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United Kingdom Atomic Energy Authority

RESEARCH GROUP

Report

A NANOSECOND SAMPLING TECHNIQUE TO AID MULTI-COIL MAGNETIC PROBE MEASUREMENTS

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A NANOSECOND SAMPLING TECHNIQUE TO AID MULTI-COIL MAGNETIC PROBE MEASUREMENTS

by

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A B S T R A C T

An electronic instrument is described which enables 32 separate input signals to be sampled in sequence in a total time of 1 microsecond, each signal being sampled for 20 nanoseconds. The 32 samples are mixed together at the output.

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CONTENTS

	Page
INTRODUCTION	1
32-CHANNEL SAMPLING UNIT	2
DISPLAY	3
CONSTRUCTION	3
CONCLUSIONS	3

INTRODUCTION

Much of the diagnostic work in plasma physics is concerned with the determination of the behaviour of plasma contained by magnetic fields of various geometries.

One method of studying the confinement of the plasma is to study the distribution of the plasma current.

Assuming cylindrical geometry, the components of the current density can be written as:-

$$jz = \frac{1}{r}\frac{d}{dr}(r\ B\theta) \qquad j\theta = \frac{d}{dr}(Bz)$$

Current density profiles can be obtained from the profiles of the components of the magnetic field.

The most convenient way of determining $\frac{d}{dr}(r\ B\theta)$ and $\frac{d}{dr}(Bz)$ is from examination of the distribution of $B\theta$ and Bz as a function of radius.

The magnetic probe coil is widely used for the measurement of magnetic field. When placed within a varying field, voltages are induced in the coil proportional to $\frac{dB}{dt}$, and these when integrated produce an output proportional to the field itself.

Much work has been done using multiple coil magnetic probes, but the coil outputs normally indicate the field as a function of time at a particular radius. This has to be converted to the field as a function of radius at a particular time, i.e. the field profile.

This requires the use of many oscilloscopes and cameras to record the individual coil outputs. After the films have been processed, there follows the tedious process of analysis.

One method of simplifying this measurement is to sample each coil-integrator output in sequence, mix the samples together, and present the result as the Y deflection of an oscilloscope. In this way a plot of the magnetic field as a function of radius is obtained.

An instrument operating on this principle and suitable for a 32 coil magnetic probe has been designed and constructed at the Culham Laboratory. The speed of operation is such that all 32 input signals are sampled in a total time of 1 μsec; each signal being sampled for approximately 20 nsec. The circuits require 1 μsec to reset so second and successive measurements can be taken with a minimum spacing of 2 μsec.

From a study of these records machine operating conditions may be quickly adjusted to give the desired plasma properties (e.g. radius and skin thickness). Useful quantitative results are also provided.

As further experience is gained with the instrument other uses will certainly become apparent.

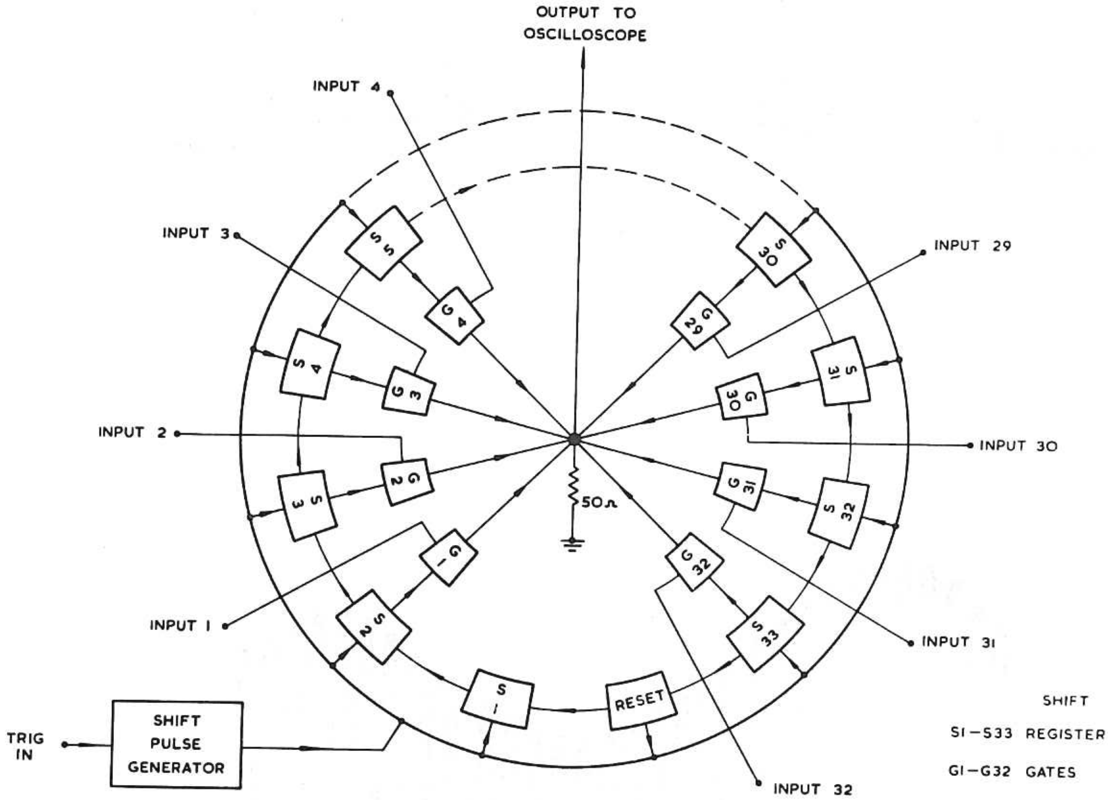

Fig.1 Block diagram of sampling unit (CLM-R50)

Fig.2 Output with zero inputs (CLM-R 50)

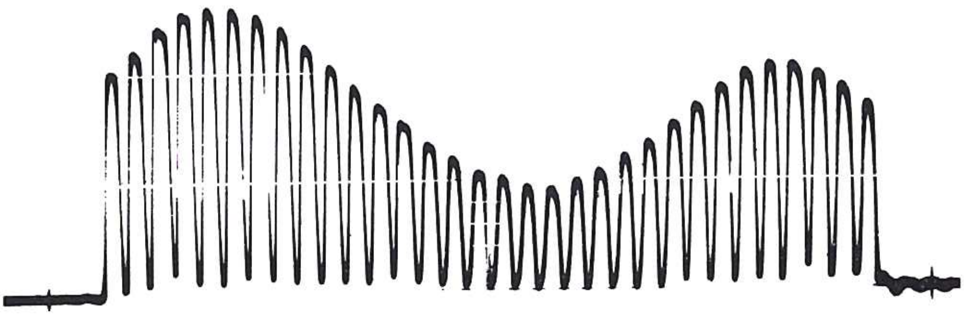

Fig.3 Output with 32 different inputs (CLM-R 50)

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