BEAM CURRENT TRANSFORMER WITH DC TO 500HZ

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Abstract: An average beam current transformer has been designed and tested. The device allows measurement of either a bunched or debunched beam in the ranges between 5mA and 500mA. The scheme is a combination of a magnetic modulator and an active L/R integrator.

Principle of operation: As shown in Fig.1, the beam current transformer employes three identically-wound cores T1, T2 and T3. The magnetic modulator consists of a pair of toroids(T1,T2) of 190mm inner diameter.

The core materials is a high permeability tape of 50μm thickness. They are excited in opposit senses and under zero beam current the net voltage in the DET coil is zero. In the presence of beam current the B/H curves are shifted and introduce an asymmetry which gives an output of even harmonics of the modulation frequency at the DET coil winding. The second harmonic component of the output signal is proportional to the beam current and its phase determined by the direction of the beam current.

The output of the DET coil is applied to the selective second harmonic amplifier, reconverted to dc current in the demodulator. The second harmonic reference signal is derived from the excitation oscillator through an adjustable phase shifter and an active filter amplifier. The voltage from the demodulator is applied to the input of a dc amplifier whose second input is subjected to the high frequency component of the signal from the core T3. The output of dc amplifier is fed to the compensating coil (NF coil) to cancel the beam current. The combination of two loops ensures that the compensating current is a perfect image of the beam current to be measured. The compensating current is converted into the voltage signal by a feedback resister R_{fb} and amplified in a dc amplifier for remote sensing.

Performance: Dynamic range is 5 ma to 500 ma. The lower limit is set by the ripple of power supply. Position dependence within the free aperture of the transformer core is very small and is 5×10^{-5}/cm and the temperature dependence is about 0.2 mAT/ºC. Linearity errors are within $\pm$ 0.2 % as shown in Fig. 2. The graph in Fig. 3 is a plot of frequency responce at different input cuttent. Passband is dc to 500 Hz. The results obtained are provisional and should be improved by further development.

Reference

1) F. C. Williams et al, ProcIEE 97,Part2,445(1950)
2) K. Unser, IEEE NS-16, 934 (1969)

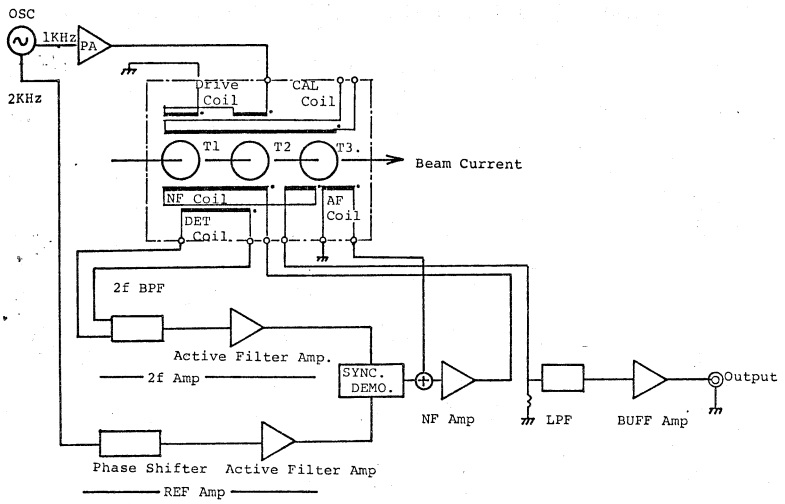

Fig.1 Block diagram of Beam Current Transformer

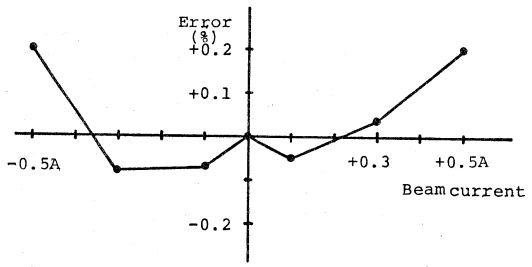

Fig.2 Linearity

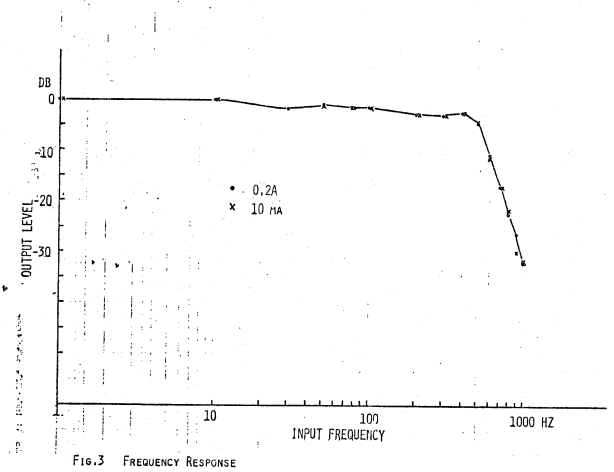

Fig.3 Frequency Response