

**N**o segment of the electronics industry is immune to competition, but skirmishes in the consumer-electronics segment are arguably among the bloodiest. Scant per-unit profit margins are the norm, not the exception, and, therefore, manufacturers rely heavily on robust volume shipments as the path to fiscal triumph. The difference between a runaway success and a never-left-the-runway failure sometimes hinges on the slimmest of feature, price, and other differentiators, and potential customers' notorious fickleness is no guarantee that what works today will continue to appeal for the next product generation or even for the next week.

Take CECBs (coupon-eligible converter boxes), for example. The intent of the US-government-funded CECB program is to ensure that individuals without access to alternative television services, such as cable, satellite, or IPTV (Internet Protocol television), and lacking the funds necessary to purchase a full-featured ATSC (Advanced Television Systems Committee) set-top box or ATSC-supportive television can still access over-the-air, "free"—that is, advertising-supported—television. Access to such programming is arguably a citizen's right and contributes to the common



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THE PENDING NTSC SHUTOFF HAS US CONSUMERS CLAMORING FOR REBATE-ELIGIBLE HARDWARE THAT WILL STAVE OFF THE LOSS OF OVER-THE-AIR TELEVISION. HOW DO MANUFACTURERS DISTINGUISH THEMSELVES FROM OPPONENTS IN SUCH A HYPERCOMPETITIVE MARKET?

# THE ATSC COUPON- ELIGIBLE **CONVERTER** **BOX:** A CONSUMER-ELECTRONICS CASE STUDY



good by virtue of the broadcast of emergency alerts, government policy sessions, election debates, and the like.

CECBs whose retail price comes close to—or matches—the \$40-per-coupon, at two coupons per request, government-rebate amount translate to a free or nearly free end-customer expense. Perhaps not surprisingly, those CECBs will likely constitute the lion's share of all CECB sales. The \$40 price needs to comprehend not only BOM (bill-of-materials), development, and manufacturing costs, but also shipping and warehousing expenses, along with distributor and retailer markups. With these criteria, there's seemingly no opportunity for differentiation, but creative engineers and their marketing counterparts have nonetheless still managed to create a diverse product smorgasbord. How? Four products provide case-study examples.

### A PROGRAM BACKGROUNDER

The CECB program aims to provide continued broadcast-television recep-

### AT A GLANCE

Given a free or nearly free after-rebate target, design engineers and their marketing partners have multiple paths to potential success.

Even considering the NTIA's (National Telecommunications and Information Administration's) stringent list of dos and don'ts necessary for CECB (coupon-eligible-converter-box) certification, several companies have discovered differentiation possibilities through hardware, software, or both.

Single-chip integration doesn't necessarily translate to design superiority, especially in non-space-constrained applications and when you factor in costly heat sinks.

The designs in this article don't indicate strong endorsements for silicon tuners' claimed abilities to deliver tangible benefits over their "can" predecessors.

featured ATSC-cognizant gear. In developing the program, the US government strove to avoid excessively burdening the taxpayers who finance it (references 1 and 2). According to the NTIA (National Telecommunications and Information Administration) program-managing organization, CECBs cannot offer high-definition video-output capabilities; this constraint disallows HDMI (high-definition-multimedia-interface), DisplayPort, DVI (digital-visual-interface), RGB, and component-video outputs. It even disallows the 480p (480-line progressive-scan) video mode, as well as digital audio or greater-than-two-channel analog-audio outputs. CECBs also cannot support encryption-free

tion for those who, for geographic or financial reasons, cannot access alternative TV services or purchase full-

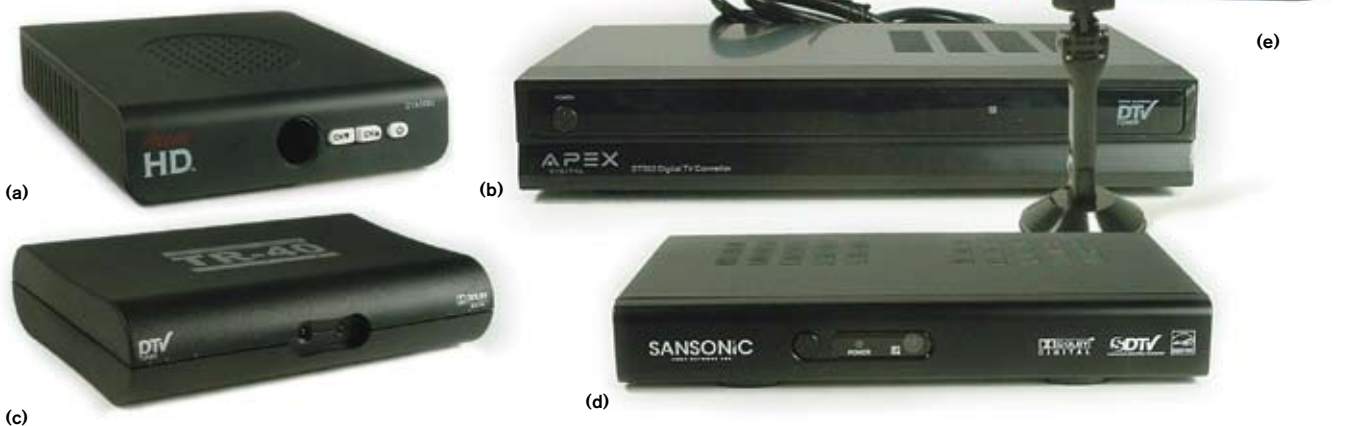


Figure 1 Multiple paths to a \$40-or-\$40.01-retail price point include Access HD's DTA-1080D (a), Apex Digital's DT502 (b), Dish Network's TR-40 CRA (c), and Sansonic's FT-300A (d). Sansonic's retail partner, Meritline, even included an Artec AN2 antenna (e).

### TABLE 1 CECB KEY SPECIFICATIONS

Product	After-rebate price	Chassis construction	Dimensions (width × height × depth) (in.)	Bundled accessories
Access HD DTA-1080D	1 cent	Plastic	5 × 1.25 × 5.25	User manual, coaxial cable, remote control and batteries, wall wart
Apex Digital DT502	1 cent	Metal	9 × 1.75 × 6	User manual, coaxial cable, remote control and batteries, analog audio/composite video cable, ac power cord
Dish Network TR-40 CRA	Free	Plastic	6 × 1.25 × 4.5	User manual, coaxial cable, remote control and batteries, wall wart
Sansonic FT-300A	Free	Metal	7 × 1 × 5	User manual, coaxial cable, remote control and batteries, wall wart, antenna



Figure 2 Notable internal disparities magnify noticeable exterior differences among Access HD's DTA-1080D (a), Apex Digital's DT502 (b), Dish Network's TR-40 CRA (c), and Sansonic's FT-300A (d). Note that the excess thermal paste in the area surrounding the DT502's Realtek RTD2885 was the inadvertent result of my removal and replacement of the SoC's passive heatsink; the excess paste was not present when the CECEB originally came to me.

“clear QAM” (quadrature-amplitude modulation) for cable-television support. Simply stated, CECEBs strictly convert ATSC to NTSC (National Television System Committee) for legacy-TV compatibility.

These stringent restrictions couple with equally stringent requirements, such as a host of broadcast-reception and de-

coded-video minimum-quality specifications that the NTIA tests before giving a product the CECEB blessing. Units must be capable of both center-cropping and letterboxing a 16-by-9-aspect-ratio program for compatibility with 4-by-3-aspect-ratio displays. They must offer composite video and two-channel analog-audio outputs, as well as a merged

audio-plus-video RF output (**Reference 3**). They must also include a dedicated remote control and offer compatibility with universal remotes. Bit-stream compatibility extends beyond basic MPEG-2 (Moving Picture Experts Group) video and Dolby Digital audio to additionally comprehend EAS (emergency-alert-system) messages, V-chip rating descriptors,

TABLE 2 CECEB PROMINENT ICs

Product	Tuner	Demodulator	Decoder	DRAM	Flash memory
Access HD DTA-1080D	Microtune MT2131 (silicon)	Zoran SupraHD 741		Zentel A3S56D40ETP	Spansion SPI
Apex Digital DT502	Samsung DTVS22D (can)	Realtek RTD2885		Nanya NT5DS16M1CSS	Spansion SPI
Dish Network TR-40 CRA	Thomson DTT76809 (can)	STMicroelectronics STV0373	STMicroelectronics STi7707WUDP	Hynix HY5DU121622DTP	Spansion parallel interface
Sansonic FT-300A	Microtune MT2131 (silicon)	Auvitek AU8515	Ali M3601C	Etron EM6AA160TS	SPI

and closed-captioning info, along with PSIP (Program and System Information Protocol) data. And CECBs must burn no more than 2W of power with audio and video outputs disabled, as well as support automatic power-down capabilities.

The differentiation-cultivating gap between what the converter must include and what it cannot include still ends up being broader than at first glance. Some companies choose to use higher-quality chassis-construction materials or make other cosmetic enhancements. Others bundle additional accessories beyond the minimum set that converter-box specifications dictate. Some vendors offer added hardware-delivered features, and others add capabilities through software.

And then there are those manufactur-

**TABLE 3 CECB SOFTWARE-ENABLED ADDITIONAL FEATURES**

Product	Electronic program guide	Digital closed-caption decoding	Multilingual menus	Reminders	VCR timer
Access HD DTA-1080D	10 hours	Yes	Yes	No	No
Apex Digital DT502	Full and list	Yes	Yes	Yes	No
Dish Network TR-40 CRA	Full (grid)	Yes	No	Yes	Yes
Sansonic FT-300A	Current (banner)	No	No	No	No

ers that choose none of these differentiating paths; instead, they build a bare-bones set-top box that stays within the NTIA boundaries in all regards. Because there's little to no marketing motivation to sell a CECB for less than \$40, these companies end up with a wider-

than-average disparity between BOM cost and price. By passing along some or all of this incremental profit to distributors and retailers, they cultivate a retail-shelf-space preference for their products, thereby creating consumer demand by squeezing competing alternatives off re-



Figure 3 Back-panel perspectives of Access HD's DTA-1080D (a), Apex Digital's DT502 (b), Dish Network's TR-40 CRA (c), and Sansonic's FT-300A (d) reveal the hardware enhancements that Apex Digital's product provides.

## BUT HOW WELL DO THEY WORK?

This article intentionally omits hands-on analysis of the four CECBs' (coupon-eligible converter boxes') operational capabilities: reception robustness, audio and video quality, and user-interface comprehensiveness and responsiveness, for example. I still plan, however, to pass along such data online. Also, every reception situation is unique. Although the impressions I ascertained at my home office might provide useful infor-

mation, they would by no means provide a definitive examination of each set-top box. And, even at my location, reception characteristics are a moving target. The ABC affiliate in Reno, NV, for example, plans to move its digital broadcast from VHF Channel 9 to Channel 8 on the NTSC (National Television System Committee) shut-off date, a migration that I hope will improve my ability to tune it in.

Regularly visit my blog

and look for write-ups with "The ATSC coupon-eligible converter box" in the titles, thereby identifying them as Web-site-published addendums to this print piece. Among them, you'll also find high-resolution close-up images of the CECBs' interiors available for download, pinpointing specific ICs. Additionally, augment your EDN research at the AVS Forum ([www.avsforum.com](http://www.avsforum.com)). This tech-enthusiast nirvana is teeming with

information from folks passionate about video in all of its myriad forms, and the information will both get you quickly up to speed and provide you with a comprehensive set of impressions on each CECB you're considering. For example, as of mid-December, just one of the several active discussion threads on Dish Network's TR-40 CRA was more than 180 pages long, with each page containing several dozen posts.

⊕ See the “The ATSC coupon-eligible converter box” posts at [www.edn.com/briansbrain](http://www.edn.com/briansbrain) for supplemental information on this article’s topics.

⊕ Go to [www.edn.com/090205df](http://www.edn.com/090205df) to post a comment on this article.

⊕ For more technical articles, go to [www.edn.com/features](http://www.edn.com/features).

tail shelves. By happy accident, the four CECBs that this article analyzes exemplify all of these strategies.

### CHASSIS AND ACCESSORIES

The CECBs this article showcases came from the two coupons I requested for my home-office residence, along with two I obtained from a friend. I based my CECB selection on the devices’ cosmetic differences, in the hope, which panned out, that these dissimilarities would translate to fundamental design distinctions (Figure 1). From CompUSA, I first acquired Access HD’s DTA-1080D and Apex Digital’s DT502, each for 1 cent after rebate. The two boxes exemplify radically different product strategies; the DTA-1080D includes scant extras: a remote control and two batteries, a wall-wart external ac/dc converter, a slender sheath of paper documentation, and a short coaxial cable. The embedded-power-supply DT502 also comes with a composite video-plus-two-channel-analog-audio cable bundle. And, whereas the DTA-1080D is small, plastic, and conjoined by plastic clips, the larger DT502 offers sturdier metal sheets held together with screws (Table 1).

The other two set-top boxes are equally diverse in both design and decor. The free-after-rebate TR-40 CRA—a CECB you can get from Dish Network (as I did), EchoStar, or Sling Media—is reminiscent of the DTA-1080D in assembly—that is, plastic, albeit this time held together with metal screws—external power supply, and scant accessory apportionment. Although the metal-fabricated Sansonic FT-300A, which I obtained free after rebate from Meritline, doesn’t include a DT502-reminiscent analog audio/video cable, the company instead thoughtfully includes a flat Artec AN2 antenna. Like the Access HD and Dish Network units, Sansonic’s CECB also employs an external ac/dc

converter, easing its use in vehicles, for example.

### BUILDING BLOCKS

Considering my pleasure with the assembly and accessorizing diversity I discovered upon opening the four products’ packaging, you can imagine how much more thrilled I was when I popped off the set-top boxes’ chassis panels and encountered four different IC assemblages (Figure 2 and Table 2). Beginning with the tuner, the initial piece of silicon that the incoming ATSC signal encounters, I found that the Apex Digital DT502 and Dish Network TR-40 CRA employ traditional “can” tuner modules from Samsung and Thomson, respectively.

A brief glance at the Access HD DTA-1080D and Sansonic FT-300A might suggest that they’re also can candidates, but they aren’t. Both boxes use Microtune’s MT2131 silicon tuner, albeit in a can-compatible-subsystem form factor that suggests that manufacturing-time comparative price and availability assessments rather than an inherent silicon-tuner technical advantage drove the IC selection on the systems’ PCBs (printed-circuit boards).

The next two steps in the ATSC-processing chain are demodulation of the bit stream from its UHF or VHF carrier and decoding the audio, video, and other digital data. Two of the four CECBs, the Access HD DTA-1080D and the Apex Digital DT502, employ a single SoC for both tasks; respectively, Zoran’s SupraHD 741 and Realtek’s RTD2885. Not coincidentally, I suspect, these units were the only two set-top boxes I analyzed that incorporate cost-incurring passive heat sinks.

On the other end of the integration spectrum, Dish Network’s TR-40 CRA leverages an STMicroelectronics STV0373-demodulator and STi-7707WUDP-decoder chip set. Sansonic’s FT-300A also uses separate ICs, but the demodulator companion to the Acer Laboratories M3601C decoder is not visible upon initial PCB inspection. Enthusiast-generated Internet documentation claims that the FT-300A employs Auvitek’s AU8515 demodulator; I suspect that it is alongside the Microtune MT2131 within the can enclosure that Sansonic’s manufacturing partner, Falcon Digital, designed (Reference 4).

The set-top boxes’ memory archi-

tures also beg for some degree of discussion. They all use a single DDR-400 SDRAM with a 16-bit system interface, albeit in a diversity of densities and from a diversity of sources: Etron Technology's 256-Mbit SDRAM (in the FT-300A), Hynix Semiconductor's 512-Mbit SDRAM (in the TR-40 CRA), Nanya Technology's 256-Mbit SDRAM (in the DT502), and Zentel Electronics' 256-Mbit SDRAM (in the DTA-1080D). Three of the four CECBs employ eight-lead SOIC-packaged SPI (serial-peripheral-interface) flash memory for system code, in two cases from Spansion. The fourth CECB, Dish Network's TR-40 CRA, instead uses a BGA-packaged parallel-interface burst-mode flash memory, also from Spansion.

Although all four STBs implement in-system-upgradable firmware potential, none of them offer a means of enabling consumers to do the upgrades themselves. Internet forums are therefore rife with posts from CECB owners attempting to discern units with latest and greatest firmware versions through product-code and manufacturing-location data, as well as from folks complaining about the need to ship CECBs back to manufacturers—at customer expense and with lengthy servicing delays—for updates to fix bugs and add features (see sidebar “But how well do they work?”).

## ENHANCEMENTS

The NTIA-defined gap between what features the box must include and what it can't include might be slender, but it does exist. A glance at the CECBs' back panels reveals the hardware-based augmentation that Apex Digital chose to include: a higher-quality, albeit still 480-line-interlaced S-video output, along with Smart Antenna array compatibility (Figure 3). And all four STBs support analog pass-through mode, enabling their owners to continue to receive signals from low-power stations and regional translator transmitters, neither of which are required to cease their NTSC broadcasts this year.

Software support can enable additional CECB capabilities, assuming that the system contains a sufficiently robust host CPU and adequate memory resources (Table 3). They include a variable-duration electronic program guide, digital closed-caption-decoding support,

## FOR MORE INFORMATION

<b>Access HD</b> www.accesshd.tv	<b>Microtune</b> www.microtune.com
<b>Acer Laboratories</b> www.ali.com.tw	<b>Nanya Technology</b> www.nanya.com
<b>Apex Digital</b> www.apexdigital.com www.apexdtv.com	<b>NTIA (National Telecommunications and Information Administration)</b> www.ntia.doc.gov www.ntiadtv.gov
<b>Artec</b> www.artec.com.tw	<b>Realtek</b> www.realtek.com.tw
<b>Auvitek</b> www.auvitek.com	<b>Samsung</b> www.samsung.com
<b>CompUSA</b> www.compusa.com www.systemax.com	<b>Sansonic</b> www.sansonic.net
<b>Dish Network</b> www.dishnetwork.com	<b>Sling Media</b> www.slingmedia.com
<b>Dolby Laboratories</b> www.dolby.com	<b>Spansion</b> www.spansion.com
<b>EchoStar Technologies</b> www.echostar.com	<b>STMicroelectronics</b> www.st.com
<b>Etron Technology</b> www.etrn.com	<b>Thomson</b> www.thomson.net
<b>Falcon Digital</b> www.falcondgt.com	<b>Zentel Electronics</b> www.zentel.com.tw
<b>Hynix Semiconductor</b> www.hynix.com	<b>Zoran</b> www.zoran.com
<b>Meritline</b> www.meritline.com	

multilingual menus, viewer-reminder notifications of pending programs, and timer-based control of both system operating mode—standby or active—and the channel you are tuning in, so a VHS or DVD recorder, for example, can capture the CECB's output. **EDN**

## REFERENCES

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