NEW TIMIG SYSTEM FOR THE SIAM PHOTON SOURCE

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Abstract

The new timing system for the Siam Photon Source has been made to provide timing signals to various accelerator components, including the linac, pulse magnets in the synchrotron for injection and for extraction, and pulse magnets in the storage ring for injection as well as power supplies of the main magnets and the RF system of the synchrotron. Since most of the components used in the timing system are standard NIM modules and digital delay generators, we could make the system in a short time and with relatively low cost. The system is very flexible and timing accuracy is expected to be very high. We plan to begin commissioning the accelerator system using the new timing system soon.

1 INTRODUCTION

The accelerator system for the synchrotron light source named the Siam Photon Source is in course of construction at Nakhon Ratchasima in Thailand, which is approximately 260 km to the northeast of Bangkok [1, 2]. The accelerator system, originally donated by the SORTEC Corporation in Japan, is comprised of a 40 MeV linac, a 1 GeV synchrotron and a 1 GeV storage ring. The storage ring has been modified to accommodate four 7 m long straight sections and to reduce the emittance of the electron beam to 74 π nm rad in the double bend achromat mode or to 28 π nm rad in the small emittance mode [3, 4].

A timing system is used in the accelerator system to operate the linac and the synchrotron and to inject the electron beam into the storage ring. The timing system used in SORTEC consisted of the clock generator, the timing controller 1 for the synchrotron, and the timing controller 2 for the linac and the storage ring. The clock generator provides the 11.8 MHz clock signal, which is one tenth of the RF frequency 118 MHz made with a frequency divider, and the one-cycle signal synchronous with the clock. It turned out that the timing controller 2 did not work and it was beyond repair. We, therefore, have made a new timing system, which is flexible and inexpensive, using standard NIM modules and digital delay generators. The basic idea for the timing system has been developed at SPring-8 and at New-Subaru [5, 6]. The new timing system enables us to inject the electron beam synchronously with the revolution frequency of the storage ring.

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1 TIMING SIGNALS FOR THE ACCELERATOR SYSTEM

The timing system provides timing signals to the linac, seven pulse magnets in the synchrotron for injection and for extraction of the electron beam, and four pulse magnets in the storage ring for beam injection, as well as a bending and two quadrupole power supplies and the RF system of the synchrotron. The operation of these components triggered by the timing system is shown schematically in Fig. 1. All the timing signals are generated with respect to the start signal, which we call the one-cycle signal. In order to make synchronous injection to the storage ring, the one-cycle signal has to be synchronous with the revolution frequency of the storage ring, 3.69 MHz, which is equal to the RF frequency 118 MHz divided by the harmonic number of the storage ring, 32. It takes 500 ms to accelerate the electron beam to the maximum energy 1 GeV in the synchrotron and the timing system has to provide delayed signals up to 600 ms with timing stability much better than 0.84 ns in order to inject the electron beam to a specific RF bucket in the storage ring. The linac has its own timing system for operation of its various components, so that only one timing signal is required. A timing signal is sent to a digital delay module for the four bump magnets of the synchrotron. A similar module is used for the three bump magnets of the storage ring. The main power supplies BM, QF and QD as well as the RF system in the synchrotron are operated using so-called pattern memories. Many timing signal are used for the pattern memories and provided by the timing controller 1. We have decided to use the timing controller 1 for operation of the power supplies and the RF system of the synchrotron, since it works well without any problems and maintenance and repair service is available in the years ahead. We have to provide the clock signal of 11.8 MHz, which is one tenth of the RF frequency, and the one-cycle signal, which must be synchronous with the clock.

2 NEW TIMING SYSTEM

The block diagram of the new timing system is shown in Fig. 2. The one-cycle signal is produced from the frequency of AC 100 V line, f_{AC} = 50 Hz to operate the accelerator system synchronously with the AC power line. This is done with a NIM module specially made to order. The 50 Hz signal is sent to a preset scaler (KN140, Kaizu Works), which can count pulses up to 10^3 to generate one-cycle signals with an interval up to 20 s. On the other hand, the RF signal is sent to a preset counter and frequency divider module (17K66AX, Digitex Laboratory), which is a 16-bit preset counter capable of directly counting the RF signal up to 500 MHz and the output signal is synchronized with the input RF signal. The revolution frequency of the storage ring is produced by dividing the input RF signal by the harmonic number 32, while a specific bunch circulating in the storage ring can be identified using a preset counter with a preset value between 0 and 31, which is denoted by M out in Fig. 2. The preset value can be externally set with the computer control system and consequently the electron beam can be injected into any one of the electron bunches in the storage ring, which is necessary to make a gap in the circulating electron bunches to avoid the ion trapping effect.

The one-cycle signal is synchronized with this bunch identifier signal using the synchronizer surrounded by the dotted square in Fig. 2. Fig. 3 shows how the synchronized signal is produced with the synchronizer.

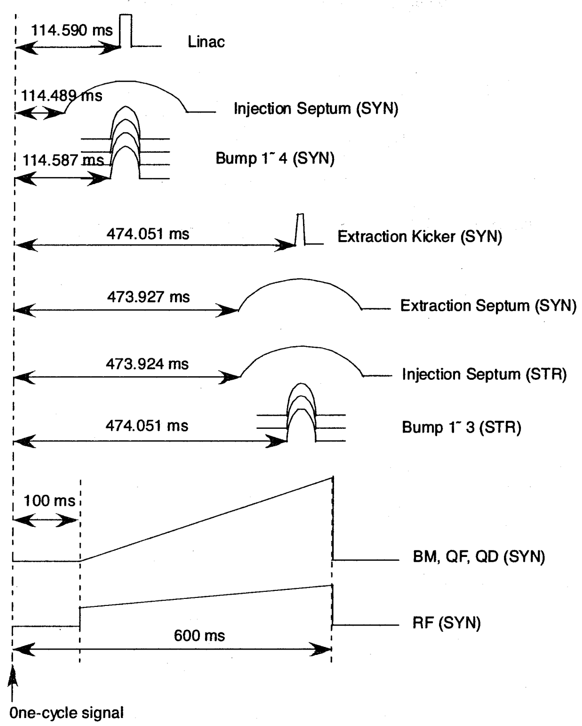

Fig. 1: Timing and operation diagram of the devices controlled with the timing system.

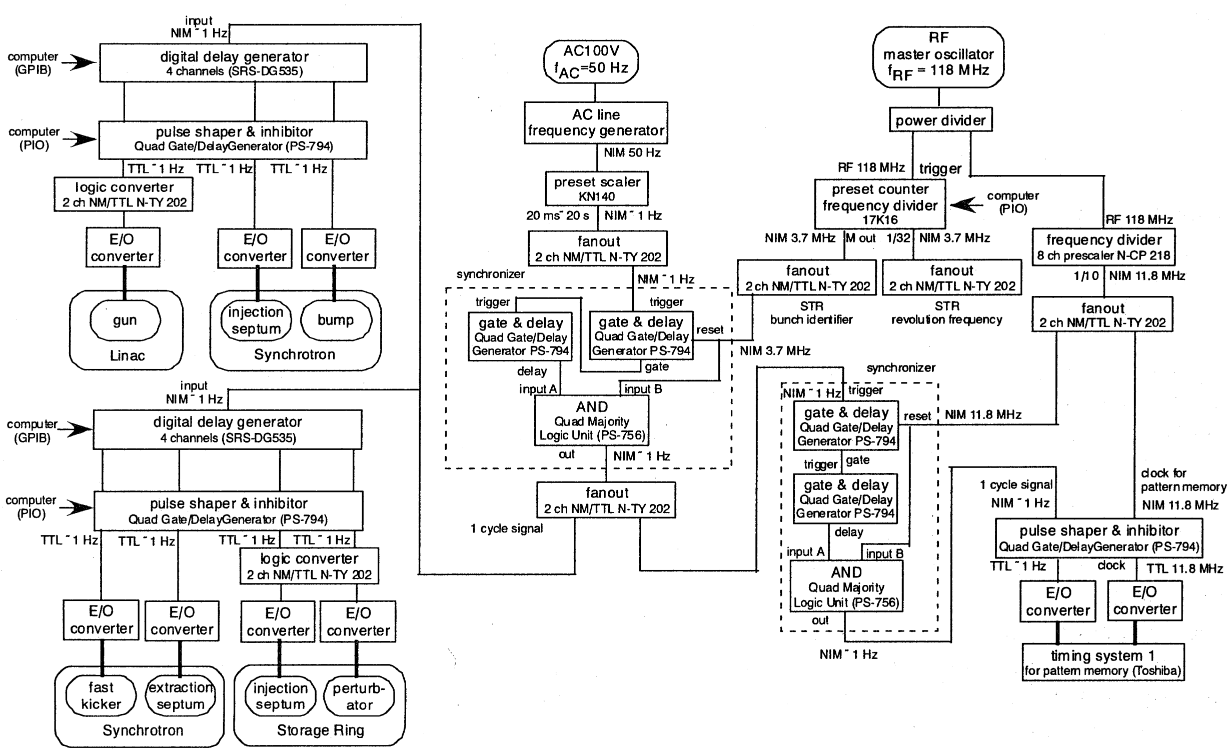

Fig. 2: Block diagram of the new timing system for the Siam Photon Source.

The one-cycle signal (A) and the bunch identifier signal (B) are fed to the gate and delay 1 (Quad Gate/Delay Generator PS-794, Phillips Scientific). This module makes an output signal synchronized with the first bunch identifier signal (B) right after the one-cycle signal (C). The signal is delayed by a half of the time interval of the bunch identifier signals T using the gate and delay 2 and the output signal with the duration equal to T is produced (D). This signal is sent to AND (Quad Majority Logic Unit PS-756, Phillips Scientific) as a gate signal for the bunch identifier signal (B) and when the gate is open a bunch identifier signal goes out from AND (E), which is the one-cycle signal synchronized with the bunch identifier signal. These are the function of this synchronizer. Because the synchronizer does not make any timing signal but makes only a gate signal, the input clock signal determines timing accuracy and the time jitter is shorter than 10 ps.

The synchronized one-cycle signal is provided to two digital delay generators (DG535, Stanford Research Systems), as shown in Fig. 2, which have four independent output channels. One of the delay generators is used for the linac and the pulse magnets of the synchrotron for injection, including the septum magnet and four bump magnets. The other delay generator is used for the pulse magnets in the synchrotron for beam extraction, including the fast kicker magnet and the extraction septum magnet, and the pulse magnets in the storage ring for injection, including the septum magnet and three bump magnets. Delay times can be set via GPIB from the control system. The output signals from a digital delay generator are fed to a pulse shaper and inhibitor module (Quad Gate/Delay generator PS-794, Phillips Scientific) and a logic converter (2 Channel NIM/TTL Fanout N-TY 202, Technoland Corp.), if necessary. The electric signals are converted to optical signals (Optical T/R, Aiden and special units made by Mitsubishi Electric) and sent to the controlled devices through optical cables.

The timing system has also to provide a one-cycle signal and a clock signal to the pattern memories for the main magnets and the RF system of the synchrotron. The clock signal 11.8 MHz is generated with a simple frequency divider (8 Channel Preset Scaler N-CP 218, Technoland Corp.). Since the one-cycle signal for the pattern memories must be synchronous with the clock signal 11.8 MHz, another synchronizer unit is used to generate such a signal from the one-cycle signal synchronous with the revolution frequency of the storage ring and with the 11.8 MHz clock signal, as shown in Fig. 2. Then these signals are sent to the timing system 1 for pattern memories through a pulse shaper and inhibitor module and an electro-optical converter.

3 SUMMARY AND CONCLUSIONS

The new timing system for the Siam Photon Source has been made using the above-mentioned NIM modules as

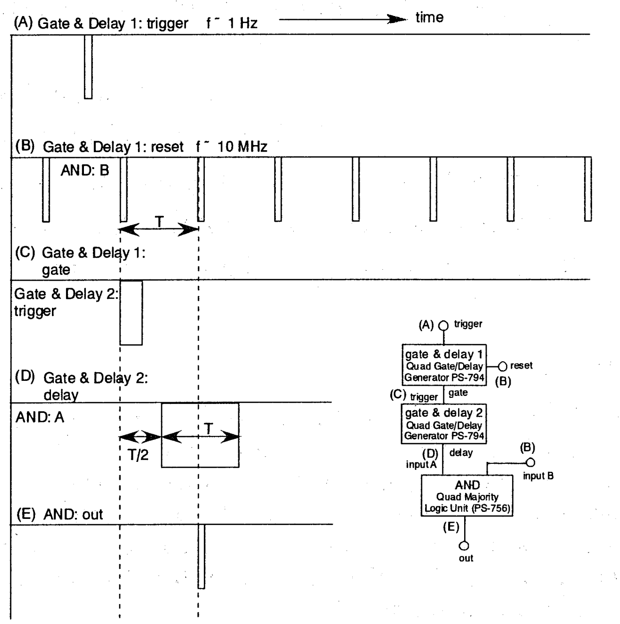

Fig. 3: Time chart of the syncheronizer.

well as two digital delay generators. All the NIM modules are installed in two NIM BIN power supplies. Since we use standard NIM modules and digital delay generators, the cost for the new timing system was relatively low and we could make the new timing system in three months. We plan to begin commissioning of the accelerator system for Siam Photon Source in October 2001 using this timing system.

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