A.6: Enhancements in Indus-2 Magnet Power Supply (MPS) control system

Accelerator Control Section has developed Control Systems for various sub-systems of Indus-2 having a three-layered architecture. The top layer, Layer-1 has computers running SCADA software for overall monitoring, supervision, data logging and alarm handling. Below that, Layer-2 has VME computers, one for each subsystem, supervising multiple layer 3 controllers down the line for each sub-system. Layer-3 has a number of VME Equipment Controllers (ECs) with analog and digital I/O boards directly interfaced to the devices in the field. In case of Indus-2 MPS Control System, there are total 68 Layer-3 ECs controlling more that 150 power supplies.

MPS control System is used to perform machine related operations like magnet cycling, synchronous ramping of beam energy, slow orbit correction, tune correction etc. The system is working satisfactorily for last 12 years. Based on operational experiences, enhancements in MPS Control System were carried out to improve the overall system performance and augment the diagnostic capabilities of the system. The highlights of the improvements done is shown in Table A.6.1.

Table A.6.1: **Highlights of improvements**

Parameter	Before	After	Significance
RAM on ADC board (K Bytes)	128	256	Captures two channels viz. Readback and Reference
Data Capture Mode	External Ramp Clock only	Both Ext. & Internal Clocks	Data capturing in cycling and DC-mode of operation also
Data Capture Rate	Depends on Ramp Clock	User Programm-able	Different rates are used during different operations
Command dispatch mode	Unicast only	Unicast & Broadcast	Improved parameter setting performance by up to 80 x
'Start of cycling' various PS	Spread over a span of 8-10 sec	Now starts under 1 sec	Provides better correlation in cycling verification

Some more features that have been added are:

- Provision to send configuration command from GUI for changing the conversion rate of ADC boards.
- Provision of safeguard against substantial number of extra/spurious ramp-clocks, if any, from taking supplies to random values.
- Facility to readback following additional parameters :
  - ✓ Number of ramp-clocks actually received during ramping
  - ✓ Number of samples captured using internal clock
  - ✓ Presently set capturing mode
  - ✓ Capturing status
  - ✓ Presently set scan mode on ADC board
  - ✓ Status of intermediate stages of ramping process
- Feature of setting the operation Mode as either Normal or Diagnostic. In normal mode, value in set command is checked against the limits and error-code is sent back if limits are violated.
- The broadcast command feature is advantageous in the following scenario:
  - ✓ Cycling : Slope and final value setting
  - ✓ Group setting
  - ✓ Ramping related commands
  - ✓ Tune feedback correction
  - ✓ Slow Orbit Feed Back (SOFB)
  - ✓ Feed Forward Correction during ID movement

Now it allows data capturing during cycling, ramp data generation and DC mode which was not there earlier and it offers a variable, uniform capture rate throughout ramping process. This allows finding changes in readback or reference, if any, during these crucial stages. The Fig. A.6.1 below shows the data of both readback and reference channels captured during ramping.

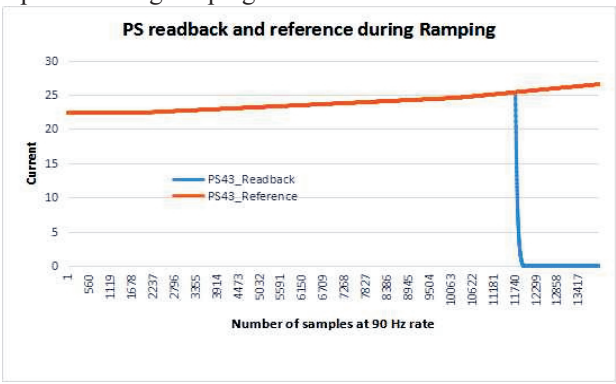

Fig.A.6.1: Reference &readback signals captured during ramping @ 90 Hz & better than 50 ppm accuracy

The work involved major changes in SCADA and embedded OS-9 software and ADC board firmware. Higher capacity RAM modules were fabricated and installed on 27 high accuracy ADC boards. These enhancements have improved the system's performance and diagnostic features.

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