10 Bit Potentiometric DAC With Off Chip External Reference Voltage

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***Abstract*—The document describes the applications and implementations of a Digital to Analog Converter. This paper also presents an introduction to the design, implementation and application of a 10-Bit Potentiometric DAC. The presented DAC would be given an off-chip external reference voltage.**

Keywords —Potentiometric, DAC

I. INTRODUCTION

With the advent and development of digital systems interfacing the naturally occurring analog signals is becoming increasingly necessary for the development of various electronic systems. Many modern devices like Audio and Video devices, Signal Processing Instruments, Software Defined Radios require converters to link the digital and analog signals. Primarily there exist Analog to Digital (ADC) and Digital to Analog (DAC) converters for such applications. These devices convert a signal from a particular domain to another domain as their names indicate. A Digital to Analog Converter, takes digital words or bits as input and converts them into an analog signal with reference to the voltage reference provided. The block diagram of DAC is shown in Fig.1. There exist different types of DAC such as current scaling, voltage scaling and charge scaling DAC. The voltage scaling DAC is also known as potentiometric DAC or a string DAC.

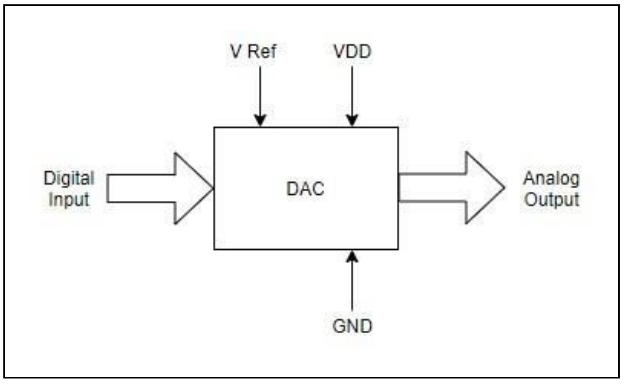

Fig. 1 Block diagram of DAC.

II. DESIGN

Various architectures are available for DACs such as Weighted Binary Resistor DAC, R-2R ladder DAC and Potentiometric DAC. The design of a Potentiometric DAC includes a series of 2^N resistors connected to 2^N switches to create a complete path for the signal from input V_{REF} to output, Fig 2. One end of the string is connected to a high reference voltage and the other end is connected to a low reference voltage.[1] The switch network samples the output by tapping at the required voltage node. One big advantage of a resistor string is that the output will always be guaranteed to be monotonic.[2] A N-to-2N decoder is required to implement the switching circuit. This configuration is also known as Kelvin Divider, Fig. 2. A major drawback of Kelvin Divider is that it requires 2^N resistors and 2^N switches.[3] The advantage of a potentiometric DAC is its inherent monotonicity, since the voltage at each tap is higher than the voltage at the tap below it.[4]

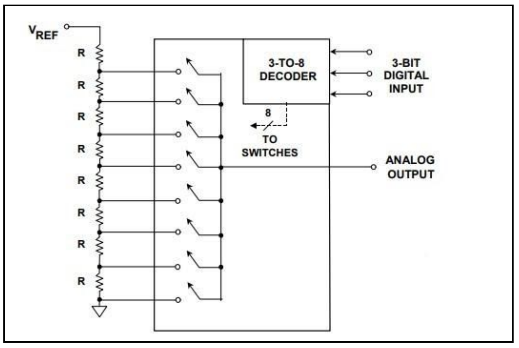

Fig. 2: Kelvin Divider.[3]

III. CHARACTERISTICS AND APPLICATIONS

The Digital to Analog Converters are selected based on the various characteristics they possess. Resolution is the levels of the output, the DAC is designed to produce. It is given by the number of bits it uses i.e. N. Monotonicity is the ability of the DAC to output it's signal in the direction of the input. This means that as the input increases the output increases too. Ideally, the output of the DAC will be lower reference voltage when the binary inputs are all 0's. However many times, the output is deviated with a small voltage, this is known as the offset error which shifts the output by the offset voltage.

DACs are used when a digital circuit is required to provide an analog signal. The common applications are for control of a device or an instrument, to control a physical property. They are also used in signal reconstruction for audio and video applications and in SDRs.

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