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A Study on Reliability of Japanese Home Network Unit Development

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Abstract

This paper describes the issues that must be considered for the diagnosis and improvement of home network systems during the product development phase, and what must be done to resolve the reliability problem when a system is about to enter the Japanese market. It suggests that after the product specifications are determined, an accurate analysis of the environment is needed, and should include factors such as the temperature, humidity and power source of the country concerned. Furthermore, the video standards, residential complex installation environment, wiring specifications, and approval standards must be considered. All the above processes are described in this paper through the case study. The purpose of this paper is that suggested procedures in this research is to be used as a reference for developing similar products in the future.

Keyword : Japanese model, Home network systems, Diagnosis

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1. Introduction

As different functions and network element technologies are applied or interfaced to the home network, various reliability problems can emerge related to compatibility, installation constraints due to the environment, and overheating issues when installed in the wall, to name a few. To overcome such problems by designing a product with consideration to diverse operating environments and patterns, a detailed and accurate analysis of the operating environment is needed. In other words, reliability and quality considerations, such as power source, image standard, home network unit installation environment and wiring specifications are needed. There is the need for various example cases that personnel can refer to during the development of home networks or other products applied in Korea and abroad, to reduce time and cost resulting from reliability problems and avoid the repetition of errors. Therefore, this study is intended to study the quality and reliability problems that can result during the development of Japanese model home network systems, and present countermeasures based on the development technology attained while developing home network units for Korean apartment complexes.

2. JAPANESE MODEL HOME NETWORK SYSTEM

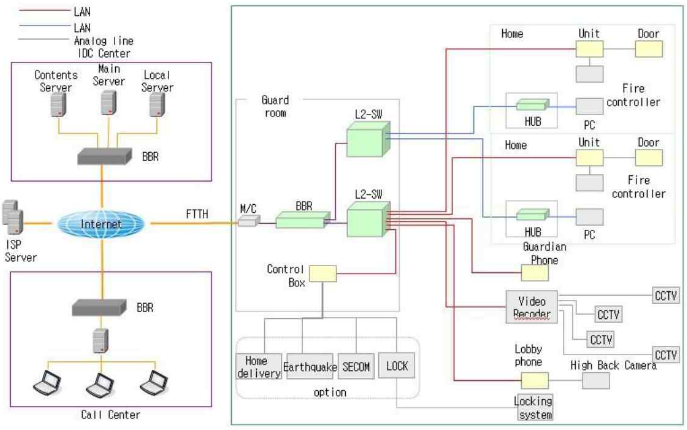
2.1 System Structure

<Figure 1> shows the overall structure of the home network system to be supplied in Japan. The system consists of a local server, home network unit, lobby phone, management office unit, and control box and door phone. Devices interfaced to the home network unit include the call button, emergency button, P type Class 3 receiver(fire detector) and gas leak alarm.

2.2 Interfaced Devices

2.2.1 Gas Leak Alarm

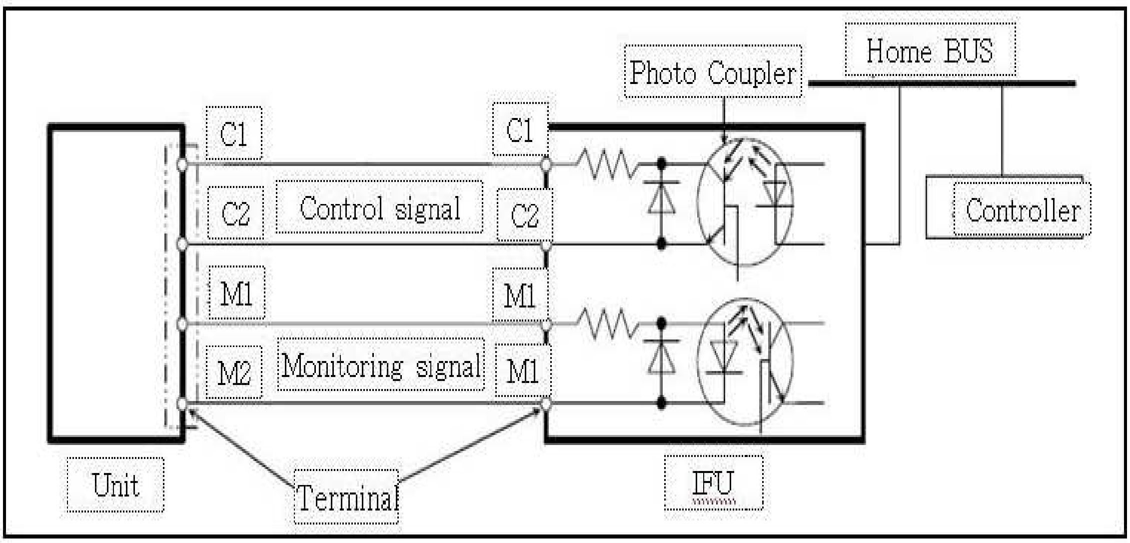
The Japanese gas detector indicates normal condition, detected condition, incomplete combustion condition, and wire cut-off condition. The maximum input voltage is 25V. As such, the circuit design needs to consider the manner in which the four condition values are to be recognized, countermeasures for voltage higher than the home network unit power source, and how to handle noise, over current and over voltage along the power line.



<Figure 1> Overall structure of home network system

2.2.2 JEMA

JEMA is located between the home network unit and the air conditioner or the electric door lock as a buffer. When the home network unit sends a control signal to JEMA to turn the air conditioner on or off, JEMA relays the signal to the air conditioner. It also relays the condition value from the air conditioner to the residential unit. <Figure 2> shows the internal structure and wiring of JEMA.



<Figure 2> JEMA wiring and internal structure

2.2.3 Other Devices

Other devices can include a fire detector, motion detector (IR), magnetic detector, call button and emergency switch. These detectors and buttons use two switched-to-on type power source contacts.

2.3 Japanese Approval Standard

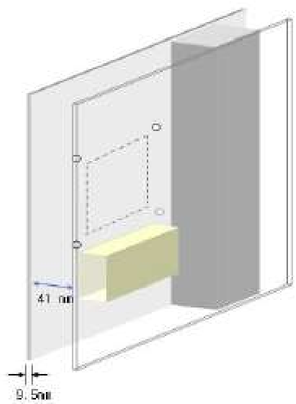
Japanese approval standards include PSE which is similar to Korea's approval standard of electrical parts, VCCI which relates to electromagnetic waves, JATE for the approval of products that include a telephone and TELEC which relates to wireless.

3. DIAGNOSIS OF HOME NETWORK SYSTEM

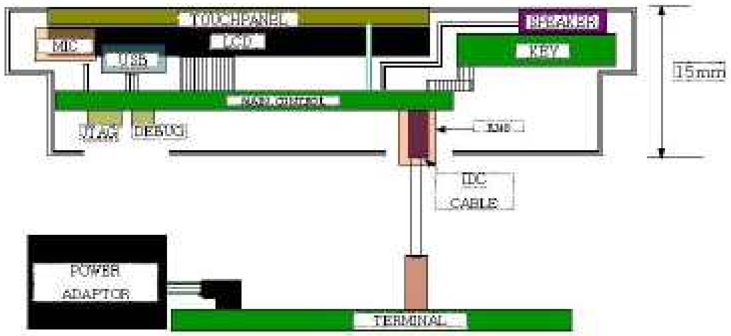
3.1 Unit Design Aspect

3.1.1 Installation Environment

As shown in <Figure 3>, the depth of a Japanese wall can be as little as 35mm, meaning that the home network unit must be around 11mm, considering the power adapter and the terminal board. We were able to reduce the wall inside installed part of home network unit to 15mm by combining two main control boards into one and aligning the additional boards with the LCD, as shown in <Figure 4>. However, this still generated around 6mm interference between the home network unit and the power adapter, as shown in <Figure 5>.



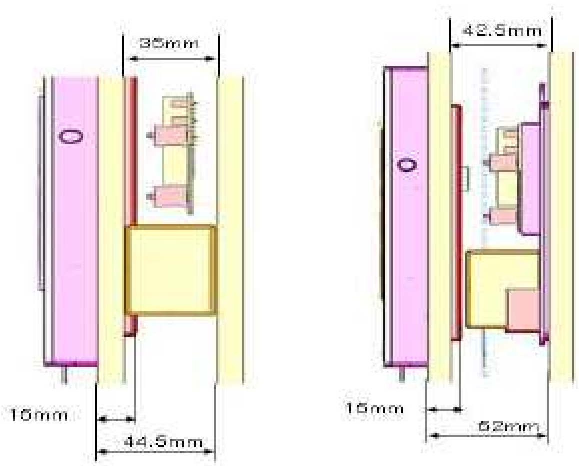
<Figure 3> Japanese wall structure



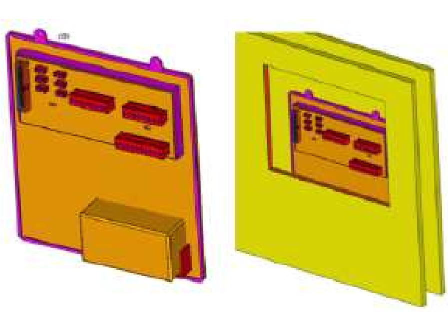
<Figure 4> Structural diagram of home network unit

The fastener shown in <Figure 6> is designed so that the power adapter can be installed below the home network unit.

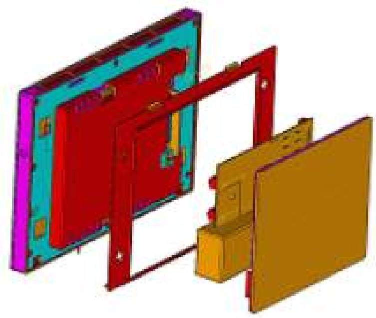
<Figure 7> shows the overall home network unit assembly diagram. The fastener is mounted inside the wall to install the terminal board and the power adapter. The overheating problem of the power adapter is resolved by ensuring that it is installed outside of the product. Since the installation box cannot be used in the same manner as a Korean installation, as the wall inside is empty, the bracket is used to fasten the product. The design specific to a Japanese installation minimizes the thickness of the part inside the wall by placing the power adapter at the bottom.



<Figure 5> Wall inside installation diagram of home network unit



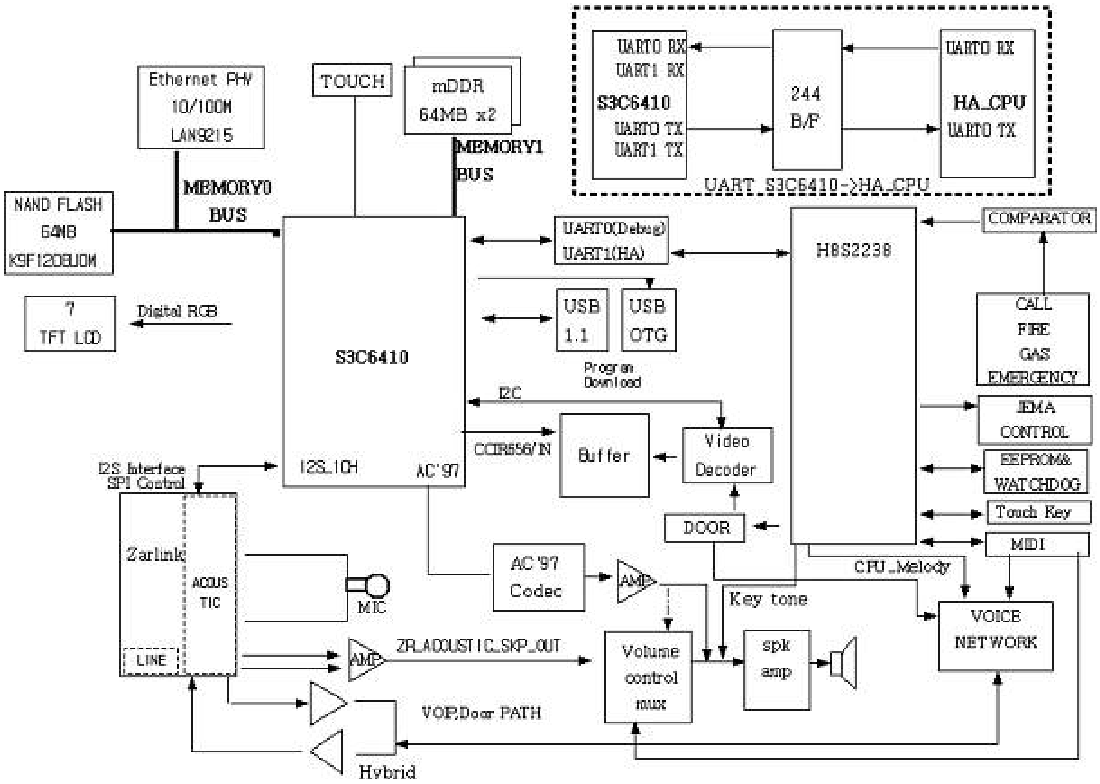
<Figure 6> Wall inside fastener



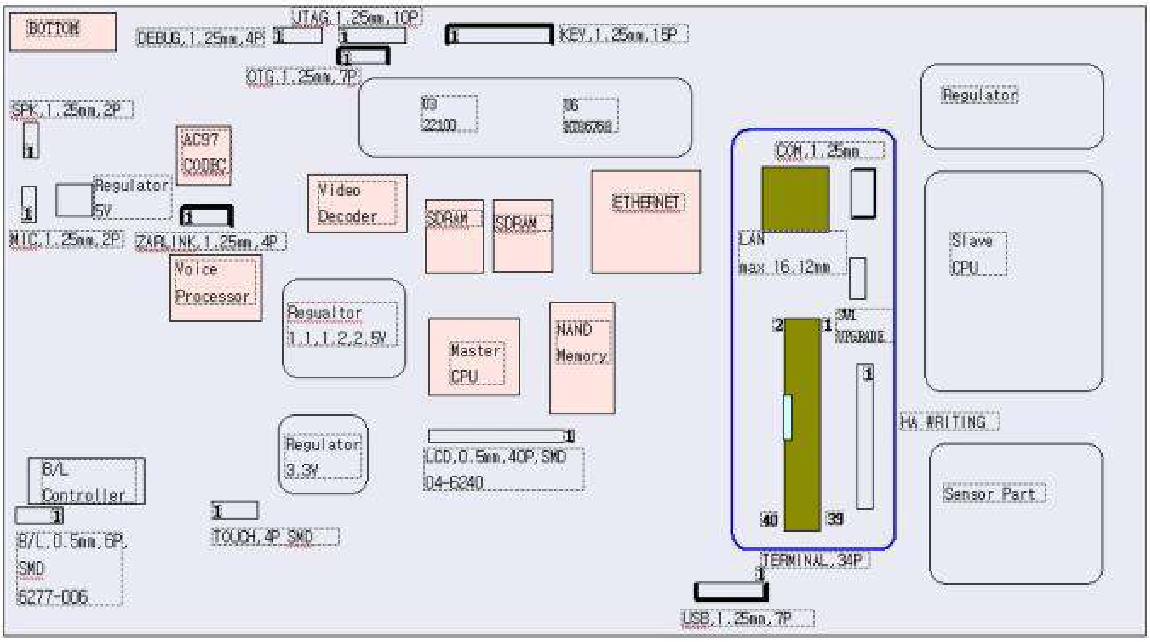
<Figure 7> Home network unit assembly diagram

3.2 Hardware Aspect

Once the product function and design have been decided, engineers must determine the platform to execute the functions, and design the circuit to operate the device. The most important part in the circuit design block diagram shown in <Figure 8> is the CPU. This product has two CPUs. The master CPU, an ARM11-based 32-bit RISC CPU, processes the Ethernet communication, image signals and voice signals, while the slave CPU controls the interfaced devices. Other elements include RAM, ROM, voice processor, Ethernet controller and video decoder. Since the home network products are interfaced with the security system, there can be security problems if the product malfunctions. Therefore, this platform ensures that when one CPU stops functioning, the other CPU automatically resets the problem CPU. This design prevents security problems due to system shutdown or failure to give notice of an emergency situation.



<Figure 8> Circuit design block diagram

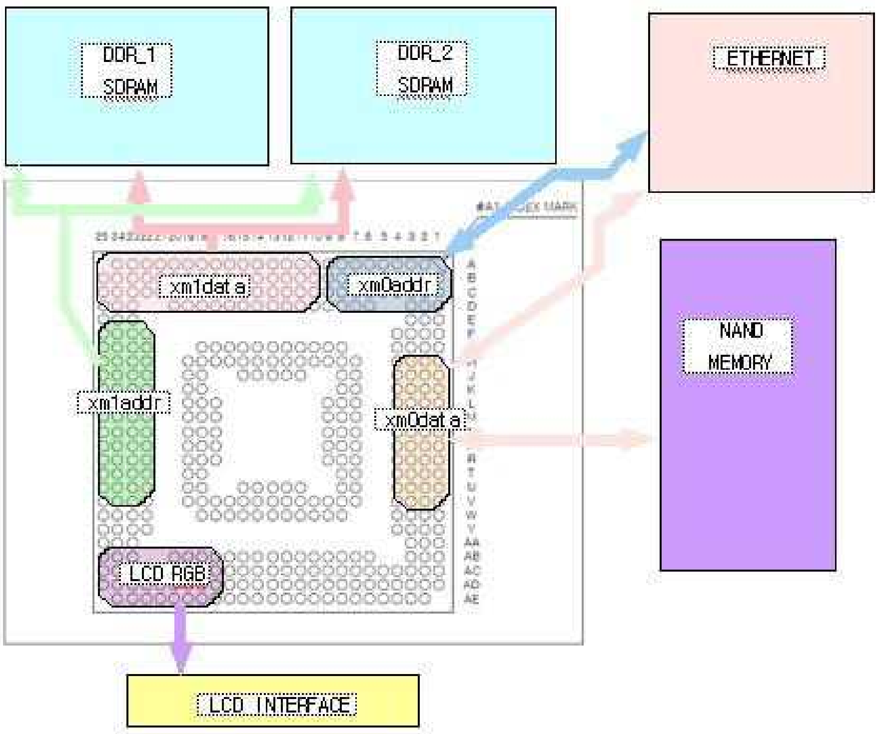


<Figure 9> Main board part arrangement diagram

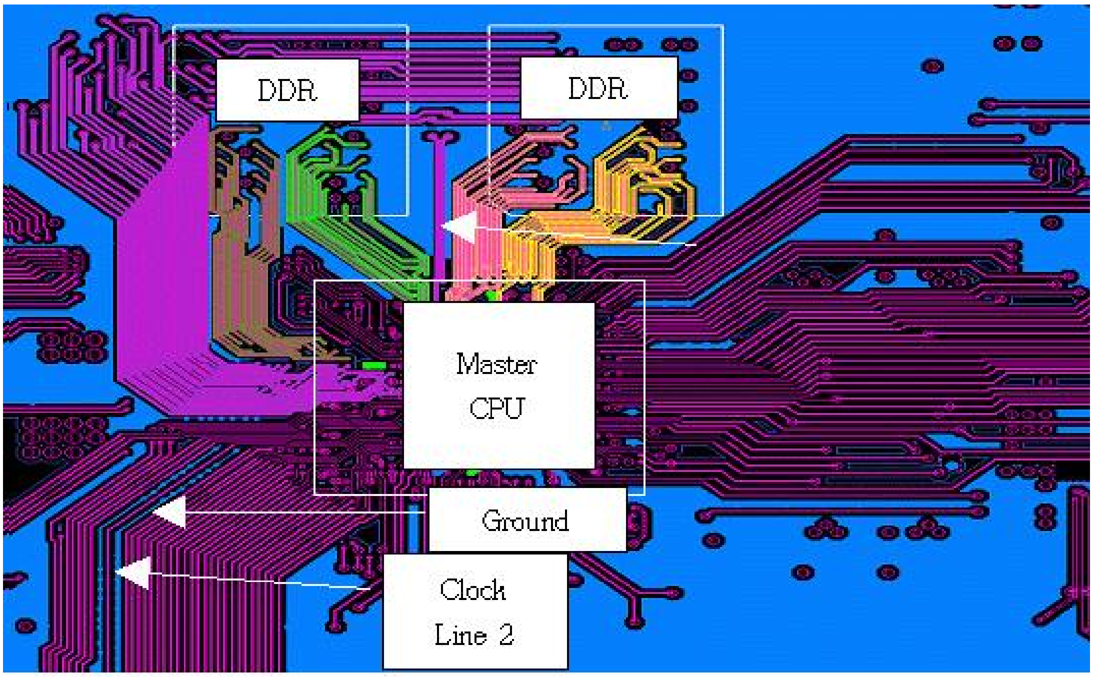
<Figure 9> and <Figure 10> show the arrangement of the component when designing the PCB (Printed Circuit Board). Product reliability and electromagnetic wave test standard must be considered when arranging the components. As shown in <Figure 10>, the elements are arranged at the shortest distance around the CPU. By arranging the parts that use fast data or the address bus close to the CPU, the approval specification is satisfied, and malfunctions due to external noise are prevented.

As shown in <Figure 11>, the clock line, which has the biggest impact in terms of electromagnetic waves, is connected to the memory via the shortest distance and is grounded so that the electromagnetic wave of the clock line would not be radiated. In addition, issues like PCB design of the DC power source and the application of electromagnetic wave shielding parts are considered during circuit design. Japanese approval standards were met by considering electromagnetic wave interference, from platform design to PCB pattern design.

The home network unit passed all ESD, power line and signal line reliability tests. However, there was a problem of the key not being recognized in the radiation noise using the capacitance-type touch sensor. This was solved by applying an inductor and a capacitor to the key touch sensor operation power unit.

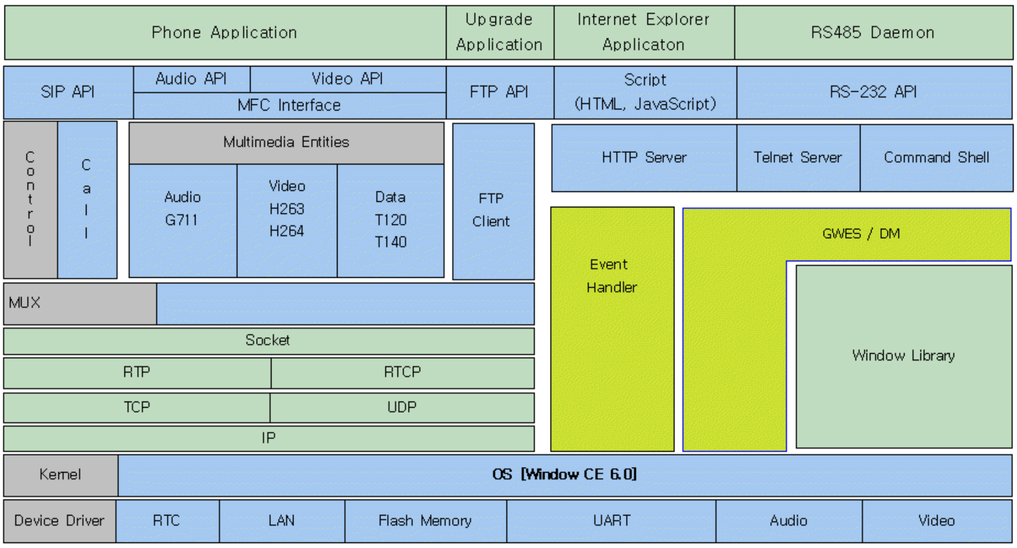


<Figure 10> Arrangement around CPU



<Figure 11> Signal line pattern design example Software Aspect

The operating system of the home network unit is WinCE 6.0. Although the use of embedded Linux and Vxworks is growing, we selected WinCE as it is already proven and is highly reliable. SIP is selected as the communication protocol, and the library package from Radvision is selected as the protocol stack. <Figure 12> is the software block diagram.



<Figure 12> Software block diagram

The use of the memory and multithread structure are important issues to ensure system stability from a software perspective. The home network unit is designed to automatically recover in the event of various software problems. For applications whose problems are relatively low-risk from a system perspective, a task to periodically monitor their operation status is created.

4. DEVELOPEMENT OF JAPANESE MODEL HOME NETWORK SYSTEM

Review and Improvement Opportunity for Each System Development Step

<Table 1> Review and improvement at development process

Step	Review	Improvement
Product Planning	1. Site environment analysis 2. Installation environment analysis 3. Interfaced device analysis 4. External approval standard analysis 5. Buyer and consumer requirement analysis	1. Use of materials with outstanding temperature and humidity properties
Structural Design	1. Platform decision 2. Fixture design	1. Adoption of mutually complementary circuit using 2 CPUs 2. Minimization of product thickness by combining the main boards
Detailed Design	1. Assembly and installation analysis 2. Circuit and software design	1. Resolution of overheating problem by using external power adapter 2. Circuit design with consideration of interfaced devices
Design Verification	1. Reliability test 2. External approval 3. Software verification	1. Circuit enhancement to improve reliability 2. PCB design for electromagnetic standard
Mass Production Verification	1. Mass production problem review	

The process from system planning to mass production involves many steps. During the product planning step, the environmental conditions, including climate conditions such as local temperature and humidity and domestic approval standards are reviewed, and the installation space and power source environment are surveyed. If the product is developed without such information, environment-related reliability problems may result. During the structural design step, the functions for reliability, quality and platform suitable to the site environment are determined, and the fixture is designed to fit the installation space to prevent product installation-related reliability problems. In the detailed design step, the circuit design needs to account for specific local standards, such as site power source and video standards. As different devices are interfaced in the Japanese case, the circuit and software specific to the interfaced device need to be designed. After the first mock-up is generated, hardware circuit, assembly and installation will be reviewed. In the design verification step, reliability and software verification and electromagnetic wave interference test are conducted. The mass production verification step corrects and supplements the problems generated during mass production after product development. <Table 1> summarizes the review and improvements made at each step of development.

4.2 Home Network System Implementation

<Figure 13> shows the developed home network unit. After the development steps described in 4.1 have been completed, the system has passed the reliability test and integration test. It will be supplied to a small-scale residential complex in Kanakawa prefecture (near Tokyo) in December 2009.

<Figure 13> Home network unit

5. Conclusions

This paper describes approaches and considerations when developing a product to be supplied to an overseas site for the first time. After the product specifications are determined, an accurate analysis of the environment is needed, and should include factors such as the temperature, humidity and power source of the country concerned. Furthermore, the video standards, residential complex installation environment, wiring specifications, and approval standards must be considered. After the analysis of such diverse operating environment factors and patterns is complete, the product is planned and then the fixture engineer, hardware engineer and software engineer develop the product with consideration of the operating environment, pattern and reliability. A design process that considers reliability and quality during the product development step will not only improve the product's reliability and quality, but also enhance the manufacturer's reputation. It is expected that the product design and procedure with consideration to reliability described in this paper could be used as a reference when developing a Japanese home network unit or other products.

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