NEW MICROWAVE FREQUENCY SYNTHESIZERS THAT EXHIBIT BROADER BANDWIDTHS AND INCREASED SPECTRAL PURITY

Paul G. Tipon
Systron-Donner Corporation
Instrument Division
Ten Systron Drive
Concord, California 94518

Abstract

A new Microwave Frequency Synthesizer has been developed that provides a spectrally pure microwave signal source for measurement of sophisticated components and sub-systems. Patent has been applied for on this unique synthesis at microwave technique.

Introduction

A new microwave frequency synthesis technique has been introduced which permits a wide band, .5 to 18 GHz microwave source with superior performance characteristics[1]. The system consists of a synthesizer driver and a microwave frequency synthesizer. The synthesizer driver uses an indirect synthesis approach to produce a low frequency, high resolution signal which has the characteristics of a number of different oscillator types. The combination of these oscillator characteristics provides exceptionally low phase noise and minimal spurious outputs. Two phase-locked crystal oscillators are used to provide controlled noise characteristics independent of the reference oscillator in a band close to the carrier. One oscillator uses a fifth overtone crystal to provide even lower noise when it is later translated up to the microwave output frequency. Other oscillators used in the driver, all phase-locked back to a crystal oscillator, provide the low-noise characteristics at further offsets from the carrier. These oscillators include both the cascaded oscillators used to obtain the frequency resolution and the final high-Q oscillator which provides the output center signal.

Synthesizer Driver

The driver unit accepts either the internal reference or an external one, supplies phase-locked crystal oscillator frequencies for low noise, and simultaneously provides a high resolution drive for the microwave portion of the system. In addition to the high resolution signal, the driver also supplies all the necessary control signals, remote programming, and system integration capability[2].

Microwave Frequency Synthesizer

The microwave frequency synthesizer portion of the system consists of an individual octave bandwidth source. One or more of these sources can be connected to the driver for control and automatic frequency selection. The microwave unit uses the 100 MHz crystal frequency to phase lock one YIG tuned oscillator in steps of 100 MHz. This oscillator operates on the nearest multiple of 100 MHz below the output. By mixing this signal with the output, an IF of 100-200 MHz is produced. This IF, divided by 10, is then phase locked to the 10-20 MHz from the driver. Since this is the only division (effectively a multiplication) the spectral purity of the driver receives no additional degredation as the output frequency increases. The composite phase noise characteristics of the output, derived from both of the microwave oscillator sources, are carefully controlled to provide the high-purity, low-spurious output required for a high quality synthesizer.

Earlier techniques required a low frequency synthesizer and a multiplier system (sometimes phase locked) which was usable only over a limited bandwidth and, unless amplified, often had low power output[3]. See Fig. 1. Using an output at 4 GHz as an ple, Fig. 2, shows how the various signals are combined (patent pending) to produce the high resolution, high spectral purity output. The graph in Fig. 3 plots the typical single-sideband phase noise (in a 1 Hz bandwidth) for various offsets from the carrier. The short dashed line on the left is the result of using a cesium or rubidium frequency standard in place of the internal oscillator.

Conclusion

The spectral purity exhibited by the new series of microwave frequency synthesizers can be shown as advancing the state-of-the-art. For the first time at microwave frequencies crystal-multiplier controlled, microwave-cavity oscillator purity can be accomplished over an entire octave with 1 Hz resolution.

Acknowledgement

The Author wishes to thank L. Kaye and J. Slater for helpful suggestions.

References

1. Tipon, Paul G., "The Microwave Frequency Synthesizer: An Improved Standard for Microwave Research, Testing, and Applications", IEEE/INTERCON '74 Conference Record, Session 39, March 1974.

2. Kaye, Larry and Tipon, Paul, "M/W Synthesizer with Sophistication", Microwave Journal-International, Vol. 16, No. 8, August 1973.

3. Seay, T.S., "Frequency Synthesizers-Applications and Techniques", Lincoln Laboratory, M.I.T., February 1972.

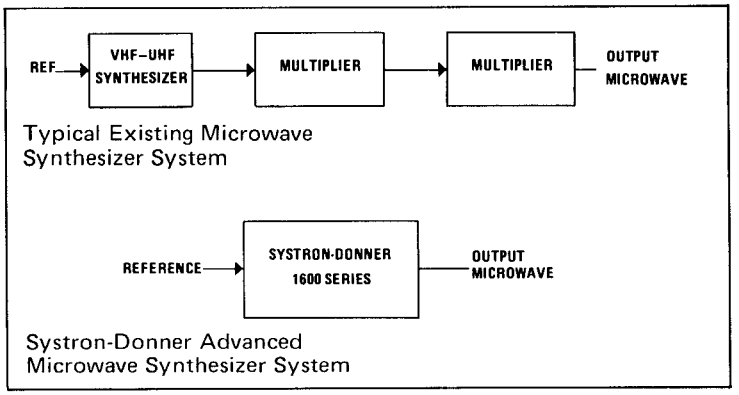

Fig. 1. System comparison

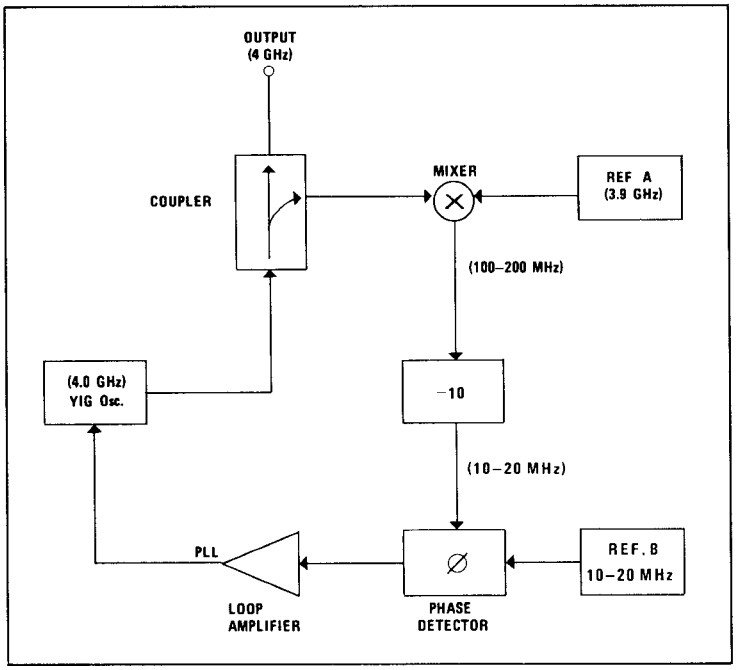

Fig. 2. Block diagram of new microwave frequency synthesizer

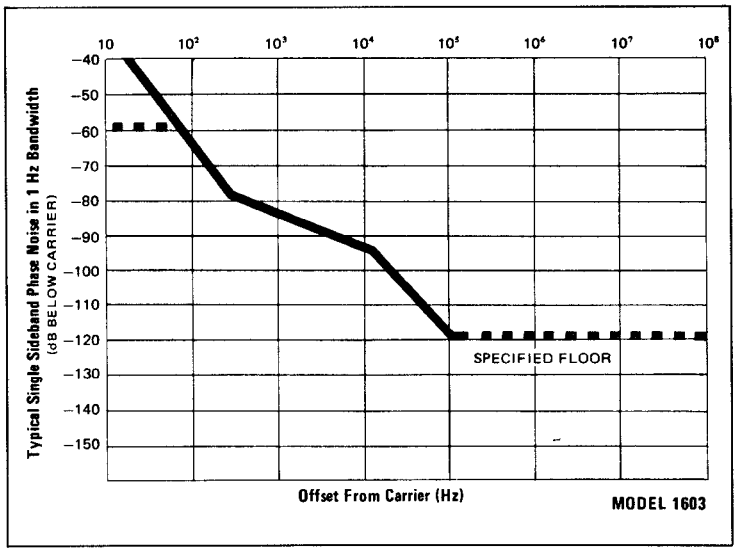

Fig. 3. Single-sideband phase noise at offsets from the carrier