



## Device Characteristic Linearization 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

The requirement for Linearization and Curve-Fitting will exist in the majority of Electronics and Instrumentation processes. This application note demonstrates meeting this demand in

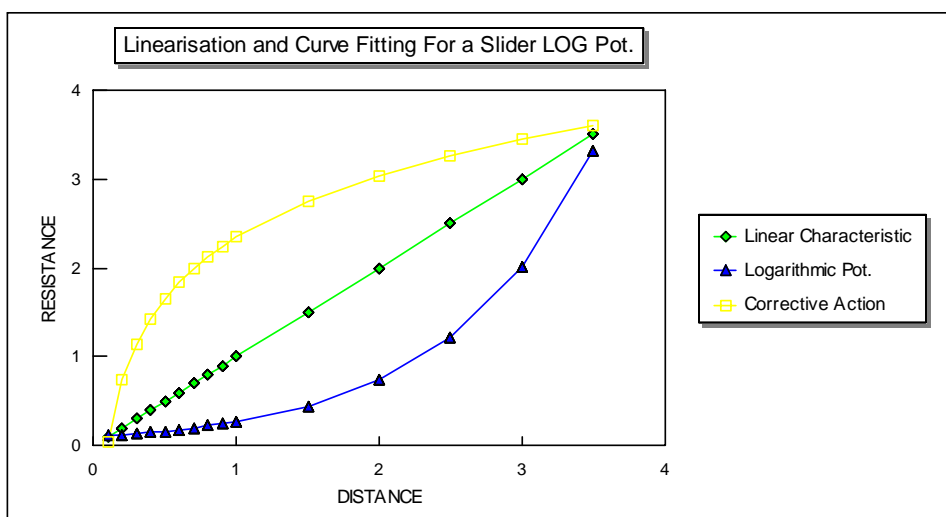
the case of Linearizing the characteristic of a 50K $\Omega$  Logarithmic Pot. However, principally, the same topology may be applied across a wide spectrum of applications and devices such as Thermistors, Pressure transducers (flow metering), and many other areas.

### Theory of Application

TRAC can easily achieve the task of device characteristics Linearization and Curve Fitting which is a major requirement in a variety of applications in Instrumentation.

Due to the fact that a number of high precision transducers exhibit a Non-Linear characteristic, and since the majority of Instrumentation equipment requires some kind of display to convey the result of signal processing, curve fitting and characteristic linearization is normally employed by means of "Look-Up Tables" which are managed by Micros in general. Linearization using Look-Up Tables, can be a very tedious and complicated task to perform. Other schemes include "Piece-Wise Linear Techniques" which although, in the analog domain, require high precision resistors, current sources and diodes as the gain switching elements.





**Figure 1**  
**LOG, Linear and Exponential Characteristics for signal processing**

TRAC is an excellent means of processing for this type of applications. The availability of LOG/Anti-LOG cells amongst the other functions and operators, allows the designer to transfer and manipulate the signals into Log domain (and vice-versa) or perform any mathematical expression which is required for a particular Curve-Fitting and Linearization process, in hours! (rather than weeks or months!).

As depicted by Figure 1 shown above, the process of curve fitting will always begin with defining the device characteristic under test. In the case of the Logarithmic Pot., the characteristic may be defined mathematically as:

$$y = e^x$$

where  $y$  = Resistance,  
 $x$  = slider Pot. movement

The above expression defines the devices to have an exponential characteristic. In order to convert its characteristic, it is therefore necessary to take the LOG of the output, perform the required conditioning and display the result of following expression:

$$\text{Log } y = x$$

This corrective action will linearize the above expression, resembling the straight line as shown on Figure 1.

$$y = x$$

## Software

Adopting the "computational approach", the TRAC software and simulator enables the designer to use the required functions and operators, in this case a simple LOG cell (followed by a NEG cell which compensates for the inversion nature of the LOG cell), to express the mathematical equation deduced for linearization and curve fitting.

The simple nature of the design shown below demonstrates the power and

versatility of TRAC in instrumentation applications.

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

This simple design demonstrates the versatility and power of TRAC in signal processing applications.

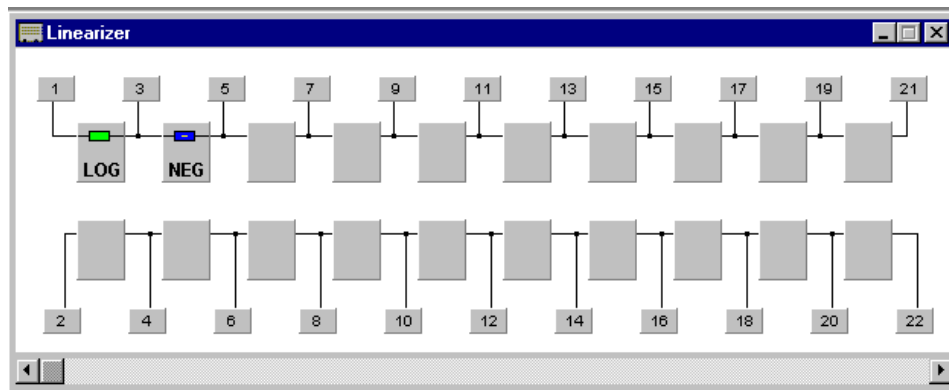


Figure 2  
TRAC Curve Linearization (Log/Linear) Design

**TRAC Application Note AN12**  
**Issue 1 September 1998**

---

**NOTES:**

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](mailto:trac@fas.co.uk) Internet: <http://www.fas.co.uk>



TRAC products are supported by agents and distributors in many countries of the world. Details can be found on our web site.



A ZETEX GROUP COMPANY

This publication is issued to provide outline information only which (unless agreed by the Company in writing) may not be used, applied or reproduced for any purpose or form part of any order or contract or be regarded as a representation relating to the products or services concerned. The Company reserves the right to alter without notice the specification, design, price or conditions of supply of any product or service.

---

**TRAC**

TAN12-4