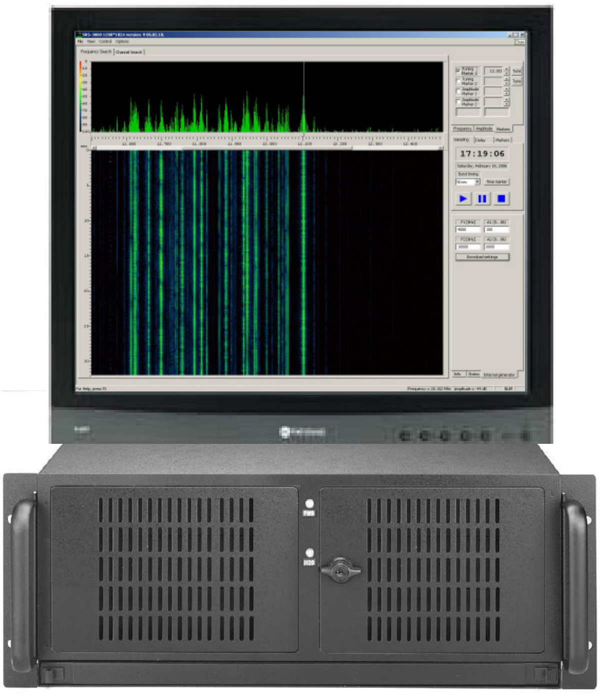
Scanning Speed of the SRS-3000 Scanning Receivers



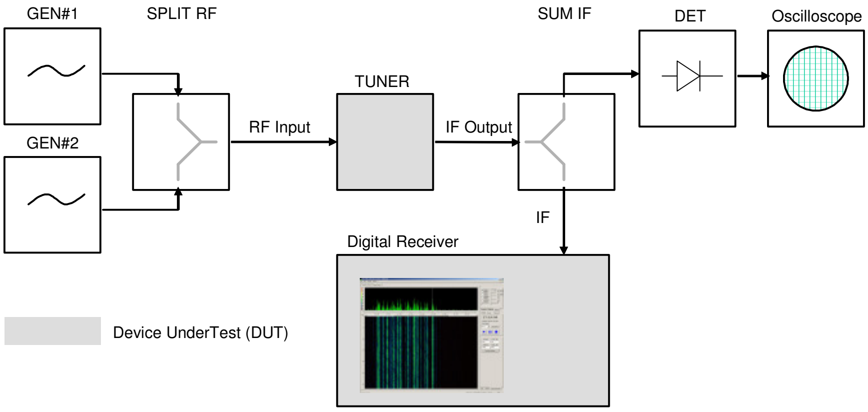
CONTENT

Introduction

The following document describes the test procedures for testing the intercept capabilities of a high-speed scanning receiver. The figure of merit is the scanning speed of the receiver.

General test setup

The measurements described in this test procedure description are implemented using the following general test setup. Not all of the measurements require using all of the equipments in this setup. See the test procedure at each test.

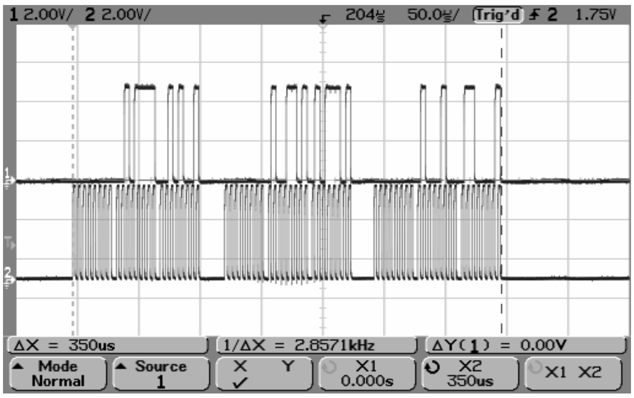


The test setup starts with two signal generator GEN#1 and GEN#2. The frequency range of these generators should be matched to the input frequency range of the device under test (DUT) e.g. 20-1000MHz or 20-3000MHz. The outputs of the generators are routed to a signal summer which could be a wide-band, resistive summer with 6dB theoretical insertion loss. This summer provides matched load for the generators and the receiver input too. In the case only one signal is required in the measurement we could use only one generator directly connected to the input of the DUT.

The IF output of the tuner generally connected to the IF input of the digital receiver. To observe this signal we have to insert a power splitter into the IF path. This splitter could be transformer based splitter with 3dB theoretical insertion loss. One output of the splitter is connected to the input of the digital receiver, the other is fed to a signal detector. In this position a zero-bias schottky detector is recommended. The detected signal is displayed on the oscilloscope.

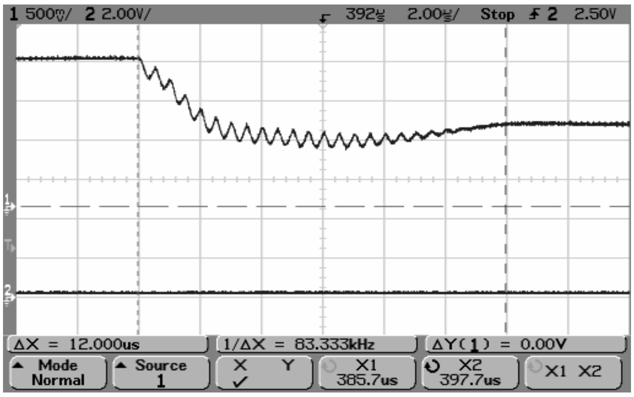
Synthesizer settling time

The receiver is based on a wide frequency band front-end tuner to cover the entry 20-3000MHz frequency range and a digital receiver operating on the intermediate frequency. The frequency coverage is described by the front-end tuner and the instantaneous bandwidth is determined by the digital tuner.
The tuner is responsible to tune to the center of next part of the frequency band where the spectrum is sampled by the digital tuner with its bandwidth. That is why the tuning speed of the synthesizers of the tuner directly influences the scanning speed of the scanning receiver.
In SRT-3000 front-end tuner which is used to extend the frequency range of the SRS-3000 digital receiver triple heterodyne structure is used. It means that in worst case changing the frequency of the tuner we need to change the frequency of all three synthesizers. The frequency changing is performed by the internal controller of the tuner to load the frequency description word to the synthesizer chips. This process could be seen in the following picture containing the clock and data signals of programming. These signals are available at internal test points of the tuner.



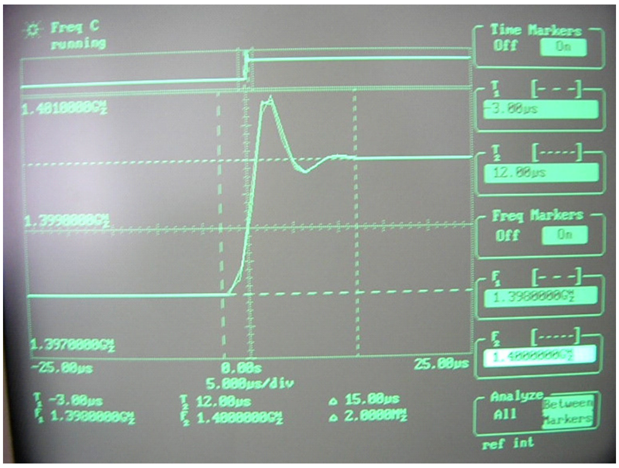
As it can be seen on the markers the frequency word downloading takes 350us. After downloading the frequency tuning word the synthesizers require less than 15us to tune to the next frequency. This tuning speed is provided by the wide loop bandwidth design of the phase locked loops in the local oscillators. The tuning speed could be measured by observing the tuning voltage of the voltage controlled oscillators in the synthesizers, or using wide-band time-frequency analyzers like Agilent HP53310A modulation domain analyzer.

The following picture shows the tuning voltage measurement of the VCO in one of the synthesizer of the front-end tuner.



In this measurement the frequency of the synthesizer was decreased. It is clear from the markers that after 12us the transient response of the phased lock loop is finished and the tuning voltage of the VCO is stabilized on its new value for the new frequency. In this kind of measurements we assume that the input tuning bandwidth of VCO is significantly higher than the spectral components of the tuning voltage. So the output frequency of the VCO is able to follow the tuning voltage. That is why it is enough to measure a tuning voltage instead of the actual output frequency.

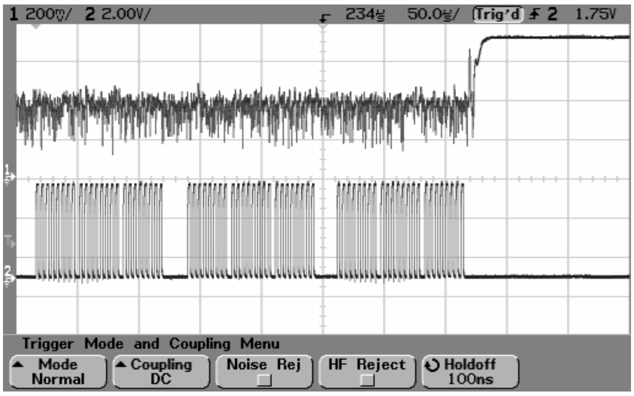
The next measurement was taken with a modulation-domain analyzer where the output frequency of the synthesizer was observed.



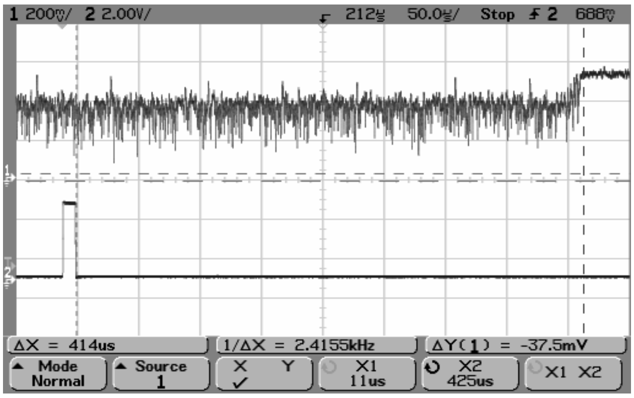
This measurement shows 2MHz up step in frequency. It shows that after a transient response to reach the final frequency value less tan 15us is required. This measurement validates our previous one.

Receiver tuning speed

The receiver tuning speed is tested in the general test setup. The following picture shows a measurement where an input signal is applied to the input of the receiver by the GEN#1 generator and the tuning is performed. The lover trace shows the data line of the synthesizers and the upper trace shows the output of the detector at the IF output of the tuner. When the new frequency of the tuner is downloaded by the three tuning word after a synthesizer transient period the tuner is tuned to the new frequency and the output of the detector is rising from the noise to a level determined by the input level.



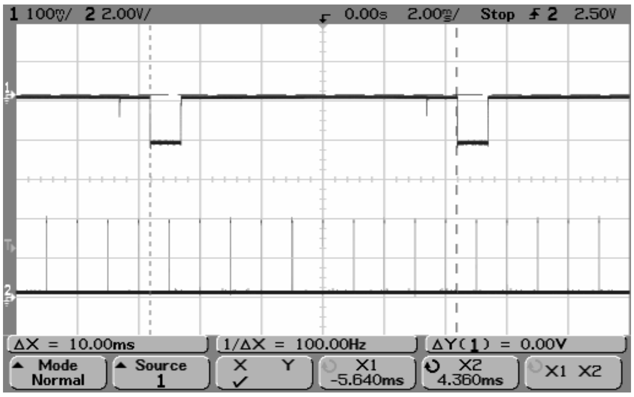
The actual implementation in the receiver the new frequency tuning is requested by the digital tuner by a trigger signal. The front-end tuner after reception of the trigger signal sends out the frequency tuning word as described and setup the tuner to the next pre-defined frequency. This pre-defined frequency list is downloaded by the receiver software to the tuner during the start-up period. The following picture shows the same measurement, but the lower trace shows the trigger signal instead of synthesizer data line.



As it can be seen in the picture after reception of the trigger signal the frequency adjustment takes 410us. In the practical implementation 500us is reserved for frequency set-up of the tuner before starting the sampling of the spectrum by the ADC of the digital receiver.

Scanning speed

The scanning speed of the receiver could be tested using oscilloscope and signal generator in the following way. We have to set up the receiver to cover the given frequency range. The receiver covers that range with 20MHz tuner steps. So the total time required for the receiver to scan is equal to the frequency range divided by the 20MHz bandwidth of the digital receiver. If we tune the input signal provided by the generator to any center frequency of the tuned 20MHz bandwidth we receive a pulse at the output of the detector.
The following picture shows a measurement with up to 10 frequencies covering the 1000-1200MHz band. The lower trace shows the trigger signal, while the upper trace shows the output of the detector.



If we tune the frequency of the generator at the input to any frequency in the covered frequency range, we will receive a pulse when the tuner is set periodically to this frequency. As the tuner visits periodically the output frequency of the generator we receive a periodic signal at the output of the detector.

Conclusions

The implementation of a wide-band, high-speed scanning receiver based on a front-end tuner and a digital tuner is introduced. The test procedure of the measurement of the scanning speed is described. Measurement results for 20MHz/1ms or 20GHz/sec scanning speed is presented.