, stipulates that there should be no setup on line 21. In order to comply with this anomaly, it is necessary for the SD-SDI closed caption encoder to shift the closed caption data down by 7.5 IRE on line 21, so that it emerges from the NTSC encoder without setup. This practice necessitates using digital video values, which are outside the legal limits specified in SMPTE 125M.

It can be noted at this point, that the digitizing process produces 7 bits plus 1 parity bit for each text character. As we have seen, we can transmit 120 characters per second, so this translates into a bit rate of $8 \times 120 = 960$ bits per second.

HD-SDI Closed Captioning

HD-SDI Closed Captioning is the migration of earlier analog techniques employed for NTSC, to the new digital domain as defined by the Advanced Television Systems Committee (ATSC). The Closed Captioning standard is defined by the Electronic Industries Alliance in EIA-708B. The transport of the Caption Channel is defined in the ATSC A/53 and A/54 documentation. The digital system, allocates a data rate of 9600bps for closed captioning use. This is 10 times as much capacity as in the NTSC system and opens up the capability to offer embellished text characteristics, multi-colors, more language channels and many other features. Caption appearance, and other characteristics, will be controllable by the viewer at home.

The HD-SDI closed caption and related data is carried in three separate portions of the HD-SDI bitstream. They are the Picture User Data, the Program Mapping Table (PMT) and the Event Information Table (EIT). The caption text and window commands are carried in the HD-SDI Transport Channel (which in turn is carried in the Picture User Bits). The HD-SDI Caption Channel Service Directory is carried in the PMT and optionally for cable in the EIT. To ensure compatibility between Analog/SD-SDI closed captioning (EIA-608) and HD-SDI closed captioning (EIA-708), the HD-SDI Transport Channel is designed to carry both formats. The diagram below represents the DTV bit-stream output from the ATSC encoder as received by the home viewer.

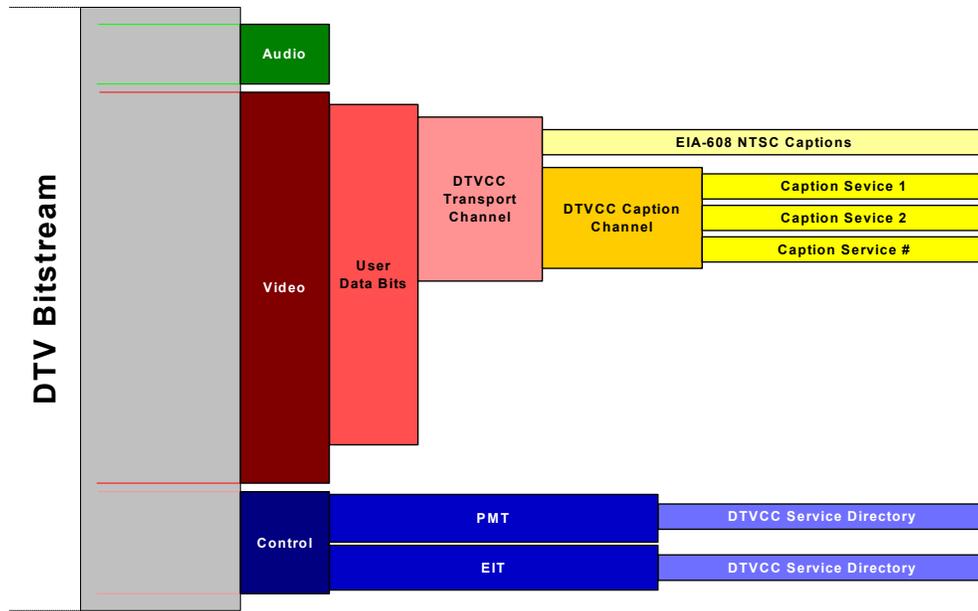
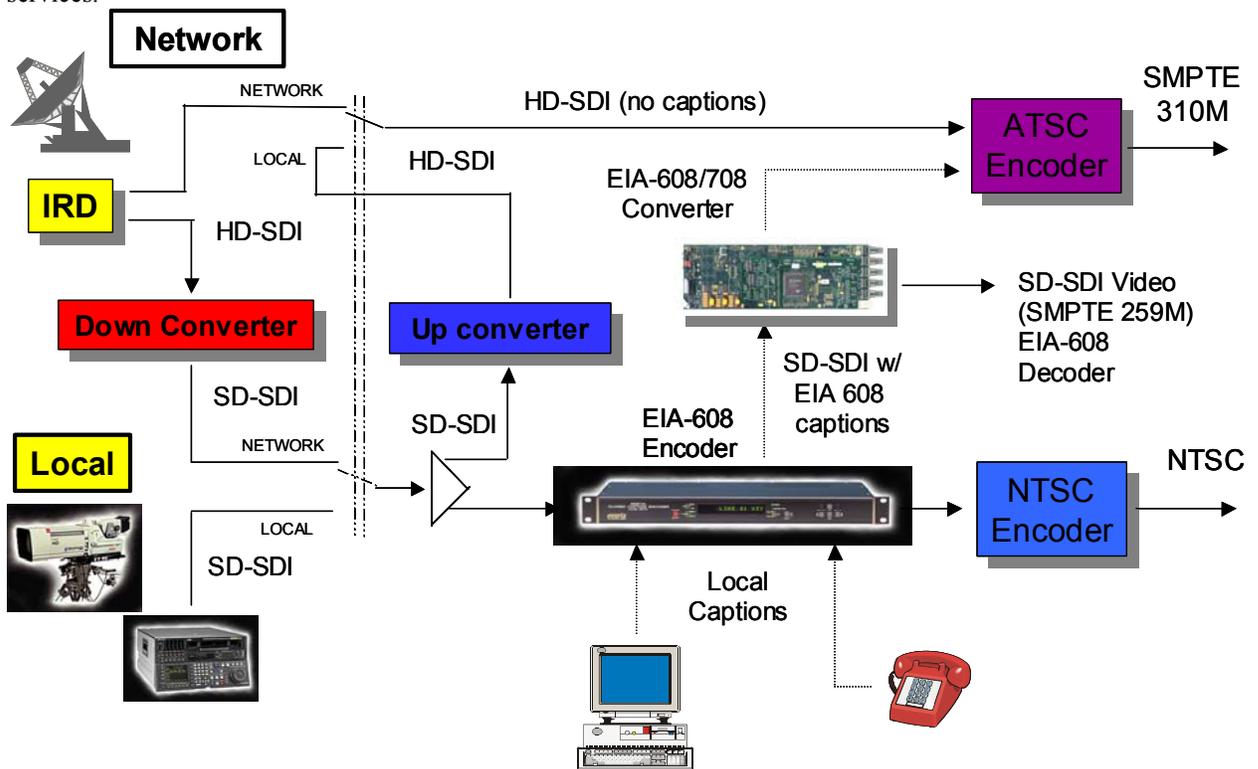


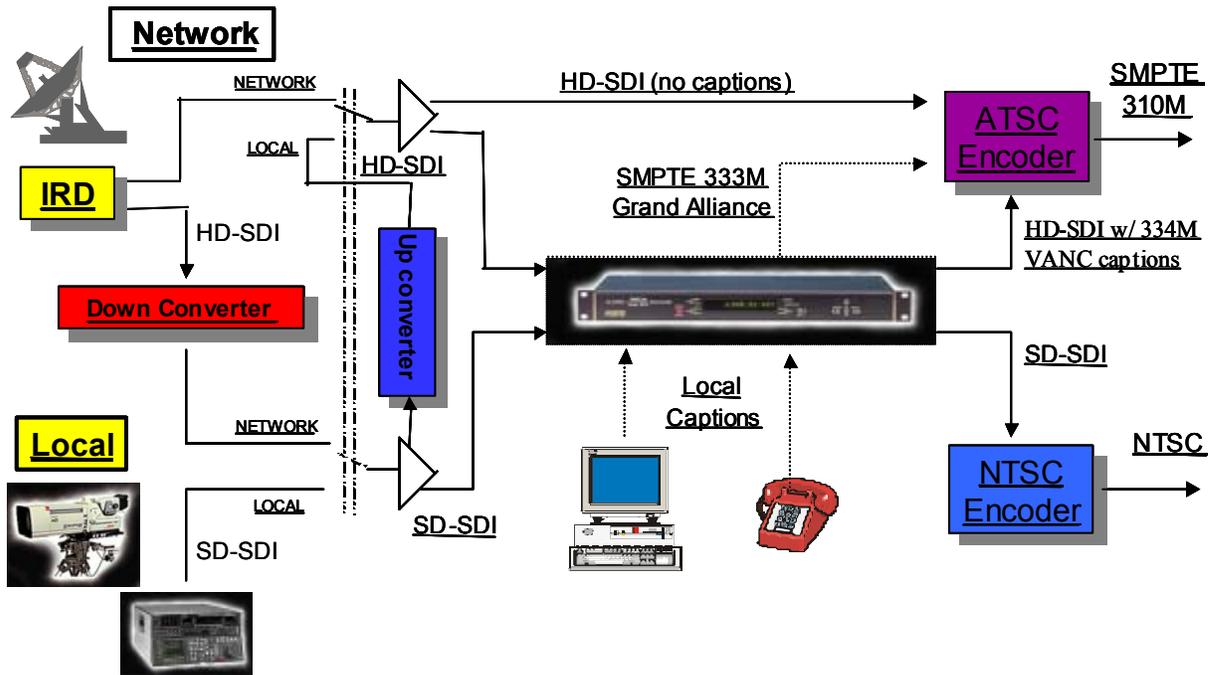
Figure 2 DTV Bit-Stream Representation

HDTV Studio Encoding Considerations

Some of the tools and techniques needed in the television studio to implement closed captioning, are described in the following paragraph. It is assumed that the TV station will offer both HD-SDI and SD-SDI services.



The first scenario shows a conventional closed caption encoder (such as models 8084 or 8084AD) used to encode captions onto line 21 of the SD-SDI signal, together with an EIA-608 to EIA-708 converter (model 7760CCM-T). The SD-SDI signal, complete with line 21 captioning, is either up-converted to HD-SDI or is transmitted as analog NTSC to service existing NTSC television sets. For HD-SDI transmission, the data is extracted and converted to the EIA-708 standard in the 7760CCM-T. This data is then passed to an ATSC Encoder for broadcasting. The 7760CCM-T also decodes captions and XDS information for verification using an on screen display.



In the second scenario, the broadcaster buys an 8085 or HD9084. These devices perform the dual function of standard definition (EIA-608) and high definition (EIA-708) closed captions. These units take the place of the existing closed caption decoder and the 7760CCM-T shown in figure 1.

The HD9084 is a multifunctional box, able to encode and decode both EIA-608 and EIA-708 captions. It supports all ATSC protocols, which include SMPTE 334M (VANC Captions), SMTE 333M, and Grand Alliance. Local EIA-608 and EIA-708 captions are inserted into the HD9084 via RS232 serial port or via modem.

The newest addition to the Evertz Closed caption family is the 7760CCM-HD Closed caption translator/monitor card. The 1 slot card has the capability of auto detecting the upstream signal (SD-SDI or HD-SDI) and outputting the Closed caption information via RS232 in SMPTE 333M or Grand Alliance formats. The card also features a EIA-608 and EIA-708 decoder, VistaLINK monitoring, and a wide range or error detection.