

# MINIATURE ULTRA-HIGH SPEED SYNTHESIZER FOR 2.25 TO 18 GHz

A new miniature wide band frequency synthesizer has been introduced that operates from 2.25 to 18 GHz, permits 3  $\mu$ s tuning, exhibits a volume of 334.3cc (20.4 in<sup>3</sup>), consumes just 22 W of DC power and provides a clean RF output spectrum with an absolute accuracy better than 10kHz. The ultra-high switching speed of this new synthesizer (typically 1000 times faster than similar devices), its ability to seamlessly cover an extremely broad bandwidth range, low power draw and low phase noise characteristics make it ideal for a variety of applications for test equipment simulator systems and as local oscillators (LO) in fast tuning superheterodyne receiver systems. For this application, the synthesizer provides substantial improvement in tuning times and spurious signal generation, while maintaining good phase noise and frequency accuracy.

The design of the new synthesizer is based upon wide band frequency locking a voltage controlled oscillator (VCO) to a clock reference. In this configuration, a pair of sub-octave VCOs are doubled and then re-doubled to provide single band 2.25 to 18 GHz frequency coverage, substantially enhanc-

ing its versatility and usefulness. Its small size (only 12.7 x 195 x 135 mm) and low power requirement opens a variety of new application possibilities, especially when combined with its fast acquisition time and enhanced accuracy.

The synthesizer is being produced in three different physical configurations, all of which incorporate a basic circuit design, as shown in *Appendix A*—the 2U rack chassis, the replacement synthesizer package and the integrated package are all shown in *Figure 1*. All three designs share the same circuits—the 2U rack chassis was configured to meet a specific installation requirement; the replacement synthesizer package was physically designed to replace a prior phase lock synthesizer design; and the integrated synthesizer configuration is a component of an airborne radar warning receiver system. All three designs share basic performance characteristics, as listed in *Table 1*.

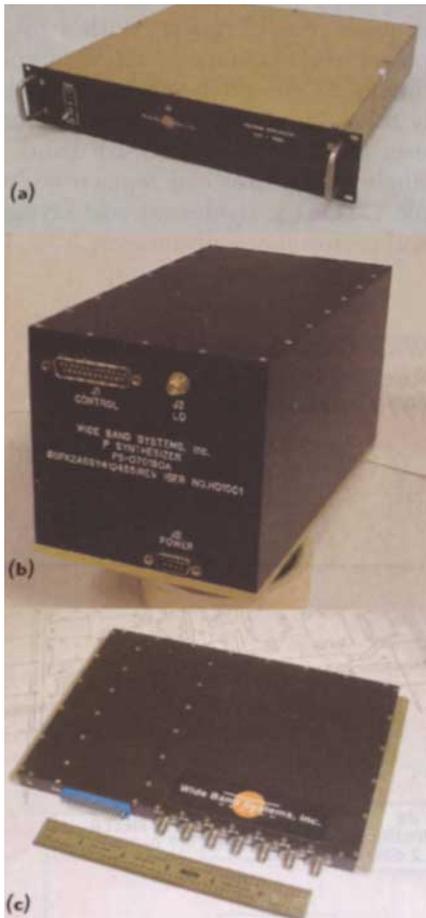
The synthesizer's frequency accuracy vs. output

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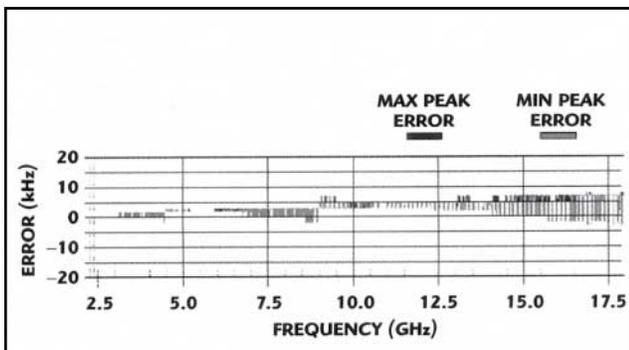
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▲ Fig. 1 The synthesizer's three physical configurations: the 2U rack chassis (a), the replacement package (b) and the integrated package (c).

frequency is shown in **Figure 2**, while **Figure 3** shows the typical phase noise and output power spectral density at 15 GHz. The synthesizer blanks the RF output during an output frequency transition. The tuning time plots in **Figure 4** show this characteristic. When a synthesizer is employed as an LO in a narrow IF bandwidth tuner, failure to blank the LO when changing the LO frequency may produce an uncontrolled spurious frequency to appear in the IF filter. The tuner would then have to wait until this

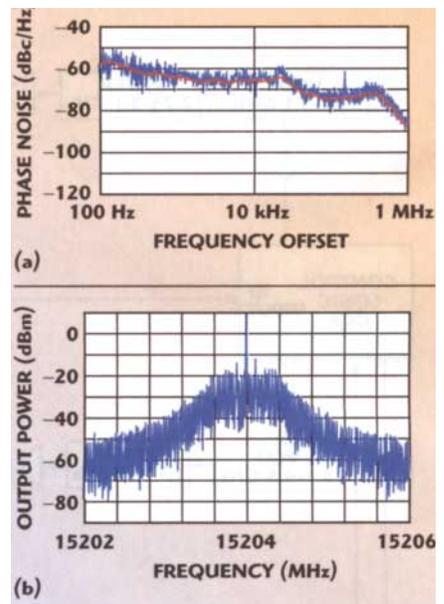


▲ Fig. 2 Frequency accuracy vs. output frequency.

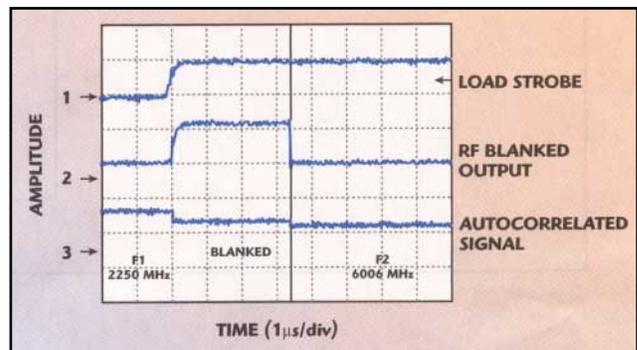
TABLE I PERFORMANCE CHARACTERISTICS		
RF output frequency range (GHz)	2.25 to 18	
RF output frequency resolution (MHz)	1 (available frequency resolution is down to 3.9 kHz)	
Output frequency accuracy (kHz)	10	
Harmonic and spurious outputs (dBc)	-60	
Phase noise (dBc/Hz)	at 10 kHz offset	at 1 MHz offset
at 2674.5 MHz	-86	-96
at 3801.0 MHz	-76	-95
at 10698 MHz	-73	-88
at 15204 MHz	-65	-82
Tuning time	Typical 3µs, maximum 7µs	
Dimensions		
2U rack synthesizer chassis	RETMA 2U rack chassis	
Replacement synthesizer chassis	120.90 x 222.25 x 120.65 mm 4.76 x 8.75 x 4.75 in.	
Integrated synthesizer chassis (dimensions do not include cooling fins)	135 x 195 x 12.7 mm 5.315 x 7.677 x 0.500 in.	
DC power (W)	22	

spurious filter response dies out; a narrow band IF filter can waste substantial receiver time. Since the synthesizer operates by comparing the current VCO frequency to the input selected RF frequency, the digital processing automatically blanks the synthesizer RF output as soon as a strobe is received loading new frequency data. Blanking is released when the processor determines that the synthesizer output frequency is within a preset margin with respect to the programmed frequency. This margin was set at 1 MHz for the data shown. If a fault should occur in the synthesizer (where the output frequency is not measured to be within this preset margin), the synthesizer will remain blanked and an output error flag will be set.

Since the processing and control of the VCO is accomplished digitally using high speed programmable gate arrays, the synthesizer is capable of not only provid-



▲ Fig. 3 The synthesizer's (a) typical phase noise and (b) output power spectrum at 15 GHz.



▲ Fig. 4 Tuning time characteristics.

# PRODUCT FEATURE

ing the selected output RF frequency, but can also provide output of programmed patterns of output frequencies. These patterns can be a sequence of RF Frequencies, a sequence of RF pulses, a sequence of RF amplitudes, or any desired combination of RF frequency, time and amplitude desired. Control inputs include a 50-pin connector, supporting parallel tuning and either USB or serial port compatibility.

Another application for this synthesizer design is the replacement of digitally tuned oscillators (DTO) in electronic

warfare (EW) systems and system simulators. The DTO employs an oven-stabilized VCO using open loop control. The open loop control corrects the VCO input digital control data using a memorized digital calibration. The DTO problems include the power required by the oven stabilization, post tuning frequency drift and long-term requirements for re-calibration. The new synthesizer design does not employ oven stabilization, does not exhibit post tuning output frequency drift and does not require re-calibration.

With a total power requirement of 22 W, a volume of 20 in<sup>3</sup> and the ability to quickly tune, in any frequency sequence, over the 2.25 to 18 GHz RF band, a single synthesizer can replace multiple DTOs for significant cost savings and performance advantages.

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## APPENDIX A

### THE ULTRA-HIGH SPEED SYNTHESIZER'S CIRCUIT BLOCK DIAGRAM

