App Note 203
Conditioning PBX Signals with FPAA

Introduction

Different PBX switches provide differing analog signals that must be conditioned (i.e. amplified, filtered etc.). Furthermore, data must be extracted from these signals to be passed on to a p rocessor/ASIC/FPGA for further processing. FPAA's provide an ideal integrated platform for implementing the analog signal processing.

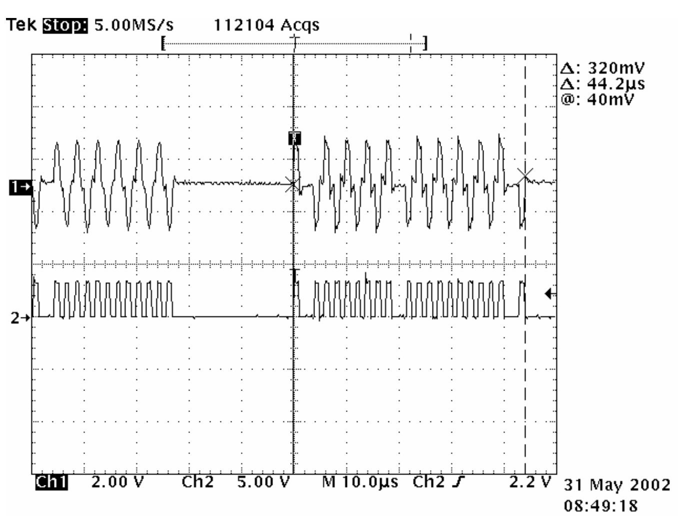
This Application Note describes a typical signal processing chain which can be used for interfacing with the PBX switch output. It also describes how the FPAA can be used to implement a simple Analog to Digita l converter using a comparator so that the digital data can be extracted from the analog pulse train.

Example Signal Encoding

The type of signal encoding used for t his example is Alternate Mark Inversion (AMI), which is a common format used in the telecom industry. The example used assumes a differential input signal whose level has been shifted externally to accommodate the 2V Voltage Mid - Rail (VMR) present on the ANx20E04 device.

The signal contains encoded data on each pulse whether it is above or below the reference voltage of VMR. Thus the effective frequency of this signal is approximately 200 kHz. An example input waveform is shown below in Figure 1 along with the desired output.

Figure 1: Basic PBX signal (top) and desired output (bottom)



The example encoding technique (AMI) is used to extract a digital bit stream through examination of the threshold voltage for each pulse. Assu me the top waveform of Figure 1 is referen ced to VMR (2V). The pulse above VMR is compared to a threshold voltage. When the signal reaches the desired threshold the digital data is interpreted as a logical one. The one value is retained until the signal passes back through the threshold at which case it is considered to be a logical zero. The data will remain low until the threshold above or below VMR is reached again. This corresponds to the bottom waveform of Figure 1. Thus the digital data can be extracted from the analog signal.

FPAA Block Diagram

A block diagram for a possible FPAA implementation is shown in Figure 2. The diagram shown makes use of common analog building blocks (CAMs) available as part of the standard library within AnadigmDesigner®2.

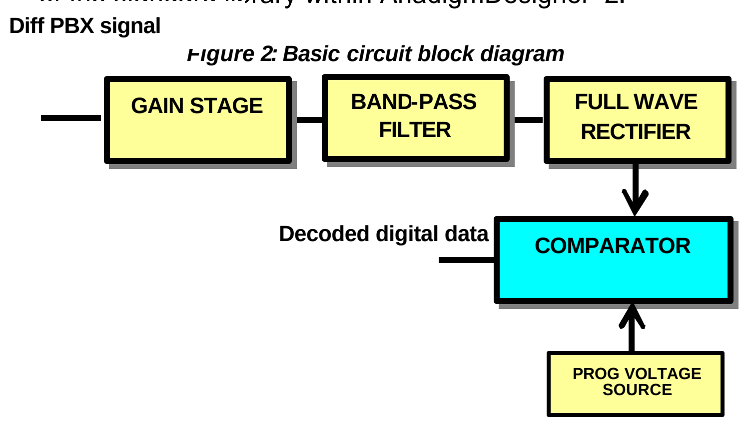


Figure 2: Basic circuit block diagram

Following Figure 2 from left to right the signal proc essing chain begins with a simple gain stage. This is used to provide maximum voltage swing within the FPAA.

The next stage is a band pass filter used to isolate the signal of interest. The desired signal in this example is approximately 200 kHz, thus the goal is to remove both high frequency noise as well as any 60 Hz component present in the system. A biquadratic second order filter from the standard library is sufficient for this purpose.

The conditioned signal from the band pass filter is then fed into a full wave rectification stage. This is used to place all signal pulses above VMR such that a single comparator stage with a progra mmable reference voltage can be used to detect the threshold crossing. The RectifierFilter CAM used for this stage also contains a low pass filter which can be used for additional filtering as well as additional gain control.

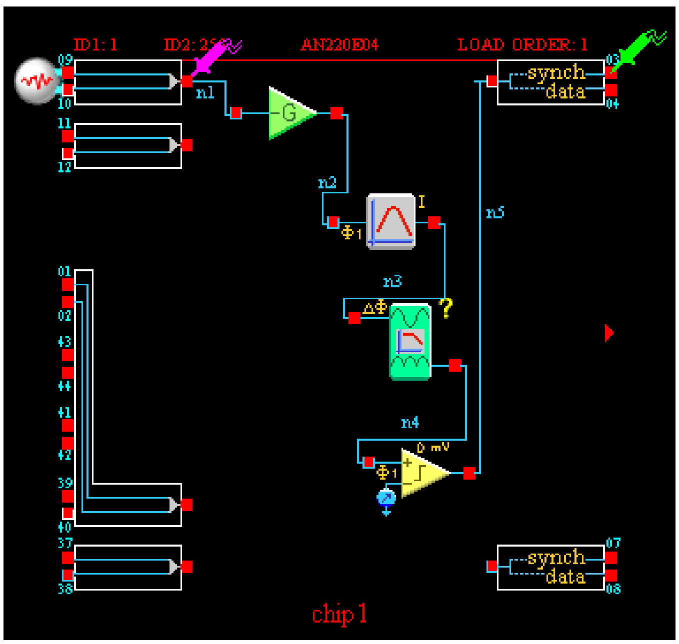
A two input comparator with a programmable voltage reference is used to perform the actual A/D conversion. This comparator can be clocked up to 8 MHz (if needed) to achieve an acceptable response time.

FPAA Implementation

The FPAA block diagram as implemented into the ANx20E04 is shown in Figure 3.

As with all AN x20E04 designs, the internal signals are processed differentially however the digital output mode for the output cell is utilized. This allows for a very sharp digital signal to be output from the device.

Figure 3: FPAA Implementation of the circuit



Simulating the circuit implemented in the FPAA

The input waveform shown in Figure 1 was captured into a text file with time/value pairs such that the user defined signal generator within AnadigmDesigner2 could be utilized. This allowed simulation to be performed on the circuit with an approximated PBX signal.

Simulation of this circuit yields a waveform similar to that shown on the bottom of Figure 1. The programmable voltage reference on one of the comparator inputs allows the threshold for the comparator to be set as needed to achieve proper decoding and the desired digital bit stream.

Also note the output cell is configured to produce a digital output since the comparator is connected directly to the output module. This produces a sharp digital signal to be fed outside the FPAA for additional processing of the bit stream.

Conclusion and FPAA Benefits

The Anadigmvortex FPAA solution is ideal for low to medium complexity analog signal processing. Also when the same type of signal processing needs have to be implemented across a range of systems, the reconfigurability inherent to the FPAA, allows the designer to easily and precisely implement the changes to tune the circuit for each system.

In this application example, the PBX signal can originate from a number of different switch manufacturers and thus the signal characteristics presented to the FPAA vary.

With a programmable and reconfigurable approach, these changes in the signal can be easily accounted for. Since the bit rate of the PBX signal is constant, the band pass filter would normally be fixed. The signal amplitude and shape does however vary between switch manufacturers.

The programmable gain stage as well as the programmable voltage reference allows the designer to adjust the circuit to account for these changes in the signal characteristics.

A single design can be used to interface to a variety of PBX switch manufacturers, thereby eliminating the need for different boards and/or implementations.

For more information, go to www.anadigm.com.