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Fluid Level Detector and Control System Utilising TRAC

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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

Many opportunities have been identified for a device which can reliably and accurately control the level of fluid in a container for a given threshold. This may be achieved by controlling the operation of pumps or solenoid actuated valves. Applications include sump pumps, bilge pumps, washing machines, humidifiers, plating baths, continuous replenishment photographic processors, coffee makers, municipal water and waste treatment plants, cooling towers, refrigeration equipment and many others.

Conventionally, various mechanical arrangements have been employed to form the required transducer, such as floating valves and diaphragm actuated switches, within the system.

These devices are bulky, inaccurate and, because they contain moving parts, unreliable and often show disastrous results when they fail.

By utilising electronic means based on TRAC, all problems inherent in mechanical solutions can be overcome and a reliable, cost effective approach to fluid level control is made possible.

Theory of Application

Figure 1 outlines the required functionality. An AC signal generated internally by an integrating oscillator is passed though two probes within the fluid. Using this AC signal will prevent plating or dissolving of the probes as occurs when using DC signals.

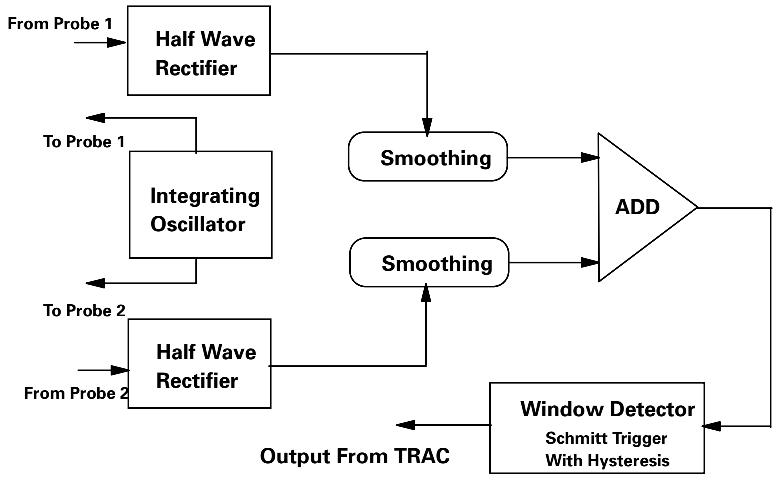

Figure 1
TRAC Fluid Level Detector & Control System.

The presence or absence of aqueous fluid is detected by using the probes in a voltage divider circuit. Although in this example two 13kΩ resistors have been used as the potential divider, the exact value may be altered to suit the impedance of the fluid.

The sensed AC voltages from the probes are rectified to produce the equivalent DC signal. They are added and used to drive a “window detector” by using the on board Schmitt Trigger with a reference voltage as shown in Figure 1.

The start and stop probes are set at their appropriate levels in the fluid container, and the ground return is connected to the third probe located at a depth greater than the start and stop probes. If the container is conductive, it may be used as the ground return.

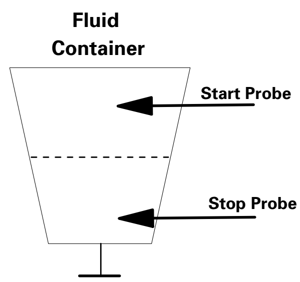

Figure 2
Fluid Container and Probes

We may evaluate this control algorithm by first assuming that we have a situation where we wish to empty the container to a predetermined level. With no fluid covering either of the probes, the output of TRAC switches LOW (small inputs being applied to the Adder). This disables the relay and hence the pump. With the pump OFF, fluid will eventually fill the container, covering the START

Probe. When this occurs, the output of TRAC switches HIGH and the pump relay is enabled, thereby draining the container.

As it can be seen the required control system is one with "three stable states" provided by TRAC.

The graphs shown in Figure 3 outline the status of each probe and the output of TRAC. As it can be seen, the output of TRAC changes only when both probes are in the same state (both ON or both OFF).

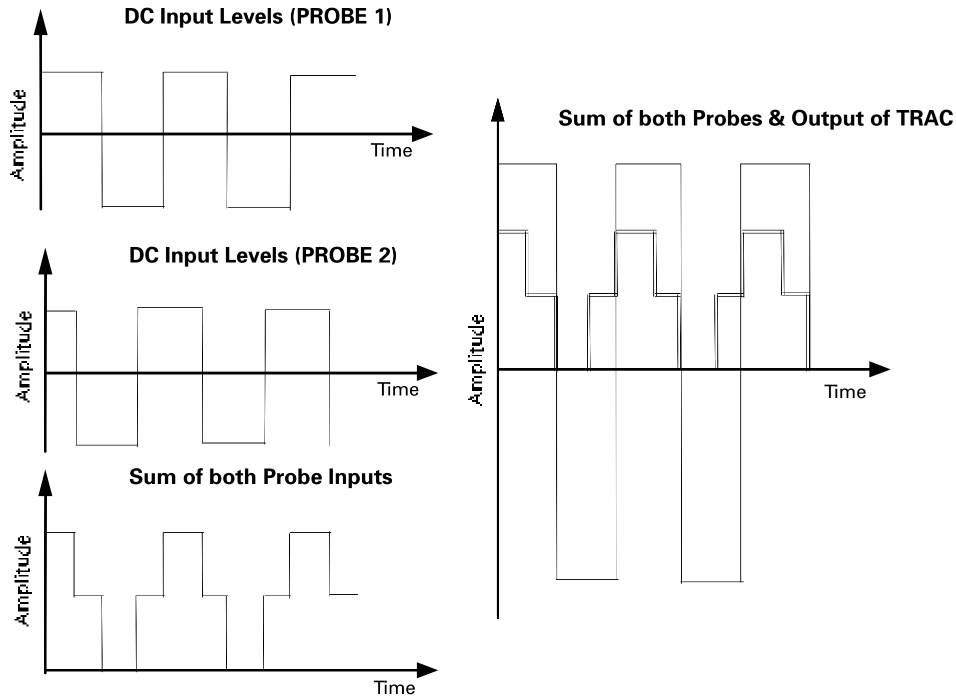

Figure 3
Probe and Output Waveforms

Software & External Components

Adopting the "computational approach", the TRAC software and simulator enables the designer to use the required functions and operators, in this case, transferring the block diagram directly in to TRAC.

The simple nature of the design shown in Figure 4 demonstrates the power and versatility of TRAC in control system applications.

Driving the pump may be achieved by simple circuitry as shown in Figure 5.

The polarity of the driving signal will allow the pump to be configured for "filling" or "draining" the container.

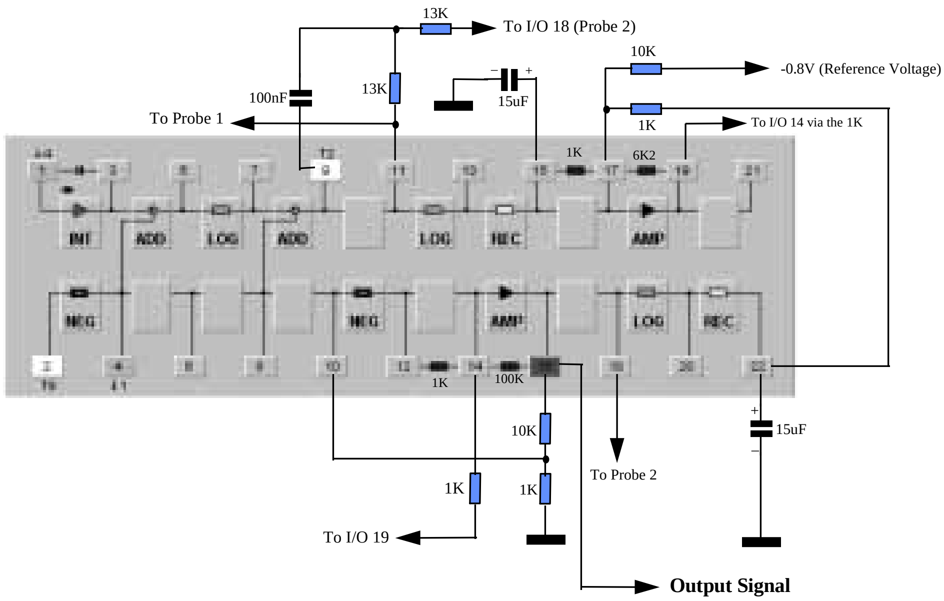

Figure 4
TRAC internal configuration and required external components

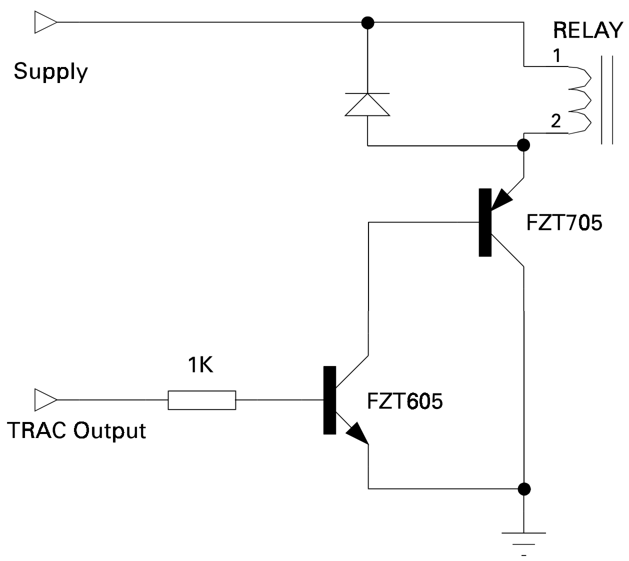

Figure 5
Suggested Drive Circuitry

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