Design and Evaluation of a Clock Multiplexing Circuit for the SSRL Booster Accelerator Timing System

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Synchrotron radiation is a technique by which highly bright beam of light is generated. This is achieved by making electrons travel at a very high speed (nearly the speed of light) and then continuously forcing them to change their direction using strong magnetic fields. It is known that when electrons moving at a very high speed are forced to change direction, they emit photons. This photons can be channeled and focused using proper techniques to form a bright beam of light which can then be used by the experimental community to study and characterize different material and biological samples. The SSRL-a synchrotron radiation facility at SLAC-is composed of two circular rings among other things. One ring (SPEAR3) serves as a storage for the beam of light from which users can tap when conducting experiments. The other ring (the booster), is used to periodically inject new electrons into the storage ring as electrons continuously leave the beam for different reasons and thus cause the beam intensity to deteriorate. The electrons are first injected into the booster and accelerated until they acquire the required level of energy. Afterwards, they are transferred into the storage ring to join the electron beam at a predetermined point. This needs high level of timing coordination. An electronic timing circuit monitors and coordinates the injection process. The timing circuit uses two signals as a source of information to time the injection process. One signal comes from the booster and the other is derived from the electric power line supplied by PG&E (Pacific Gas and Electric Company). The timing circuit primarily uses the signal from the booster to monitor the process. However, this signal is not available all the time since the booster is turned off between injection cycles. Therefore, the timing circuit periodically switches between the two sources of signal. During switching from one source to the other, this circuit causes glitches (irregularities on its output wave form). The glitches cause SPEAR3 to lose some injection cycles, and thus are undesirable. This project was intended to see if the timing circuit can be upgraded in a way that would eliminate glitches form the output waveform. I constructed a clock multiplexing (switching) circuit to 'switch' between the booster generated 'injection ready' clock signal and PG&E based clock signal. The circuit uses digital integrated circuit components and is capable of making glitch-free transitions between the two clock signals. This report details construction of a prototype multiplexing circuit including test results and suggests improvement opportunities for the final design.

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