Application of a Linear Array in a Telemetry System

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ABSTRACT:

Advances in integrated circuits have provided “single mask programmable” linear arrays that can be used to greatly reduce the volume requirements of the analog front end circuitry used in airborne telemetry applications. This volume reduction has led to telemetry systems with high levels of computational power and data acquisition in constrained spaces of irregular shape. In this paper we describe a specific application of a linear array to telemetry and discuss more general applications.

INTRODUCTION

A primary goal of airborne telemetry systems is accurate, reliable reporting of host system function with minimal electrical or physical perturbation of the host. Operational amplifiers offer a method to virtually eliminate electrical loading effects introduced by a telemetry system. Although advances in the integration of digital circuitry have significantly reduced circuit volume while increasing processing capability, advances in integration of operational amplifiers have progressed little since the introduction of the quad op-amp in the mid 1970s. This is a problem for telemetry designers who must meet increasingly complex monitoring requirements while imposing minimal physical impact on the host (no more space). This paper describes a macrocell-based linear array that has been successfully used in an airborne telemetry system to achieve the goals previously described.

APPLICATION: A TELEMETRY SYSTEM FOR A BOMB FAMILY

The example telemetry system is used to monitor signals generated/received by any of a family of modular, similar nuclear bombs. Monitoring requirements include a total of 77 channels of weapon data. The impedance presented by the telemetry to each of these channels must be a minimum of 40 Kohms, measurement accuracy must be within +/- 5% of the actual value, and signal levels may vary from 0 to 40 volts. In order to meet these requirements the front end analog signal conditioning illustrated in Figure 1 was used for each of the 77 channels. This configuration offers excellent characteristics for accurate gain, common mode rejection, and minimal circuit board area. A space analysis determined that it would require 20 quad op-amps and over 300 resistors to implement the front end signal conditioning using standard, commercially available parts. These 320 discrete parts were replaced with six linear array parts each having 15 op-amps supplemented with resistor networks to form fully integrated gain stages. This miniaturization of signal conditioning circuitry saved 14 square inches of circuit board space for the telemetry system.

LINEAR ARRAY UTILIZED

The macrocell based linear array for this telemetry system is fabricated with a two-layer metal technology which includes thin film resistors. A simplified schematic of the bottom metal layer is shown in Figure 2 [1]. This array utilizes a grid or tile layout of components so a given subcircuit can fit into a number of locations. The standard building block of this array is a differential gain block called the macrocell which can be configured as an operational amplifier or comparator. In addition to the 15 macrocells, the bottom layer contains the foundation for 10 PNP transistors, 47 NPN transistors, 240 resistors (1.25K to 150K), 15 compensation capacitors, a voltage reference, and two supply bus structures. The top metal layer only is customized and interconnects these components to form the linear system. The 44 bonding pads form input/output connections between the die and the package. The die size itself is 3.12 by 4.8 mm.

For the telemetry system, the macrocells were configured as operational amplifiers. Each macrocell has a bias current called Isetx which controls the quiescent operating currents and determines macrocell performance characteristics. With an Isetx of 17uA, each macrocell has a common mode rejection greater than 80dB.

The resistor blocks utilize thin film resistors which are made with a silicon chromium process and have performance characteristics similar to the discrete equivalents. The thin film resistors have an absolute tolerance of +/-10%, a matching tolerance of +/-1%, and no parasitic capacitances. These low tolerances produce accurate gains and allow high measurement accuracy. The macrocells are configured with differential gains less than unity to accommodate large input voltages.

The telemetry system also employed the bandgap voltage reference section of the linear array. The reference voltage of 1.25 volts is used by the system. This section of the array also generates temperature stable Isetx currents for the macrocells.

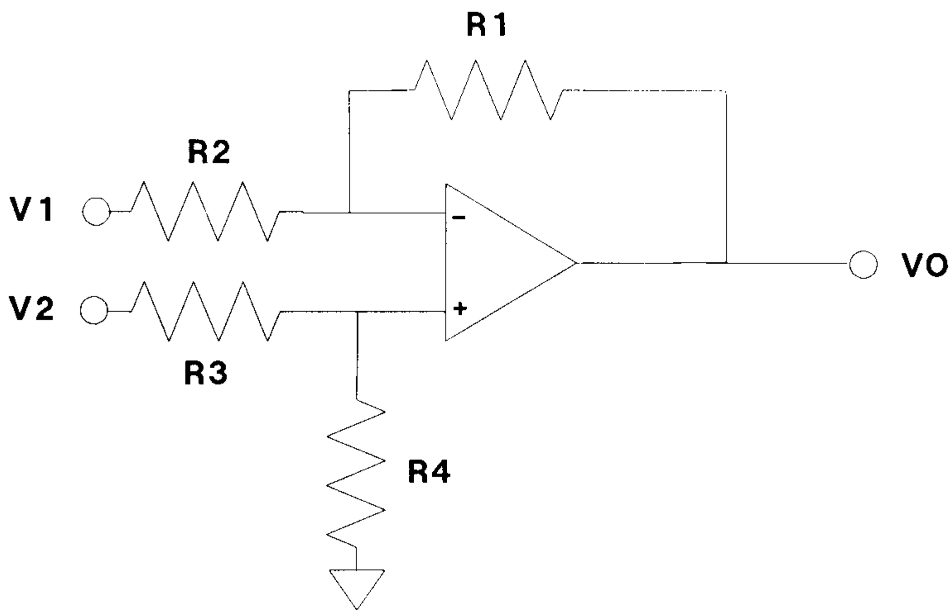
This macrocell based linear array has been used in commercial and military systems with single and dual supplies. In addition to the example telemetry system, applications include bar code scanners, power supplies, and missile guidance systems.

CONCLUSION

Linear arrays have improved in performance and ease of application. For the airborne telemetry system, a linear array decreased the system parts count and conserved circuit board space while meeting the critical system specifications.

REFERENCE

1) "RLA Series Linear Array Design Manual," 3rd edition. Raytheon Semiconductor, Mountain View, California, 1989.



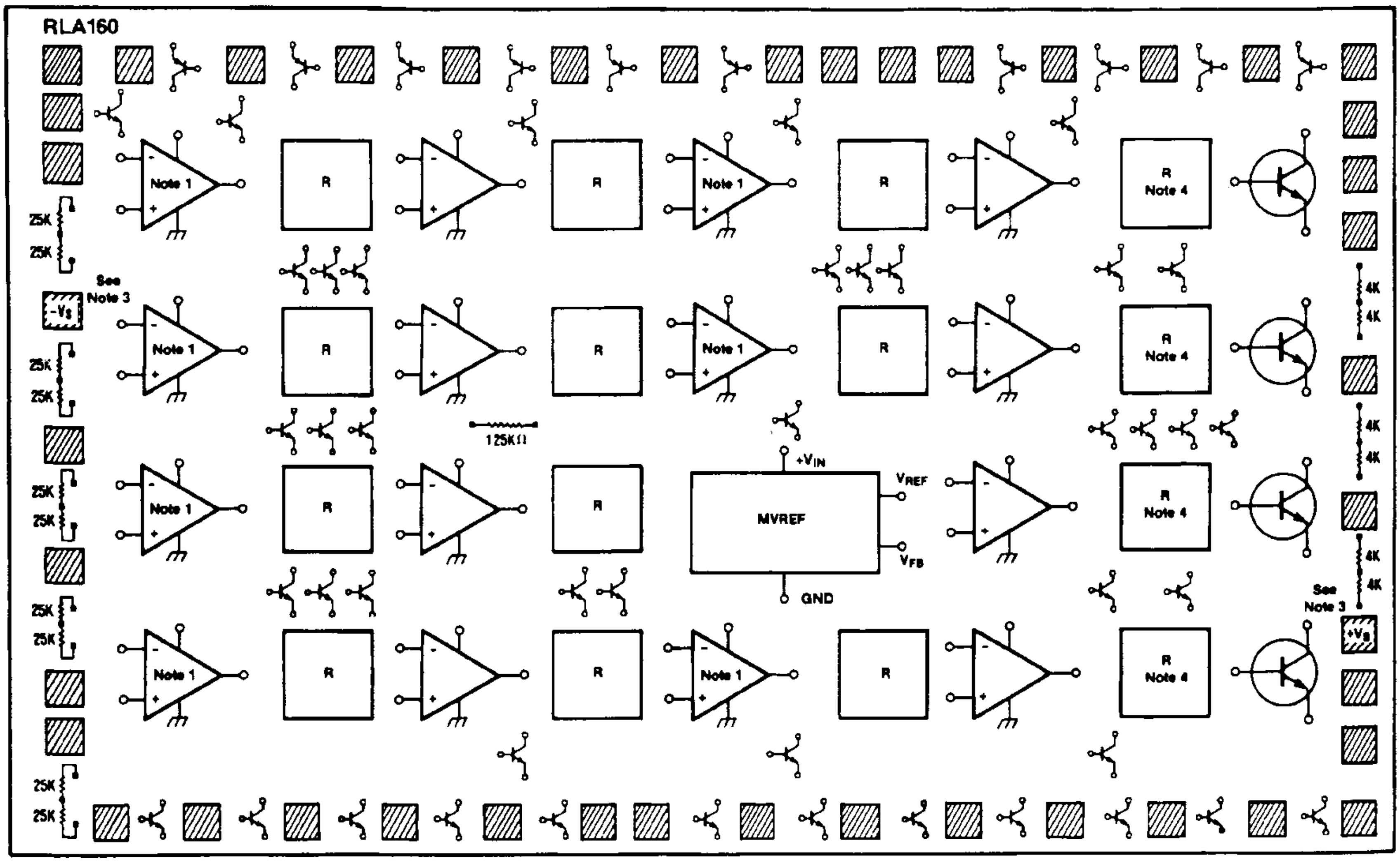
VO = ((R4*(R1+R2))/(R2*(R3+R4)))*V2 - (R1/R2)*V1

WITH R1/R4 = R2/R3 :

VO = (R1/R2) * (V2-V1)

Figure 1: Front End Analog Signal Conditioning

RLA160 Simplified Schematic Diagram



Notes:

1. These four macrocells are complete macrocells which include extra PNP transistors to enable ground sensing operation (V_{CM} = 0V).
2. R = Resistor Array (1-150kΩ, 1-100kΩ, 1-40kΩ, 2-20kΩ, 4-10kΩ, 2-5kΩ, 2-2.5kΩ, 2-1.25kΩ).
3. $+V_S$ and $-V_S$ busses not depicted.
4. These resistor arrays lack the 100kΩ value.

Figure 2: Linear Array