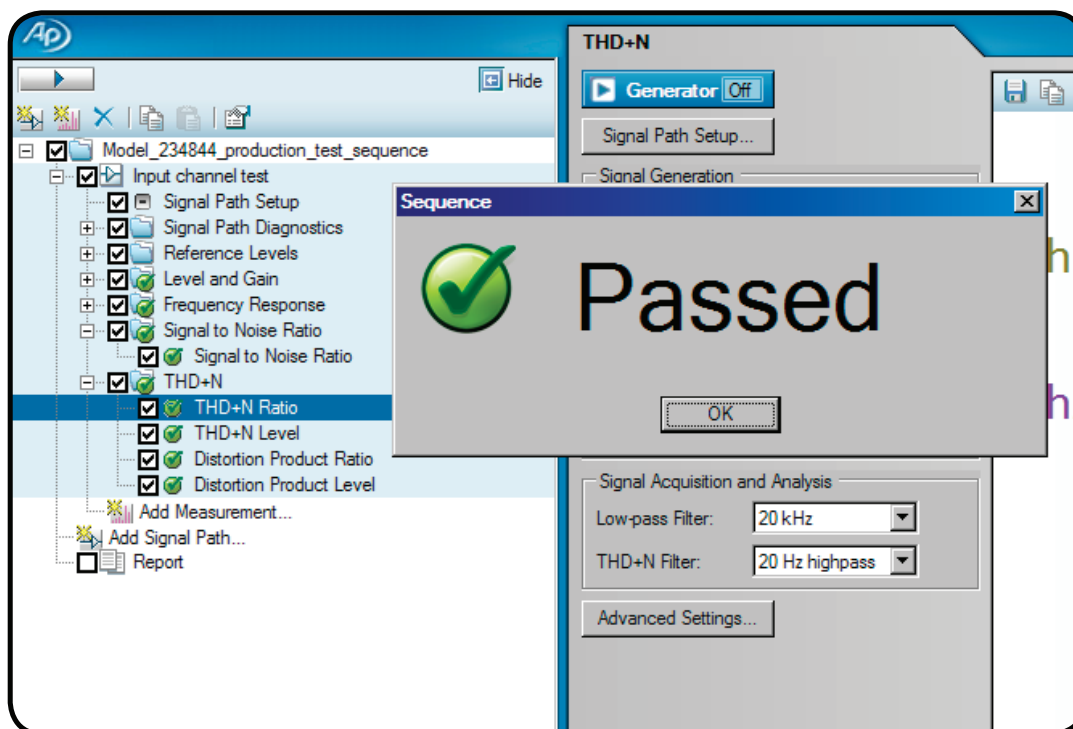# Calculating ROI in Audio Production Test

Cost benefit analysis of high performance, low price audio test equipment in production

In a production environment, two questions drive most decisions: How do we increase output and how do we decrease cost?

Output can be measured in different ways: units per day, or beat rate, beat rate divided by defect rate, beat rate divided by return rate. Cost is easier: does this decision increase costs more than it increases the value of the output?

A similar cost-benefit analysis influences production audio test: comprehensive test can increase output (by increasing quality and reducing returns), but with a top-of-the-line audio analyzer costing $25,000 or more it can get expensive quickly.

Less expensive test solutions are slower, less reliable, and harder to integrate, adding uncertainty into quality assurance and causing potential bottlenecks. No test at all is always an option, but the hidden costs of high return rates or damage to brand reputation can easily outweigh the perceived savings in test equipment. Just what is the right level of test?

This AP Applied looks at how a low cost audio analyzer such as the APx515 can help line managers and quality assurance engineers maximize the return on their audio test investment with the right mix of features and performance at a production-level price.

> **There are three key factors when calculating return on investment for audio production test: quality, speed, and analysis.**

ROI Factor: Quality

Quality can be viewed from two perspectives: improving the quality of the devices being manufactured, and ensuring that the test station itself is of sufficient quality not to interfere with production.

Comprehensive production test will always improve production quality. Improved quality means fewer defects and returns, and thus improved profitability.

Well designed test stations should have at least 10 dB of headroom to ensure the noise floor of the test system isn't obscuring defects in the device under test.

A quality audio analyzer will also have features that can speed up test, eliminate the uncertainty of inconsistent results and reduce downtime caused by failure of low-end test gear.

OEMs and Contract Manufacturers

Companies that focus on design and outsource their production need to pay special attention to testing: Poorly executed manufacturing ultimately reflects on the brand of the original company, not the contract manufacturer.

Systematic test helps ensure that products are being built to the original specification, which will maintain quality and reduce the failure rate.

A carefully designed test will also reduce the risk of contract manufacturers attempting to make undocumented cost reduction decisions that can totally change an end product.

ROI Factor: Speed

There are two aspects to speed: setting up the production line, which can take months, and the actual day-to-day testing. The key is to make sure at no point does test become a bottleneck.

Ideally during the setup phase, tests can be designed by an audio engineer without requiring a software developer. Test is implemented faster, and the inevitable last minute changes are less likely to hold up the line going live. Long term, a low cost of change makes it less likely that tests will fossilize for want of budget.

Once up and running, the speed of a production test system has a very simple ROI metric: how many test stations are required per production line to test each unit without causing a bottleneck?

The faster each individual test station, the fewer analyzers are required: Fewer analyzers translate to lower capital and maintenance costs.

ROI Factor: Analysis & Reporting

Successful production line managers need good data to identify trends before they become catastrophes. Unfortunately, if reporting requires programming expertise to develop or make changes, its budget may be cut to reduce costs.

Essentially, the more sophisticated the built-in reporting of the test system, the better off the line manager will be.

For analysis to be useful, it must be based on reliable data. Using a recognized standard like AP makes it easier for external parties to share measurements and other data.

Working with world-class equipment also makes it easier for others to accept analysis at face value without having to question the underlying data.

Every production line manager has different priorities and looks for different features from their audio test systems. The same basic ROI rules still apply however: How can we increase output while reducing overall cost?

Small scale, high quality operations

1. The R&D department creates a sequence on their APx525 by selecting measurements from the APx Measurement Navigator list. Limits are based on the published spec plus an offset defined by the engineer. Any required changes over time are made by opening the project, editing and re-saving.

    - Easy initial set up
    - Simplified operator interface
    - Rich reporting

2. The engineer opens the Sequence properties dialog to add prompts for the Operator. In the APx Aux Control menu he sets the 8-bits of TTL compatible logic for integration with external equipment: a light pole pass-fail indicator and a footswitch control to initialize the sequence.

3. Each unit receives a comprehensive test that includes multiple signal paths. The project file is locked, then handed over to Production.

4. Production opens the project on an APx515 and runs tests all day using the footswitch and pass-fail indicator. APx High Speed Test reduces test time to 3 seconds ensuring audio test is not a bottleneck.

5. Custom reports (created in Microsoft Word by Engineering with design flair from Marketing) are generated automatically for each unit.
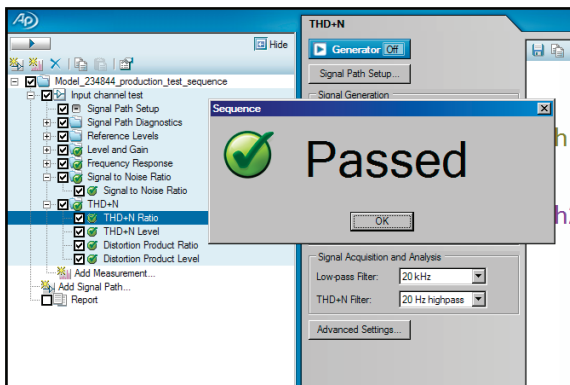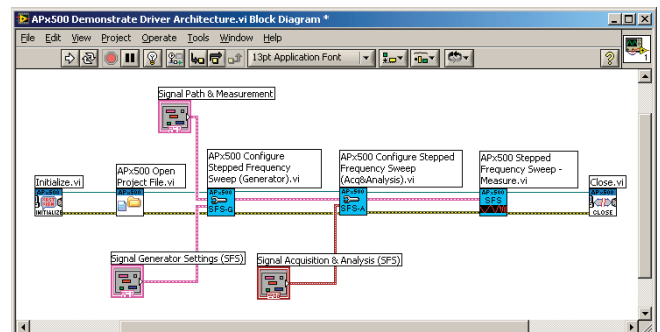

▲ **FAST & INTUITIVE UI**
A locked production sequence with operator message. No code required to create or edit.

High volume heavily automated line

1. A single master LabVIEW application controls the entire production line (of which audio test is just one part). An audio test station could be stitched together with custom programming and off-the-shelf components, however, time to market, the risk of a poor implementation due to lack of audio expertise and cost of ongoing support determine that a dedicated audio analyzer is more cost effective.

    - Speed
    - Automation integration
    - Long distance troubleshooting

2. The Test Engineer uses an APx525 UI to set up all the required measurements, then switches to LabVIEW. Using the APx LabVIEW driver, audio tests are integrated into the master application, controlling individual parameters where necessary.

3. APx High Speed Test running on APx515 reduces test time to 3 seconds, allowing a theoretical 17,000 units a day to be tested on a single test station.

4. Troubleshooting must be performed long distance since R&D is in a different country. Knowing that the test station is based on an ISO:17025 calibrated APx515, the remote engineer can trust the data and focuses his attention on the device under test.

5. Problem units are tested and a recording of their audio stream is saved along with the project. The whole project is then emailed to the engineer for remote triage, saving days of transit time.

▲ **LabVIEW, C# AND OTHER .NET SUPPORT FOR SYSTEM INTEGRATION**
Integrating an audio test sequence with the APx LabVIEW driver.

Key Features

- Typical THD+N –106 dB and 24-bit, 1M point FFTs

- Comprehensive test in 3 seconds without any coding

- Intuitive UI with one-click measurements

- Supports VB.NET, C#.NET, full LabVIEW driver

- Small footprint and only 4 kg

- Share projects and .wav acquisition files with any APx

- Create custom reports using MS Word and the APx UI

- Advanced measurement library includes IMD, MOL, dynamic range, FFTs, more

High speed, reliable production test

The APx515 is a high performance audio analyzer optimized for production test. It is a best-in-class instrument for its speed, performance, automation and ease-of-use. APx515 can make all of the key audio measurements in less than three seconds. Despite its low cost, APx515 still has excellent performance, with a typical THD+N of –106, 24-bit FFTs, and 192K digital I/O as well as the one-click automation and ease-of-use of all APx Series audio analyzers. Like all AP instruments, APx515 comes with an ISO:17025 Accredited Calibration and three year warranty, so its results are trusted everywhere.

APx515 Audio Analyzer Key Specifications

SYSTEM PERFORMANCE

Residual THD+N (20 kHz BW)
–102 dB + 1.4 µV
Typical <–106 dB (1 kHz, 2.0 V)

GENERATOR PERFORMANCE

Sine Frequency Range
5 Hz to 80.1 kHz
Frequency Accuracy
2 ppm
IMD Test Signals
SMPTE, MOD, DFD
Maximum Amplitude (balanced)
16.00 Vrms
Amplitude Accuracy
±0.06 dB
Flatness (20 Hz–20 kHz)
±0.010 dB
Analog Output Configurations
unbalanced, balanced, common mode
Digital Output Sampling Rate
22 kHz–192 kHz
Dolby / DTS Generator
Yes

Specifications subject to change.

ANALYZER PERFORMANCE

Maximum Rated Input Voltage
125 Vpk
Maximum Bandwidth
>90 kHz
IMD Measurement Capability
SMPTE, MOD, DFD
Amplitude Accuracy (1 kHz)
±0.06 dB
Amplitude Flatness (20 Hz–20 kHz)
±0.010 dB
Residual Input Noise (20 kHz BW)
1.3 µV
Individual Harmonic Analyzer
d2–d10
Max FFT Length
1024K points
DC Voltage Measurement
Yes

ISO/IEC:17025 ACCREDITED

Accredited by A2LA for equipment calibration under ISO/IEC: 17025. Calibration report and test data included with all new instruments.

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