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CTF3 Note 021 (Tech.)
(Timing)

PROPOSAL FOR CTF3 TIMING SYSTEM

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1 INTRODUCTION

For reasons of klystron output stability, CTF3 must be synchronised to the zero-crossings of the 50 Hz network. In fact, for RF synchronisation, timing signals must be referenced from the nearest tick after the network zero-crossing of a clock derived from the RF. For the preliminary phase [1], this clock will either be the EPA 19 MHz or a 19.2 MHz signal derived from the LIL frequency. The former will be used for accumulation and the latter for the combination test. For the later phases of CTF3, only the 3 GHz-derived clock will be required (unless the combiner ring contains a RF cavity for beam storage).

In the present proposal, the central timing system will also be synchronised to the 50 Hz network zero-crossings. This is in contrast to the rest of CERN's central timing, which is synchronised to the GPS network. CTF3 will therefore require an independent Master Timing Generator (MTG) [2,3]. Synchronisation with the electric power grid will both simplify and enhance the performance of the central timing and, consequently, the CTF3 control system.

Timing pulses (for modulators, klystrons etc.) will be provided by the counters incorporated in the CERN standard Tg8 timing modules [2,3]. These will provide the majority of the timing signals. However, for more precise timing, an ECL system running at higher frequency is being developed.

2 RF SYCHRONISATION

A block diagram of the proposed RF synchronisation scheme is shown in Fig. 1. The master source will be a 3 GHz synthesiser and all other frequencies will be produced by division and, for the 4.5 GHz (if required), multiplication. The 250 MHz will be used as a clock for ECL precision delay counters (Section 4). The 19.2 MHz will clock the Tg8 modules of the central timing system as described in Section 3.
To ensure good phase stability, the RF synchronisation equipment will have to be located in temperature controlled racks.

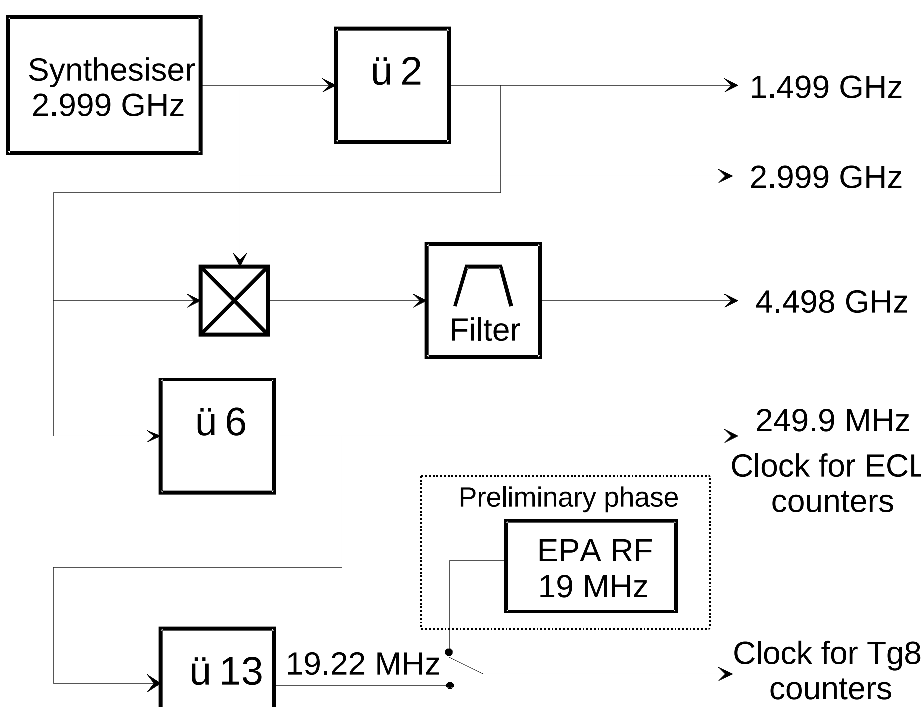

Fig. 1:Proposed frequency generation scheme for CTF3.

3 CENTRAL TIMING

3.1 Shortcomings of present system

There are several reasons why the LIL/EPA timing architecture is not suitable for CTF3. They arise because of the different operational constraints, the age of the present equipment and the need for a more versatile timing system for a test accelerator that will constantly evolve.

As LPI injected into the CPS, there is, at present, a dependency on the CPS timing composed of the 1.2 s basic period and the 1 kHz C-Train clock, both of which are derived from a very stable GPS-piloted clock. This greatly complicates and limits the control of a machine that must also be synchronised to the 100 Hz network zero-crossings (the NZC signal). For example, the present production/dummy selection scheme is very rigid and there is no possibility to use the machine timing system to tag zero-crossings for, say, beam measurements. In addition, most of the hardware is composed of obsolete CAMAC modules.

For the start of CTF3 preliminary phase, the existing LIL/EPA system will be used with the addition of special modules for gun and streak camera timing [1]. However, during the 2001/2002 shutdown, it is proposed to replace the entire central timing with a more powerful system that will permit operation of CTF3 then and in future phases of the project.

3.2 Proposal for new timing system

At the core of this proposal is the need to reconcile the requirements for a machine synchronised to the 50 Hz network with the wish to exploit existing PS investments in the 1.2 s cycling and pulse to pulse modulation mechanism (PPM, [2]).

The CTF3 central timing will be completely de-coupled from the CPS. It will have its own MTG piloted from a 1 kHz clock (termed CTF-C-Train) synchronised to the 100 Hz network zero-crossings. A 1.2 s Basic Period (CTF-BP, 120 zero-crossings) will be derived from this clock. The control system PPM will run at 1.2 s and 100 Hz. Two CTF3 telegrams will be defined and sent over the MTG cable to the Tg8 timing modules, a fast CTF3 telegram (FCT) running at 10 ms and a slow one (SCT) running at 1.2 s.

The SCT will contain USER values organising a collection of 120 NZC periods into operational modes. Simple examples could be called “5 Hz”, “10 Hz”, others could pulse different groups of equipment at different frequencies. The CTF3 could be run with an endless repetition of a USER or with more than one USER where there is some operational structure needed in the timing. USERS are places where acquisition values could be stored in the equipment module data tables, they could be used by application programs on work stations to select acquisition values, and they would remove the need for applications to remain synchronous with the much faster NZC period by grouping data. Most standard applications controlling power supplies, reading instruments, providing displays and accessing equipment modules will be PPM on SCT USER, and this will allow a huge amount of standard software to be used directly, without any modifications. The FCT telegram will contain only information which may change every NZC period, and will control the selection of production, dummy or null timings, the choice of EPA bucket to be filled, and the NZC period number.

A block diagram of the proposed hardware is given in Fig 2. It is applicable to the preliminary phase where accumulation is required. If, later, this is no longer required, then it could be simplified. The timing event Start RUN is for initialising the system. A chain of three standard Tg8 modules is used to generate the signal General Start. The first of the three generates the revolution frequency from the RF clock. The second, clocked by the revolution frequency and started by each 100 Hz zero-crossing, produces an output 1.5 ms before the next zero-crossing. The third delays this pulse between 0 and 7 RF periods to allow filling of the desired bucket. The first and last of these modules are only useful in accumulation mode. The General Start is used to start all Tg8 counters controlling individual pieces of equipment (klystrons, modulators etc.). They cover the range from 1.5 ms before to 1.5 ms after the network zero-crossing. Each one is followed by a fine delay module that increases the delay resolution to 1/256th of a clock period. Two Tg8’s are used with an internal clock to produce the 1 kHz CTF-C-TRAIN. Although this results in 0.5 μs jitter between NZC and the timing events, it ensures that the central timing does not stop if there is a fault with the RF reference. The CTF-BP is produced by division of the CTF-C-TRAIN.

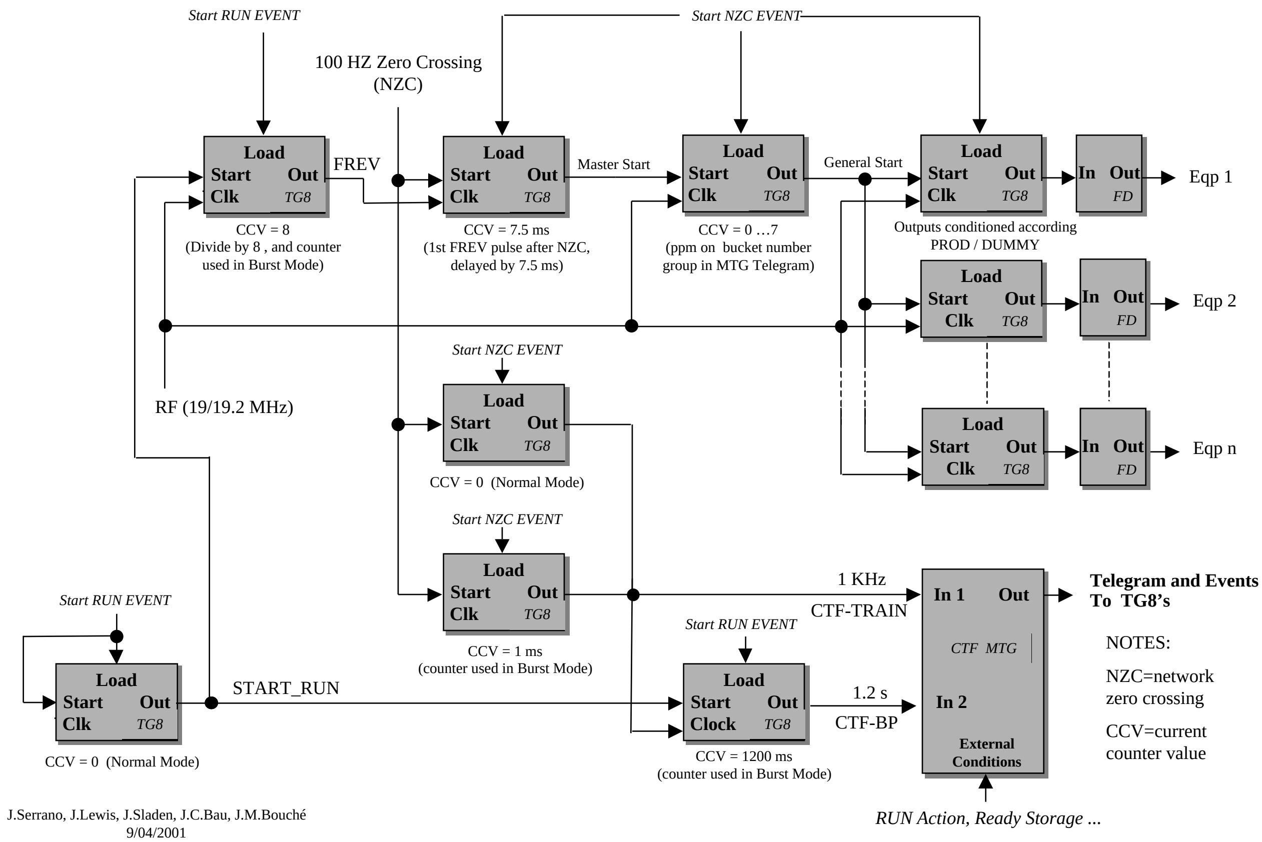

Fig 2: Proposal for central timing for CTF3.

4 ECL COUNTERS

The combination of the Tg8 counter and fine delay unit described above have an output jitter in the order of 1 ns. For equipment requiring a more precise trigger, a 250 MHz ECL system is being developed. It will consist of 24 bit counters followed by a vernier delay covering the 2 ns clock period in 20 ps steps. Short term stability, which can only be measured after a prototype is completed, is expected to be in the ps range. For applications requiring very good long term stability, the counter chassis will need to be housed in a temperature controlled environment.

Each of these counters will receive its start from a corresponding Tg8 counter. The trigger rate (5 Hz, 10 Hz etc.) of each individual ECL counter is therefore controlled in the standard way by the central timing. The delay setting will be via a parallel interface to the control system.

5 REFERENCES

[1] CTF3 preliminary phase design report.

[2] J. Lewis, V. Sikolenko, "The new CERN PS timing system", ICALEPCS93 conference, 1993.

[3] J. C. Bau, G. Daems, J. Lewis, J. Philippe, "Managing the Real-time Behaviour of a Particle Beam Factory: The CERN Proton Synchrotron Complex and its Timing System Principles", RT97 conference, 1997.