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LOW FIELD CORRECTION READBACK EVALUATION

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AGS DIVISION TECHNICAL NOTE

No. 149

LOW FIELD CORRECTION READBACK EVALUATION

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The low field correction (LFC) coil current readback system tends to be erratic. The LFC, both horizontal and vertical, are checked periodically using a computer program. This program uses approximately 10 steps to control LFC current between 0 and 2A for a selected coil. The program compares the command and readback currents and prints out the deviation from the mean value. Just prior to the September 1978 shutdown the 196 LFC (dipole) currents were scanned and typical deviations from the mean were greater than 30 counts (0.5 ma/count). During the shutdown the system was recalibrated and thoroughly examined to determine the cause of the error build-up.

The LFC is basically a DATACON I system controlling current regulators. Figure 1 is a simplified block diagram of the dipole LFC system. The LFC system investigation was split into two basic areas: (a) Command/Control and (b) Readback.

A. Command/Control

1. D/A Conversion

A manual DATACON control head was used to send current control information to the 10 bit D/A converter. There was good tracking accuracy between command value and reference voltage output. Most of the D/A converters had developed a slight DC offset at 0 (± 3 or 4 mV), but tracked very well (less than 10mV error--0 - 10V). The polarity reversing command and readback came through every time.

2. Regulator

The current regulators using shunt voltage readback, tracked the reference command voltage very well with less than a 0.2% error.

B. Readback

Most of the errors are in the readback portion of the DATACON I system. The major culprit is a mechanical problem involving the readback board/connector. There also is a noisebuild-up problem in readback concept.

1. Board/Connector

The readback boards are fabricated using a 98-circuit card edge connector.

a. PC layout of circuit lands for connectors used are too narrow a width. This results in many of the connections being made at the edge of the lands. The card must be positioned perfectly at insertion to make sure all connections are made.

b. High insertion force required to mate the single 98-pin connector results in cracking mating connectors. In addition, if the board is not fully mated, it will slowly creep out.

c. The board is not plated and this results in electrical noise build-up due to corrosion at the connector interface.

2. Conceptual Problem

Figure 2 illustrates the conceptual problem in the present LFC system; i.e., the signal conditioning amplifier (gain of 5 operational amplifiers) follows the FET switching ladder amplifying the noise contribution of the ladder and connector noise noted in 1c above. The signal conditioning amplification should take place before the FET switching ladder (at the regulator shunt) to improve the signal to noise (S/N) ratio of the input to the A/D converter. The data input to the FET ladder should be amplified to the maximum value that can be accepted by the FET switch then attenuated after the switch ladder.

C. Conclusions and Recommendations

The present LFC system (DATACON I) is adequate for the job if two conditions are met; i.e., 1. A two week minimum shutdown approximately every six months to allow repair and recalibration of the LFC subsystem, and 2. Ignore the 0 to 100 mA range of the readback due to system noise. In addition, if a discrepancy between command current and readback current develops, the LFC will follow the command current very accurately and the command current trusted while ignoring the readback.

The most desirable solution would be to connect the LFC to DATACON II. Since DATACON I is obsolete (LFC the only remaining system using it) there are no readily available spares. At present there is one board of each type available as spares, requiring all boards removed from the system to be repaired immediately. DATACON II is a standardized system and replacement cards, card buckets, power supplies, etc. are stocked at the AGS. However, a very coarse estimate of \$100K to \$150K and approximately six month building, installation and debugging time would be required to convert the entire LFC to DATACON II.

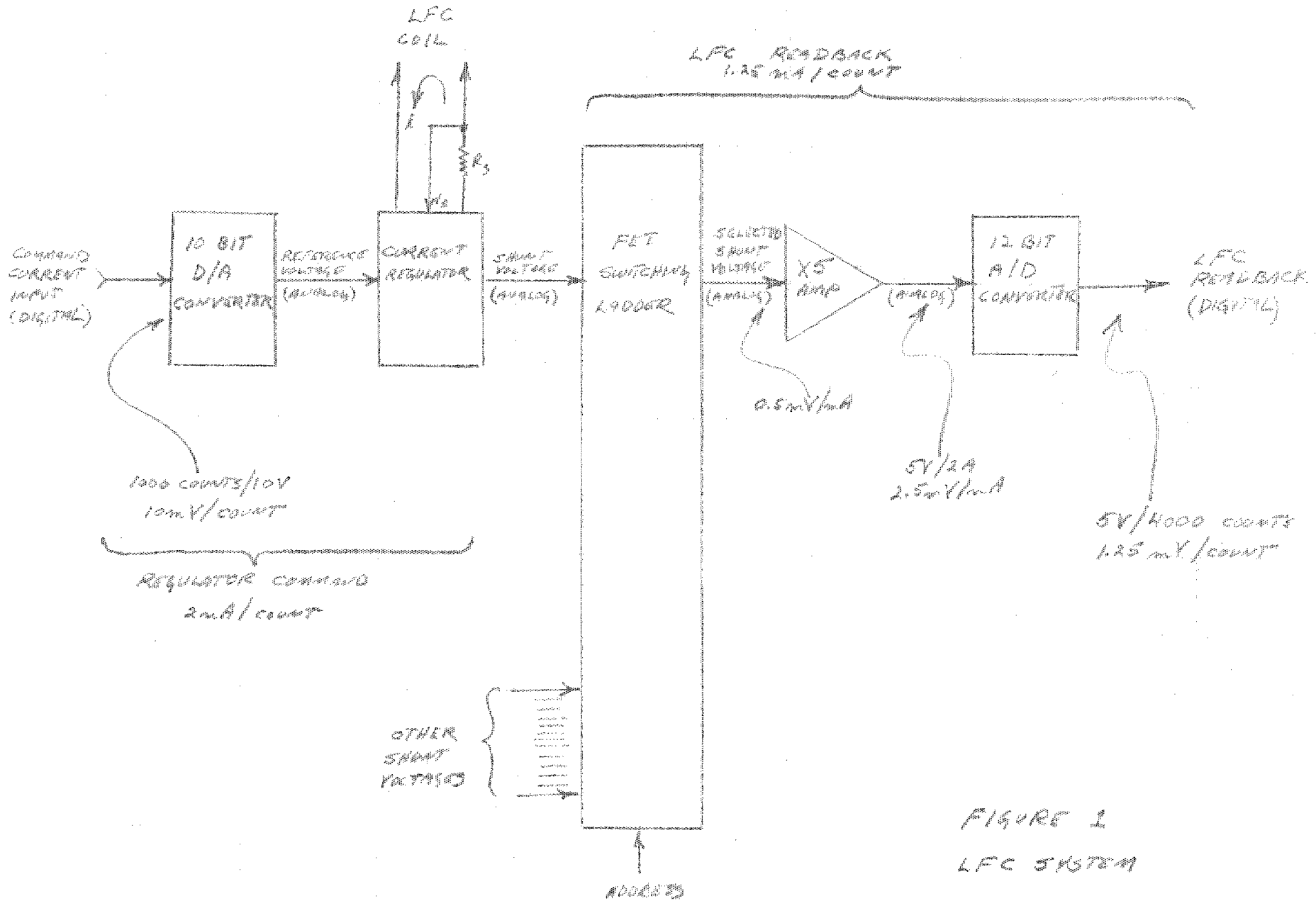


FIGURE 1
LFC SYSTEM

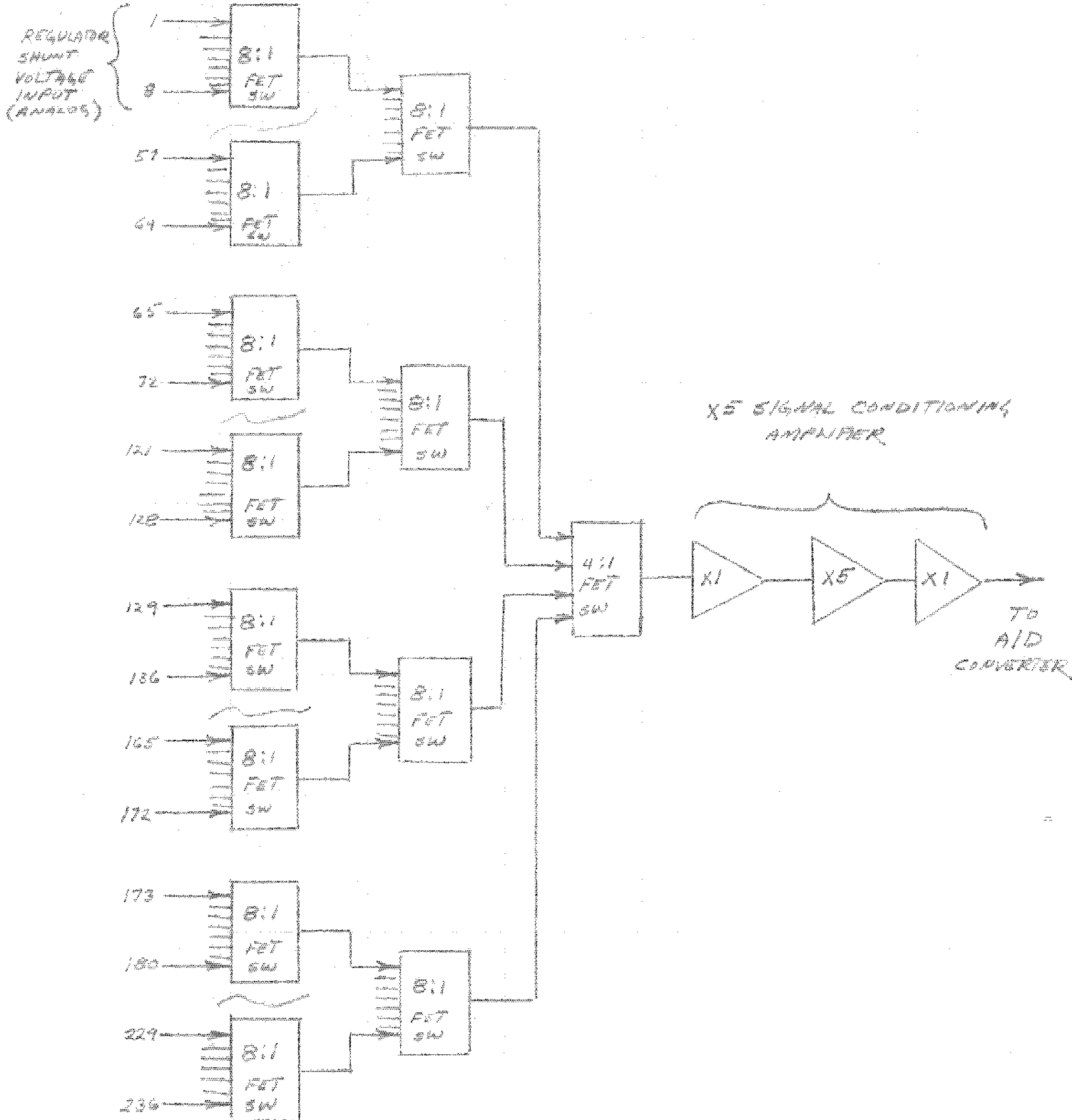


FIGURE 2
LFC SWITCHING LADDER
(PART OF DATA CON I)