Development of Beam Loss Measurement Electronics Based on ZYNQ in RCS of CSNS-II

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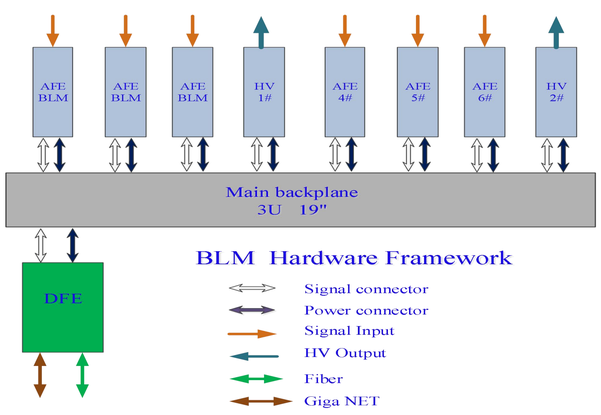
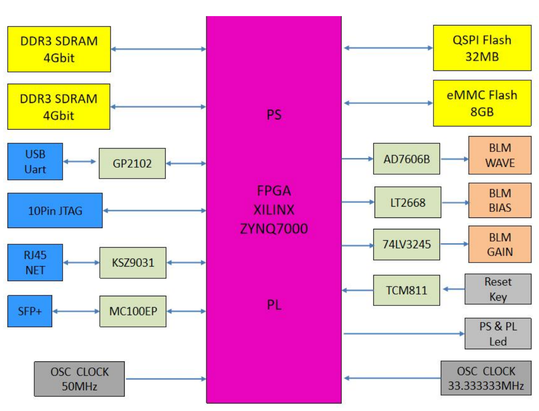
Introduction

The CSNS-II ring beam loss measurement electronics system is independently developed by us. The electronics consists of a custom chassis, front-end analog board, digital board developed based on zynq, and high-voltage output module. It can connect up to 6 BLM simultaneously, enabling high-voltage output, signal acquisition, MPS signal output, and data transmission through epics. At the same time, the electronics can adjust the gain according to the signal size to improve the signal measurement range and measurement accuracy.

Hardware Architecture

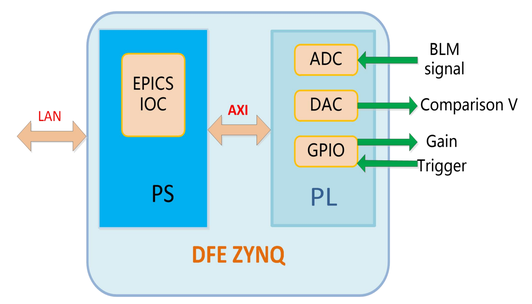
The BLM electronics system consists of a 3U custom chassis, AFE, High-voltage output module, and DFE. Each chassis can be configured with six AFE, two high-voltage output module, and one digital board, which can be used to connect six beam loss monitor (BLM) simultaneously.

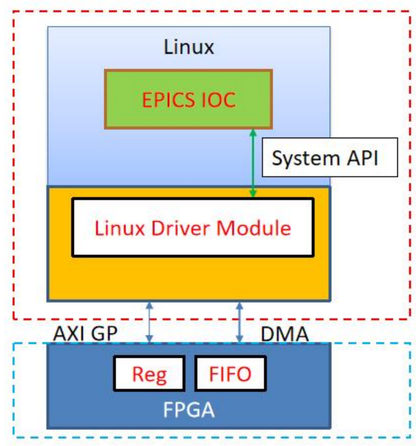




Software Architecture

The software of BLM electronics consists of an embedded Linux system running on a DFE module, ADC\DAC\GPIO drivers, and epics ioc applications for gear control, high-voltage control, data acquisition, and data transmission. Epics ioc runs on the PS of zynq, and ADC\DAC\GPIO are directly connected to the PL.





Software program development

- Build embedded Linux system
- Edit the user device tree file
- Epics ioc Application Development

Gain control
Comparative voltage output
External trigger signal acquisition
Background subtraction

db

```
record(mbbo,"$(P)01:gear")
{
    field(DESC,"0")
    field(DTYP, "blmgear0")
    field(SCAN, "Passive")
    field(NOBT, "3")
    field(ZRVL, "0")
    field(ONVL, "1")
    field(TWVL, "2")
    field(THVL, "3")
    field(ZRST, "BIT")
    field(ONST, "Low")
    field(TWST, "Mid")
    field(THST, "Hig")
    field(VAL, "2")
}
```

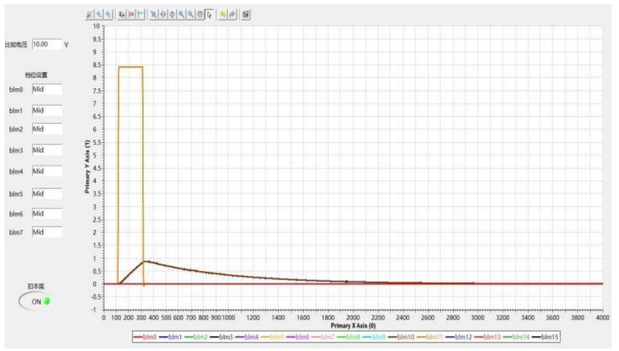
device support.c

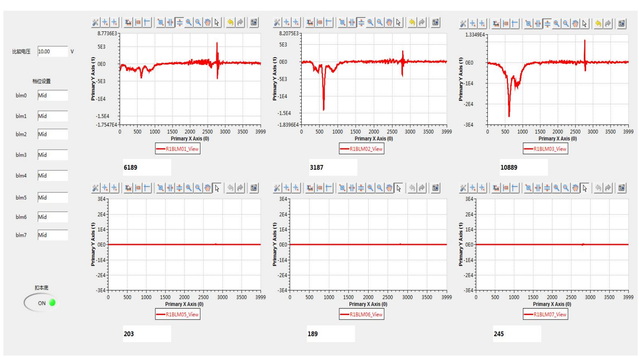
```
static long write_mbbo(mbboRecord *prec)
{
        dbPutLink(&prec->out,DBR_USHORT, &prec->val,1);

        switch (atoi(prec->desc))
        {
        case 0:
                blmgear_setting(0,prec->val);
                break;
        case 1:
                blmgear_setting(1,prec->val);
                break;
        case 2:
                blmgear_setting(2,prec->val);
                break;
        ·····                                  API
        return 0;
}
```

Electronics Test

Generator was used to output a pulse signal with width 1ms and frequency 25Hz, which was then input to the electronics.

Three RCS BLM connected to the electronics during the normal beam supply period for beam loss testing.





Conclusion

Based on the zynq-based beam loss measurement electronics, the development of digital board, front-end analog electronics, high-voltage output modules, and chassis has been completed, achieving the measurement of beam loss and the MPS output. It has been tested in the laboratory and actual beam loss tests, showing that the electronic functions are basically normal.It can replace the existing signal acquisition system of CSNS. The next step is to optimize the electronics to improve stability and measurement accuracy.

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