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SEB SPILL SERVO

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AGS DIVISION TECHNICAL NOTE

No. 147

SEB SPILL SERVO

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Introduction

Resonant slow beam extraction from the AGS requires precise control of the main magnetic field slope during the flatop portion of the AGS cycle. This is accomplished by the SEB spill servo system, whose analog output controls the main magnet (Siemens) power supply voltage and hence the rate of change of magnetic field ($\dot{B}$) during flatop.

The new servo is similar to the old servo except for the following modifications and improvements:

1. It provides computer control of parameters such as spill length and servo gain. It also provides computer monitor of many parameters not previously entered in the computer.
2. Spill length and gain are now independent variables, i.e., changing gain does not affect spill length.
3. Allowance has been made for inhibit or beam abort. If certain radiation loss monitors (e.g., H20LM) exceed a computer pre-set limit, the beam will be inhibited in either of two modes:
    a) rf turn-off during the acceleration cycle,
    b) main magnet flatop slope control which moves the beam to the inside, away from resonance and latches off until computer RESET is activated.
4. In the zero circulating beam condition, the main magnet power supply is not driven by the servo error signal but only by the open loop function generator signal and hence motor speed excursions are minimized.

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5. It is now physically incorporated at one location which consists of one datacon crate and one NIM crate.

Circuit Description and Construction

As stated earlier, the new servo system is constructed in two crates; one being the computer/datacon crate and the other, a NIM crate. These are located on the second floor above the main control room.

The NIM crate houses several modules which make up the reference, compensation amplifiers and the inhibit circuits. A block diagram of the system is shown in fig. 1. Following is a brief description of each module. Reference is made to fig. 1. For further details, the schematic drawings should be referred to.

1. Reference Module (D09-E1051-2) and Switch Module (D09-E1050-2)

These modules produce a normalized pulse which becomes the reference for the closed loop portion of the system. The reference output is derived from an analog divider and is proportional to the circulating beam intensity and inversely proportional to the computer controlled spill length voltage. Thus, the higher the level of the output reference the higher will be the spill and also correspondingly shorter. If longer spills are desired, the computer spill length voltage level (SSLNG) is increased. The on time for the pulsed reference is derived from the flatop pre-pulse trigger plus an autodet delay (SSDLY). The off time is derived from the invert trigger. The actual switching is accomplished by a shunt FET transistor, which normally grounds the signal reference until triggered on by SSDLY. The AGS circulating beam (L15CBM) is sampled at flatop pre-pulse and held (AD582 S/H) until sampled a second time (invert) when L15CBM is zero and is hence reset.

2. Servo Amplifier Module (D09-E1052-3)

The servo amplifier is the main block in the feedback loop. The first stage consists of a differential amplifier which compares the reference and a feedback signal from the CE010 secondary emission chamber which is proportional to the SEB intensity. The error signal is then passed through an analog multiplier (AD 428J) which has as its other input a computer controlled voltage (SSGAN) which when varied adjusts the loop gain.

The compensation section provides switched time constants which permit various lag networks to be included in the feedback loop and hence provide different degrees of loop damping or response.

The final section of the servo amplifier module is a summing amplifier which combines the function generator input, the error signal input and the INHIBIT

INPUTS (described later) and provides the output signal to the Siemens main magnet flatop power supply. Fig. 2 shows typical sketched waveforms of the operation.

3. Comparator Modules (D09-E1053-3)

The comparator modules are used to inhibit the AGS circulating beam when radiation levels on the wire electrostatic septum (H20) used for extraction of the SEB become excessive and may cause damage to the 0.002 inch wires. The beam may be inhibited in either of two modes. First, during injection and acceleration if losses are detected a fast pulse is provided by the comparators to turn the rf system off (SW3 OFF). Second, during flatop when the rf system is off (debunched beam mode), the comparators provide a voltage level into the servo system output which reverses the normally negative going main magnet current to a positive slope and hence moves the AGS circulating beam radially inward and away from the resonance region used for extraction and hence SEB is aborted and losses on the extraction septa should be minimized.

Both comparators are identical. A flip-flop is controlled by a comparator op-amp which has the H20 electrostatic septum loss monitor (H20LM) and a computer controlled trip voltage level (SSTP1 or SSTP2) as its inputs. If the loss monitor level exceeds the computer voltage, the flip-flop is triggered and its output goes through a switch to the servo amplifier and drives it to positive saturation and inhibits the beam. Also, whenever the flip-flop is triggered, a synchronized high level AGS standard pulse is produced via an autodet which may be used to turn other devices on or off on subsequent AGS pulses.

The switch is used to enable or defeat the beam inhibit mode either manually or via the computer. In addition, once the flip-flop is triggered it remains in a latched condition unless reset via the computer or a manual pushbutton located on the module front panel.

4. Loss Monitor Module (D09-E679-4)

This module is used to convert the current from an ionization loss monitor which is located at the H20 electrostatic septum straight section into both an analog and digital output. The analog output is fed to the comparator chassis to inhibit the beam when it exceeds the preset trip levels and is also fed to the analog crossbars for oscilloscope viewing. The digitized output is connected to the scaler crossbar and to a datacon scaler for recording on SEB readout programs.

5. Computer Interface (D09-E992-3)

Interface to the AGS operating computer (PPB) is accomplished via a datacon crate which provides the outputs to control the servo system and also to monitor its status. The modules included in the crate are a 16-channel multiplexer, analog-to-digital converter, three power supply controllers, two autodets and two function generators.

One of the function generators is used to provide the open loop input to the servo. The other function generator was included for future applications such as real-time error signal correction.

The power supply controllers are employed to adjust the spill length and the servo gain parameters, to provide On/Off control and reset, and also to provide the trip voltage settings for the two comparators used to inhibit the beam.

The multiplexer/ADC modules are used to monitor various levels in the servo system which determine proper operation amd also which can be monitored and stored as permanent operational records. Also, analog outputs A and B are fed through a buffer amplifier (D09-E1024-2) to the analog crossbars.

The autodets are used to provide the various timing pulses required in the servo operation (refer to fig. 2).

In addition, the comparator beam inhibit and interlock defeated information is fed to a datacon input register card in a separate crate and this information is read by the ALARMS program and displayed in the main control room.

Operational Aspects

Control and set-up of the desired SEB spill is controlled from an AGAST page entitled SSRVO which is found on the library of SEB files.

The set-up of the spill should be accomplished by first adjusting both the function generator and the main magnet power supply flatop slope control with the CED10 feedback loop open. This is done by setting the loop gain (SSGAN) to zero. The spill pulse should have as close an approximation to the desired spill shape as possible. Then the servo gain should be increased and the spill length should be adjusted to square up the spill pulse and to operate in a closed loop fashion.

An autodet delay (SSDLY) trigger which starts at flatop pre-pulse time is used to start the spill at a pre-determined time. The closed loop reference program ends at the invert trigger time.

The other parameters which affect spill output and the main rf system are the two comparator trip levels (SSTP1 and SSTP2). These levels should be set just above normal operating levels of beam loss on the H20 electrostatic septum, as indicated by the H20 loss monitor. High radiation trips will be indicated on the ALARMS monitor. In addition, if the radiation protection system is DEFEATED (i.e., off) it will also be indicated by the ALARMS program. If either of the comparators has been tripped, it must be reset via the AGAST RESET command.

The analog multiplexer A and B outputs are fed to a buffer amplifier and to the analog SEB crossbars. Signals may be selected via the multiplexer and reviewed on oscilloscopes in the main control room.

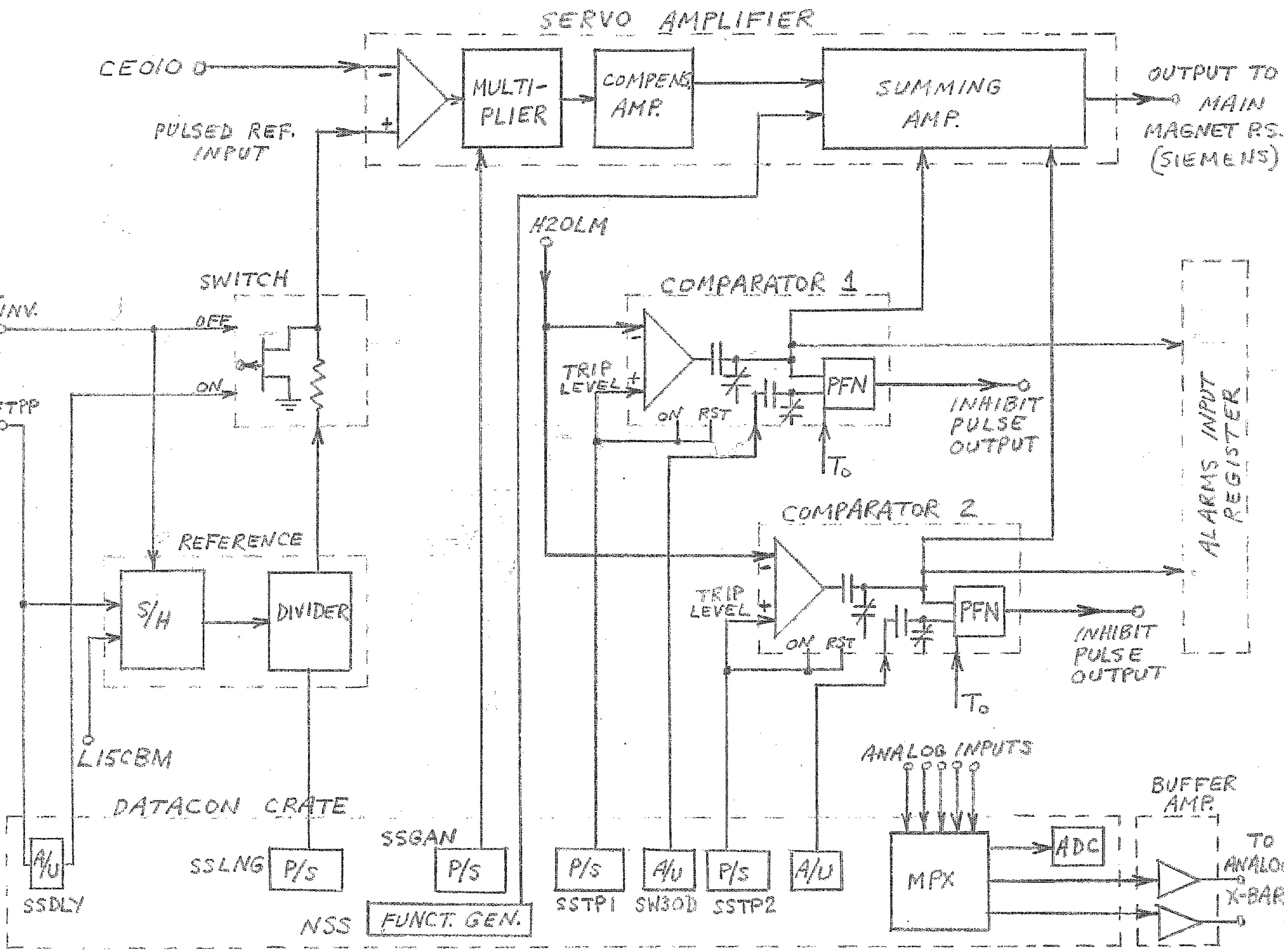

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Fig. 1 - System Block Diagram

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