

MOTOROLA

High-Definition Television Over Cable

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Motorola, Inc.
Broadband Communications Sector
6450 Sequence Drive
San Diego, CA 92121

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Overview

This paper discusses the HD television market and describes methods for cable operators to efficiently begin to deliver HD content to subscribers.

HD over Cable

With more HD programming becoming available every day, viewers will expect to be able to obtain this content via their cable systems. In addition, as consumers continue to purchase HD-ready home theater systems at a rapid rate, the demand for available content will also climb. Currently, many consumers are relegated to watching DVDs on their new HD systems, but as the DBS providers start to promote their HD offerings, content-starved consumers may consider installing a DBS system to gain access to a source of HD content.

Overview of the DTV conversion

The conversion and controversy surrounding the migration from an analog television system to a digital television (DTV) system in the U.S. began in earnest in 1997 when the FCC announced a timetable for the conversion to digital. The FCC granted each licensed TV station a second frequency to use for digital broadcasting, which must be relinquished in 2006, when the frequencies are re-shuffled and the analog carriers disappear. If at least 85% of the TV viewing population cannot receive a digital signal, the deadline will be pushed back.

Progress

Currently, about 160 TV stations (reaching about 60% of TV households) are broadcasting digital signals – a mix of HD and SD content. Cable programmers, such as HBO and Showtime, offer multiple channels of HD content, and the broadcast networks

offer about 21 hours a week of HD content in addition to special sporting events like the Super Bowl, NCAA Tournament, Masters Golf Tournament, etc.

On the consumer side, the one-millionth DTV set was sold on May 1, 2001. Of those, about 860,000 are “HD-ready” with only about 150,000 actually having DTV set tops that can process (decode) the digital broadcast signals. That means that there are now over 700,000 HD ready sets that are not receiving any HD content. Home theater systems mark the fastest growing segment of the U.S. television market – and 50 percent of those are digital. The two large U.S. DTH providers offer HD programming, and they have clear intentions of adding to the HD lineup – making it easy for these high-end buyers to obtain HD content in their living rooms.

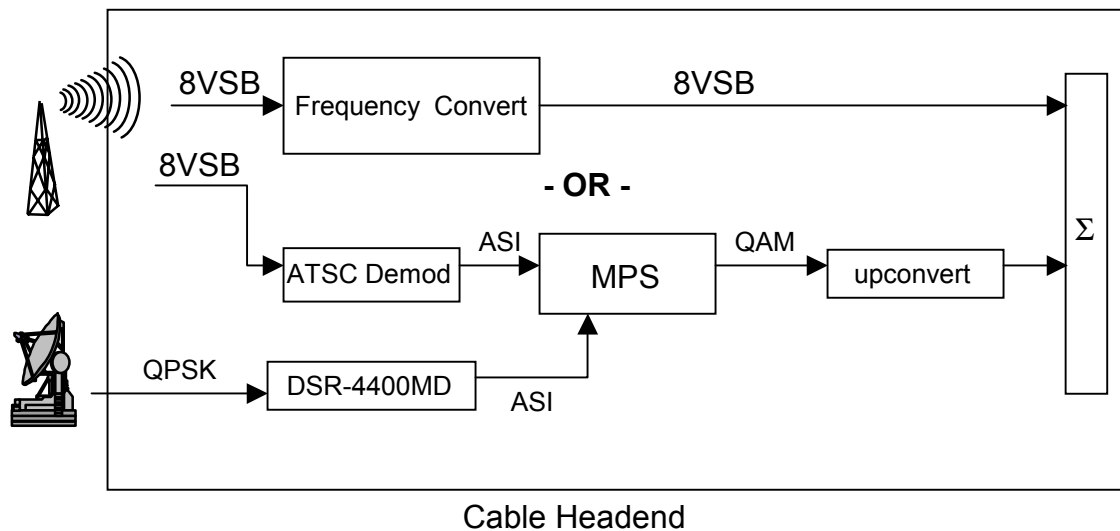
Until now, the argument has always been that there is not enough HD programming to really ignite the rapid deployment that everyone may have anticipated a few years ago. The Consumer Electronics Association often cites “cable carriage” as a key to speeding up the transition, since 70% of the viewing public receive their signals over cable and are reluctant to erect an antenna in order to receive the off-air DTV signals in their area. For those cable systems with a few channels of spare capacity, there’s an opportunity to fill the void and offer a new, upscale service to eager viewers.

Technology

Although there are many formats possible for what has been referred to by the FCC as “DTV” (digital television - encompassing HD and SD programming), true HD signals are typically either 1920 x 1080I (interlaced) or 1280 x 720P (progressive) resolution. Since SD signals at full resolution are 720 x 480I, HD signals require greater bandwidth to deliver high-quality images –typically 11Mbps to 18Mbps, depending on program content.

The ATSC standard mandated for FCC licensed television stations limits overall MPEG-2 transport stream bandwidth to 19.39Mbps. That limit marks the maximum a TV station can transmit in its allocated digital broadcast spectrum. Within that 19.39Mbps, stations are allowed to carry any combination of HD, SD, and data services. The MPEG-2 technology specified for ATSC broadcasting and the MPEG-2 standardized by SCTE for digital cable are compatible at the transport level and, thus, can technically be carried on each other’s digital distribution systems.

For consumer premises equipment, many consumer electronics companies offer ATSC-compatible HDTV receiver/decoder set-top terminals. These are ATSC-compliant, so they receive 8VSB-modulated signals, which are not compatible with cable’s 64 or 256 QAM modulation. In addition, they process ATSC’s PSIP (for channel navigation) rather than the SI specified by SCTE for digital cable set-tops. Those two key technology factors mean that today’s digital cable set-tops cannot receive ATSC signals, and vice-versa. This means that there are really two technically feasible methods for cable operators to carry broadcaster-generated DTV signals: (i) carry the full 8VSB signal occupying 6 MHz on the cable plant, or; (ii) receive the 8VSB signal at the cable headend and combine with other digital signals at the MPEG-2 level to form new MPEG-2 multiplexes.



Since option (i) is fairly straightforward (similar to carrying a broadcast analog channel), this paper will focus on the variety of configurations and content carriage options afforded by option (ii) and the necessary headend and customer premises equipment to implement each configuration.

Sources of High-Definition Content

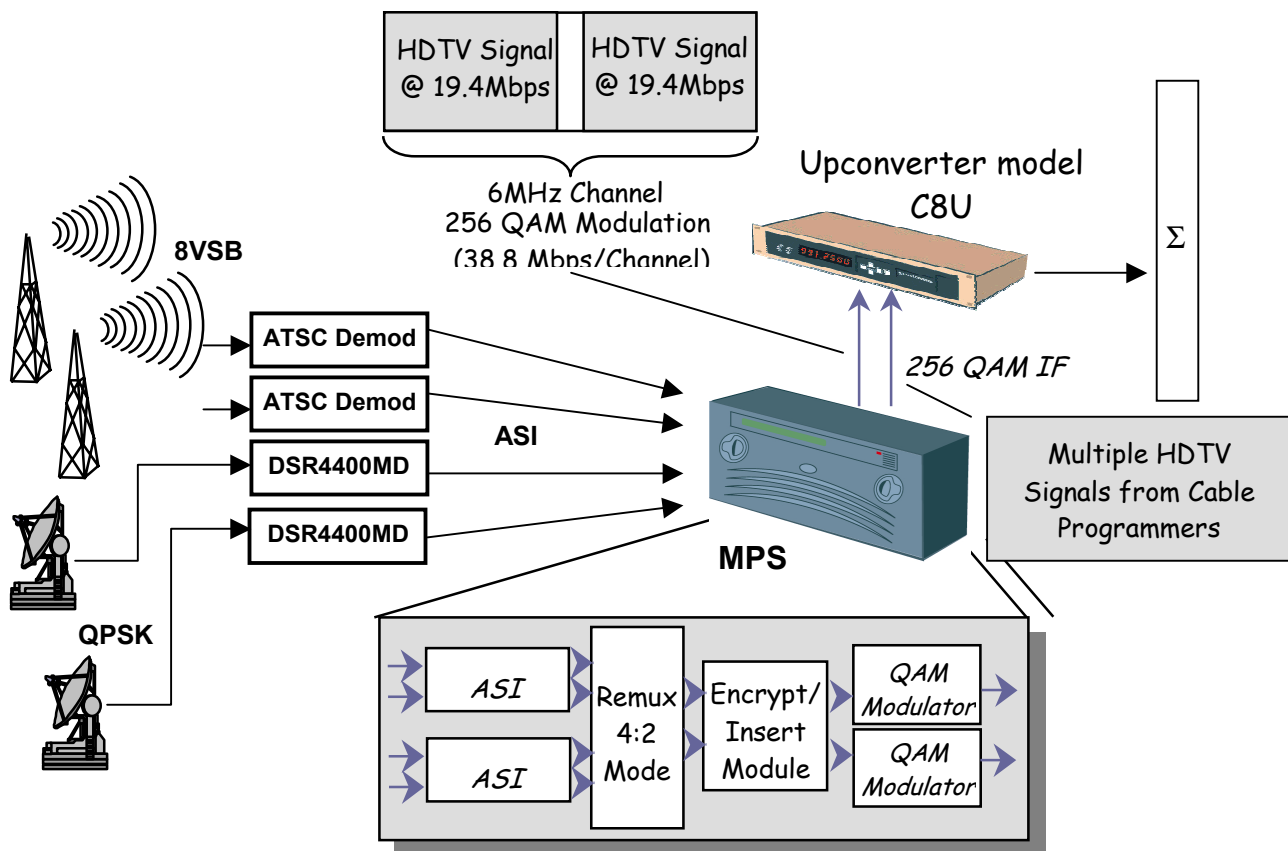
HD content may be delivered to the cable operator from local broadcast stations or from existing cable programmers. In some special cases, HD video content may be made available as pre-encoded content on video servers. In any case, the primary technique for handling the content is to obtain a valid MPEG-2 transport multiplex containing the HD programming and mix it with other content present in the headend to form efficient, SCTE-compliant digital multiplexes.

The Cable Headend

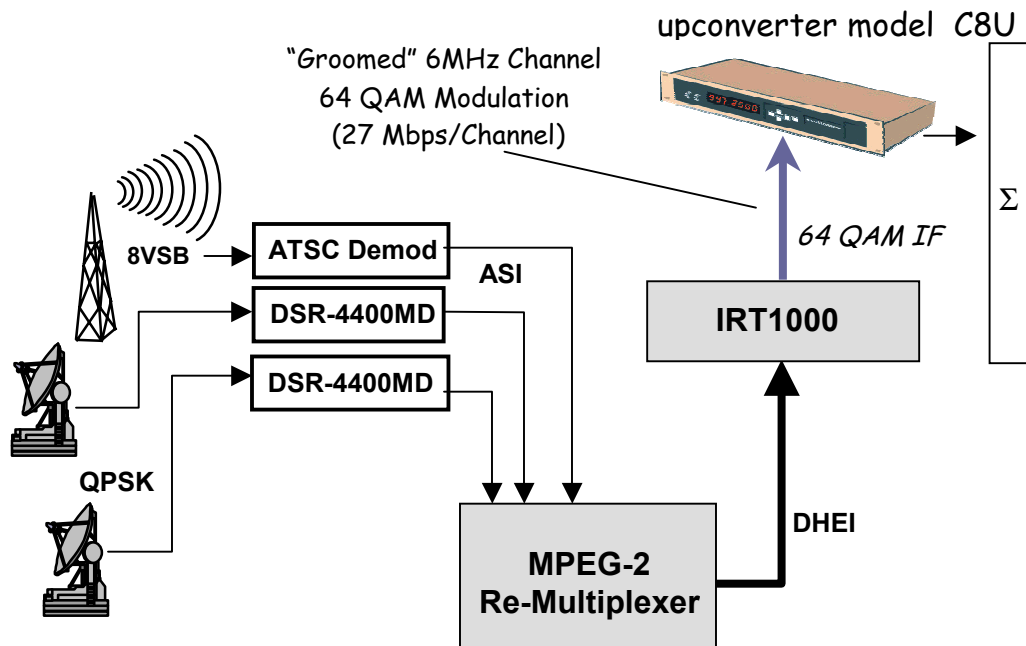
At the cable headend, a variety of signals (HD and SD) are processed to yield MPEG-2 transport streams, entered into channel maps to allow simple consumer navigation, and combined to form efficient 6 MHz channels. The addition of HDTV services to an

existing digital cable infrastructure is very simple, given that HDTV is based on the MPEG-2 standard that is already the basis for digital cable distribution. There are three basic steps:

1. Bring all sources of HDTV content to the MPEG-2 transport level. This involves demodulating incoming DTV 8VSB broadcast signals and converting to a cable headend-equipment friendly format such as DHEI or ASI. Currently, there are at least four suppliers of 8VSB receivers that simply demodulate the 8VSB signal and output the MPEG-2 transport stream via the ASI format.



- For HDTV content supplied by cable programmers, standard receiving equipment such as Motorola's IRT1000/2000, DSR-4400MD, DSR-4400X, or DSR-4500X can all demodulate and decrypt the satellite signal and then pass via ASI or DHEI to digital headend systems.
2. Select the desired programs and combine into efficient multiplexes. Since both HDTV and SD are MPEG-2, any combinations of HD and SD programming can be assigned (taking into consideration the bandwidth constraints) to the same 6MHz digital multiplex. The criteria for these assignments will focus on overall plant capacity and minimization of headend (multiplexing equipment) capital expenses.



Groomed Multiplex

3. Configure the appropriate channel maps via the DAC6000 or via the National Authorization System (NAS).

Customer Premises

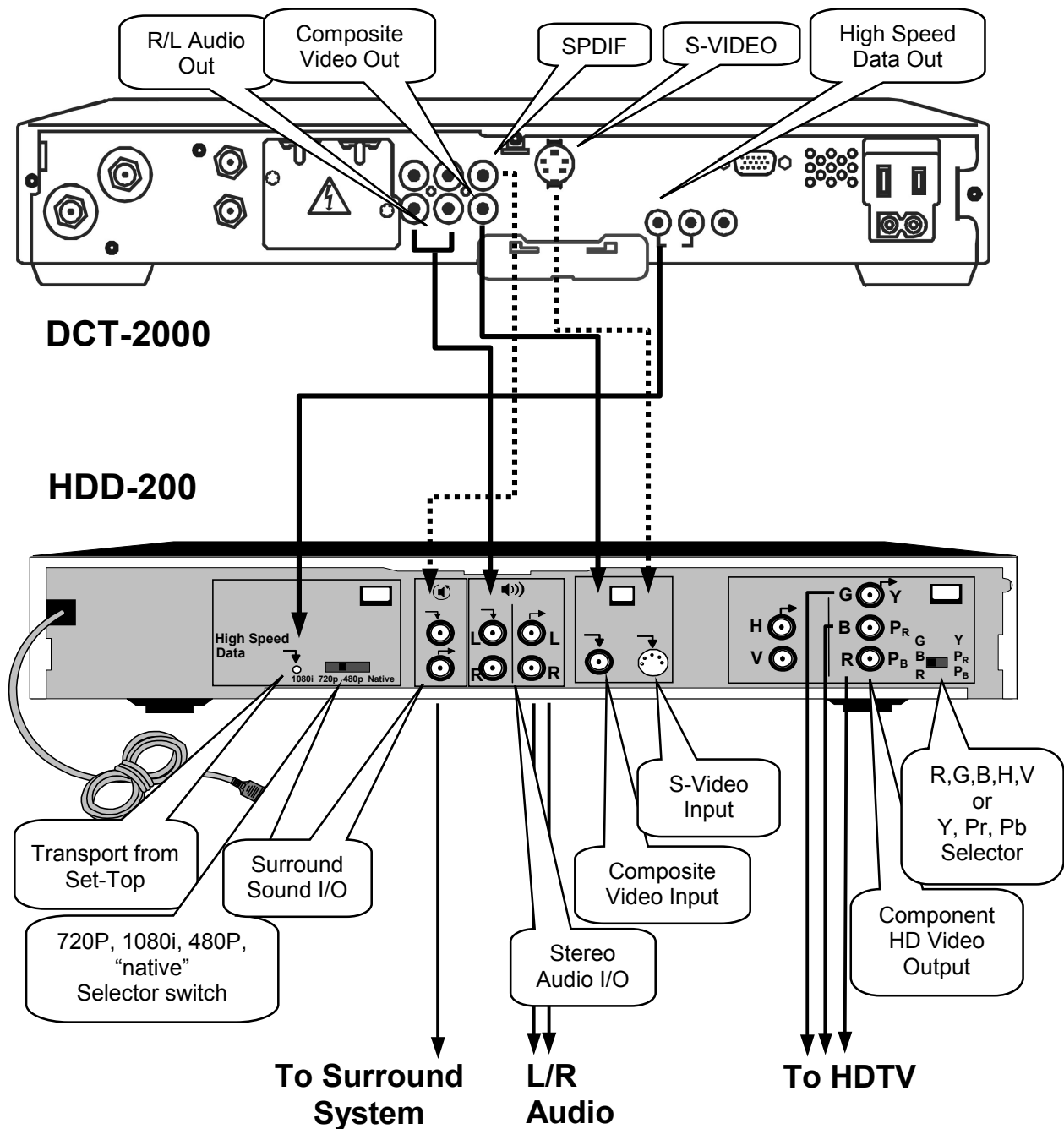
The Motorola model HDD-200 HDD is all that is required to convert any SD DCT2000 digital cable set-top terminal into a full-function HD receiver.

The Motorola HDD-200 is a state-of-the-art consumer decoder that employs the latest in MPEG-2/HD technology. The model HDD-200 uses a specialized digital output on a DigiCipher® consumer set-top to recover a HD signal.

The standard DCT2000 unit handles decryption of authorized digital services, as well as the decoding of SD television signals. The Motorola HDD-200 accepts and decodes the MPEG-2 HD signals from the DCT2000 and “up-converts” the SD baseband signals from the DCT2000 to fit within the viewing area of a HD television set.

The model HDD-200 preserves all the features and functionality of the DCT2000, including, but not limited to, parental controls, impulse pay-per-view, etc., while providing a high resolution video output. The model HDD-200 supports both 4:3 and 16:9 aspect ratio HDTV and “HD ready TVs.”

Connections between the digital cable set-top and the model HDD-200 are simple and quick to install - as shown in figure on the next page.



The model HDD-200 is equipped with S-Video and Surround Sound inputs to interface with similarly configured set tops. To connect with a variety of HDTV models, the Motorola HDD-200 has both Y, Pr, Pb and R,G,B,Hs,Vs outputs as wells as a selector to specify the video format (1080i, 720P, etc) of specific model HD television sets (some

sets may only accept specific input formats). The model HDD-200 also has a “native mode” selection, where any format received by the HDD-200 is passed to the HD television set.

Getting started

Since a number of popular cable programming services now offer HD content on a regular basis, the quickest, most cost-effective way to add HD to the channel lineup is to add IRTs and begin to deploy Motorola HDD-200s to interested subscribers. Adding the local broadcasters’ DTV services requires an ATSC/8VSB receiver that can deliver the MPEG-2 transport stream as an ASI output (there are several of these devices currently available). These ASI streams can be processed by a Modular Processing System (MPS) ordered as configuration D19 (four ASI inputs, a 4:2 remultiplexer, and 2 QAM outputs).

Summary

All of the technology to carry and process HD television signals – in the headend and in the home - is currently available and is simple to deploy. In addition, more content is becoming available on a regular basis – from cable programmers and broadcasters alike. Finally, consumer electronics manufacturers are proceeding with more affordable models of HDTV sets – and consumers are stepping up to purchase HD-ready home theater systems in the \$3,000 - \$6,000 range. For these high-end consumers, the addition of a Motorola HDD-200 is a modest expense - considering the ease and quality involved with receiving HD content as a cable service.

ACRONYMS

8VSB	8 – Vestigial Side Band
ASI	Asynchronous Serial Interface
ATSC	Advanced Television Systems Committee
C8U	Commander [™] 8 Unit Upconverter
DAC	Digital Access Control
DBS	Direct Broadcast Satellite
DCTXXXX	Digital Cable Terminal model XXXXX
DHEI	Digital Headend Expansion Interface
DSR	Digital Satellite Receiver
DTH	Direct-to-Home
DTV	Digital Television
DVD	Digital Video Disk
FCC	Federal Communications Commission
HD	High Definition
HDD	High Definition Decoder
IF	Intermediate Frequency
IRT	Integrated Receiver/Transcoder
MPS	Modular Processing System
NAS	National Authorization System
PSIP	Program and System Information Protocol
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
SCTE	Society of Cable & Telecommunications Engineers
SD	Standard Definition
SI	System Information