FAST ON LINE PHASE MEASUREMENT OF PULSED RF SIGNALS IN THE RANGE OF 9 - 108 MHZ

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A new fast on-line measurement system was developed for the UNILAC multiple beam operation. The system allows the measurement and storage of the digitized phase values of 6 pulsed rf-signals during a time intervall of 333 micro-seconds. The rf-signals are grouped into blocks of 6 and measured in a sequential order. At present 6 blocks are connected to the measurement system and therefore, one complete measurement cycle lasts 2 milliseconds. The system can easily be extended to more than 6 blocks. A micro-processor handles the data acquisition, monitoring and synchronization. A touch panel is used as communication interface between operator and phase measurement system. For convenience of trouble shooting the phase detector signals can be viewed on an oszilloscope. A numerical display integrated in the hardware allows to control the electronics without the microprocessor.

Introduction

Due to the planned time shared operation of the Unilac (see Ref. 1) rf-phases of the various accelerator structures have to be measured in less than 10 ms. Therefore a new measurement system was built and installed at the Unilac. It has been tested in routine operation since about 6 months. At present all the rf-accelerator structures like prebunchers, Wideröe- and Alvareztanks, single gap resonators as well as various rebuncher systems are equipped with the new system. Most of the electronic circuits and a microcomputer system for the control of the electronics including the appropriate software have been developed at GSI.

General Description

A simplified functional block diagram of the electronics is shown in Fig. 1. The vector voltmeter VVM (Hp 8405 A) converts the reference rf-signal (c.w.) connected to channel A and the signal from the selected rf cavity (pulsed, connected to channel B) to an intermediate frequency (if) of 20 kHz. Conversion is performed by two sampling mixer stages integrated into the VVM. The frequency of the two input signals may vary from 1 to 1000 MHz. The if-signals represent exactly the original input signals in amplitude and phase. Both sine wave if-signals of 20 kHz are fed to an operational amplifier with a dynamic range of about 30 dB. To derive precise phase related time markers the outputs of the operational amplifiers are processed by two zero crossing detectors. The detector output signals are differentiated and fed to the SET and RESET inputs of an RS-Flip-Flop. The width of the resulting square wave is proportional to the phase difference between both channels of the VVM. The following integrator acts as a time to amplitude converter. The resulting analog signal is a measure of the phase difference.

The analog signal is digitized via a multiplexer by a 10-bit ADC.

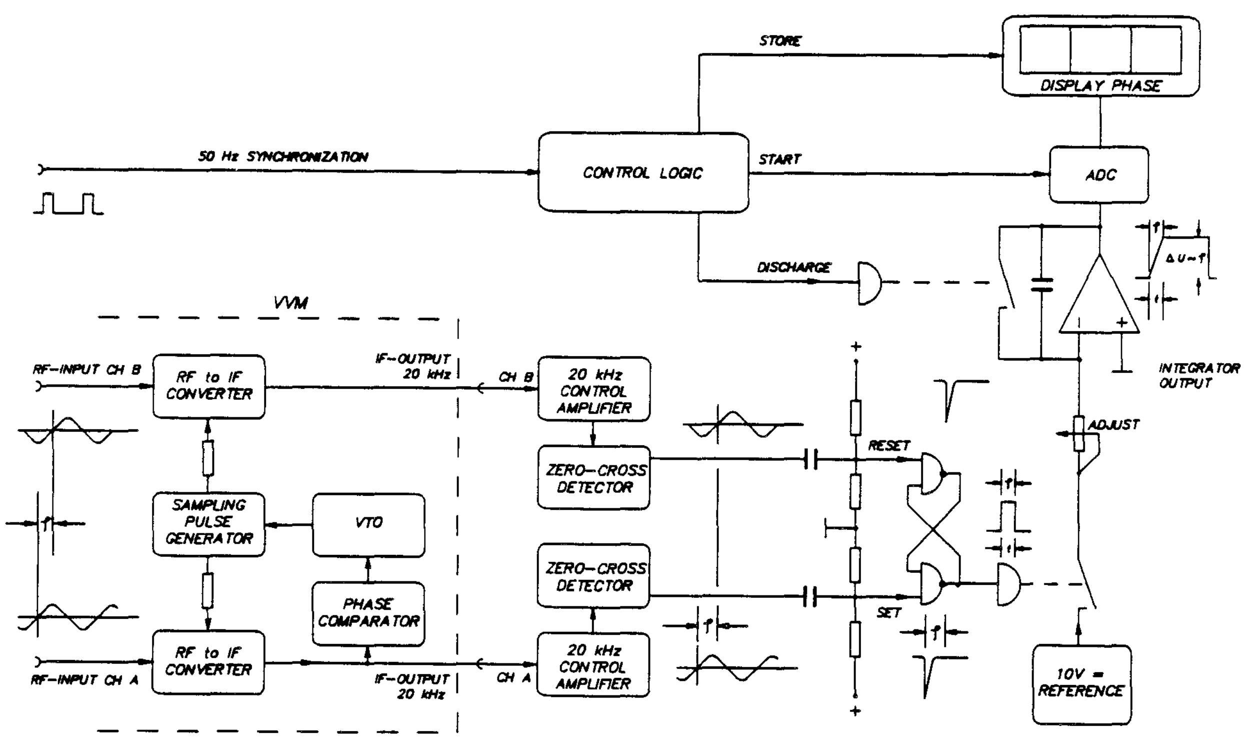

FIG.1 FUNCTIONAL BLOCK DIAGRAM

Measurement Sequences

The rf-signals are grouped into blocks of 6. One measurement cycle for the determination of the 6 phases lasts 333 μs. At present there are 6 blocks of rf-signals connected to the system and therefore one complete measurement is performed within 2 ms. The system can be extended to more than 6 blocks very easily which will be necessary in near future considering the upgrading program of the UNILAC.

Digital Control

As shown in the block diagram of the signal processing electronic (Fig. 2) a hardware logic selects the rf-cavities, controls the complete measuring cycle and finally distributes the digitized phase values to a phase display integrated into the hardware. For convenience of trouble shooting and maintenance the phase detector signals can be viewed there on an oscilloscope. For the communication with the main control room the logic control unit is interfaced via an I/O-register (INTEL 8255 Chip) to the microcomputer system.

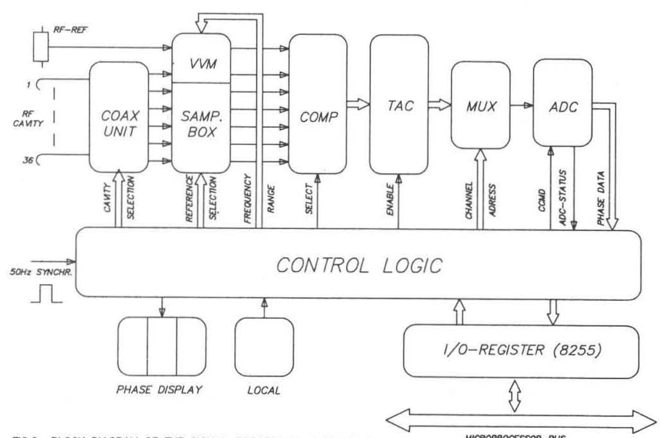

FIG.2 BLOCK DIAGRAM OF THE SIGNAL-PROCESSING-ELECTRONIC

Fig. 3 shows a picture of the complete electronics installed in a local control room of the UNILAC.

Microprocessor Control

A touch panel, installed in the main control room, is used for the communication between the operators and the phase measurement system. The microprocessor handles data acquisition, monitoring and synchronization. On demand the measured phases are displayed on the touch panel.

Specifications

The specifications of the system can be summarized as follows:

Bandwidth	: 1 - 1000 MHz (range of the Hp 8405)
Intermediate frequency	: 20 kHz
Unilac frequencies	: 9 - 108 MHz
Phase accuracy	: ± 1 degree
Minimum input signal	:
channel A	20 mV-peak, c.w.
channel B	20 mV-peak, pulsed
measuring time	: 333 μs for 6 signals
number of rf-tanks, connected	: 36 (6 blocks, 6 signals each)
total cycle of measurement	: 2 ms
microprocessor	: INTEL 8085 A

Option: The addition of one further vector-voltmeter offers the possibility to measure the phases of rf-tanks with different rf-frequencies at the same time.

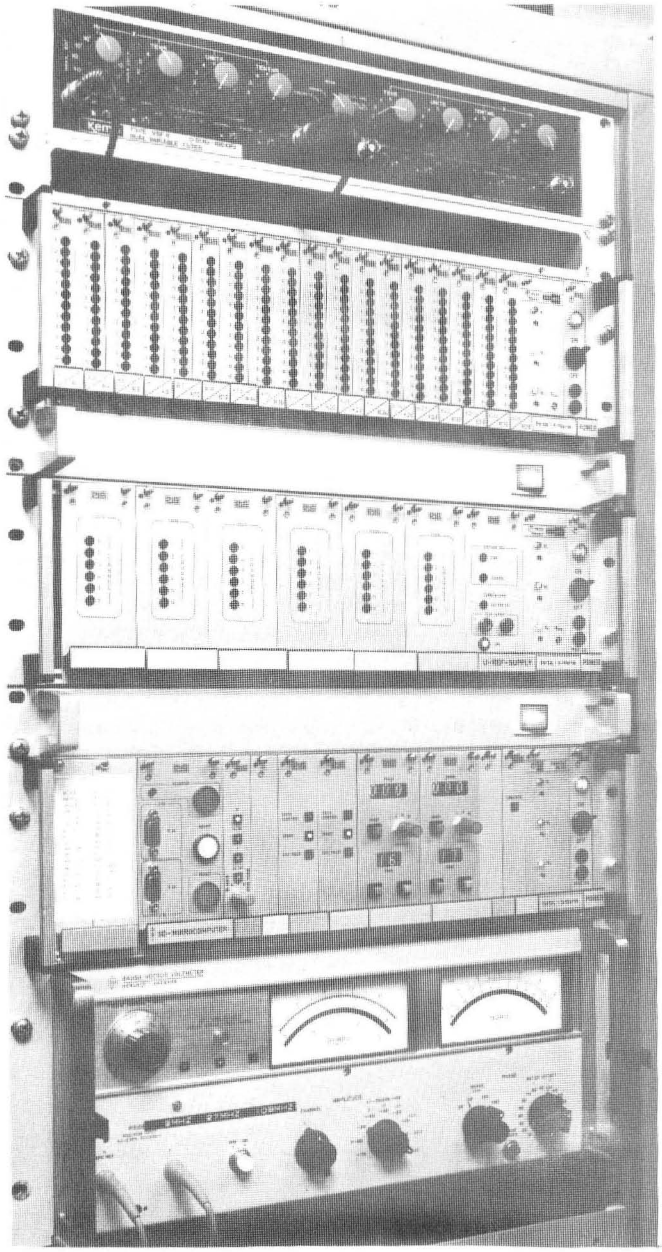

Fig. 3: First rf-phase measurement electronics

The new system was installed in September 1985. Due to the improved electronics described at the Unilac rf-phase adjustment can be performed very comfortable within a short time.

References

[1]Glatz, J., The Unilac as a Fast Switching Variable Ion and Energy Accelerator, these proceedings.