Set-Top Box Manufacturing Test

▶ It's A Matter Of Time!

Testing set-top boxes for today's consumer television market demands both speed and efficiency. The signals are complex, but state-of-the-art test systems can make the tests both fast and accurate.

In increasing numbers, consumers are switching from analog to digital TV reception. They're looking for more channels, clearer and more reliable pictures, and, if they can get it, lower costs. To meet this growing demand, and to keep prices down, manufacturers of MPEG-2 compliant IRDs (Integrated Receiver/Decoders; or, simply, "set-top boxes") are ramping up their production lines while doing everything possible to keep manufacturing costs to a minimum. With the entry price-point of consumer-grade standard-definition-TV set-top boxes falling below $200, the need to keep a tight rein on manufacturing costs is a necessity. A critical component in keeping these costs down is the speed and efficiency with which these units can be tested on the production line.

This application note focuses on the manufacturing tests required to produce standard-definition-TV set-top boxes in high volume production lines. High-Definition-TV (HDTV) boxes require similar tests, but the idiosyncrasies of those tests are not discussed here.

Manufacturing test

Production volumes in today's IRD manufacturing facilities can reach into the thousands of units per day… per assembly line. With such high-volumes, the time allotted for testing is necessarily limited to a few seconds at each test station. Unlike design tests – which involve in-depth, methodical exercising of all signal paths – manufacturing tests call for very quick checks of a limited number of parameters. These tests typically consist of rapid go/no-go, pass-fail inspections at designated points on a rapidly moving line.

The initial task of the manufacturing test engineer, then, becomes one of designing tests that will verify as much as possible about the proper functioning of the box in the shortest possible time. This includes identifying and acquiring the most cost-effective and reliable test equipment available for exercising the inputs and outputs of each box.

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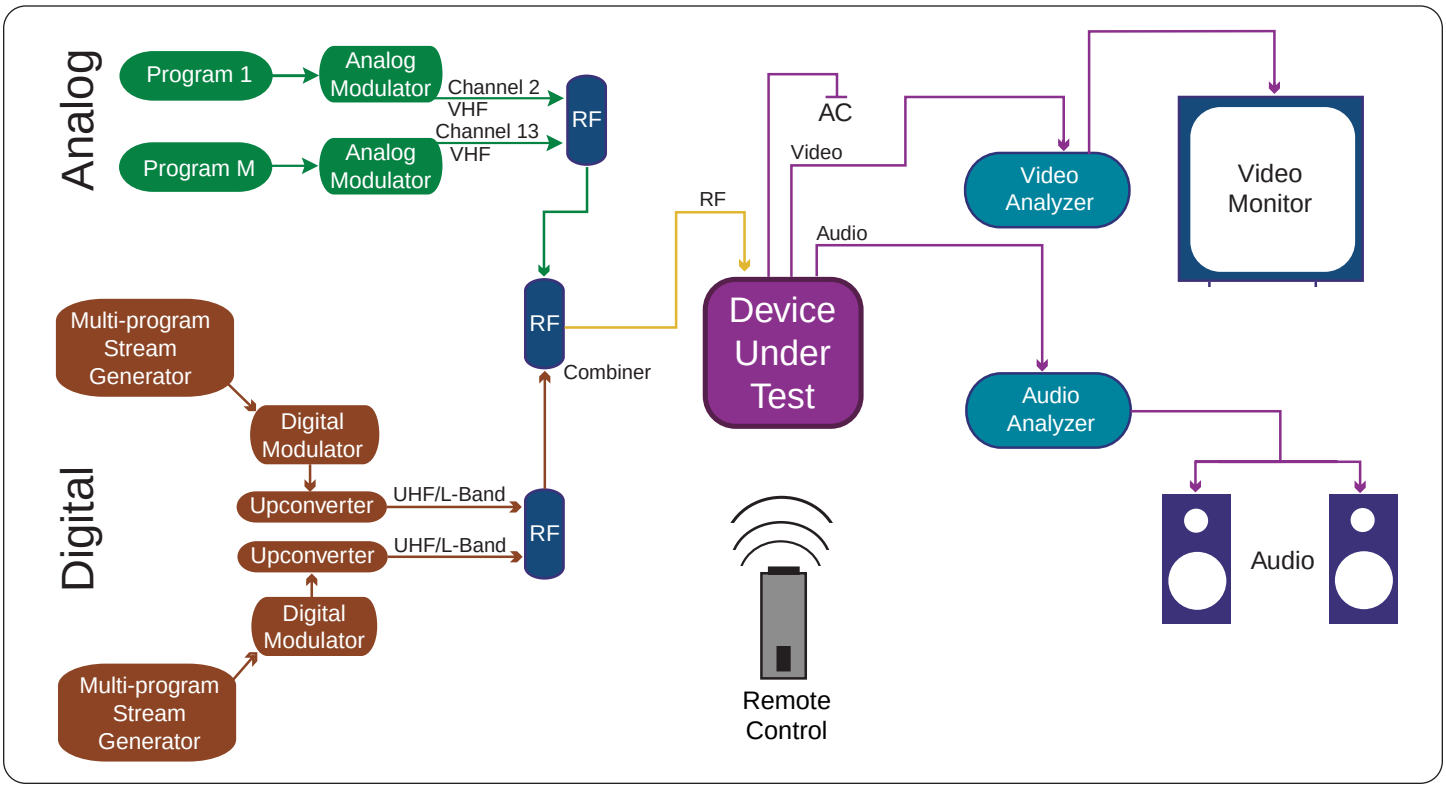


▶ ***Figure 1.*** *Block diagram of typical set-top box manufacturing test set up.*

Aside from the very simple inspections of the mechanical aspects of the box – turning the Power switch On and Off, changing channels, making sure the appropriate coaxial connectors are in place, and verifying an audio output – the most important parameters to test on the production line are the IRD's ability to:

- demodulate VHF/UHF analog video signals
- lock to and demodulate digital RF signals
- demultiplex a program from an MPEG-2 transport stream

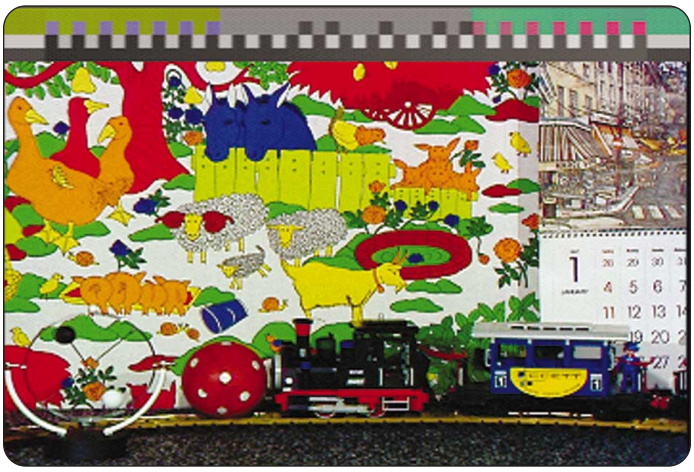
In addition, manufacturing tests will typically include procedures to verify the analog performance of the video and audio.

If simple audio and video test patterns are used, all of these tests can be performed quickly. Then, an operator can give final subjective approval on motion or moving sequences by simply watching a segment of a real TV program on a monitor.

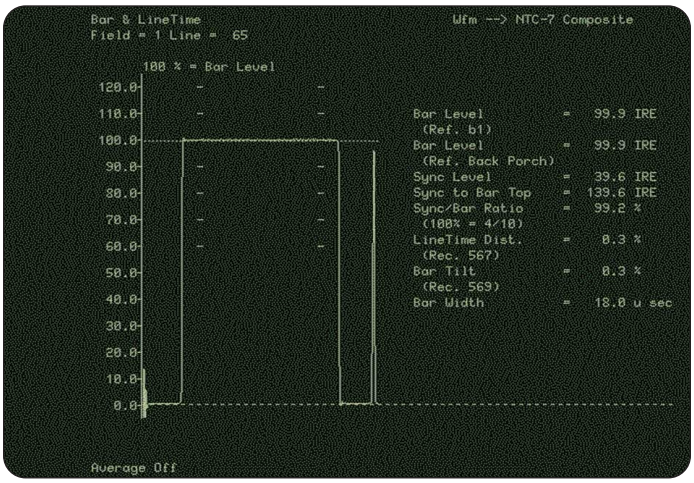
Test configuration

Figure 1 shows a complete production line test configuration for MPEG-2 compliant set-top boxes. Today's set-top boxes must receive not only digitally modulated TV signals – which may be transmitted by satellite, by cable, or by terrestrial broadcast – but also traditional composite analog VHF and UHF signals. Therefore, as we see in Figure 1, the test configuration includes both analog and digital program streams.

In the digital stream, each MPEG-2 signal generator produces a seamless looping PCR (program clock reference) along with multiple programs in a single transport stream. When testing set-top boxes designed for cable hookup, the test transport streams typically contain five to seven programs.



▶ ***Figure 2****. Moving Standard Video test sequence Mobile and Calendar.*



▶ ***Figure 3****. Bar and line-time measurement from VM700T using NTC-7 composite test signal line.*

The Sony/Tektronix MTG100 MPEG-2 Generator is a flexible and cost-effective signal generation solution for providing compressed digital transport streams in a manufacturing environment. It provides storage and playback of MPEG-2 streams compliant with ATSC, DVB and ARIB standards. With the MTG100, any transport stream can be looped with real-time update of all timestamps, continuity counters, and time tables. And it includes a PC software program that allows remote PC control of stream generation Start/Stop, output stream selection, and recall of user presets.

In the manufacturing test configuration of Figure 1, we see that the digital stream includes two layers of modulation. The first accepts the digital signal from the stream generator and modulates it according to DVB, ATSC, or ARIB standards. It may, for example, provide forward error correction (FEC) to transform the transport stream into a QPSK signal in order to test satellite reception, or into a QAM signal to test for cable applications.

The second modulation layer is an up-converter. It moves the signal up the RF scale to the appropriate frequency for simulating satellite, cable or terrestrial transmissions. For satellite transmissions, for example, a QPSK signal will be up-converted into the L-band – 950 MHz to 2.150 MHz.

The analog test stream requires a signal generator that will simulate traditional VHF and UHF signals – traditionally, channels 2 through 13. The Tektronix TG2000 is a multiformat modular test signal generator for testing set-top boxes in a manufacturing environment. The TG2000 allows creation of matrix test signals so that one full-frame picture can provide multiple test lines, such as color bars, multiburst, and FCC composite. This allows quick testing of parameters such as video levels and picture alignment.

The analog and digital RF streams are combined and fed into the set top box under test. An infrared remote control is used to verify the channel changing capabilities of the decoder.

The set-top box then outputs an analog composite TV signal that can be input to a video/audio analyzer where rapid measurements are made on the decoded streams. It should be noted that the patterns generated on the stimulus side should be chosen to match the measurement capabilities of the analyzer.

Also on the measurement side, a color picture monitor is not required but can be very useful in making visual verifications of moving picture sequences (Figure 2).

The Tektronix VM700T Video Measurement Set is a complete video monitoring and measuring instrument that allows both automatic and manual operations. Audio measurements are available as an option to the VM700T. The Auto mode makes measurements specified by various industry standards and regulations and compares them to user-defined limits – making it ideal for rapid testing in high-volume production lines. The operator can quickly view numeric values to confirm signal path quality, or select measurement graphic displays such as noise spectrum, group delay, K-factor, and bar and line-time for closer analysis (Figure 3). User programmable functions allow definition of operation sequences for automatic or conditional playback.

For quick verification of the composite baseband video signal, manufacturing engineers can employ the VM100 Series Automatic Video Measurement Set. Its automatic video measurements include those required by cable regulations.

Each of the Tektronix instruments mentioned in this application note provides interoperability features that allow easy integration into a multi-vendor stimulus and response measurement system.

Conclusion

Although the technology of MPEG differs dramatically from the technology that preceded it, the testing requirements for manufacturing are basically the same. The manufacturing test engineer wants to have simple, regular confidence checks that ensure all is well. Tektronix leads the market in developing products for new and emerging audio, video, and cable technologies. Pioneering work in MPEG test and picture quality analysis makes Tektronix the obvious choice when testing and evaluating an MPEG-based design. As communications standards converge – with audio, data, images, and video merging in new networks – innovative test equipment from Tektronix will ensure the integrity of the overall information system.

For Further Information

Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology.

Please visit "Resources For You" at **www.tektronix.com**

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