

Magnet Power Supply Control System using "i-DIO" FPGA Program in a VME Fieldbus Card

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A VME optical link remote IO module system (i-DIO card) has been made and tested with a two channel enclosed power supplies for magnets in the XFEL/SPring-8.
 An FPGA in the i-DIO card is used for current deviation monitoring and for a local control system.

Summary

- 1) Two channel control (small power supplies) → **Good Cost Performance !**
- 2) Remote card direct connection using optical fiber → **High Reliability !**
- 3) FPGA application (ADC averaging, current monitoring, local control, etc.) → **High Availability !**

Magnet Power Supply

Over 330 sets small power supplies (PSs) of ±3A~20A for Steering and Quadrupole magnets are used with a pair of vertical and horizontal direction sets. Five large PSs (130~600A) are used for 8GeV bending magnets. Stabilities of PSs are required less than 1E-4 or 1E-5. Unipolar, bipolar and four-quadrant type PSs were designed and manufactured.

Control System

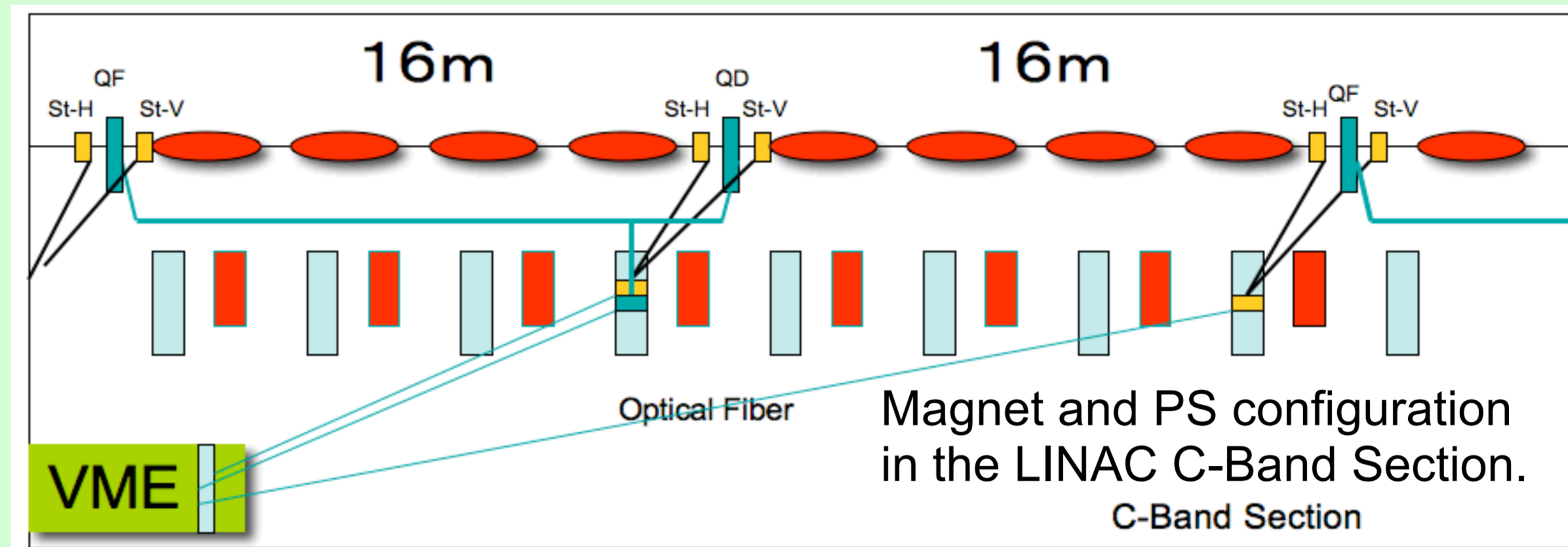
Magnet power supply control system takes a VME field bus and the "MADOCA".

OPT-CC

OPT-VME was first developed as a master module of the VME field bus in 2001. Then it is modified to OPT-CC, which has 12 optical ports in order to increase the number of slave card connections. Also it has relay mode becoming available for a star connection. The card size is 6U in the VME chassis.

i-DIO

OPT-VME's Remote IO card (OPT-DIO) contains an FPGA for communication with the VME master module. This Remote IO card is modified to i-DIO in order to manage high level application programs, for example, ADC averaging, current deviation monitoring and local control sequences.

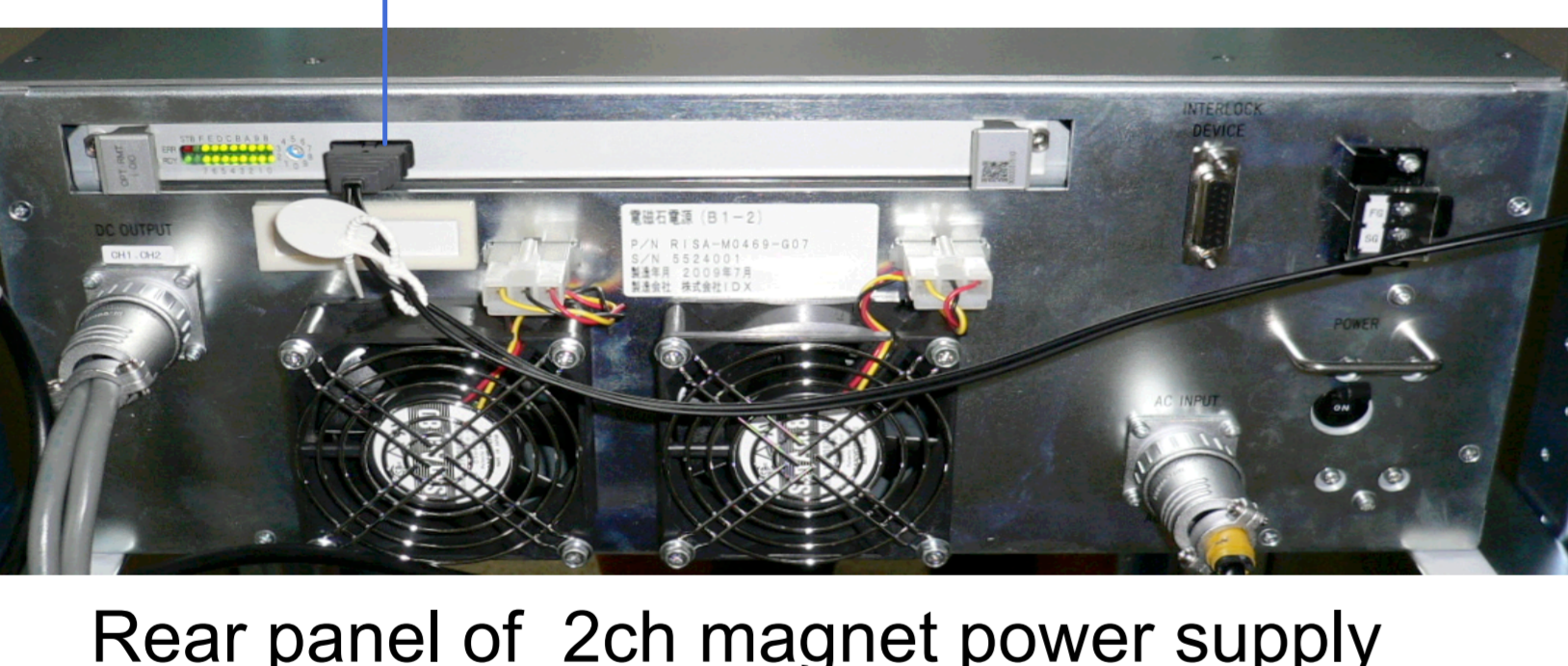
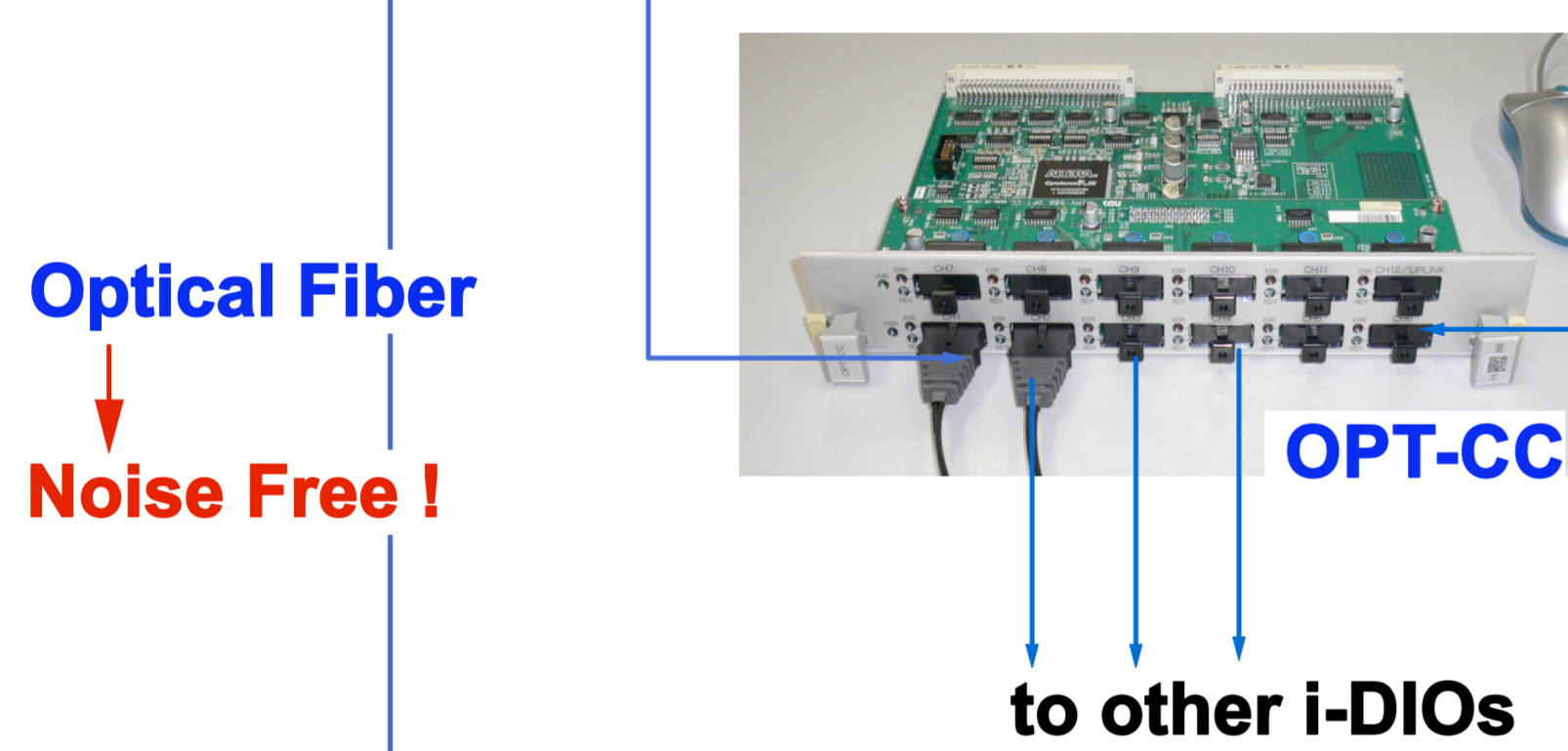
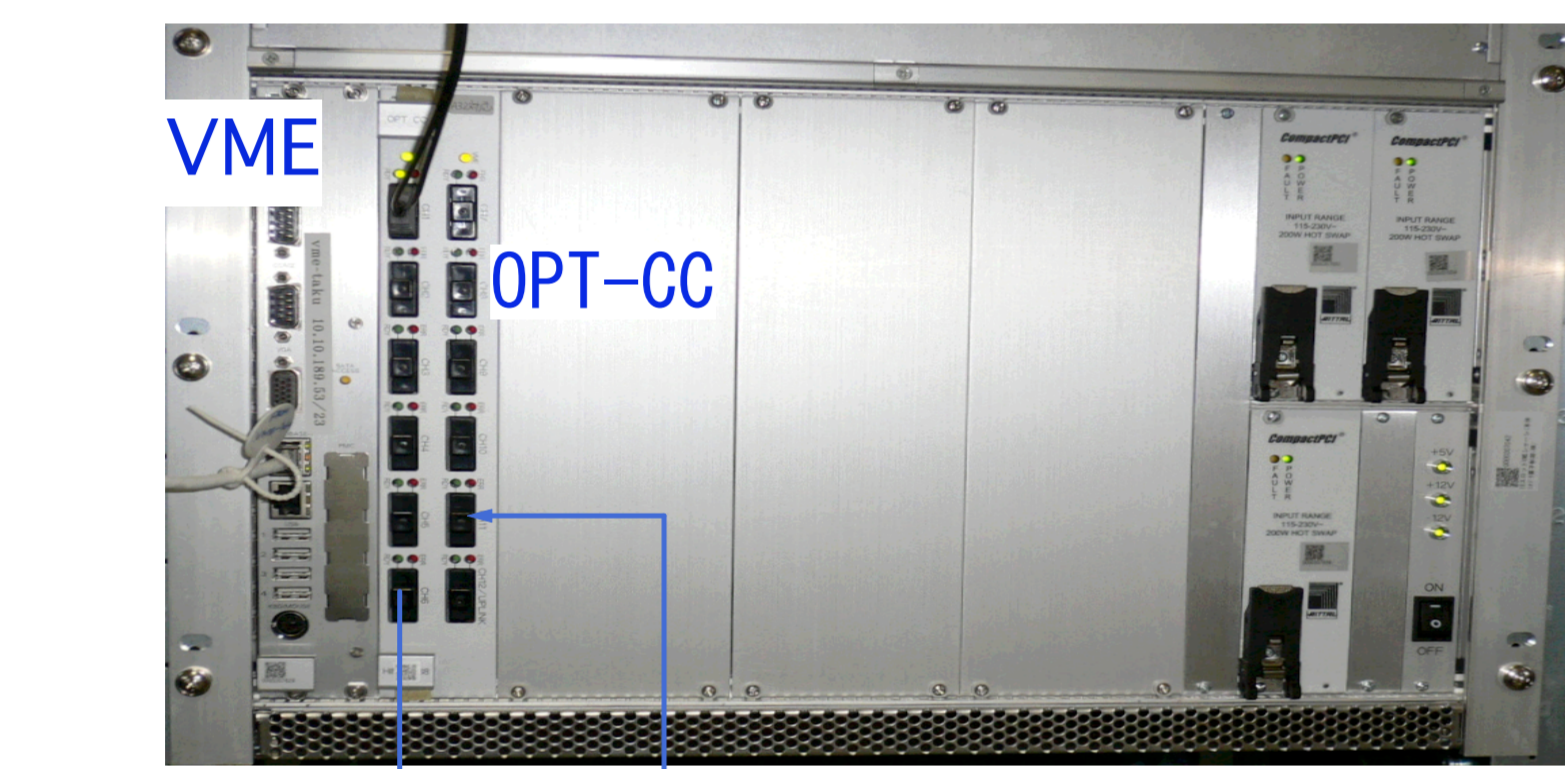


Two Channel Control / One Remote Card

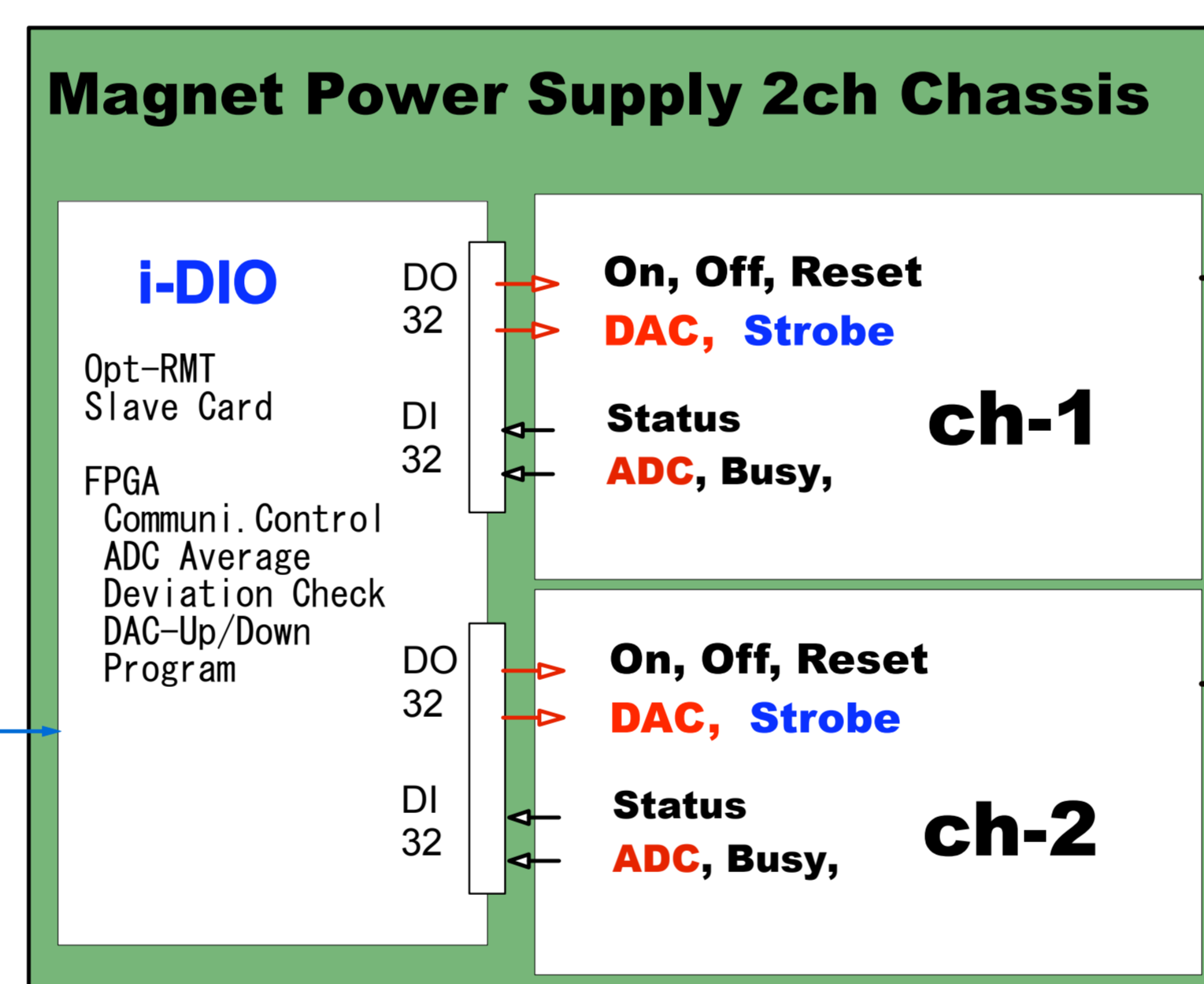
One PS control interface module (i-DIO) has 64bit DO and 64bit DI, and it can control two PSs. Therefore most of the small PSs are enclosed by two sets in one chassis, which are used for horizontal and vertical steering magnets and quadrupole magnets.

→ **Good Cost Performance !**

→ **High Availability !**
Good Cost Performance !



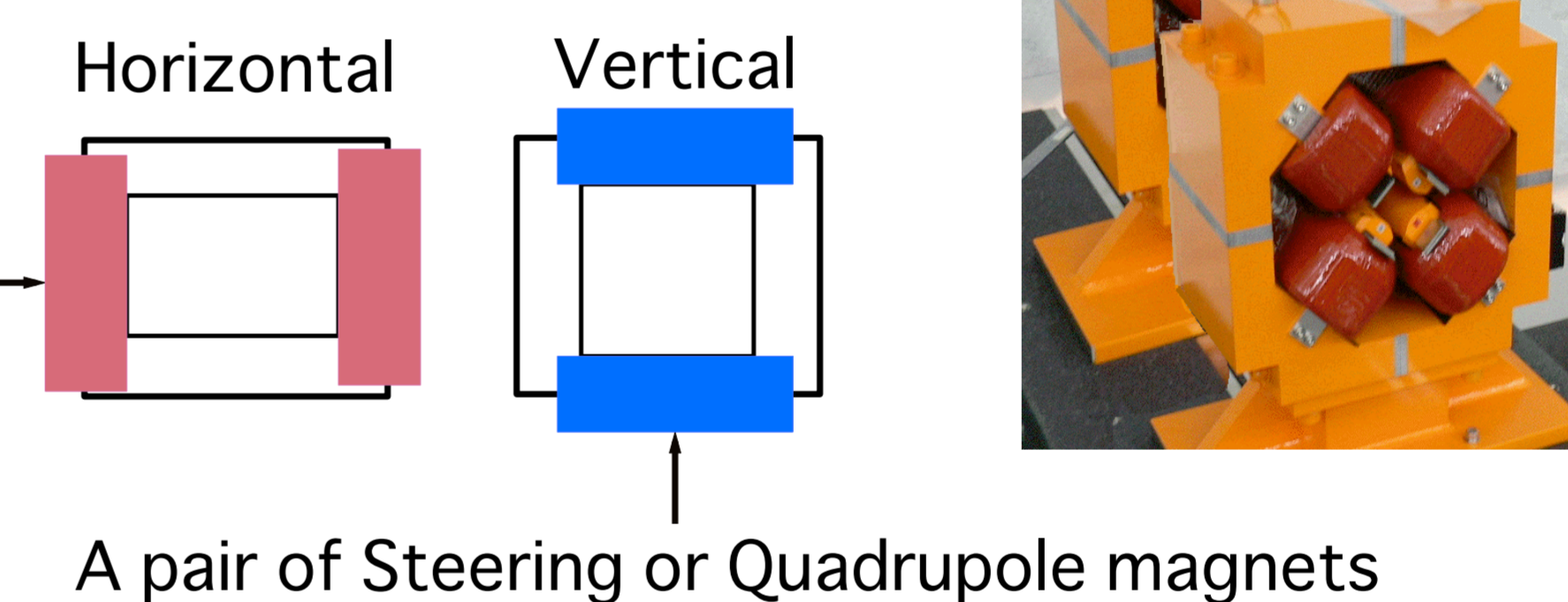
The i-DIO is inserted into the PS rear panel.



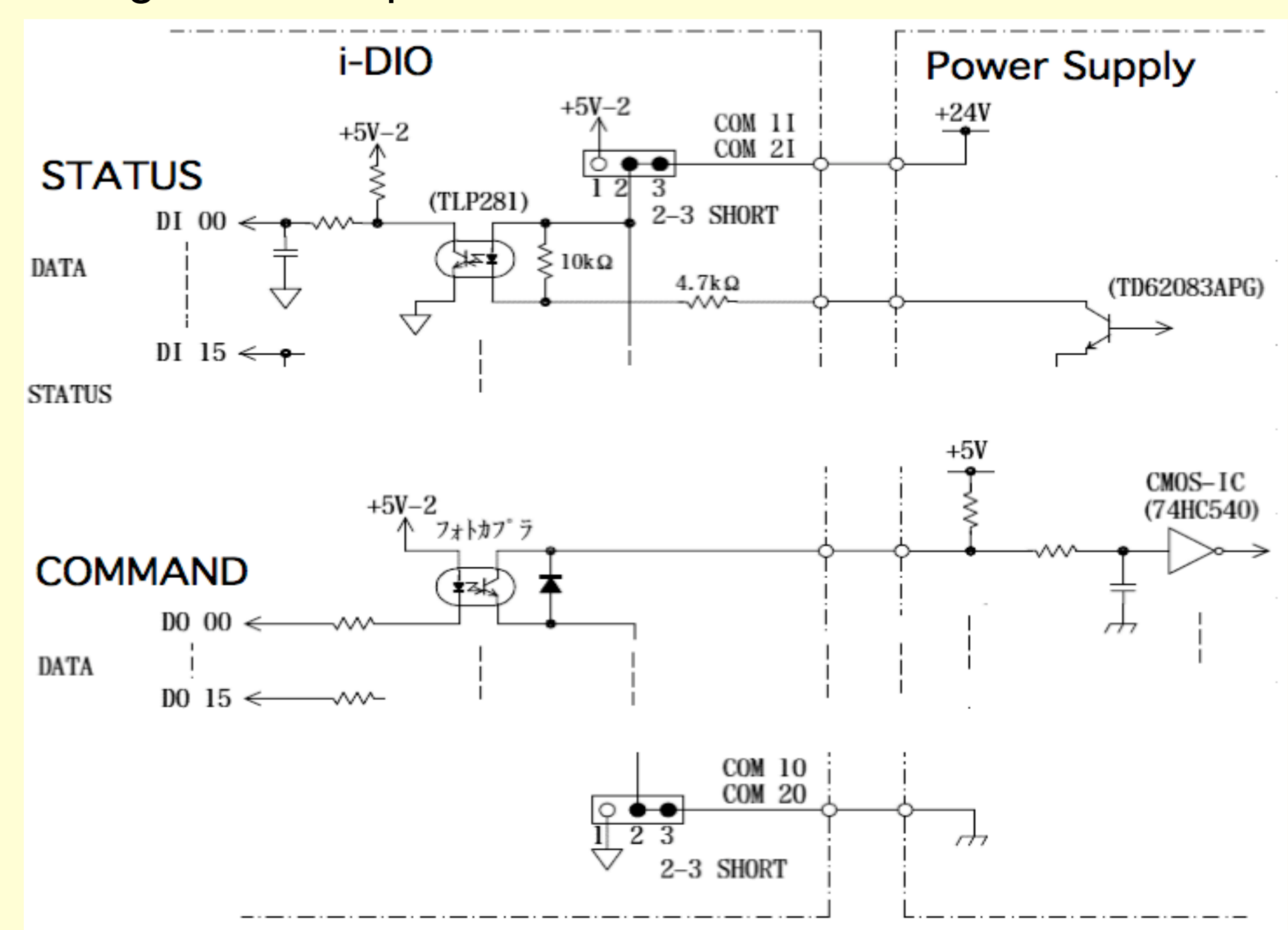
Direct Connection.
 → **High Reliability !**



Front and top view of 2ch magnet power supply

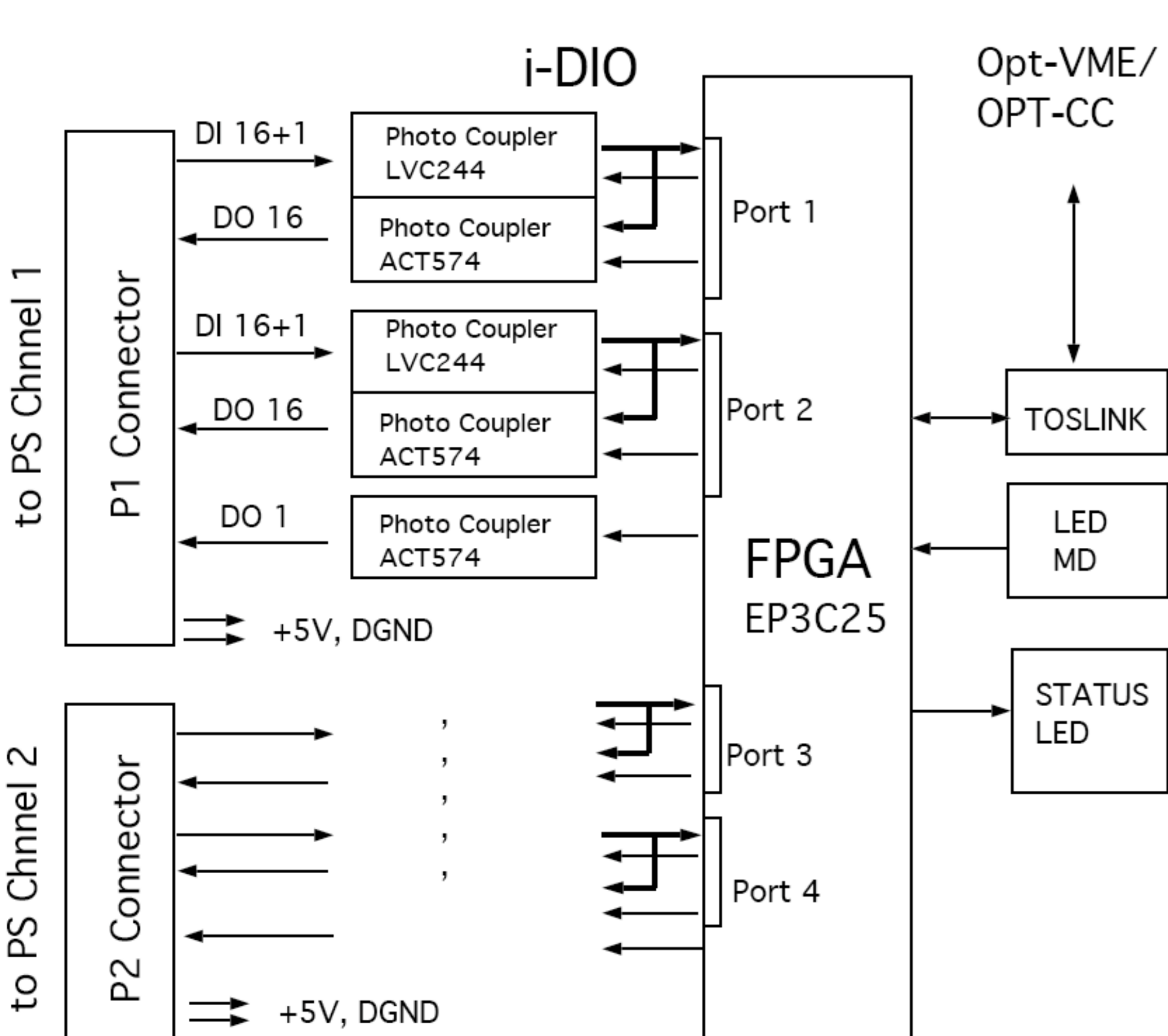


Four Ports Isolation Circuit of the i-DIO



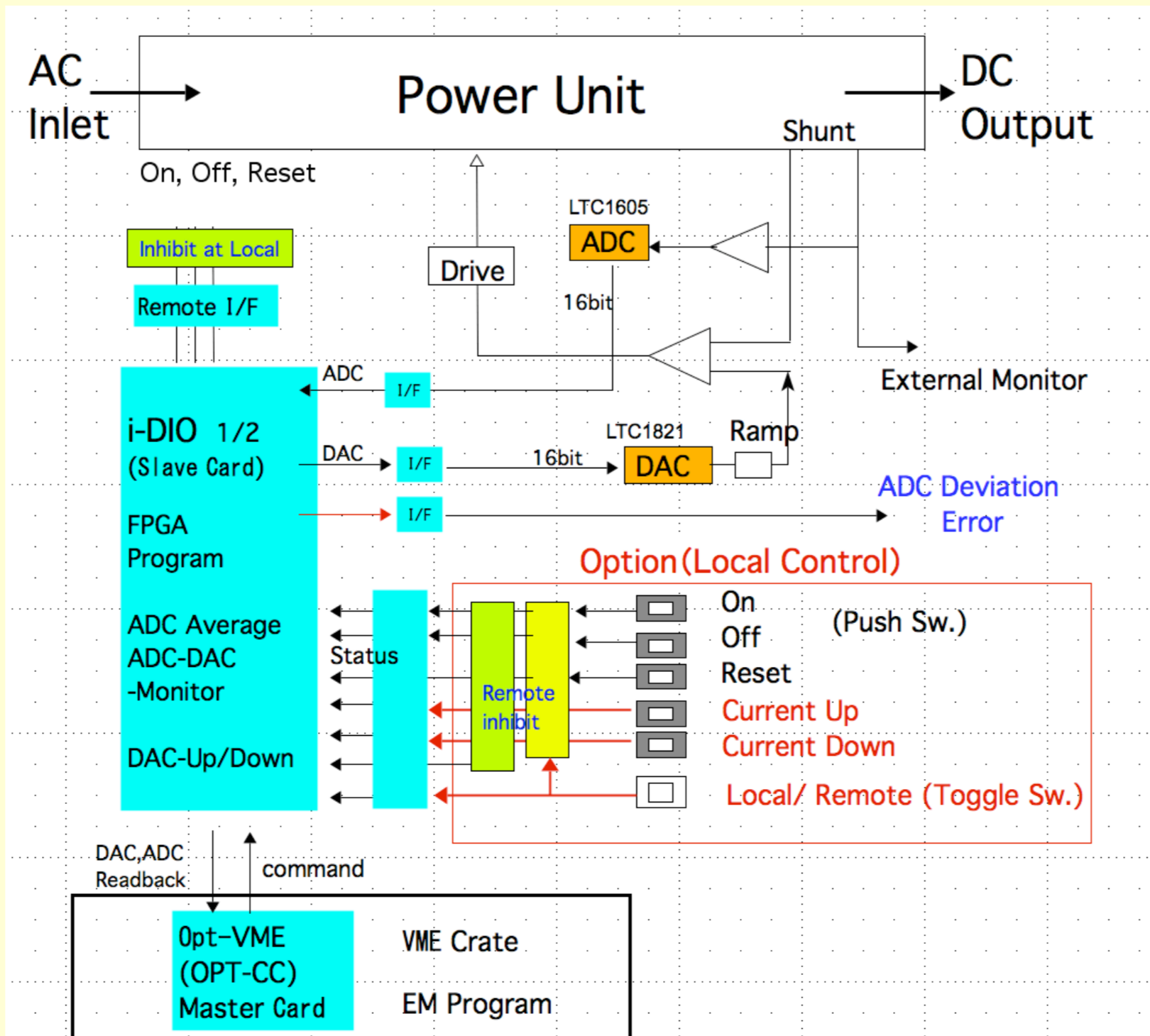
Block diagram of the i-DIO

Cyclone III (EP3C25) FPGA with 25 μs clock



Local Control System

For the local control of large PSs, the i-DIO changes the DAC data according to a command from current up/down buttons on the local control panel. The command is sent through the DI status signal and processed by the i-DIO program. On/off and reset sequences are also achieved in the same way.



ADC Monitor Application

The i-DIO receives the ADC data in every 1 ms. Then the i-DIO takes a moving average of the period between 1ms and 1016ms. For the current deviation alarm, the i-DIO can compare the ADC and DAC data with a threshold level between 0.1% and 12.7%. These parameters can be set by the EM program of the VME.

