

# Application Note

**AEROFLEX**  
A passion for performance.

## Fractional-N Synthesis in 2030/2040/2050 Series Signal Generators



The 2030/2040/2050 Series of Signal Generators use advanced fractional-N technique to overcome the problems normally encountered in signal synthesis.

For the very latest specifications visit [www.aeroflex.com](http://www.aeroflex.com)

## Introduction

When designing single loop synthesisers incorporating frequency dividers there is a conflict between frequency resolution and the phase detector operating frequency. If the phase locked loop uses an integral divider the frequency resolution cannot be smaller than the operating frequency of the phase detector.

There are, however, persuasive arguments for maintaining as high a phase detector frequency as possible, since both the speed and noise performance of the loop are considerably improved. The most successful technique of avoiding the frequency resolution / phase detector conflict is a technique usually referred to as fractional N-synthesis.

## Basic System

In its most basic form a fractional-N system achieves a fine frequency resolution whilst maintaining a high phase detector frequency by manipulating the division ratio of the frequency divider. The price to be paid for the improvement in frequency resolution is that the manipulation of the divider ratio inevitably generates phase perturbations and hence spurious signals.

The nature of the phase perturbations is predictable, and can be cancelled to a reasonable extent by applying an analog correction signal to a phase modulator in the phase locked loop. There is a limit to how accurately this cancellation can be achieved, and often good analog cancellation results in the phase detector being operated at significantly below its maximum potential frequency.

## Digital Solution

An ideal system should not require any analog cancellation of the residual phase jitter, and the all-digital solution found by IFR results in a phase locked loop performance which is virtually indistinguishable from a non-fractional loop operating at the same phase detector rate.

The single accumulator normally used in fractional-N systems is replaced by 3 or more accumulators, the output of each accumulator being connected to the input of the next accumulator. As with conventional fractional-N the division ratio is manipulated by the overflows of the accumulators, with the first accumulator changing the division ratio of the divider from N to N+1 for one clock cycle when it overflows.

The second accumulator changes the division ratio to N+1 and the N-1 on the next clock cycle, and the third accumulator changes the division ratio to N+1, N-2, N+1, although they have no long term effect on the division ratio. Larger division ratio changes are experienced, but if the results are passed through the phase locked filter the end result is much more accurate cancellation of phase error.

## Performance

Aeroflex have simulated the performance of a fractional-N system using this technique and shown that the cancellation becomes more precise as further accumulators are added. In practice most systems would require only 3 or 4 accumulators before the resulting spurious signals are unmeasurable.

The most demanding test for the technique is to compare its performance with what can be achieved with a loop operating under the same conditions but with integer division ratios. If the system has been well designed the difference in performance is negligible.

### CHINA Beijing

Tel: [+86] (10) 6539 1166  
Fax: [+86] (10) 6539 1778

### CHINA Shanghai

Tel: [+86] (21) 5109 5128  
Fax: [+86] (21) 5150 6112

### FINLAND

Tel: [+358] (9) 2709 5541  
Fax: [+358] (9) 804 2441

### FRANCE

Tel: [+33] 1 60 79 96 00  
Fax: [+33] 1 60 77 69 22

### GERMANY

Tel: [+49] 8131 2926-0  
Fax: [+49] 8131 2926-130

### HONG KONG

Tel: [+852] 2832 7988  
Fax: [+852] 2834 5364

### INDIA

Tel: [+91] 80 5115 4501  
Fax: [+91] 80 5115 4502

### KOREA

Tel: [+82] (2) 3424 2719  
Fax: [+82] (2) 3424 8620

### SCANDINAVIA

Tel: [+45] 9614 0045  
Fax: [+45] 9614 0047

### SPAIN

Tel: [+34] (91) 640 11 34  
Fax: [+34] (91) 640 06 40

### UK Burnham

Tel: [+44] (0) 1628 604455  
Fax: [+44] (0) 1628 662017

### UK Cambridge

Tel: [+44] (0) 1763 262277  
Fax: [+44] (0) 1763 285353

### UK Stevenage

Tel: [+44] (0) 1438 742200  
Fax: [+44] (0) 1438 727601  
Freephone: 0800 282388

### USA

Tel: [+1] (316) 522 4981  
Fax: [+1] (316) 522 1360  
Toll Free: 800 835 2352

As we are always seeking to improve our products, the information in this document gives only a general indication of the product capacity, performance and suitability, none of which shall form part of any contract. We reserve the right to make design changes without notice. All trademarks are acknowledged. Parent company Aeroflex, Inc. ©Aeroflex 2006.

[www.aeroflex.com](http://www.aeroflex.com)

[info-test@eroflex.com](mailto:info-test@eroflex.com)



Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused.