A.6: Active shunt for Indus-2 quadrupole magnet for beam based alignment study

Study for centring electron beam in beam based alignment (BBA) method through quadrupole magnets was performed in the 2.5 GeV Synchrotron Radiation Source, Indus-2, at RRCAT. Each group of the series connected quadrupole magnets were powered by a precision current source (IM). To perform BBA, the magnetic field of each quadrupole magnet was varied independently by a few percent of IM, by putting an active shunt across it as shown in Fig. A.6.1.

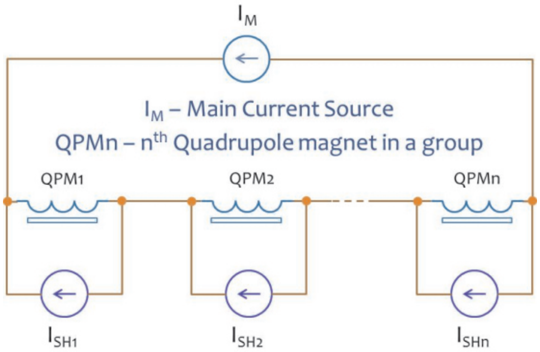

Fig. A.6.1: Active shunts (ISH) with quadrupole magnets.

A prototype active shunt was designed and developed for this purpose in Power Supplies and Industrial Accelerator Division. It was tested for full load sinking and sourcing capacity of 6 A current at ±80 V. The performance of the active shunt in terms of load current stability, sensitivity to disturbance, ripple, power-factor, line harmonics and power converter efficiency was evaluated during the testing.

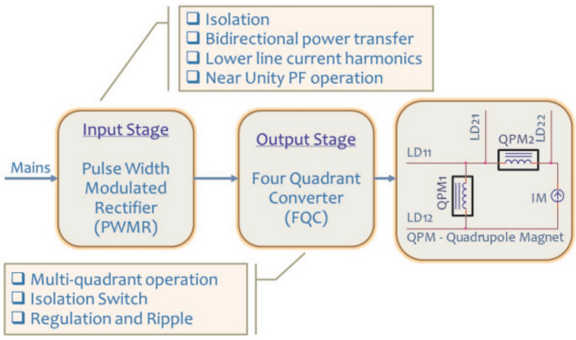

Fig.A.6.2: Block diagram of the active shunt.

The active shunt was operated in different quadrants during its operation. The power absorbed by the shunt while working in II and IV quadrants needed to be managed properly. A pulse width modulated rectifier used as the input stage of the shunt, as shown in Fig.A.6.2, provided bidirectional utility interface aiding efficient four quadrant operation. It was also helpful in achieving lower line current harmonic distortion and maintaining input power factor close to unity over wide operating current range. The increase in power transfer efficiency resulted in significantly reducing the cooling load and thus alleviating the need for complex heat-sinking solution.

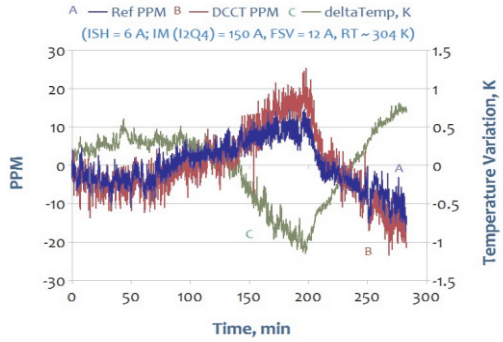

Fig. A.6.3: Stability curve of the shunt.

Output current stability is shown in Fig.A.6.3. Table A.6.1 and A.6.2 give performance of the active shunt from the output and the mains sides. A photograph of the developed prototype can be seen in Fig. A.6.4.

Table A.6.1: Output performance of the shunt.

Parameter	Value Achieved
Stability (drift and regulation)	< |± 50| PPM
Ripple	< 25 PPM
Sensitivity (Active shunt to IM)	±5 PPM
Sensitivity (IM to Active shunt)	±6 PPM
Turn 'ON' transients	< 500 PPM

Table A.6.2: Mains side performance of the shunt.

Parameter	(I Quad)	(II Quad)	Unit
Output Power	456	-456	W
Power Transfer Efficiency	76	74	%
THDi	2.2	6.5	%
THDv	1.8	1.6	%
Input Power Factor	0.99	-0.97	

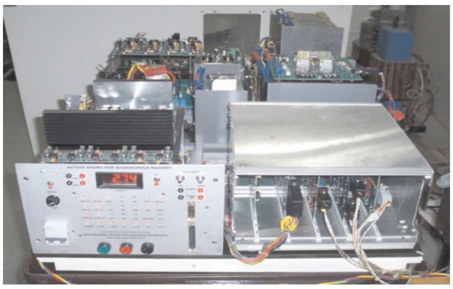

Fig. A.6.4: Active shunt with test magnet.

Eight units of the active shunt based on the above design were fabricated in-house. Six of those units were used in the recent BBA exercise.

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