TRAC Application Note AN22

June 1999

Issue 1 - Preliminary

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Pulse Amplitude Modulation (PAM) Utilising TRAC*

Introduction

The ever increasing demand for more and more junction and trunk circuits has led to the widespread use of multiplexed telephone systems using Time Division Multiplex (TDM).

The TDM technique allows a number of different channels to have access to the common transmission path for a short period of time.

The Pulse Amplitude Modulation (PAM) is the first stage of the Pulse Code Modulation (PCM) technique.

Outlined in this Application Note is the method of PAM utilising TRAC.

Theory of Application

The TDM system is based upon the sampling of the amplitude of the information signal at regular intervals, and the subsequent transmission of one or more pulses to represent each sample. In an analog pulse system, for the intelligence contained in the information signal to be transmitted, the characteristics of the pulse must be varied in accordance with the amplitude of the sample. This can be achieved by varying the amplitude, width, or the position of the pulses, to give either pulse amplitude, pulse duration, or pulse position modulation.

With PAM, pulses of equal width and spacing have their amplitudes varied according to the characteristics of the modulating signal.

Figure 1(a) shows a series of pulses, commonly referred to as the Clock, which has the periodic time *T* seconds. The number of pulses occurring per second, known as the pulse repetition frequency, is equal to 1/*T*.

* See brief explanation of the TRAC concept at the end of this Application Note or visit the FAS web site at http://www.fas.co.uk or http://www.zetex.com for a detailed presentation.

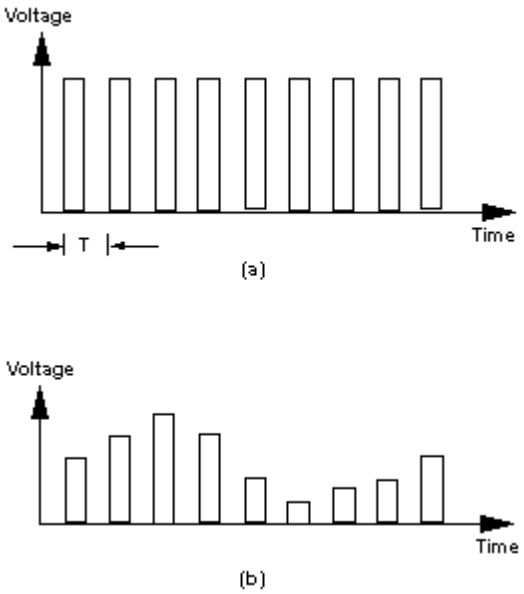

Figure 1. Pulse Amplitude Modulation: (a) Unmodulated Pulses, (b) PAM Wave

TRAC Design Procedure

The clock and the modulating signal may be applied to TRAC configured as a multiplier, as shown in Figure 2. (for more information on multipliers please refer to Application Note AN5).

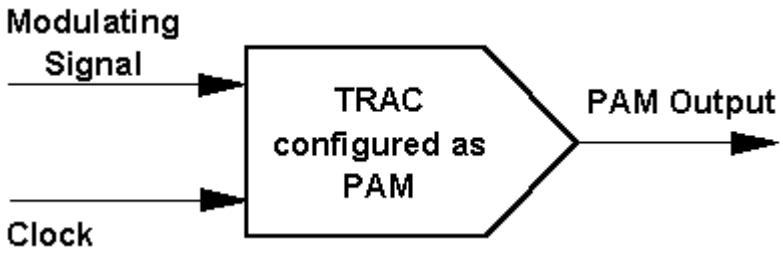

Figure 2. Production of PAM signal utilising TRAC

TRAC produces an output signal, equal to the instantaneous value of the modulating signal, only when a clock pulse is present. Therefore, the PAM output of TRAC consists of successive samples of the modulating signal and, assuming a sinusoidal modulating signal, the result is shown in Figure 1(b).

The PAM output waveform contains components at a number of different frequencies.

i. The modulating signal frequency.

ii. The clock (sampling) frequency and upper and lower side-frequencies centred about the clock frequency.

iii. Harmonics of the clock frequency and upper and lower side-frequencies centred upon each of these harmonics.

iv. A DC component whose voltage is equal to the mean value of the PAM waveform.

It must be noted that since PAM involves the sampling technique, the clock frequency must be at least more than twice the highest frequency in the modulating signal.

Software

The TRAC software and simulator enable the designer to use the required functions and operators in order to produce a multiplier. The layout of the design can be seen in Figure 3. The simple nature of the design demonstrates the power and versatility of TRAC in signal processing and telecommunication applications.

Inputs applied to TRAC for simulation purposes are the modulating signal (in this case, a sinusoidal signal) at I/O1 and the clock at I/O8 (see Figure 4.).

The output of the PAM is observed at I/O15 (see Figure 5.).

All practical tolerances can be compensated for by applying a small DC voltage to I/O12 (for full details please refer to Application Note AN5).

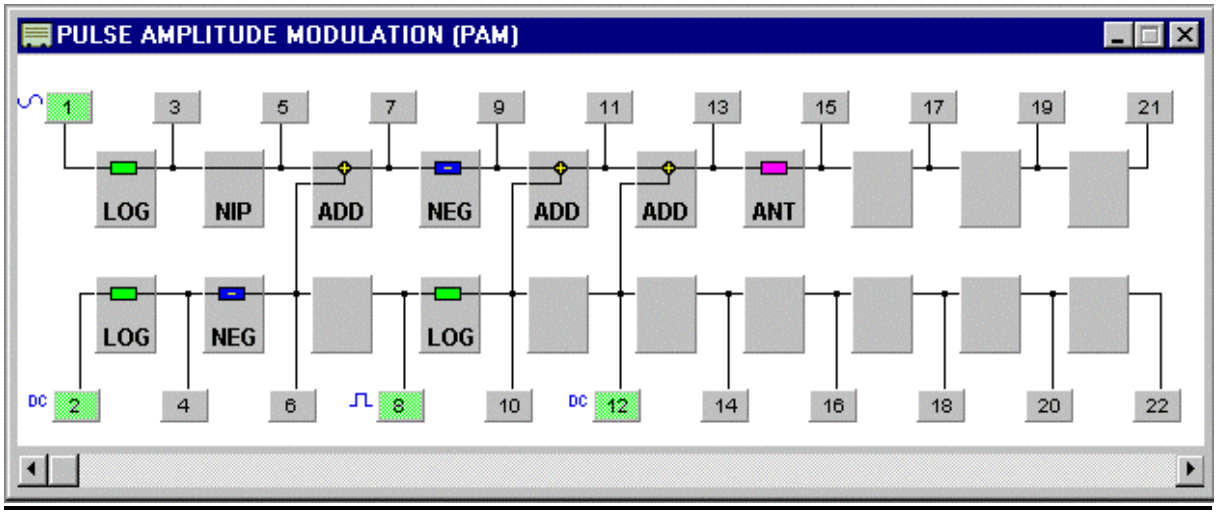

Figure 3. TRAC configured as Pulse Amplitude Modulator (PAM)

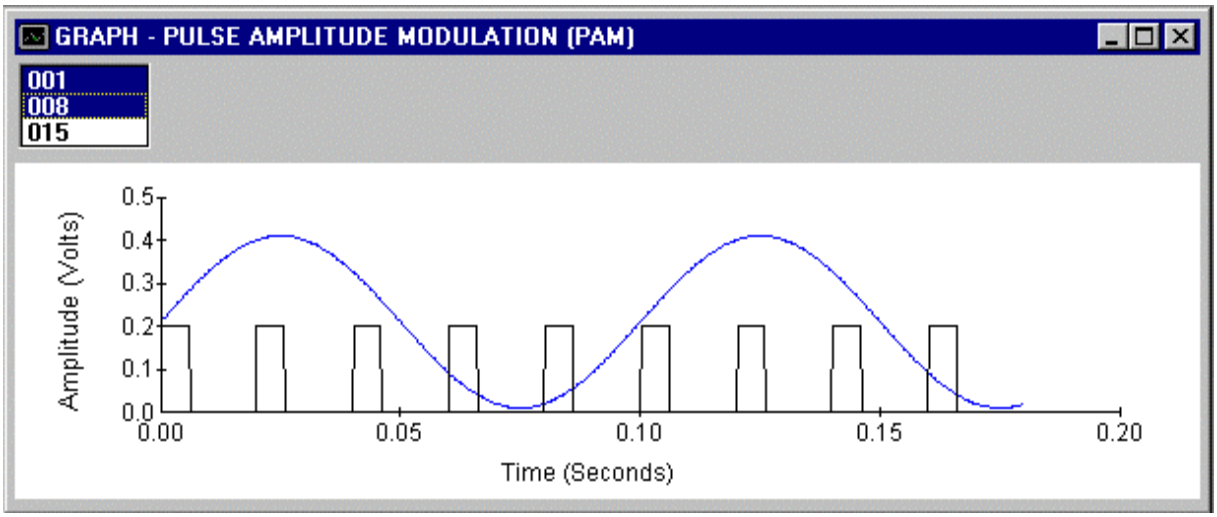

Figure 4. Simulation results outlining the Modulating Signal and the Clock

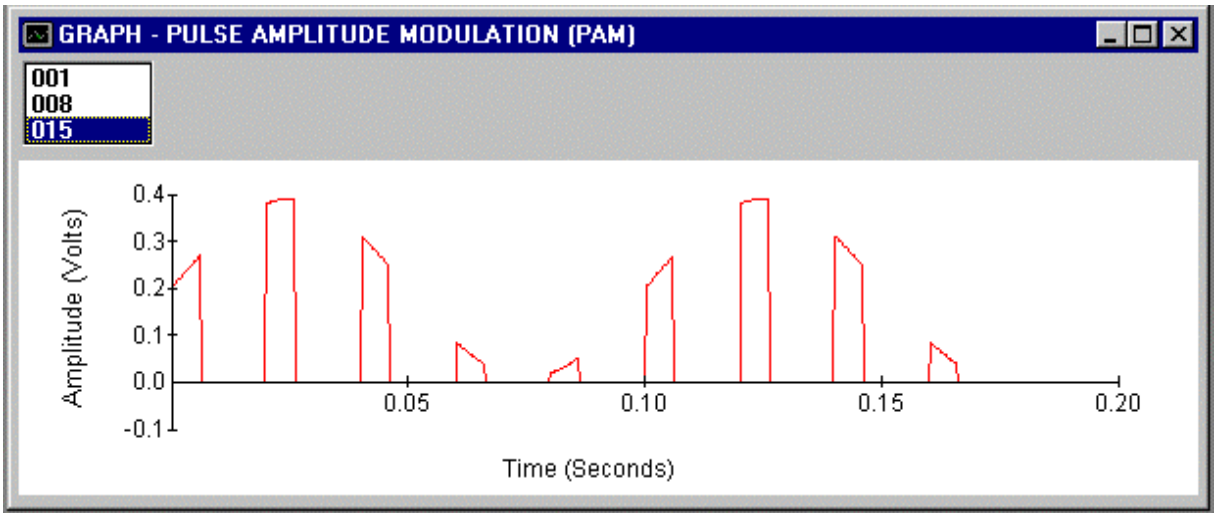

Figure 5. Simulation result outlining the PAM output on I/O 15

Design Specification

The core design of the Pulse Amplitude Modulator (PAM) has been outlined in Figure 2. The Four Quadrant Multiplier (4QM) design has been adopted as the basis of this Application (please refer to Application Note AN5). The design specification for a PAM is therefore very similar to that of a 4QM and all practical considerations would apply to the PAM application utilising TRAC.

The TRAC concept

The TRAC family of Totally Re-configurable Field Programmable Analog Devices offers an integrated path from signal processing problems to working silicon solutions - in minutes.

Introducing a Top-Down, Structured design discipline, TRAC enables rapid implementation, prototyping and product release. Rather than designing at the component level, TRAC champions a Computational Approach. Using eight simple mathematical building-blocks, any transfer function or mathematical equation can be implemented on TRAC.

With a combination of programmable silicon and design & simulation software, together with a Development Kit for fast hardware prototyping, TRAC brings a truly integrated route to signal processing problem solving, providing designers with benefits formerly associated only with programmable digital devices.

Production

All TRAC designs presented and discussed in the Application Notes are in programmable format. Due to the special nature of TRAC, cost-competitive solutions can be achieved even for low volume applications.

For higher volume applications where re-configurability is not required, once the design is proven in concept (using the TRAC simulator) and in practical terms on the silicon (using the TRAC Development Kit), a migration to a lower cost **Cell-based Computational ASIC** (CASIC) can be quickly achieved. The CASIC route offers cost advantages by enabling higher cell utilisation and by removing the need for an external memory device for design configuration data storage.

For more on the TRAC concept and for the latest information on TRAC devices please log-on to our web site at http://www.fas.co.uk or http://www.zetex.com

The TRAC software, Application Notes and Technical Data Sheets can be downloaded from the web site.