The Designing Bus for Nuclear Safety Class Controller

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Abstract

EtherCAT (Ethernet for Control Automation Technology) is based on the IEEE 802.3 standard as one of the communication which is the I/O (Input/Output), sensors and communication function of PLC (Programmable Logic Controller) in industry and factory environment use is increasing. The Nuclear Safety Class Controller implemented by the EtherCAT applied bus can be shown the improving performance of data transmission in the controller.

1. Introduction

Existing nuclear safety class controller typically used the Parallel Link. The increase of a small data communication in a result of increase in the number of I/O contacts demands to high-speed bus but it could not use some unstable problem that is switching noise, reference voltage unclear, magnetic coupling, FEXT-induced jitter and etc. in the parallel link. However to be shown to solve uses the E-Bus of EtherCAT widely used industrial site. (See to Figure 1)

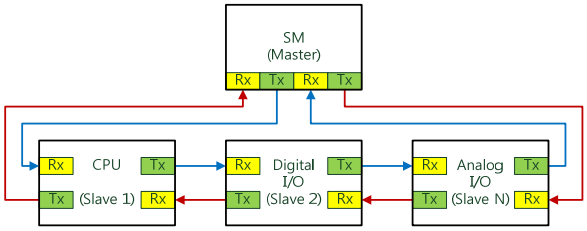

Figure 1 The General Configuration of the EtherCAT

The EtherCAT supports almost Line, tree or star topology. The On-the-fly processing way which can read and write data when the frame passes through in the network and the using the FMMU (Fieldbus Memory Management Unit) mapping in the 4GB (Giga Byte) space base on the hardware can process easily for a packet to each slave data. (See to Figure 2)

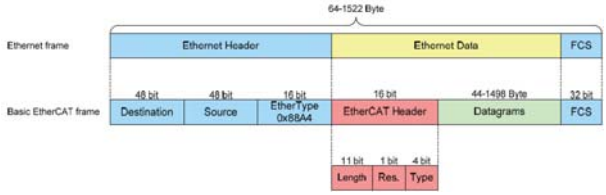

Figure 2 Ethernet Fame with EtherCAT Data

2. Methods and Results

The I/O module, communication module and CPU (Central Processor Unit) module and the backplane, the E-bus applied the physically LVDS (Low Voltage Differential Signaling) and data transaction using a manchester encoding, module satisfied with the design requirement (ex. response time, contact signal number and etc.) of Nuclear Safety Class Controller compos this system.

The EtherCAT uses the PHY chip in the physical layer (1 of 7 OSI (Open Systems Interconnection) layer) but the mac of data link layer can make FPGA or ASIC (2 of 7 OSI layer).

2.1 Controller structure

In case of a EtherCAT Chip by ASIC, it has four (4) ports zero (0), one (1) ports are used as the default and auto-forward orders are zero (0) → three (3) → one (1) → two (2) port. In addition, each module shall install a chip in order to configure an “On-The-Fly” format a feature of EtherCAT and each slot shall setup a chip for Hot-Swap function in the backplane. And it shall implement a using three (3) of four (4) ports. (See to Figure 3)

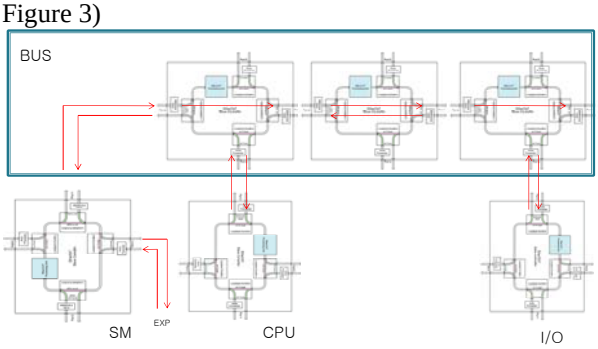

Figure 3 Controller Compose Using a Frame Processing (Auto Forwarder and Loop Back)

2.2 Controller shape

The figure below is the shape of each module for controller. (Figure 4) The pin of backplane was saved and was possible designed to high speed data transaction because to design an E-bus using a LVDS line.

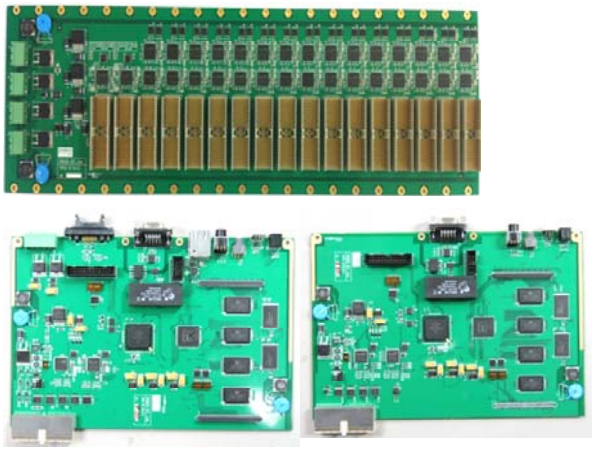

Figure 4 Shape of Each Module

2.3 Verification of performance for controller

The performance was tested for component operation, interface, bus communication and etc. using a RS-232.

A sub-rack was installed modules such as a below figure and then read information for each module after connected a computer through a RS-232. (See to Figure 5)

Figure 5 Shape of Sub-rack

Information about the module, as shown in the following figure was confirmed by serial communication.

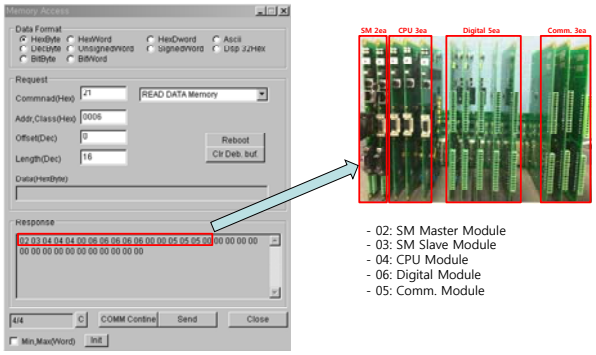

Figure 6 Check a Module Installed

In order to confirm to performance of bus communication such as Figure 7 is constructed. All CPU and SM (System Manager) module connected computers and then confirmed an operation to read and to write of a data in CPU.

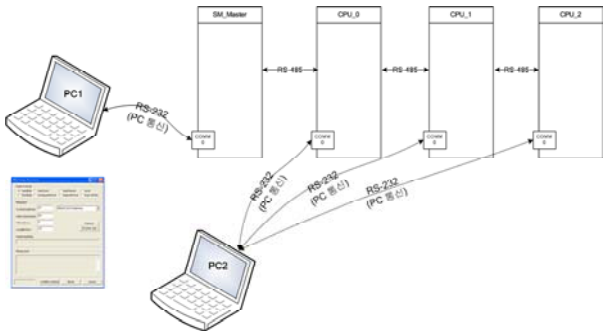

Figure 7 CPU and SM Module Communication Test

Each CPU in the data transmission was a constant pattern SM normally received in the data could confirm that it has. Data can also be read normally the normal bus communication was confirmed. (See to Figure 8)

Figure 8 Confirm a Communication Test Results3. Conclusions

Data of the many contacts transmission was confirmed that there is no problem by means of using bus that a nuclear safety class controller was used by the E-bus of Widely used in EtherCAT of industrial communication network.

The transmission of quantity will have many limitations because Commercial ASIC chips 8KByte Data transfer only. In the future a FPGA implementation of EtherCAT is required in order to transfer more DATA.

REFERENCES

[1] BECKHOFF, ET1100 Hardware Data Sheet v1.8, p26, p36, 2010

[2] EtherCAT Technology Group, EtherCAT Communication Presentation, p60, 2011