Evaluation and Improvement of PoE-based Temperature Measurement Module

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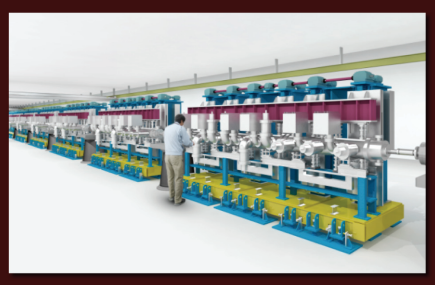
1. INTRODUCTION

Temperature measurement of Insertion Device (ID) magnets at the Japanese XFEL



- requires 24 measurement points per ID (18 IDs at BL3)
- requires a total accuracy of 0.1 degree C, a resolution of ~0.01 degree C
- difficult to provide enough space for conventional instruments

-> PoE technology will be effective !!

Advantages of using PoE technology

- reduce the wiring required for power-line
- monitor/control power-feeding through network switch

E-060

Linux-based temperature measurement module using PoE technology

consists of
- a CPU card (240MHz SH-4 CPU)
- a temperature measurement card (4 CHs of 3-wire Pt100 sensors)

Applying six sets of E-060 is not cost-effective

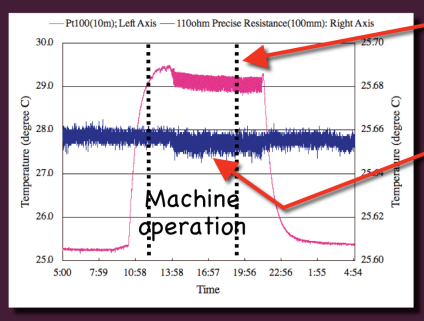
-> We developed a new PoE-based temperature measurement module with 24 inputs of Pt100 sensors.

2. DEVELOPMENT

Approach : Expand and improve the E-060 module

We were able to feed back our experiences obtained from the E-060 installation in the SCSS prototype accelerator.

Feed back from E-060 Experience



- Result using 3-wire Pt100 with 10m unshielded and untwisted lead line.
  -> affected by RF noise.
- Result using 110ohm precise resistance with 100mm unshielded untwisted lead.
  -> observed some noise but satisfactory

The noise was suppressed when 3-wire Pt100 with 10m unshielded but twisted lead line was used.

These measurements indicated

- E-060 was satisfactory
- have to pay more attention to the lead lines of the sensors.
  - use a 4-wire shielded and twisted lead line.

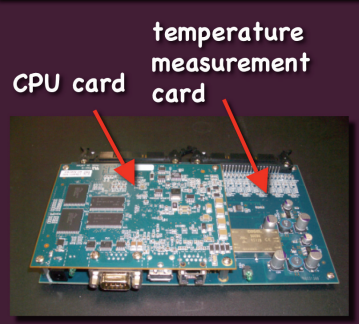
+

- prepare an external terminal for analog ground of the module.
  - can select any ground for the analog signals.

-> developed a new module E-069.

- can be connected to up to 24 four-wire Pt100 sensors.
- can be powered through PoE.

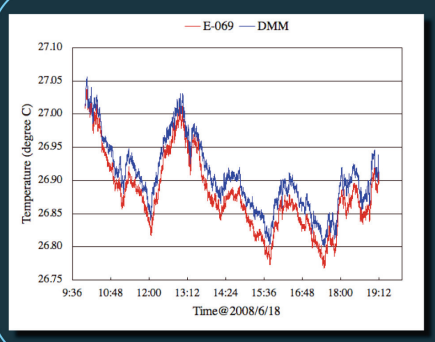
E-069



	E-069	E-060
Channels	24	4
Sensors	4-wire Pt100/JPt100	3-wire Pt100/JPt100
Size (HxDxW)	200x130x 32mm	130x100x 30mm
Power Consumption	~6.3W	~4.7W
Resolution	0.0001 degree C	0.001 degree C
Sampling Rate	~0.9Hz	~1.8Hz

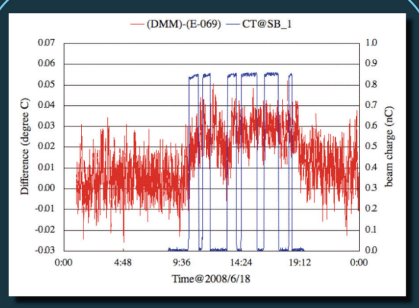
3. EVALUATION

Installed E-069 in the SCSS prototype accelerator to verify its feasibility for temperature measurement of XFEL ID magnets.



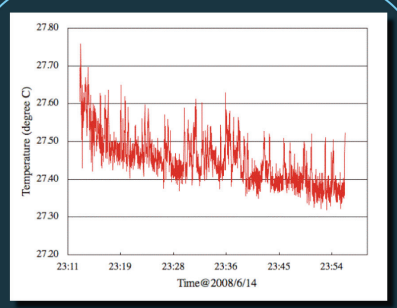
E-069 showed good results even during the accelerator operation and successfully realized almost the same measurement precision as the 6 1/2 digit DMM of about 0.01 degree C.

- connected 4-wire Pt100 with 10m shielded and twisted lead lines.
- connected the shields of the lead lines to the analog ground of the module.



Difference between measured values obtained from E-069 and DMM.

- The differences appears to be rather large (0.03 - 0.04 degree C) during the machine operation.
- We do not know whether this is due to RF noise or the variation of the air temperature.



Measurement without connect the shield of the lead line to the analog ground of the module.

- The noise level was markedly large.
- The external terminal of E-069 analog gound was very important for the precise measurement.

4. SUMMARY

- We have successfully developed E-069, a PoE-based temperature measurement module with 24 four-wire Pt100 inputs, by expanding and improving E-060.
- The new module has been installed in the machine tunnel of the SCSS prototype accelerator. By connecting shielded and twisted lead lines to the Pt100 sensors, the module showed good results with a precision of about 0.01 degree C even during machine operation.
- We consider that the new module is feasible for the measurement of XFEL ID magnets.
- Since E-069 can be powered through PoE, we can obtain the benefit of greater freedom of module deployment.