

Developing of the Pulse Motor Controller Electronics for Running under Weak Radiation Environment

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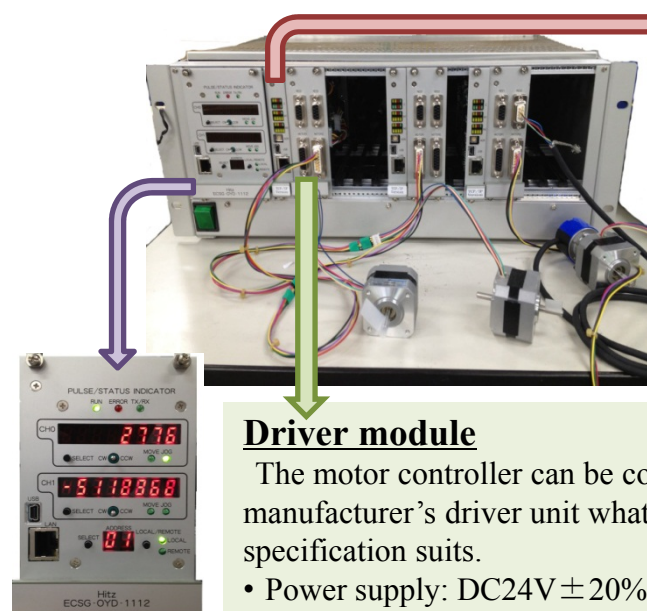
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Abstract

Hitachi Zosen Corporation has developed new pulse motor controllers for accelerator equipment drive control. The controllers have functions operating two axes per one controller. We can operate the controllers through Ethernet TCP/IP(or FLnet). We plan to drive the motor controllers in optics hatch filled with weak radiation.

If we can put the controllers in optics hatch, wiring will become simple. Therefore, we have evaluated the controllers electronics running under weak radiation.

We performed on the controller board γ -ray and X-ray irradiation test. The results of approximately 200Gy irradiation dose, we guaranteed the controller to work without problems.



Controller module

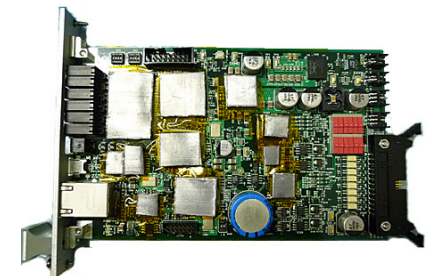
The controller module is an implementation of SH-2 CPU, PCL6123 pulse controller, the resolver/encoder and LAN controller.

The module can control two axes (rotation angle monitor) in one board and maximum 16 axes by local bus (RS-485A) connection between modules.

Driver module

The motor controller can be connected any manufacturer's driver unit whatever signal specification suits.

- Power supply: DC24V \pm 20% 3A Max.
- Step angle: full/half(0.72° /0.36°)



Indicate module

The indicate module can perform minimum operation and a position monitor.

The module also has the specification of the master mode of a controller module. However, a motor is not operated by the indicate module itself.

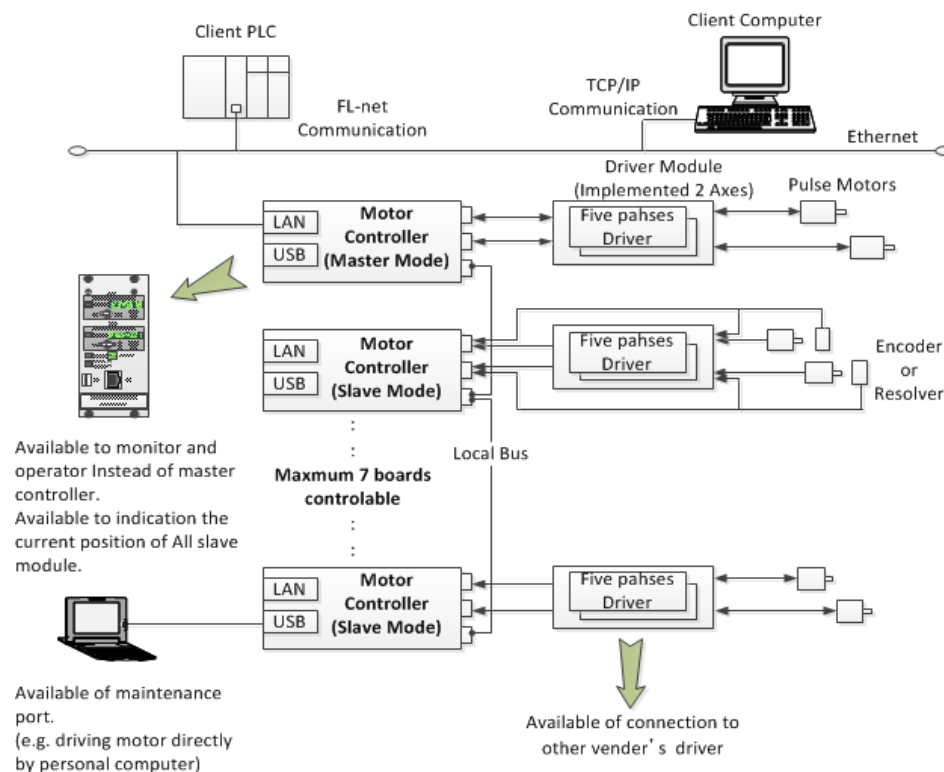


Figure: Block diagram

Test procedure

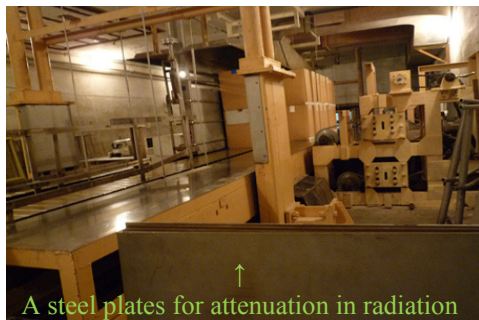
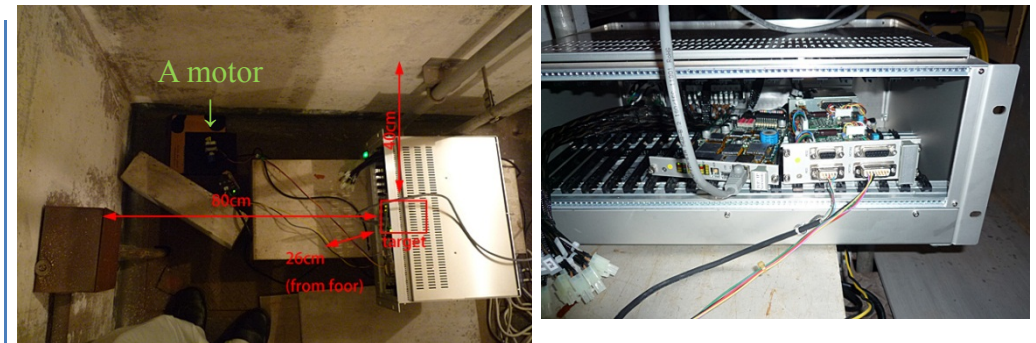


Figure: Inside of irradiation chamber

- Date: September 3, 2013 10:00am-5:00pm
- Place: RIC-1 irradiation chamber, at RADIA INDUSTRY co.,ltd
- Source: ^{60}Co , 40Gy/h
- Irradiation time: 5h
- Distance from radiation source: 2.5~3m
- Shielding materials: Lead(IC mounting side of PCB;2mm, back side:1mm)



We located the controller module, driver module and case in irradiation chamber. LAN cable was laid irradiation chamber to outside. We operated to the controller module from outside.

Result

- Actual dose value: 38.26Gy/h
- Irradiation time: 5.23h
- Integrated dose: 200.0998Gy

Motor was good operation till the end of test. And the communication error didn't occur.

Consideration

Because of a lead mass attenuation ratio, mostly Compton scattering went on under our test. According to a report about radiation test to transistor, transistor's threshold voltage dropped to a lower value after irradiation. However the result was caused more than 2kGy dose case. The dose is 10 times of our test.

The motor was driving continually without the abnormalities in communication during the test. Accordingly, it seems that the radiation resistance of the pulse motor controller to 200Gy doses was collateralized by the PCB.

Conclusion

We tested to irradiate 200Gy dose in pulse motor controller. As a result, we checked that the pulse motor controller ran without any incident up to the value nearly. We clarified the scope of available under radiation environment by the minimum shielded processing.

| | Number of times |
|------------------|-----------------|
| sending command | 205703 |
| received command | 205703 |
| moving times | 320 |
| error times | 154 |
| error times(S) | 151 |