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Integrating Oscillator Utilising TRAC

Kambiz Pourhady

The TRAC family of totally reconfigurable 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, and more besides!

With a combination of programmable silicon and design software, TRAC brings a truly Integrated Route to signal processing problem solving, providing designers with benefits formerly associated only with programmable digital devices, and offering a path to Custom Silicon for higher volume users.

Introduction

Nearly all electronic instruments contain an oscillator or some sort of waveform generator. Apart from the obvious case of equipment such as signal generators, function generators, and pulse generators, a source of regular and accurate oscillation is necessary in any critical measuring instrument, or in any instrument that initiates measurement or processes, and in any instrument whose function involves periodic states or waveforms. This includes just about anything.

Depending on the application, an oscillator may be used simply as a source of regularly spaced pulses (such as a “clock” for digital systems), or the requirements may be for its stability and accuracy (e.g., time base for a frequency counter), or its ability to produce an accurate waveform (e.g., horizontal sweep ramp generator in an oscilloscope).

This application note intends to utilise the power and versatility of TRAC in implementing an integrating oscillator (triangular waveform generator) which is a basic building block in many instrumentation and signal processing applications.

Theory of Application

A simplified block diagram for an integrating oscillator utilising TRAC is shown in Figure 1.

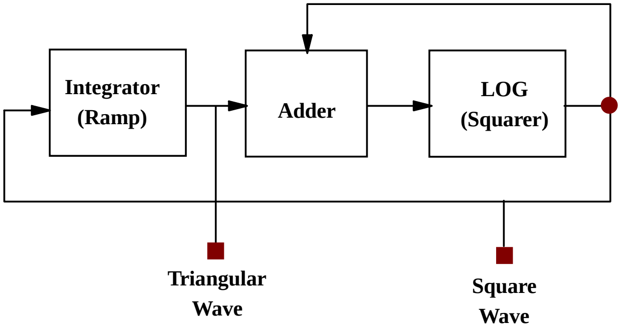

Figure 1
The block diagram of an Integrating Oscillator

This is an extremely useful design in its own right and features in many more complex systems including the "Voltage Controlled Oscillator" (please refer to AN19).

As outlined in Figure 1, this TRAC design consists of an integrator, and an adder followed by a log cell which constitutes a comparator function.

There is a positive feedback loop from the output of the log cell to the adder input and an inverting loop back to the integrator input.

The output from the log amplifier switches between its log extremes of plus and minus a V_{BE}. The output from the integrator is;

$$E_O = -1 / RC * V_{BE}\ dt$$

Since VBE is essentially constant, the integral becomes;

$$E_O = -V_{BE}\ t / RC$$

At some time T, the inputs to the adder will become equal and opposite, and E_O has moved through $2V_{BE}$. Therefore;

$$2V_{BE} = V_{BE}\ T / RC$$

$$T = 2RC$$

At time T, the output from the log cell will switch polarity and the integrator sets off in the other direction. A complete cycle of oscillation comprises two T periods and the oscillation frequency, f_O is therefore given by;

$$f_O = 1/2T = 1/4RC$$

This oscillator (waveform generator) will provide triangular and square wave outputs.

Software

Adopting the "computational approach", the TRAC software and simulator enables the designer to use the required functions and operators, in this case an Integrator, Adder, and a Log cell in order to form an integrating oscillator.

With reference to Figure 1, it can be seen that the block diagram has been directly transferred to TRAC as shown in the design in Figure 2. In this design, it should be noted that a very small DC voltage of 0.001V is added (via I/O10) to the output of the log cell. This is to ensure that oscillations actually start within the simulator. The DC input to the last adder will not be necessary in the hardware where noise will provide the same function.

The simple nature of this design shown in Figure 2, demonstrate the power and versatility of TRAC in a variety of complex applications.

Simulating the design (taking only few seconds!) will outline the successful implementation of TRAC for this rather generic design.

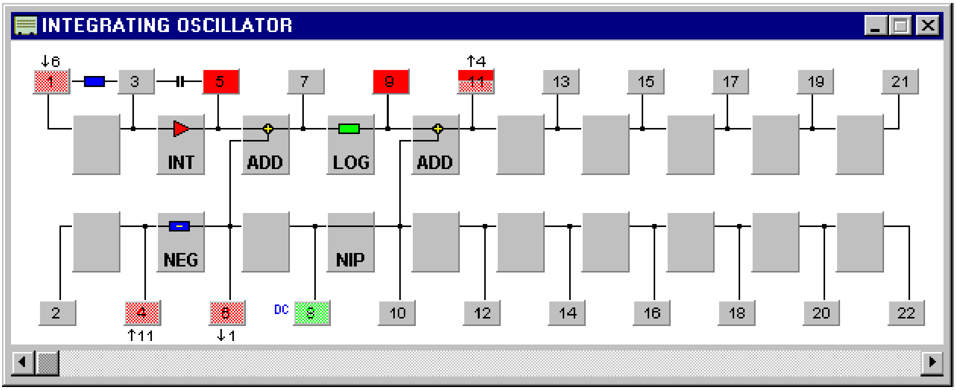

Figure 2
Integrating Oscillator Design Utilising TRAC

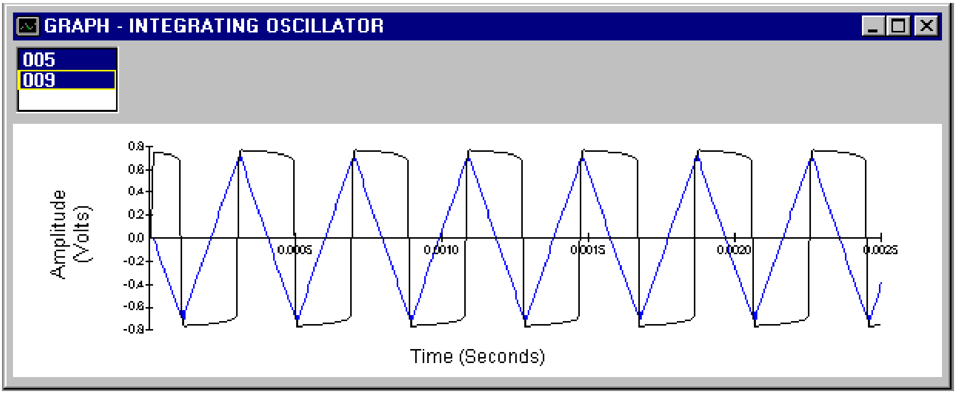

Figure 3
The simulation result showing Triangular and Square Wave Outputs

Fast Analog Solutions Ltd.
Fields New Road, Chadderton, Oldham, OL9 8NP, United Kingdom.
Tel: (+44) (0) 161 622 4567 Fax: (+44) (0) 161 622 4568
e-mail: trac@fas.co.uk Internet: http://www.fas.co.uk

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