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Overview of JT-60SA Magnet Power Supply System
JT-60SA磁場コイル電源システムの概要

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The JT-60SA tokamak device consists of superconducting toroidal and poloidal field coils, and some in-vessel coils. This paper describes the key features and the expected performances of the main power supply system for the superconducting magnets in JT-60SA.

1. Introduction
JT-60SA magnets consist of superconducting Toroidal Field (TF) and Poloidal Field (PF) coils, some in-vessel coils. In the following sections, the key features and the expected performances including the protection for the superconducting magnets in JT-60SA are described.

2. TF Coil Power Supply
The TF coil circuit is shown in Fig. 1. A single thyristor converter provides a unidirectional DC current to 18 series-connected TF coils continuously. The nominal DC voltage is determined to be sufficient to charge/discharge the full current of 25.7 kA within ~20 min. In order to reduce the voltage to ground in the case of Quench Protection Circuit (QPC; after-mentioned) operation to < 2 kV, TF coils are divided into three blocks, and three QPCs are interleaved among them. As a typical operation of TF coil PS, TF coils are energized every day in the morning before the starting of the plasma experiments, and demagnetized after the end of the daily experimental period.

3. PF Coil Power Supply
There are ten superconducting PF coils, i.e. four Central Solenoids (CS1–4) and six Equilibrium Field (EF1–6) coils. Each PF coil circuit is independent from the others although mutual couplings exist. Every PF coil PS provides a bidirectional DC current adequate to achieve the required plasma scenarios within the common ratings of 5 kVdc and 20 kAdc. The typical DC circuits of them are shown in Figs. 2 and 3, respectively. Their basic PS components are series-connected Base PS, Switching Network Unit (SNU) or Booster PS, and QPC (after-mentioned). Each grounding resistor is connected to the midpoint of the Crowbar Switch unit in Base PS in

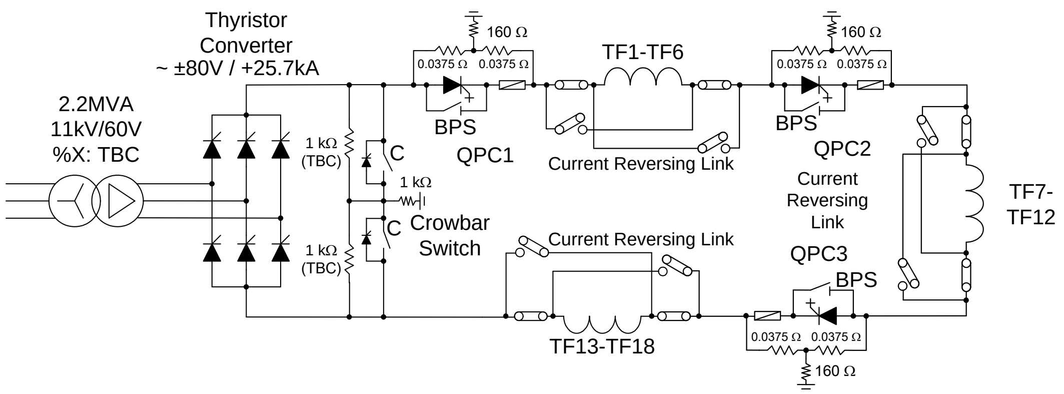

Fig.1. Schematic DC circuit diagram of TF coil PS

order to fix the potential from the viewpoint of the withstand voltages for PS components.

3.1 *Base PS*

Base PS is based on low-voltage back-to-back four-quadrant thyristor converters (±~1 kVdc, ±20 or +10/–20 kAdc) with long-time rating. Because SNU or Booster PS can be operated only in short duration, PF coils are driven by Base PSs for whole operation period including pre-magnetization, plasma current flat-top and demagnetization phases. From the viewpoints of harmonic current and reactive power, Base PSs are planned to be powered by a motor-generator (H-MG reused from JT-60).

3.2 *Switching Network Unit (SNU)*

SNU consists of a fast unidirectional DC current interrupter and discretely variable discharge resistors, and is used to produce a negative high voltage (–5 kVdc) necessary for stable breakdown and fast plasma current ramp-up. Since SNU is workable with using the magnetic energy stored in the coil, it is adopted for the inner PF (CS1–4 and EF3, 4) coils through which a high pre-magnetization current flows.

3.3 *Booster PS*

Because a low pre-magnetization current is required and then the current polarity reverses immediately for the case of the outer PF (EF1, 2, 5 and 6) coils, high-voltage thyristor converters (±5 kVdc, +4/–14.5 kAdc) with short-time rating, which are reused from JT-60, are utilized as Booster PS for the same purpose as SNU. As in the case of Base PSs, Booster PSs are also planned to be powered by a motor-generator (H-MG reused from JT-60) from the viewpoints of harmonic current and reactive power.

4. Quench Protection Circuit (QPC)

In the case of superconducting coil quench or failure inside the PS system, fast extraction of the magnetic energy stored in the superconducting coil is necessary to protect the conductor. For this purpose, QPC consisting of a DC current interrupter, a dump resistor and a Pyrobreaker (pyrotechnic circuit interrupter) for backup protection is provided for each superconducting coil. The DC current interrupter is a hybrid circuit breaker composed of a mechanical ByPass Switch (BPS) for conducting the continuous current and a static circuit breaker for the current interruption in parallel. The Pyrobreaker also provides the remarkable performance of continuous conduction. The final design of QPCs is referred to [2].

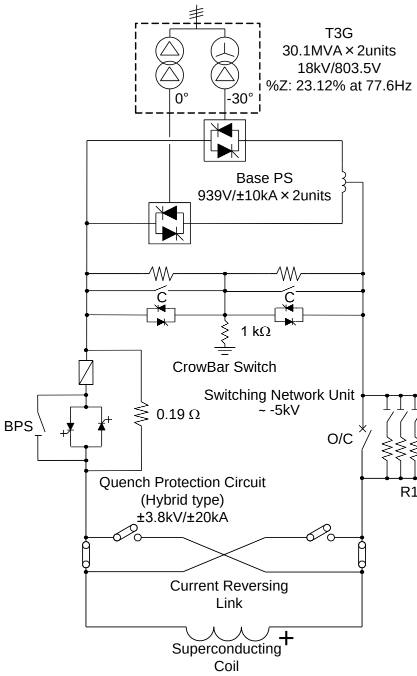

Fig.2. Schematic DC circuit diagram of typical PF coil (CS1) PS with SNU

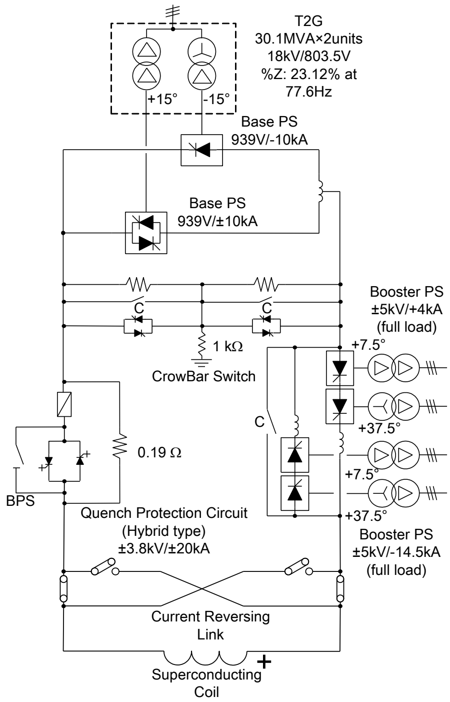

Fig.3. Schematic DC circuit diagram of typical PF (EF1) coil PS with Booster PS

Acknowledgments

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