White paper

Quality Assurance Process
: Development

4th 03, 2017
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Quality Assurance Equipment Status
1. Overview

There are multiple factors that influence consumers to purchase products. Some consumers choose to purchase a product because it satisfies their requirements, and some consumers choose to purchase products for their design. These characteristics exist in various forms of application or implementation, and they can be regarded as the differentiating factor compared to other products. Aside from these differentiating factors, there are also common elements which any company's product possesses - price and quality.

Product quality refers to the overall reliability of the properties that compose the product. The term "properties" in this context should be interpreted comprehensively which not only means the inherent properties, such as size, power type and operating temperature, but also the properties intentionally designed during product development and production stages, as well as properties that the user can modify during usage. In other words, quality is the warranty that ensures the product's intended performance without any degradation due to changes in the device's environment. For this reason, quality is not an option manufacturers can choose but is a core element which determines whether the product can survive the market and further, whether the company can survive the market.

Therefore manufacturers are investing large amounts of resources in quality management to maintain product quality along with production and development. Quality assurance of Hanwha Techwin aims to go beyond quality control implemented to reduce product defects during production and achieve quality management which aim to maintain quality throughout design, development, production and distribution by operating dedicated organizations and suitable processes.

This white paper is composed to describe key assessment processes for quality assurance (QA) designed to confirm whether products satisfy detailed standards from various stages of quality management implemented by Hanwha Techwin.
2. Background

2.1. Purpose of Quality Assurance

QA Process aims to ensure reliability on the level of consumer satisfaction by defining test conditions, test methods and measurements for evaluating all types of stresses imposed by the overall distribution, storage, usage and disposal environment for product uniformity and reproduction.

2.2. Basic Concept of Quality Assurance

2.2.1. Definition of Quality

- Characteristics (operating probability) of an item (component, part, product or system) which satisfies the defined level of reliability and maintains the intended performance without any malfunctions over a certain time period
- Quantitative index of whether designed components, parts, products or systems perform without any malfunctions

2.2.2. Concept of Quality Assurance

(Quality Assurance & Reliability Assessment)
2.2.3. Quality Index

**MTTF**: Mean Time to Failure (Parts)

\[
\text{MTTF} = \frac{t_1 + t_2 + \cdots + t_n}{n}
\]

**MTBF**: Mean Time between Failure (System)

\[
\text{MTBF} = \frac{\text{Total operating time (T)}}{\text{Number of faults (n)}} = \frac{T}{n}
\]

**B10 Life**

Ex) B10 = 61,320Hrs

B10 Life: 61,320Hrs

Occurrence point of 10% accumulated defects

**Meaning of MTBF**

Ex) MTBF = 300,000Hrs

MTBF 300,000hrs (index distribution)

Occurrence point of 63.2% accumulated defects

2.2.4. Necessity of Quality Assurance

: Economic Loss due to Poor Quality Design

<table>
<thead>
<tr>
<th>Economical Loss of Manufacturer (weighted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
</tr>
<tr>
<td>Design Phase</td>
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<tr>
<td>10</td>
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<tr>
<td>Engineering Phase</td>
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<tr>
<td>100</td>
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<td>Production Phase</td>
</tr>
<tr>
<td>1,000</td>
</tr>
<tr>
<td>Customer Phase</td>
</tr>
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</table>
2.2.5. Optimize Design vs Quality Assurance Test

Design Engineering and Test Engineering combined can only assure successful R&D.

2.2.6. Quality Assurance Test Design Procedure

(Quality design considering the path of product shipment to customer usage)

Image 1. Concept map of quality assurance environment
3. Quality Assurance Process

3.1. Quality Assurance Process

- **TP**: Test Plan
- **PVTR**: Product Validation Test Report
- **FPTR**: First Production Test Report
- **DVTR**: Design Verification Test Report
- **PQTR**: Product Qualification Test Report
3.2. Software Quality Assurance

Despite the fact that "software does not wear down" while hardware leads to malfunctions, software is able to identify hidden defects which lead to malfunctions through operations over time based on user experiences that were never tested before. Software quality is assumed to be a special aspect of quality engineering. According to this definition, system quality applies to the entirety of the system, including hardware, software, the operator and procedures. Traditionally, quality engineering focused on key hardware components, whereas modern day elements that determine the performance of a system are hardware performance and the quality of software as systems become automated and intelligent systems are developed over the years.

Software quality has several properties to differentiate it from hardware quality. While physical stress and aging are the major causes of hardware malfunctions, defects in the design stage are the major cause of software malfunctions, and aging or user mistakes cannot be the cause of this malfunctioning. As information technology advances rapidly, establishing systems and managing development has become complex, and the use of zero-defect (fault-free) software is mandated in virtually all fields.

As the malfunctioning of software results in not only massive financial damage but also significant damage to a company's trust, the development and application of zero-defect software assumes a decisive role in successful business operations.

As a measure for focusing on software quality, Hanwha Techwin manages shipment schedules through optimized software verification in order to minimize the average cost of the estimated defects within software, the estimated cost incurred due to software defects and cost for software testing before shipment.

Furthermore, the cause of the software failure is the number of faults in the software being executed, the software environment, and the operational profile. A (common cause error) in software design and development will have a lot of impact on the reliability of the software.
Therefore testing is more crucial in software than in hardware, and even the most ideal software development process cannot predict which software defects may arise until actual testing is done. For this reason, Hanwha Techwin ships software products that undergo multiple tests and verification steps from individual units up to the highest level of integration, just like that of hardware products.

3.2.1. Static Testing

Static Testing refers to all planned systematic procedures done to reach the SW quality objective. In principle, this aims to improve SW quality and reliability by preventing potential defects and eliminating defects that are identified.

Static Testing includes SW review, open source SW verification, SW static analysis, SW coding rule analysis and SW audit procedures.

3.2.1.1. SW Review

This is the product created during SW development. It includes standard documents and source codes. The products must be reviewed through SW review, and the results must be recorded. Types of SW review are as follows:

1) S/W Inspection

It is the most formulative and procedural method among SW reviews and it aims to identify defects of SW products at early stage and to efficiently eliminate these defects.

2) SW Walkthrough

This is a review session hosted by the product creator where the SW product is reviewed by a group of related staff, and the required quality and suitability of the product is reviewed.
3.2.1.2. SW Audit

SW Audit is a series of procedures that verify the uniformity and completeness between the requirements and the product, and procedures that confirm whether SW development regulations and rules are observed.

SW Audit consists of SW Product Audit and SW Process Audit, and each of them aims to accomplish the following:

1) SW Product Audit

SW Product Audit targets products per each SW development stage, and is implemented to verify the uniformity and completeness between the SW requirements and product.

2) SW Process Audit

SW Process Audit is conducted to confirm whether SW development regulations and rules are observed.

3.2.1.3. Open Source SW Verification

Open Source SW refers to copyrighted SW with its source code disclosed allowing anyone to copy, install, use, modify and redistribute. However, depending on the open source SW, there may be mandatory source code disclosure obligations, and as the right for SW patents cannot be claimed, Open Source SW Verification, which identifies open source SW used for each

SW development stage, is implemented to ensure open source SW license related obligations are observed.

3.2.1.4. SW Static Analysis

It is the quality procedure which identifies logical errors within the program by analyzing the source code without executing the SW program.
3.2.1.5. SW Coding Rule Analysis

This refers to a series of procedures conducted to improve the readability and uniformity of the SW program, establish SW coding rules and contribute to SW reliability and productivity increases by analyzing whether a development source code SW coding rule violation occurred.

3.2.2. SW Unit Testing

This is a test which identifies defects and verifies functions in SW modules, programs, objects and classes organized into testable (minimum) units.

3.2.3. SW Integration Testing

This is a test conducted with a focus on whether the functions and performance of a SW system or SW module after SW execution and unit testing are appropriate.

3.2.4. SW System Testing

This is a test conducted to evaluate whether the requirements related to system performance and reliability are perfectly executed in real-life environments where SW and HW are integrated and operated as a singlesystem.

3.2.4.1. Functional Testing

This is a test which verifies whether executed system functions operate according to the requirements. This is a test conducted based on the Software Test Case designed according to the SW requirement specifications.

3.2.4.2. Performance Testing

This is a test that implements qualitative and quantitative methods to verify whether key performance objectives are achieved.
Key performances of a product are selected as following:

- **Image Quality**
  - Precision measurement of image quality characteristics, evaluation of characteristics per lighting environments, evaluation of image quality in a real-life environment

- **System Performance**
  - Booting, upgrade, searching, recording, time accuracy, etc.

- **A/V Analysis**
  - Motion Detection, IV Detection, Audio Detection, Tampering Detection, Face Detection, Audio Detection, DIS, Defog, Auto Focus, Auto Tracking, Video Summary, Heat Map

- **Network Performance**
  - Latency, transmission performance, evenness, etc.

### 3.2.4.3. Product Compatibility Test

This is a test conducted on a specific range of elements to minimize risks of environment-specific failures in various environments the product is used.

- **Product Compatibility**
  - This is a test conducted to identify and improve issues related to compatibility between CCTV components and protocols/specifications.
  - Evaluates various aspects to minimize issues related to linking mass produced products including cameras under development, storage devices, control system software and control units.

- **Market Operation Environment Compatibility**
  - Evaluates compatibility with peripherals and installation environments (OS, browser, router/switch, player SW, etc.) used for operating the product.
3.2.4.4. **SW Stability Test**

This is a test conducted to minimize the risk due to faults from long-term usage by securing SW stability for long-term usage.

It analyzes Use Cases of real-life environments to identify time progression and event occurrences (lighting changes, power cuts, SW upgrades, network traffic changes, events, etc.), and as such is accelerated to confirm the effects of long-term usage.

![Image 2. Product compatibility test lab](image)

3.2.5. **Image Quality Evaluation**

Image Quality Analysis & Evaluation features a series of objective and subjective measurements to determine whether an image is good or bad (image quality evaluation), and as an image is composed of a multitude of complex physical image properties, it is impossible to evaluate the overall image quality with just a few evaluations.

For this reason, Hanwha Techwin seeks to achieve a high level of image quality through qualitative and quantitative evaluation methods based on specific evaluation criteria developed through the analysis of the various elements that influence image quality satisfaction, thus consequently resulting in being able to gain high customer trust.
3.2.5.1. Camera Image Quality Precision Measurement Evaluation

3.2.5.1.1. Color Reproduction Evaluation

Evaluates accurate color reproduction capability and white balance performance under various light sources such as standard light source Daylight65, Cool White, TL84, Incand A, Horizon, etc.
3.2.5.1.2. Contrast Property Evaluation

Evaluates properties of Dynamic Range, Contrast and Noise.

![Contrast property evaluation](image5.png)

3.2.5.1.3. AWB Property Evaluation

Evaluates whether AWB performance and color performance according to color temperature change satisfy the specifications. It utilizes color filters to evaluate AWB performance and color performance according to color temperature changes.

3.2.5.1.4. Low Light Level Performance Evaluation

Evaluates what can be distinguished at low light levels (minimum low light level performance) and verifies AE (Auto Exposure) performance according to brightness signal level.

![White level evaluation](image6.png)
3.2.5.1.5. Day/Night Property Evaluation

Verifies Day & Night transition takes place at a suitable time or whether it functions abnormally.

3.2.5.1.6. Resolution

Evaluates definition and chromatic aberration.

Image 7. Resolution evaluation

3.2.5.1.7. Angle & Focus Margin

Verifies the view angle and focus margin of a camera.

3.2.5.1.8. Lens Uniformity

Evaluates the shading of the surrounding lens.

3.2.5.1.9. WDR Performance Evaluation

Evaluates WDR (Wide Dynamic Range) wide backlight compensation performance by verifying the expression stages of dark and bright areas.
Image 8. WDR performance evaluation

Image 9. WDR measuring equipment
Image 10. WDR on/off comparison
3.2.5.1.10. LDC (Lens Distortion Compensation)

Evaluates lens distortion and compensation rate.

Image 11. Lens distortion compensation

3.2.5.2. Lighting & Environment Property Evaluation

Evaluates sensory image quality according to illumination changes and various lighting environments (LED lighting, mechanical fluorescent lighting, daylight white fluorescent lighting, soft white fluorescent lighting, incandescent lighting, mercury lighting, sodium lighting, halogen lighting, spotlight, automotive headlight, signal lights).

Evaluation Item

- Definition (Sharpness), Color, Brightness
- Auto white balance property
- Auto Exposure stability
- Contrast
- Low Light Level property: Distinguishability, Definition, Noise
- Distinguishing moving objects in daytime/nighttime
- Bitrate Image Quality property
- Backlight property
- IR property
- Light spread
- WDR property
3.2.6. ISV Compatibility Evaluation

This is an evaluation to secure compatibility between the products and clients of various ISV companies.

3.2.6.1. Protocol Level Test (SUNAPI, CGI, ONVIF)

Verifies protocol level functions using automation tools.

- ONVIF Conformance Test (ONVIF Device Test Tool, ONVIF Device Manager)
- SUNAPI Conformance Test (SUNAPI Conformance Tool)

3.2.6.2. ISV Link Testing

This is a test conducted to minimize ISV link issues through compatibility verification with the latest versions of major ISV companies at the product development stage.

- Axxon Next, Genetec Center, Milestone Xprotect Enterprise, Mirasys VMS, Seetec Cayuga R6
3.3. Hardware Quality Assurance

3.3.1. Reliability Test

It makes estimates (expectations) or decisions (verifications) regarding whether the product will be able to achieve the level of reliability (defect rate, product strength, etc.) demanded by the market. The purpose of this reliability test is to identify potential design flaws as soon as possible. This will lead to the system being trusted and able to satisfy the required reliability.

The test can be implemented on various stages, and it can also be applied to components, circuits, parts, subsystems and the system level of complex systems. Indication of test levels vary according to the application (i.e. low level for environmental stress), and implementing the test on components or small units allows flaws to be identified before reaching higher levels.

Reliability tests conducted by Hanwha Techwin feature the highest level testing, development testing and operation testing for each integration level, and consequently result in reduced program risks. As mentioned in "2.2.6. Quality Assurance Test Design Procedure," Hanwha Techwin identifies key verification factors through real-life market environment analysis starting from product development to implement verifications through reliability tests for customer satisfaction.

System reliability is calculated at each test level, and it is capable of improving reliability as the test progresses with the application of reliability improvement technology, a defect reporting system, analysis and correction system. Hanwha Techwin endeavors in supplying the highest quality products to its customers.
Image 13. Outdoor real-life environment test: company roof

Image 14. Outdoor real-life environment test video in the snow
3.3.2. Room Temperature Function Evaluation

3.3.2.1. Room Temperature Function Testing

This is a test to verify whether the set is capable of executing basic functions and performances, and each test criteria is defined according to each test item.

3.3.2.2. Failure Verification

The Failure Check List manages product issues that occur in the market and manufacturing plant (inspection) to prevent re-occurrences.

3.3.2.3. Overhaul

Set is disassembled at room temperature to identify structural issues in each part's assembly and attachment conditions, and is reassembled to identify functional defects due to weaknesses or incomplete assembly during disassembly/reassembly.

3.3.2.4. Exterior Quality Evaluation

This is an evaluation item aimed to improve exterior quality by inducing improvement on areas which hinder exterior quality identified through evaluation.

3.3.2.5. Remote Control Testing

This is a test designed to improve remote control operation for user convenience, and to improve remote control quality by upgrading the operation performance with advanced technology.
3.3.3. Precision Measurement

3.3.3.1. Power Consumption Measurement

This is a test designed to make improvements by measuring power consumption at different states under maximum load condition, compare measurements against product specifications and minimize power consumption levels to a level that is advantageous in comparison to competitors.

3.3.3.2. Time Accuracy Testing

This is a test designed to evaluate whether the product maintains RTC at usage conditions, and whether the product satisfies standards defined by the specification. (RTC: Real Time Clock)

3.3.3.3. Noise Measurement

This is a test conducted to identify the influence of noise generated from the product has on users, and relative noise measurement is implemented.

3.3.4. Climate Environment Test

Climate Environment Test refers to tests conducted to evaluate product strength by applying the artificial stresses of temperature and humidity at the levels of a natural environment.

CCTV products are exposed to high temperatures, high moisture, vibration and shock during transport after shipment, and they are also used in extreme conditions such as in the cold climate of Siberia, the blazing heat of the Middle East, and locations with large temperature changes from day to night. Furthermore, security cameras are installed on high grounds such as poles or building roofs which expose them to strong wind and powerful sunlight.

For such reasons, warranties on operation temperatures are a major feature of CCTV products.

Long-term exposure to high temperatures leads to a significant product life reduction. Humidity can not only damage components, but it can also cause fogging within the camera dome at warm temperatures or icing at cold temperatures.
Being one of the most critical issues that must be addressed during development and mass-production, Hanwha Techwin ensures its products are capable of operating flawlessly under extreme climate conditions through various verification measures.

The Specification sheet indicates not only the minimum and maximum operational temperatures, but also the operation initiation temperature. In order to confirm whether its CCTV products all satisfy the defined specification values, Hanwha Techwin implements a wide range of climate environment tests in a laboratory using real-life environmental temperatures and humidity.

3.3.4.1. High temperature & humidity Storage

This is a test conducted to determine whether the physical properties and characteristics are suitable when exposed to long-term high temperatures and high humidity conditions.

- Test Condition: 60°C / 90% / 120Hrs

3.3.4.2. Low temperature Storage

This is a test conducted to determine whether the physical properties and characteristics are suitable when stored in low temperature environments.

- Test Condition: -30°C / 48Hrs

Image 15. Reliability test lab environment
3.3.4.3. CERT (Combine Environment Reliability Test)

This is a test evaluating a product's strength under stress caused by real-life temperature and humidity changes by reviewing suitability against physical properties and characteristics when undergoing extreme vibration as well as temperature and humidity changes.

- Test Condition: HTW SS Business evaluation standard
- Profile: 5 STEP: 10 Cycle / 490 Hr
- Precondition: Vibration Test
- See Power On/Off test conditions (simultaneous Power On/Off test)

![CERT Test Equipment](image)

Image 16. CERT (Combine Environment Reliability Test)

3.3.4.4. Water Proof Test

3.3.4.4.1. Rain Spray Test

This is a test that determines whether the product remains suitable after physical property and characteristic changes due to water infiltration by submerging the product in water and continuously spraying water on it in real-life operating conditions.

- Test Condition: HTW SS Business evaluation standard
3.3.4.4.2. Moisture Proof Test

This aims to prevent moisture build up in the product in high temperatures and high humidity environments by applying temperature and humidity changes to the product to verify moisture infiltration.

- Test Condition: HTW SS Business evaluation standard

![Image 17. Water Spray Test](image)

3.3.4.5. PBA (Printed Board Assembly) Reliability Test

This is a test designed to evaluate strength under stress from environmental elements during distribution and storage by reviewing the suitability against physical property and characteristic changes in PBA solder areas with Lead Free application.

3.3.4.5.1. Thermal Shock Test

- Test Condition: 30 min. each / 500 cycle, -40°C ~ +85°C

3.3.4.5.2. High temperature & humidity Storage

- Test Condition: 85°C/85%Rh / 500 Hrs
3.3.5. Power Environment Test

The Power Environment Test refers to all tests conducted to evaluate the product's strength under all sources of stress or electric charges generated in power environments by artificially simulating static electricity on the product.

3.3.5.1. Voltage Regulation Test

This is implemented to identify issues and strength under conditions caused by voltage fluctuation such as surging or dropping due to unstable domestic and overseas voltages.

3.3.5.2. Voltage Dip/Up Test

This is designed to identify issues and ensure product strength under conditions caused by sudden voltage drops due to unstable power supply environments.

3.3.5.3. Impulse Noise Test

It evaluates strength against malfunctions caused by amplification of noises at wiring, circuits and patterns from merging, reflecting, vibrating and IC due to impulse noises of inductive load opening/closing such as relay on/off.
3.3.5.4. EFT/B (Electrical Fast Transient/Burst) Noise Test

This is implemented to identify and to ensure strength under conditions caused by temporary interruptions due to repeated fast bursting applied to common power lines.

3.3.5.5. ESD (Electro Static Discharge) Test

This aims to evaluate the strength of products against various types of static electricity generated during production, distribution, use and service of products, and to consequently ensure reliability.

3.3.5.6. Lighting Surge Test

This aims to evaluate the strength of products against natural phenomenon such as lightning surge entering the product, and to consequently ensure reliability.
3.3.5.7. Withstand Voltage & Insulation Resistance Test

This aims to evaluate the strength of products against unstable elements of abnormal power supplies, and to consequently ensure reliability.

3.3.5.8. Earth Continuity Tester

This aims to secure product safety by determining the suitability of the protective grounding installed on the product for safety.

3.3.5.9. Power On/Off Test

This aims to evaluate the strength of the products against power outages (power on/off) that occur during production, distribution, use and service of products, and to consequently ensure reliability.

- Test Condition: HTW SS Business evaluation standard

[Images of test equipment]

Image 21. Power Environment Test Equipment

3.3.6. Transport Environment Test

The product (package) undergoes continuous vibration and impacts, such as falling, during shipment via vehicle or container. By identifying the level of force generated by mechanical handling, such as loading and unloading, the package can withstand, the packaging quality can be improved, and the Transport Environment Test evaluates product and package performance at low temperatures and the types of falling which can occur during transport.
3.3.6.1. Vibration Falling Test

It refers to the minimum test conducted to verify whether defects can be caused by vibration and falling during transport from the factory to the hands of consumers. Tests are implemented at room temperature conditions.

3.3.6.1.1. Vibration Test

- Test Condition: X, Y, Z axes

3.3.6.1.2. Normal Falling Test

- Test Condition: 1 angle, 3 edges, 6 sides, 10 times for each weight

3.3.6.2. Limit Falling Test

This refers to tests conducted to evaluate the durability against falling defects which occur during transport by checking the guarantee margin.

- Test Condition: Test for each Step

3.3.6.3. Cold Falling Test

This is a test to evaluate low temperature environments where the package falls during distribution.

3.3.6.4. Single Item Falling Test

This refers to tests conducted to verify potential structural issues of mobile and home network products (Smart Home Camera) falling during user movement.
3.3.7. Product Life Test

A test conducted to evaluate the product life until the product breaks down or deteriorates under real-life environment conditions is called a Product Life Test.

3.3.7.1. HALT (Highly Accelerated Life Test)

HALT is employed to identify weaknesses in design during the design and production stages. These stress elements are not intended for field environments, but are rather designed specifically to identify weaknesses in the design and production by using critical units.

These stress elements increase beyond the field environment level with the aim of causing a breakdown.

- Test Method: HTW SS Business evaluation standard
• HALT Verification Example

<table>
<thead>
<tr>
<th>Cold Step (°C)</th>
<th>Hot Step (°C)</th>
<th>Vibration Step (Grms)</th>
<th>Combined Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOL</td>
<td>LDL</td>
<td>UOL</td>
<td>UDL</td>
</tr>
<tr>
<td>-50</td>
<td>-50</td>
<td>112</td>
<td>120</td>
</tr>
</tbody>
</table>

Breakdown at field

Stress : Stress > Strength

Failure : Stress > Strength

HALT verification

Stress : Temperature + Temperature cycle + Random vibration

Failure : Stress > Strength

HALT Result

Before HALT

Increase product strength

After HALT

Product strength curve narrower due to improving low margins

Image 23. Highly Accelerated Life Test Equipment
3.3.7.2. ALT (Accelerated Life Test)

The purpose of this test is to calculate and improve upon breakdowns caused by stress during the product’s life cycle, and it is used to verify the breakdown rate before a product launches and the accumulated breakdown probability (B10 life minimum 7 years or more) within the product's life.

- Test Condition: HTW SS Business evaluation standard

\[ \text{B10} = 7 \text{ Years (61,320 Hrs)} \]

**Failure Model**

\[ T_f = \exp \left( \frac{Q^*}{kT} \right) A(\%RH)^{-2} (V_{on/off})^{-2} (V_{ib})^{-2} \]

**Life Calculation Example**

<table>
<thead>
<tr>
<th>Expected Failure rate per hour((\lambda))</th>
<th>Failure rate per Year</th>
<th>Probability of Failure</th>
<th>Required Reliability (99%)</th>
<th>Bx Information</th>
<th>Mean Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>ppm/hr</td>
<td>(%)</td>
<td>(%)</td>
<td>(hrs)</td>
<td>(Years) B1 Life (Years) B10 Life</td>
<td>(Years)</td>
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<tr>
<td>0.8406</td>
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<td>11,956</td>
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*The above calculation is based on index distribution*
3.3.7.3. Parts Stress Analysis

When the product operates normally, the electricity (voltage, current, power consumption (Pd)), heat (temperature) and stress applied to each circuit the product is composed of is measured. The measurements are compared to the each part’s specification to confirm whether they fall within the specifications. Such a comparison reviews the suitability of electric components on the circuit, and by improving the reliability of each circuit and component, the overall product’s reliability is improved.

By identifying and eliminating the causes of defects at the early development stage improves the reliability of mass produced products, and such contributes to business operations by reducing COPQ, defect rates and service costs.
- Test Condition: HTW SS Business evaluation standard

○: Mandatory, △: Optional, ×: Unnecessary

<table>
<thead>
<tr>
<th>Parts</th>
<th>Vp</th>
<th>Vrms</th>
<th>Ip</th>
<th>Imean</th>
<th>Irms</th>
<th>Pd</th>
<th>Ts</th>
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<td>Resistor</td>
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<td>○</td>
<td>×</td>
<td>×</td>
<td>△</td>
<td>○</td>
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<td>×</td>
<td>△</td>
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<td>○</td>
</tr>
<tr>
<td>Coil/Trans</td>
<td>△</td>
<td>×</td>
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<td>×</td>
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<td>○</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>○</td>
<td>△</td>
<td>○</td>
</tr>
<tr>
<td>Transistor</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>×</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>MOSFET</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>△</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>IC</td>
<td>○</td>
<td>×</td>
<td>△</td>
<td>△</td>
<td>×</td>
<td>△</td>
<td>○</td>
</tr>
<tr>
<td>Fuse</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>○</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>

**Purpose of stress analysis**

- **Average Stress Reduction**: Reduce temperature by using fan, heat sink, etc.
- **Average Product Strength Increase**: Improve strength by using higher rated parts.
- **Stress Spread Reduction**: Reduce stress through the use of noise filters.
- **Product Strength Spread Reduction**: Reduce spreading through the use of parts with minimal error.
3.3.7.4. Parts Transient Analysis

It measures electric stress created by surges or inrushes of current applied to each part when sudden overvoltages or overcurrents affect the product and improves product reliability by preventing breakdowns due to excessive stress through ensuring a sufficient design margin.

- Test Condition: HTW SS Business evaluation standard
- Target Unit: SMPS, AC Adaptor
- Target Parts: IC, FET, Transistor, Rectifier Diode, Resistor, Fuse, Relay

3.4. Safety Requirement Certification & Evaluation

Hanwha Techwin Products take safety requirements into consideration from the early product development stages, and by evaluating, reviewing and satisfying the regulations of different countries within development schedule, Hanwha Techwin continues to invest its full capacity in responding to various kinds of regulatory incident prevention and post management of mass production markets. In addition to the power environment tests conducted internally within Hanwha Techwin, the company also implements a certification processes and post management procedures through official external certification agencies.

3.4.1. Safety

This refers to the mandatory requirements for different devices and product attachments designed to protect people and property against hazards like electrocution, fire, injury, explosion, etc., and they are categorized by mandatory regulations and non-mandatory regulations according to the mandatory enforcement status.
3.4.2. EMC (Electromagnetic Compatibility)

This is the term containing both EMI (Electromagnetic Interference) and EMS (Electromagnetic Susceptibility) Immunity.

3.4.2.1. EMI (Electromagnetic Interference)

This refers to the amount or power of electric energy interfering with other devices' operations or functioning through radiation or transmission, and it also refers to interference applied to electric devices by radiation or conducted electromagnetic radiation generated by an external source. The cause can be artificial elements, which include other electric devices (radio transmitters, mobile phones, microwaves), digital communications, power grid fluctuations and lighting, or natural elements.

3.4.2.2. EMS/Immunity (Electromagnetic Susceptibility)

It is the capability/level of a device or part to withstand external electromagnetic interference.

3.4.3. Certification of different Countries

<table>
<thead>
<tr>
<th>NO</th>
<th>Country</th>
<th>Agency</th>
<th>Logo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Korea</td>
<td>KC</td>
<td>🇰🇷</td>
</tr>
<tr>
<td>2</td>
<td>USA</td>
<td>FCC</td>
<td>🇺🇸</td>
</tr>
<tr>
<td>3</td>
<td>Japan</td>
<td>VCCI</td>
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<td>CE</td>
<td>🇪🇺</td>
</tr>
<tr>
<td>6</td>
<td>China</td>
<td>CCC</td>
<td>🇨🇳</td>
</tr>
</tbody>
</table>
3.4.4. KC Mark Certification Example

1) Conductive Discharge Test (Main Power Port)
2) Conductive Discharge Test (Asymmetrical Mode)
3) Differential Voltage Conductive Discharge Test
4) Desired Signal of RF Output Terminal and Differential Voltage Discharge Test
5) Radiative Discharge Test (30 MHz – 1 000 MHz)
6) Radiative Discharge Test (1 GHz or more)
7) Static Electricity Discharge Resistance Test
8) Radiative RF Electromagnetic Field Resistance Test,
   Radiative RF Electromagnetic Field Spot Resistance Test
9) Electric Rapid Transient / Burst Resistance Test
10) Surge Resistance Test
11) Conductive RF Electromagnetic Field Resistance Test
12) Power Frequency Magnetic Field Resistance Test
13) Voltage Drop & Instant Power Failure Resistance Test
• Telecommunication Emission Measurement Example (part of KC Report)

Image 25. Telecommunication emission test result (XRN-2010)
3.4.5. **IP66/67 Certification**

IP certification stands for Ingress Protection rating which means the protection level against dust and water, and it is indicated by a 2-digit number (ex. IP66). Each digit has a meaning, and the greater the number, the higher the safety.

- The first digit indicates the dust protection level
- The second digit indicates the water protection level

<table>
<thead>
<tr>
<th>Protection against ingress of solid object</th>
<th>Protection against ingress of liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st Digit</strong></td>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>0</td>
<td>No Protection</td>
</tr>
<tr>
<td>1</td>
<td>Protected against solid objects up to 50 mm eg accidental touch by hands</td>
</tr>
<tr>
<td>2</td>
<td>Protected against solid objects up to 12 mm eg fingers</td>
</tr>
<tr>
<td>3</td>
<td>Protected against solid objects up to 2.5 mm (tools and wires)</td>
</tr>
<tr>
<td>4</td>
<td>Protected against solid objects up to 1 mm (small tool and wires)</td>
</tr>
<tr>
<td>5</td>
<td>Protected against dust, limited ingress (no harmful depositi)</td>
</tr>
<tr>
<td>6</td>
<td>Totally protected against dust</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4.6. IK Certification

IK10 certification is implemented according to EN (Europe standard) and IEC (International Electrotechnical Commission) standard EN/IEC 62262.

IK standard indicates the level of protection for the internals of an enclosure against external impacts, and the test is used to demonstrate the solidity level when evaluating product safety.

☐ IK code and impact energy (values changed in Amd 1:1998)

<table>
<thead>
<tr>
<th>IK Code</th>
<th>IK00</th>
<th>IK01</th>
<th>IK02</th>
<th>IK03</th>
<th>IK04</th>
<th>IK05</th>
<th>IK06</th>
<th>IK07</th>
<th>IK08</th>
<th>IK09</th>
<th>IK10</th>
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<td>Impact Energy (Joule)</td>
<td>*</td>
<td>0.14</td>
<td>0.2</td>
<td>0.35</td>
<td>0.5</td>
<td>0.7</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

Image 26. IK test equipment
3.4.7. PLP(Product Liability Prevention) Evaluation

The purpose of PLP is to secure consumer (user) safety and to avoid risks to the company, and it consists of activities ranging from development, design to A/S. This comprehensive, systematic procedure collects and interprets various types of safety information for the corresponding product from the development stage to identify unsafe elements and establish guidelines.

In other words, it is the quality assurance procedure with safety as its highest priority, and with the concept of "product safety" at the core of all thought and practice procedures, Hanwha Techwin is managing and applying it to the company's capabilities and business directions. PLP evaluation is a voluntary certification evaluation.

3.5. Stage Certification Report

The Stage Certification Report refers to the process of decision making for what the next stage will handle through evaluating stages for whether the newly introduced product design result satisfies the development objective.

For this purpose, verification items of samples defined by each development stage (DV-PV-PR-SR) according to the "New Product Development Regulation" of the Business Department to determine the product’s completeness at the stage and whether to proceed to the next stage. Ultimately, it also determines whether the final shipment should be made after reviewing the probability of quality issues occurring by implementing development product shipment certification.

3.5.1. Test Plan

This is the document that develops plans for various tests conducted to ensure the product's quality. This defines test items tested for each stage, and it also records and manages test schedules, the number of samples, the staff in charge, anticipated issues and items to note for each stage in advance.
3.5.2. DVTR (Design Verification Test Report)

This tests test items specified on the test plan, documents the results, and utilizes it as reference material for the following stage. It evaluates whether the product of the design implementation stage satisfies the planned development objective (function, operation, performance, etc.), and it determines whether follow up work should be implemented.

This identifies quality risk factors of circuits, structures and SW of new models, develops measures to address them, applies them in the PV stage, and promotes design completeness and evaluation linearity at PV stage for the purpose of securing design quality in early stages.

3.5.3. PVTR (Product Validation Test Report)

This is a document containing the results of PV test items specified by the test plan. Its content must be reflected on the decision making for PVR (Development Verification). Improves unaddressed items in the DV evaluation stage to verify whether the design quality is sufficient by implementing function, operation, performance and reliability tests.

Check whether preparations for production/sales are complete, and determine whether to proceed to the next stage.

3.5.4. PQTR (Product Qualification Test Report)

This is a document containing the results of test items and the results of CS certification test items specified by the test plan. The content must be reflected in the decision making during CS certification and PRA approval.

Determine whether the objective is satisfied through the result of production prototype (PR set) and determine whether to approve mass-production.

3.5.5. FPTR (First Production Test Report)

This is a document to evaluate the process stability through the initial mass-production of products.
4. Conclusion

Work implemented by QA process is not limited to simply checking whether the specified requirements of the product is satisfied. The QA process is a process that objectively guarantees the product is capable of operating normally in a specific environment. Depending on how systematic a company's QA process is, and how many environments and circumstances the process can cover, the company's products will be able to gain objective trust rather than subjective faith.

In addition to the QA processes described above, Hanwha Techwin employs rigid software and hardware evaluation processes which range from the installation environment, operation environment, to climate characteristics, and all developed products are mandated to undergo these processes.

These QA processes of Hanwha Techwin are conducted according to strict standards in order to maintain the highest quality of products and to improve the trust value of the company's products, and they continue to evolve for the purpose of adapting to new technologies and various environments through continuous research and development based on demands made by customers and markets.