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DYNAMIC RANGE EXTENSION OF BPM at the NSLS*

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Abstract

In order to overcome range limitations, the existing Beam Position Monitor (BPM) receiver was modified, extending the dynamic range from 35 dB to 60 dB. The modifications include the insertion of an RF PIN attenuator, RF amplifier, and control circuitry in line with the RF link to add an extra 25dB to the existing AGC loop. This stand alone 25dB RF gain control stage is integrated into the present system without any change to the existing receiver.

I. *INTRODUCTION*

The 30 to 35 dB dynamic range of the existing receiver is sufficient for normal operation of the VUV and XRAY rings. However, this limited range is insufficient for research which requires low currents in the rings, resulting in large errors in the receiver's position outputs. Since the useful ranges of the receivers do not exactly overlap the range of ring operation, an additonal margin of receiver range would be useful. Three different approaches were considered:

1. Improve the 10.7 MHZ IF section. This approach is time consuming in that it requires replacing an existing working board. This means deleting existing circuitry, installing new circuitry and finally, recalibrating and checking the new receiver.
2. Build a separate AGC at the 158.66 MHz, RF frequency. This appraoch has the advantage of minimizing the RF power range at the input to the mixer. This stand alone AGC need not be extremely precise because the existing IF AGC will continue to operate, controlling the overall loop performance. The major drawback in this method is that it requires more complex circuitry and careful attention to ensure the two loops do not interfere with each other.
3. Insert a voltage control RF attenuator (PIN diode). This is the approach ultimately chosen (Figure 1). The control voltage to the PIN is derived from the existing 0-10v voltage that drives the IF AGC. The input-output for this box is in the form of SMA connectors that can be placed just before the 158.66 MHz band pass filter. This approach does not necessitate any modification to existing circuitry. Installation of this box is simple, so the overall upgrade is easily accomplished.

II. *RF ATTENUATOR*

The attenuator consists of Watkin Johnson G2 PIN diode attenuator with frequency range up to 1000 MHz , and attenuation range over 45 dB. The PIN attenuator is followed by a Watkin Johnson A81-2 RF amplifier which has 17dB gain and operates to 400 MHz.

At low current levels in the ring, the PIN diode is in its minimum attenuation level (insertion loss). The combination of the 2dB insertion loss of the PIN diode and the 17 dB gain of the RF amplifier actually improves the noise figure of the receiver at these low levels. The AGC input signal to the RF attenuator must be offset and gain adjusted in order to optimize the performance of the combined AGC. Figure 2 shows the RF AGC layout.

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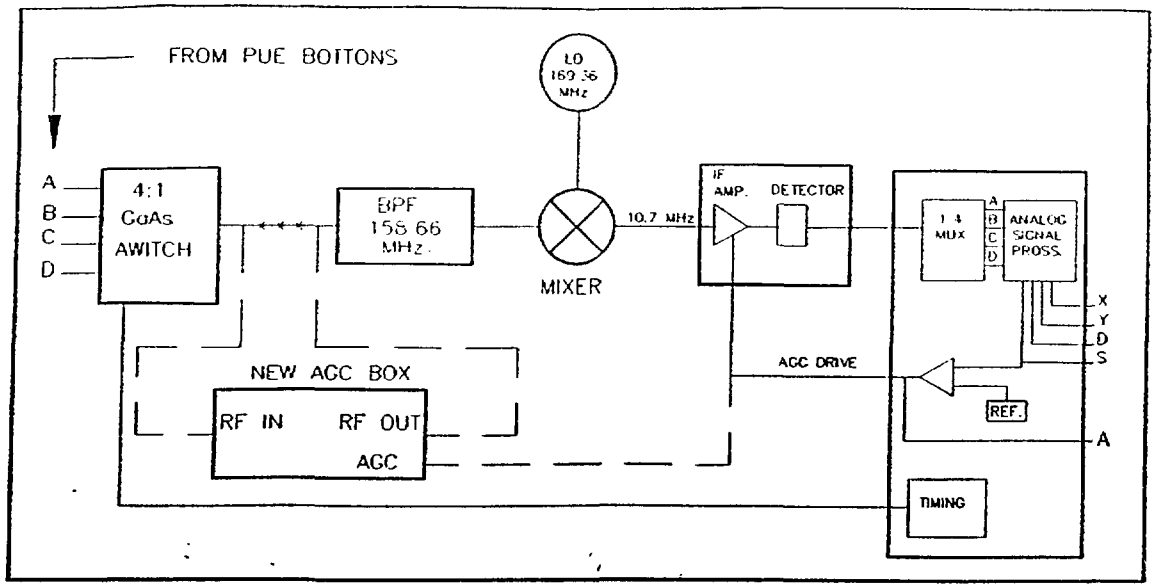

Figure 1. RF BPM receiver block diagram.

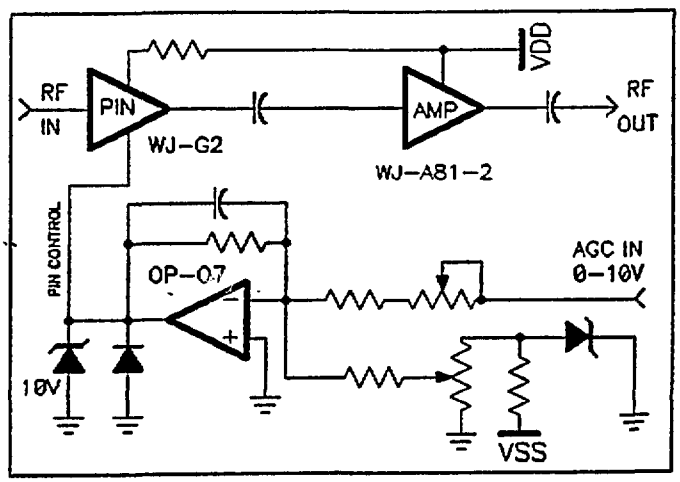

Figure 2. RF attenuator diagram.

III. *RESULTS*

Figure 3 shows a typical attenuation vs. control voltage characteristic of the WJ-G2 PIN diode. These diodes have greater than 40 dB dynamic range at 158 MHz. However, at low input voltages the non linearity is extremly severe, eliminating the usefulness of this range. The offset and gain potentiometers were adjusted in such a way that 0 to 10 volts at the input to the box resulted in 1.5 to 8 volts at the input to the PIN diode.

Figure 4 shows the PIN diode attenuator box characteristics. All units were calibrated this way, and showed little deviation from one to another. Thus far, 5 units have been integrated into the BPM receivers. The improved overall dynamic range is shown in Figure 5 and 6. The tight position control ranges close to 50 dB, and up to 60 dB with small deviations.

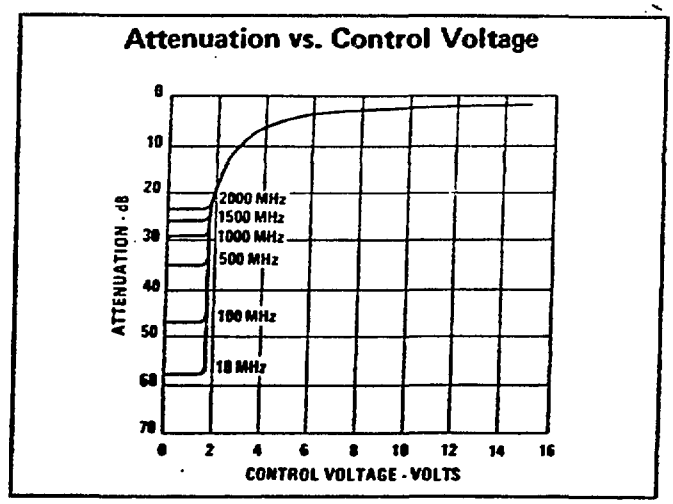

Figure 3. WJ-G2 diode characteristics.

IV. *CONCLUSION*

The addition of an RF voltage control attenuator to the existing BPM extends the dynamic range of the receiver by 25 dB. The integration into the receivers proved to be simple, requiring very little adjustment. In three of the five units integrated, nothing more was required than to place

The attenuator box in the receiver. Since each receiver is different, some adjustments and optimizations of the overall AGC loops should be expected.

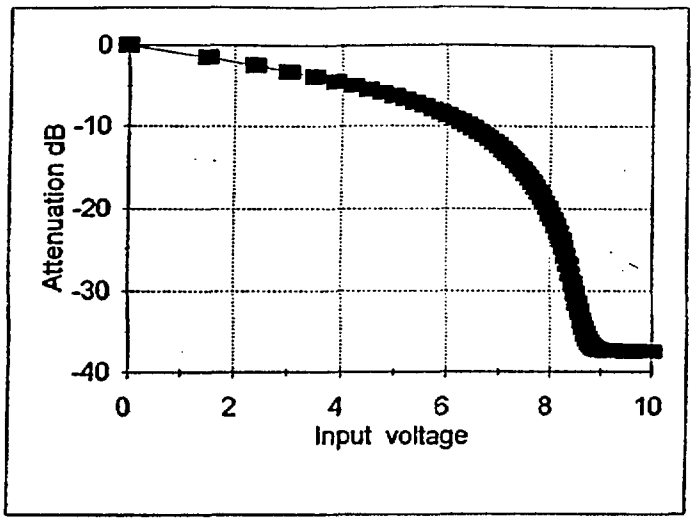

Figure 4. AGC box characteristics.

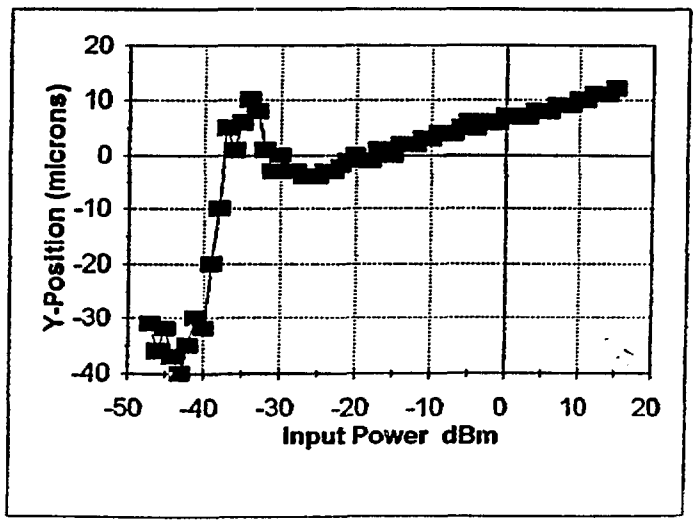

Figure 5. Y - Position variation (3,3 mm) vs. input power.

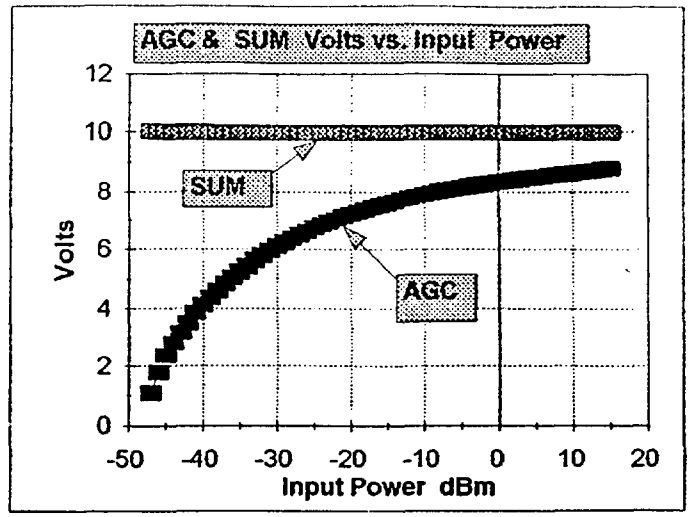

Figure 6. AGC and SUM variation vs. input power.