Thermal and Humidity Testing

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Abstract

Conditions and procedures for thermal and humidity testing applicable for the AXIOM camera.

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1 Conditions

1.1 Extreme Temperature

A well isolated chamber which can be heated or cooled within the applicable range can be easily built with an of the shelf air conditioner and some thermal insulation.

Sensors for measuring temperature and humidity are readily available and cheap enough to place them in various spots around the device under test (DUT).

It is important to differentiate between extreme temperatures at which the DUT is expected to operate without any problems and temperatures at which the DUT can be stored without any ill effects on the device.

1.2 Thermal Shock

Putting the DUT between different zones of high and low temperature or rapidly altering the environmental temperature will cause a thermal gradient which results in differential expansion which causes stress to the affected materials.

1.3 High Humidity

Increasing humidity with the help of humidifiers or ultrasonic vaporisers is a simple way to test the effect of varying conditions on the DUT.

A climate or environmental chamber when available is a good although quite expensive alternative to do-it-yourself (DIY) solutions.

2 Instrumentation

2.1 Temperature Measurement

There are several ways to measure temperature efficiently and record the resulting data from various points on the DUT.

Thermocouples provide high temperature ranges but are limited in accuracy, which typically is worse than one Kelvin.

Thermistors are limited in range but provide excellent precision over a small range which is usually sufficient for simulated thermal conditions.

Integrated solutions where the sensor is combined with a high precision analog to digital converter (ADC) are available with excellent precision for the expected temperature range.

2.2 Measuring Humidity

Both capacitive and resistive sensors are cheaply available to measure relative humidity which can then be converted to digital data utilising a measurement ADC.

2.3 Measuring the Effect on the DUT

Besides the obvious case where the DUT suddenly stops working a continuous but easily verifiable test loop needs to be designed and implemented and the resulting data recorded and evaluated.

Care needs to be taken to design the test loop in a way which resembles normal operation to avoid testing unrealistic scenarios.

2.4 Calibration

Obviously all involved measurement devices need to be tested and calibrated before they are attached to the DUT, otherwise the results would be inconclusive.

3 Procedures

3.1 Reliability Testing

Exposing the DUT to the expected range of temperatures and relative humidities while exercising a test loop ensures that the device will work reliably under given conditions.

A wider temperature/humidity range can be expected when the DUT is not operating but a certain acclimatisation time has to be followed.

3.2 Effects on Image Quality

The effect of temperature changes in the environment on the resulting image quality, or more specifically on the amount of thermal noise generated in the sensor and integrated ADCs can and should be measured and evaluated.

3.3 Temperature and Ageing

The AXIOM cameras are equipped with a number of internal sensors which allow to measure temperatures and voltages at critical points throughout the system. The sensor itself also provides thermal measurements which allow to predict the effect of high environmental temperatures on the ageing process.

Extreme temperatures will age electronic as well as mechanical parts and can result in early failure of the DUT.