

Improvement of Heat Power Supply Module

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1. Introduction

A module which provides power to Heat Junction Thermocouple(HJTC) is called Heat Power Supply Module(HPSM). The main roles of HJTC are as below.

1. Measuring reactor coolant level (providing loss of coolant information)
2. Measuring temperature in reactor head area (Calculating subcooled margin in reactor head area)

HPSM supplies power to such HJTC and it is equipped in a QIAS-P Cabinet.

2. Outline of HPSM

2.1 History of HPSM

After TMI accident in America, NRC(Nuclear Regulatory Commission) felt the necessity of checking the inside of the reactor when pressurized coolant make a problem and then they designed "Inadequate Core Cooling Monitoring System(ICCMS)." Major functions of ICCMS is monitoring coolant level in reactor and measuring subcooled margin in reactor through HJTC. To perform these functions, Qualified Indication and Alarm System – PAMI(QIAS-P) processor is built in logic which controls HJTC power then, calculates coolant level in reactor and checks temperature in reactor head area. In the past, HJTC was controlled by QIAS-P directly with relay junction. However, operator found that using relay affects the life of heater to be getting shorter and shorter quickly. Because of that, to connect QIAS-P with HJTC indirectly, HPSM, when the QIAS-P processor sends a current, it changes to voltage proportionally, was created.

2.2 Requirements of HPSM

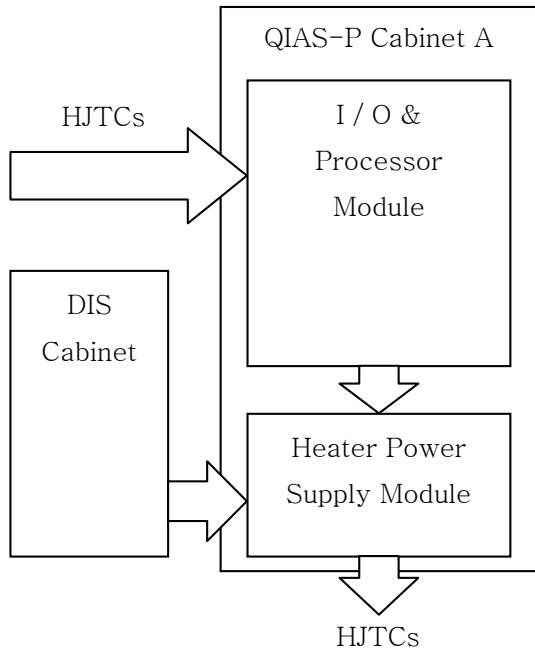
1. HPSM receives a current from QIAS-P and changes to DC voltage proportionally then, sends power to HJTC.
2. According to redundant criteria in safety system, when QIAS-P built in HJTC control logic makes a problem, DIS catch up the fact and acknowledges that and Operator confirms that and operates Transfer Switch at Safety console manually and then, input source signal to HPSM is changed from QIAS-P to DIS.
3. Safety Failure : HPSM receives source signal with periodic pulse from QIAS-P Processor. This pulse status is checked by Analog Counter in the module and if the input pulse does not check over designated time,(It means that QIAS-P has a problem.) Watchdog Error Alarm is actuated. At the same time, Output signal to HJTC is changed the lowest value and HPSM ignores the source signal from QIAS-P Processor. In this situation, operator would check the alarm signal and switches signal source from QIAS-P Processor to DIS. Then, HPSM selects input signal form DIS and transmits power to HJTC.

3. Design Improvement

3.1 Module Separation

In the past, existing HPSM outputted power from one combined module to each HJTC. In such case, when HPSM broke down, every HJTC did not operate. To avoid this case, we divide HPSM into the number of

HJTCs. In other words, each HJTC connects to be separated HPSM. Thanks to this improvement, even if one HJTC makes an output failure, we can fix the HJTC without stopping the other HJTCs. Therefore, it is definitely developed in maintenance and repair of HPSM.



Picture 1. HPSM Configuration

3.2 Easy to check operation status

HPSM can check the status information to be easy by LED or junction point. When situations such as Watchdog Signal Fault, Fuse Fail or Over Voltage Error occur, Watchdog Fault Alarm or Common Fault Alarm is arisen while this condition became known to QIAS-P Processor. Through these two works, operator is possible to check easily and feedback quickly.

4. Test

4.1 HPSM Power test

Output voltage resulted from input current was satisfied to put in the $\pm 2\%$ for designated value.

Input Current (mA)	Available output voltage range (V)	Actual Output Voltage(V)	Decision
0	4.9~5.1	5.0	O

10	25.3~25.6	25.5	O
20	30.6~30.9	30.9	O

4.2 Watchdog Fail test

When the watchdog signal from QIAS-P is not checked in setting cycle, HPSM turns on the Watchdog Alarm Signal and then, output voltage is changed to the low limit value.

4.3 Fuse Fail Test

When a Fuse has a problem, Common Fault Alarm is arisen. Since then, operator push the Fault Reset button, HPSM is recovered.

4.4 Over voltage Test

If output voltage exceeds the high limit value, Common Fault Alarm is arisen while HPSM sends the over voltage error message.

4.5 DIS Transfer Test

When DIS Transfer Signal is inputted, HPSM changes control signal from QIAS-P Processor to DIS. HPSM ignores input current from QIAS-P Processor and it operates based on the DIS input signal. In addition, when the situation is occurs, HPSM sends transfer message to QIAS-P processor.

5. Conclusions

HPSM is the critical part to operate HJTC therefore it designs perfectly to supply to the project. Until now, we improve maintenance / repair of HPSM and upgrade to be convenient. In the future, we continue improving more and more and make it possible to develop better HPSM.

6. References

- [1] KOPEC, "The QIAS-P Design Specification", Rev. 00, November 2009
- [2] KOPEC, "Heated Junction Thermocouple System Requirement" Rev. 00