A.10: Variable frequency ac current source for characterization of magnetic and superconducting materials

A variable frequency ac current source is developed at PSIAD, RRCAT which is required by MAASD, RRCAT to generate an alternating magnetic field of about 1 to 2 oersted to study the response of various magnetic and superconducting materials at various frequencies. The current source is rated to provide constant sinusoidal current at the output with peak current and voltage ratings of 100 mA, 63 V respectively and frequency ranging from 1 Hz to 100 kHz. It is based on "Improved Howland Current Pump" configuration which is a voltage controlled current source (VCCS) for grounded load. The power amplifier used in the circuit is APEX PA85. The salient features of current source are: simple configuration, reliable, rugged and wide operating frequency range.

To achieve minimum distortion of the output sinusoidal current, a higher value of bipolar dc voltage is required to feed input power to the power amplifier. However, higher value of supply voltage leads to increased power dissipation in the amplifier and therefore a larger heat sink is required to keep thermal stresses of the device within limits. Hence, a tradeoff is required to be made between the total harmonic distortion of the output sinusoidal current and power losses in amplifier. Figure A.10.1 shows a graph between total harmonic distortion (THD) of output current at R-L load and input supply voltage to the power amplifier at the lower and upper limits of operating frequency range at 1Hz and 100 kHz respectively. It is evident from the curve that there is no significant distortion in output current beyond 85 V of input supply voltage. Therefore, a bipolar dc power supply of ±100 V is developed to feed input power to the power amplifier to achieve minimum THD of 0.7% in output sinusoidal current as well as to keep power losses within limits and also to ensure proper operation under ac mains under-voltage condition.

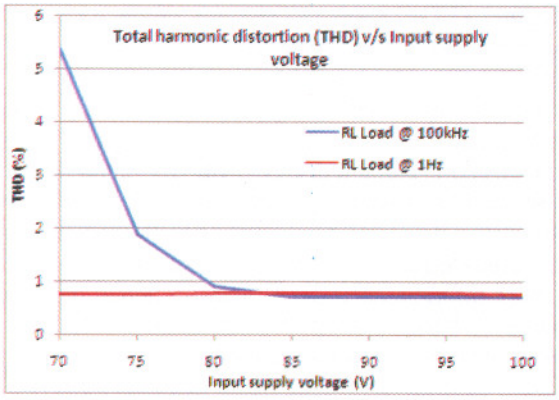

Fig. A.10.1: Output current THD v/s input supply voltage

The current source is designed to be operated with local as well as remote reference source with 1 V of peak reference voltage corresponding to peak output current of 100 mA. Various protection features such as auxiliary supply fault, over temperature fault, over current fault and power amplifier input supply fault have been incorporated in design to trip current source in case of occurrence of any of these faults.

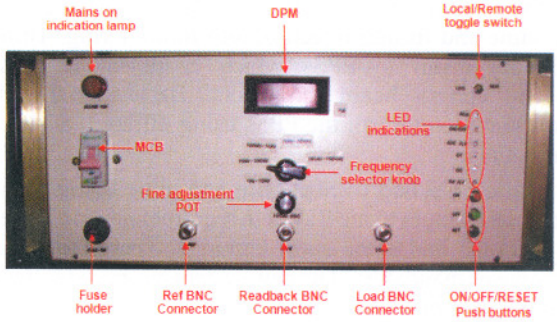

Fig. A.10.2: Photograph of ac current source

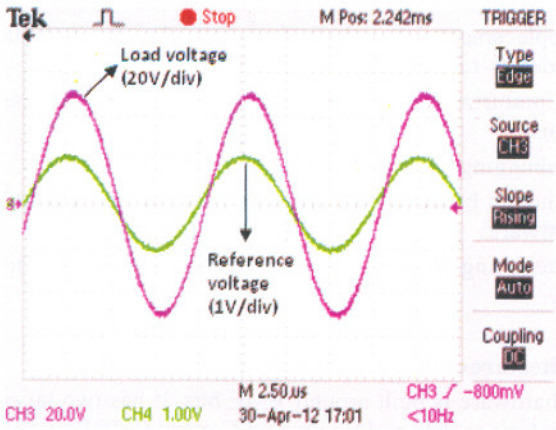

Fig. A.10.3: Reference and load voltage (measured at resistive load) waveforms: Ch 3- Load voltage, Ch 4- Reference voltage

Figure A.10.2 shows a labeled photograph of current source. Figure A.10.3 shows experimental waveforms of sinusoidal reference voltage and voltage across load of 500Ω at frequency of 100 kHz. In Fig. A.10.3, y-axis for Ch 3 shows load voltage with scale of 20 V/div while y-axis for Ch 4 shows reference voltage with scale of 1 V/div. Time scale is shown on x-axis with scale of 2.5 µs/div.

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