

Precision Power Level Accuracy Measurements Reduce Risk for Wireless Receiver Manufacturer

Reduce test risk, increase yield, and reduce production costs

Organization

- Industry-leading wireless receiver manufacturer

Challenges

- Improve power level accuracy
- Ensure optimal receiver range for every unit
- Increase yield and lower production costs

Solutions

- Keysight's risk calculator demonstrated lower measurement uncertainty, improved power level accuracy measurements, and reduced test result risk

Results

- Reduced risk 50x due to false pass test result
- Decreased scrap cost by an estimated \$1.5M USD annually
- Reduced power level measurement uncertainty from 1.5 dB to 0.25 dB, increasing yield and reducing cost

Company

Designing reliable receivers for military applications demands precise and accurate measurements. When designing a new receiver for the aerospace and defense market, a leading manufacturer needed to ensure its products could capture the intended signal in a crowded RF environment, even when operating at the maximum distance. To ensure performance, the company tests receivers during production to verify receiver sensitivity meets design parameters. The device must receive the signal and successfully demodulate it to pass the test.

Key Issues

The company measures receiver sensitivity using a signal generator. The signal generator supplies an input signal to the wireless receiver under test. A test engineer decreases the signal generator power level until the wireless receiver can no longer demodulate the signal. The results are recorded as a power level accuracy measurement. Power level accuracy determines receiver sensitivity.

During a power level accuracy measurement, there are four possible test outcomes, as shown in Figure 1: true pass, true fail, false fail, and false pass. True Pass and True Fail are expected outcomes. However, two additional outcomes are possible when measurement uncertainty is considered. False fail - when a perfectly good product fails the test, and false pass — when a defective product passes the test.

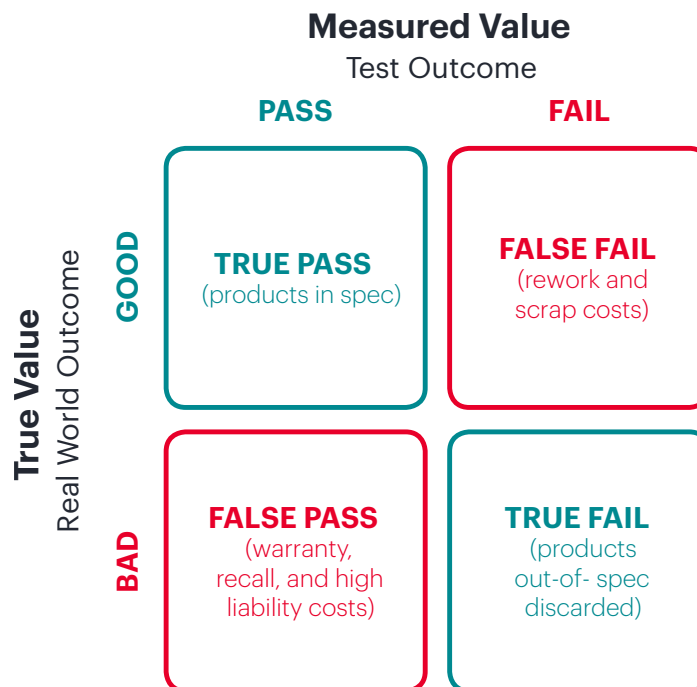


Figure 1. Measurement uncertainty introduces four possible test outcomes

This wireless receiver manufacturer turned to Keysight Technologies to improve power level accuracy measurements.

Solution

Keysight evaluated the manufacturer's test procedure, and determined that the manufacturer's calibration procedure was contributing unnecessary measurement uncertainty (MU) in their test process. From the customer's calibration report, it could be seen that the manufacturer was using a state-of-the-art signal generator, but their calibration service provider was calibrating it using an older portable spectrum analyzer. The older portable spectrum analyzer, a Keysight 8563E (9 kHz to 26.5 GHz) had larger MU or less accurate specifications than a modern Keysight E4440A PSA (3 Hz to 26.5 GHz). The differences resulted in substantially more measurement uncertainty, increasing the risk of false pass and false fail measurements.

The older unit used by the customer's service provider for calibration had significantly higher MU at $< \pm 1.5$ dB, versus $< \pm 0.25$ dB for the new instrument. The striking difference is driven by analog components inside the older spectrum analyzer, which contribute to the much higher MU in the older instrument as shown in Figure 2.

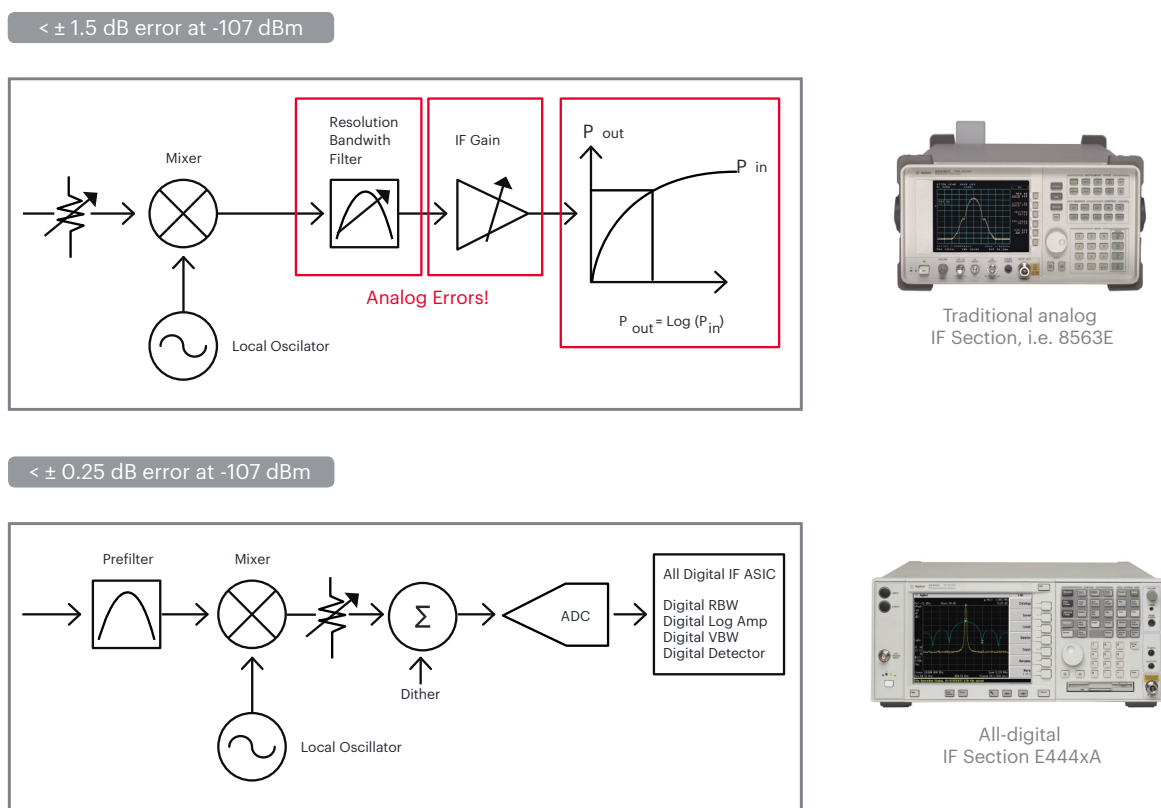


Figure 2. Older and modern test equipment with high and low MU

The newer analyzer uses all-digital components, which results in much lower instrument MU. The lower MU generates a more precise calibration, which reduces both false fails and false passes during testing. Figure 3 shows how a lower MU reduces false fails and false passes.

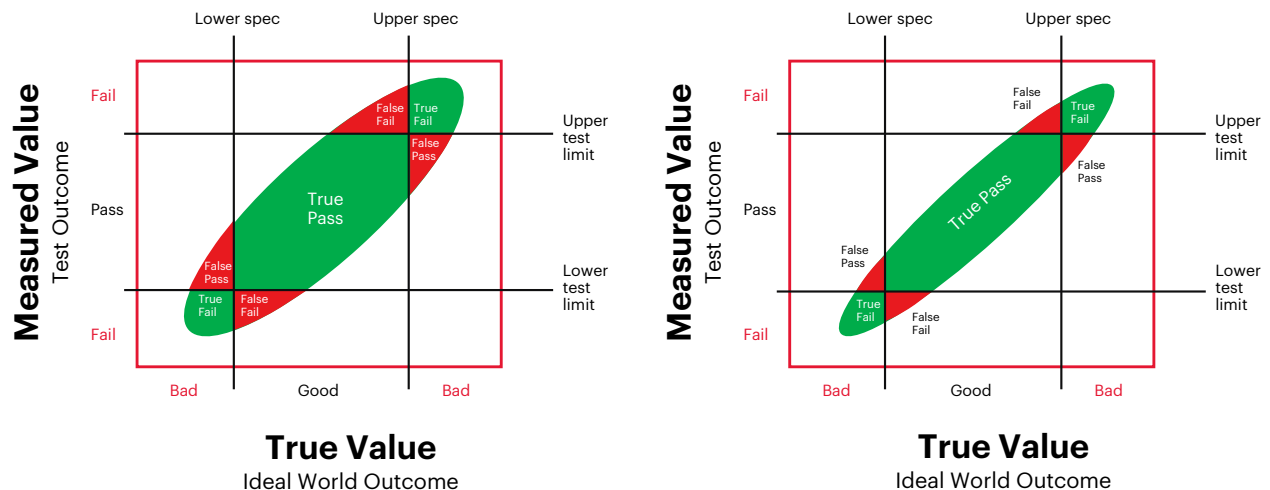


Figure 3. Two possible risk outcomes (false pass and false fail)

The ROI on Calibration

The customer understood the additional risk of calibration, but needed a business case to help justify the investment in calibration services. A mathematical equation defines these test outcomes for calculating risk as established by the Joint Committee for Guides in Metrology (JCGM), a world-recognized organization formed by seven international standards organizations in JCGM 106:2012 per section 9.5, Calculation of Global Risks.¹ Keysight calculated risk by modeling an industry-based scenario that resonated with the customer per JCGM 106:2012.

The highest risk of missing production volume targets comes from false passes, and the most significant costs are due to good filters mistakenly failed during testing.

¹ BIPM (Bureau International des Poids et Mesures), GUM: Guide to the Expression of Uncertainty in Measurements [<https://www.bipm.org/en/publications/guides/gum.html>]

The risk assessment determined that a manufacturer producing 100,000 units per year could reduce its volume of false passes from 500 per year to under 10 per year if a more accurate calibration is performed. Improving power level measurement accuracy, a critical measurement parameter for receivers, can reduce test result risk by 50 times. And reducing false fails and false passes could result in \$1.5M annual savings (see Figure 4).

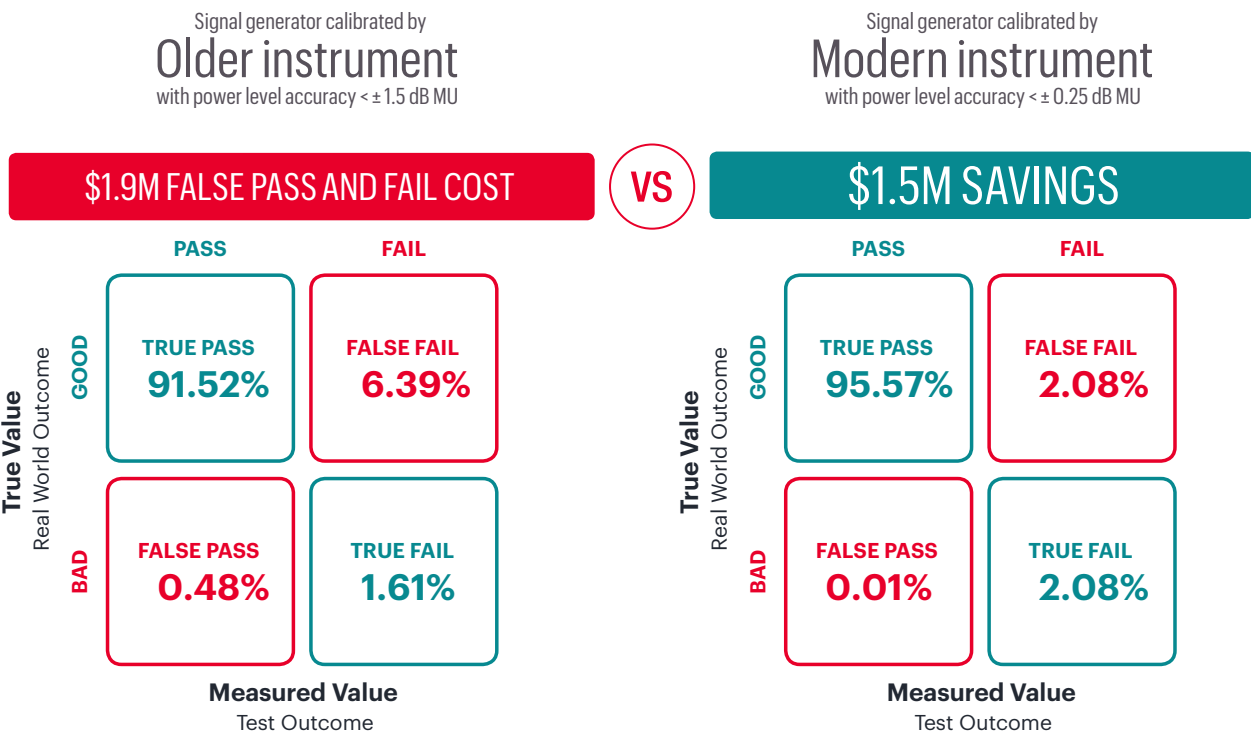


Figure 4. Cost savings using a modern instrument to calibrate test equipment

Results

The customer had never seen a risk calculator based on JCGM's mathematical definition of risk, used to quantify business results. The before and after comparisons of lowering the measurement uncertainty of the critical power level accuracy specification were impressive.

The real-world scenario shared with the manufacturer provided new insights into its production environment. The manufacturer wanted to reduce false fails, which would increase yield and decrease scrap costs. It would also reduce false passes, which would increase customer satisfaction and decrease warranty, product recall, and liability costs.

Armed with the results from the model, the manufacturer could apply insights to both their risks and potential cost savings. The data convinced this customer to shift from their existing calibration service provider to Keysight Calibration Services to dramatically reduce risk, increase yield, and decrease production costs.

Keysight Calibration Services – Avoid risk by ensuring your test system performs to specification.