NEL's HALT/HASS Procedure

Assures Crystal Clock Oscillators Reliability

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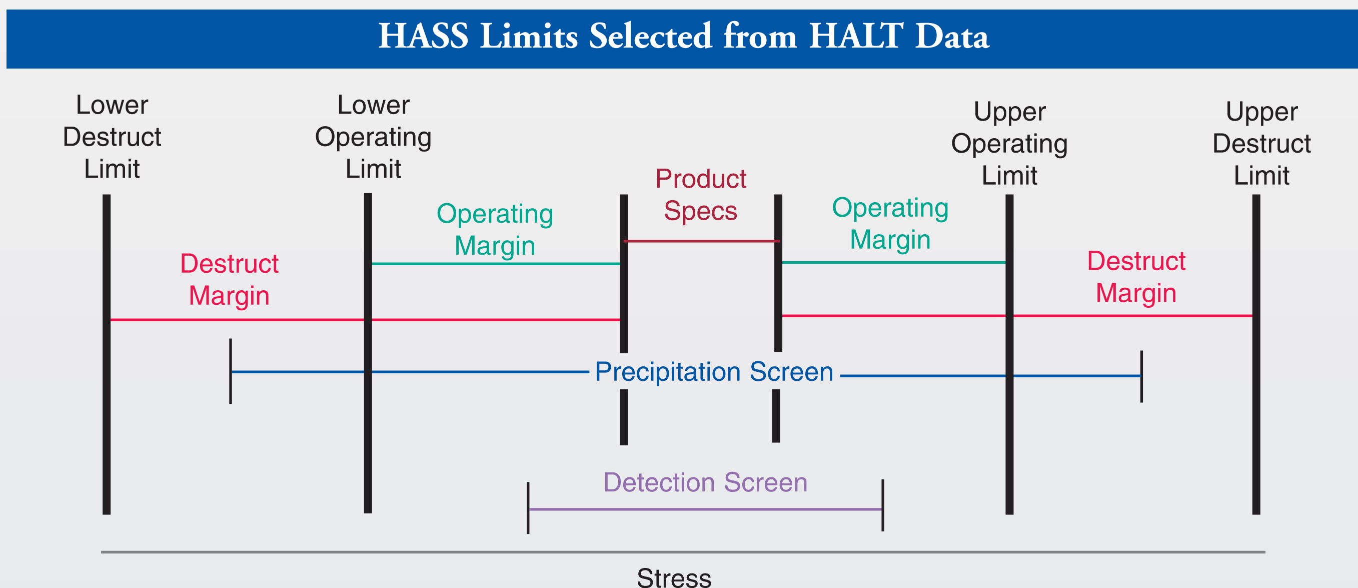
NEL Frequency Controls uses the NEL HALT/HASS procedure in the development and manufacturing process to assure crystal clock oscillator reliability. This procedure is a highly accelerated life test that takes the clock through a series of failures and improvements to determine its limits. As part of this process, historical failure points are reviewed and, based on this information, critical points for failure are predicted.

The NEL HASS Procedure is used in production to confirm that all reliability improvements made in the NEL HALT procedure are maintained. This process insures that no defects are introduced due to variations in the manufacturing process and vendor parts.

Methodology

The NEL HALT Procedure determines the critical points of product failure by applying stress to the device under testing conditions to cause failure, then making improvements to the device. This procedure is repeated until the ultimate failure limit is determined. The stresses that are applied are stepped up each time until the device fails, even if it is significantly outside of the normal operating limits of the part. Based on these failures, improvements to the product can be evaluated. The intent of this testing procedure is to improve the product beyond the specified requirements, as long as such improvements do not add significant cost to the product.

The NEL HALT results provide the basis for the NEL HASS Procedure which is used to develop screens during the manufacturing process to insure that defects are not introduced due to variations in the manufacturing process and vendor parts. The limits for the detection screens are based upon the HALT results and are located between the operational specification limits and the ultimate HALT failure limits, as shown below.



Scope of Process

NEL has taken sixteen years of documented crystal clock oscillator problems and determined that the majority of these problems and 100% of all catastrophic failure have been related to oscillator startup. Thus, NEL has limited the scope of the HALT/HASS Procedures to the oscillator startup.

NEL uses HALT testing as part of the design and qualification process for the development of a new product. This testing procedure allows NEL to create robust clocks with short development times. As a result, NEL's customers are able to meet their product ramp up schedules.

Applied Stress Stimuli

Because the crystal is by far the weakest component mechanically in the completed oscillator, mechanical shock and vibration will not be considered as possible stimuli for these tests. The limits of the mechanical structure of the crystal are well known. Additional cost to improve the strength of the structure is generally not justified.

The following stimuli are often used when NEL conducts HALT testing:

1. Power supply voltage (Vcc, Vdd, Vee, etc)
2. Power supply ramp time (turn on time)
3. Oscillator output loading
4. Temperature
5. Other factors that may or may not be significant and can be added as needed.

Sample Size

Sample size is intentionally small in order to accomplish the test quickly. Because margin is not a consideration, the test data is used only to correct problems and not to determine statistical failure rates. Ten units, for example, should be adequate to achieve representative failure modes for a given design. These units must be representative of the units that are supplied to the customer. As the frequency changes, the failure models and levels will change, too.

Test

Each stimulus is applied individually and stepped until the part no longer meets the specification (proper startup in NEL's case). If the stimulus is outside the part operating limits, then the part is analyzed and improvements are made, if possible. Failures that occur within the normal operating range of the product would follow the same process; customer product cannot be shipped or released until the product is improved to meet the specification. Once this process is complete, the stimuli are combined to further accelerate the testing. Again, improvements are made where possible.

Testing is complete once all improvements that are practical have been made, and all stimuli have been tested. The limits of the product with respect to these stimuli are recorded for reference and for development of a HASS test for production testing.

Generally, the test is intended to locate two sets of limits. The first is the minimum and maximum limits within which the part will operate, and the second is the minimum and maximum limits where permanent damage occurs. Some stimuli cannot be practically applied to cause permanent damage, such as power supply ramp time or output loading (output loading could be applied to cause damage if there is no short circuit protection in the IC, but generally this area is not of major concern). Even temperature could be difficult to apply to cause damage.

Power supply ramp will be limited to those ramp ranges that we can supply with NEL's present power supply ramp tester (0.1 msec to 300 msec).