REVIEW OF SCP TEST SET-UP AND RESULTS – II

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Abstract

The specific test set-up equipment and the obtained experimental results of the proposed by the author SCP technology are given in the report. Special attention is given to the methods and equipment, suitable to measure the spatial interference suppression of the SCP technology. An improved analog scheme for SCP processing (BPSK modulated signal and residual unsuppressed carrier as pilot signal were used), as well as the obtained experimental results, are considered. The objectives of the near field set test-up and trials were to measure the amplitude distribution, as well as the phase distribution of RLSA with random distributed and oriented slots (tangential, inclined and radial, fed by probes).

1. SCP TEST SET-UP FOR SPATIAL INTERFERENCE SUPPRESSION

The objectives of the SCP test set-up and trials for spatial interference suppression are to prove in experimental way the SCP spatial interference rejection with nonstandard equipment, as well as to test in SG anechoic chamber the shapes of the SCP cooperative pattern and spatial interference patterns of RLSA with diameter Φ 30 cm. The test (fig.1) was held in the following conditions:

- In SG anechoic chamber, the distance between transmit and receive antenna was 3,5 m.
- Two signal generators (simulated pilot and information signals) were used. The frequency difference between them is 2 MHz, the term *same sense* in the applied figures means the same CP for information and pilot signals.
- Modified satellite receiver, shown in fig. 1 and [1] was used.
- RLSA with diameter Φ=30 cm and about 300 tangential random distributed slots were used.

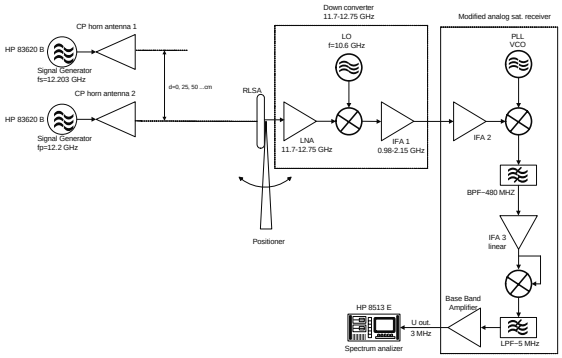

Figure 1. SCP test set-up for spatial interference suppression

The obtained tests results are very important, because the spatial resolution is the second in importance SCP objective. It was studied by means of matrix signal presentations by the author in [2]. Her the final evaluation parameter was named Spatial Cross-Correlation Function (SCCF). The practical measurement of SCCF in SG open test facility is not possible. It needs two points of transmission (one for the pilot and one for the information signal). The information signal transmission point should be shifted at small angles step by step in order the SCCF to be measured precisely. The spatial resolution of a SCP system was tested in anechoic chamber (Fig. 1) only to be proved as principle. The pilot and information sources were shifted in vertical direction at different distances, while the RLSA patterns were tested in the azimuth plane. The results, shown in fig. 2, proved the intuitive and theoretic resolution properties of the SCP approach.

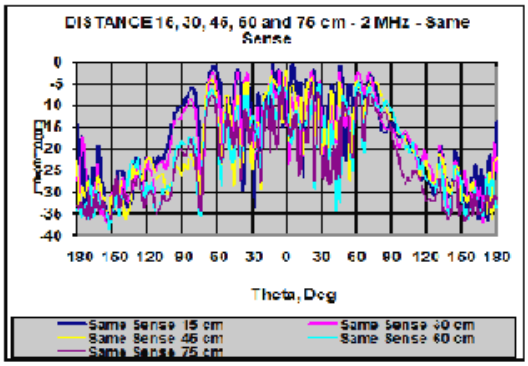

Figure 2. SCP cooperative patterns at different distances between information and pilot sources

2. SCP TEST SET-UP WITH BPSK MODULATED SIGNAL (UNSUPPRESSED CARRIER IS USED AS PILOT SIGNAL)

The objectives of the SCP test set-up and trials with BPSK modulated signal are to prove in experimental way the SCP approach with improved nonstandard equipment (BPSK modulated signal and residual unsuppressed carrier as pilot signal were used), as well as to test with this equipment the shape of the SCP cooperative pattern (RLSA – Φ 30 cm and Φ 57 cm with random distributed and inclined slots, RH-LH CP, V-H P) in SG anechoic chamber and open range test facilities. The test was held in the following conditions:

- The distance between transmit and receive antennas is 3,5 m in anechoic chamber and 20 m in open range.
- The correlation process was held at low First IF=38,9 MHz for simplicity.
- The modulation waveform was 5 MHz pulse signal instead test PN-code for better separation of pilot and information sidebands before the process of correlation in the receiver.

A lot of tests were performed in order to meet the objectives, mentioned above. The variable parameters in the different tests were:

- Frequency
- Slots distributions, inclinations and numbers
- Polarizations and angles of the antenna pattern cuts
- Satellites EIRP

Some of the test results, provided by the last SCP set test-up, are shown in the figures below, as follows:

- Fig. 3. SCP cooperative pattern (test set-up fig. 3, RLSA Φ 57 cm)
- Fig. 4. SCP cooperative patterns at different frequencies (test set-up fig. 3, RLSA Φ 57 cm)
- Fig. 5. SCP cooperative patterns at different EIRP (test set-up fig. 3, RLSA Φ 57 cm)

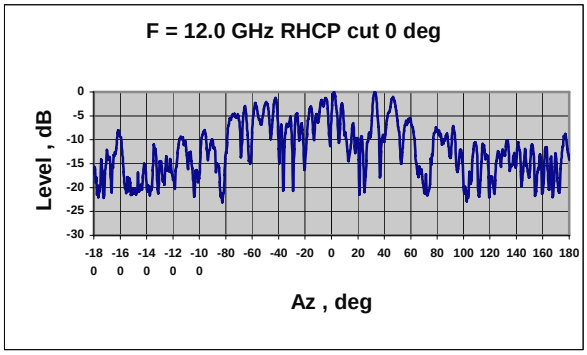

Figure 3. SCP cooperative pattern

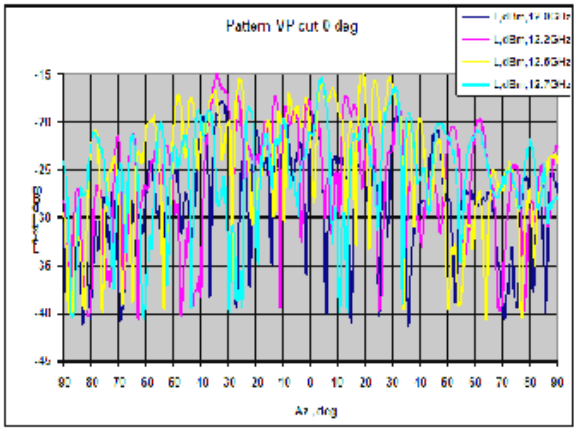

Figure 4. SCP cooperative pattern at different frequencies

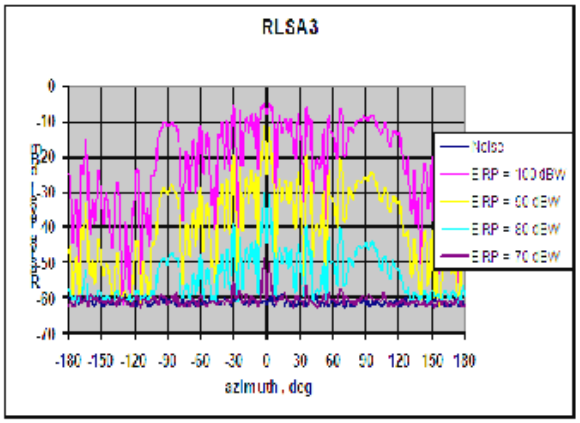

Figure 5. SCP cooperative pattern at different EIRP,s

The conclusions, based on the test results, could be summarized as follows:

- The cooperative pattern ripples are smaller than in the previous tests, but still they are significant. There were proposals for their origin, based on the existing strong mutual coupling phenomena among RLSA slots. Special investigation was held in SG for this reason. It included HFSS simulations and experimental tests of the mutual coupling between two slots in RLSA with different distances and mutual orientations. The results show that even in the worst case of parallel slots at distance half wavelength the coupling is low (-11 dB or lower).
- According to the paper [2], the SCP correlation matrix should be pure diagonal (which means smooth omnidirectional SCP cooperative pattern) in the case of AWGN channel environment. In the tests, described above, the level of the signal is several order higher that that of the receiver noise. For real satellite test it is necessary to support only several dB signal to noise ratio in the receiver, which is not convenient for measuring the shape of the cooperative pattern. The conclusion is that instead of the cooperative pattern, the system BER (at low signal to noise ratio and digital signal processing in the receiver) as function of the spatial angular coordinates should be measured. Such tests were not possible to be provided in SG test facilities.

3. NEAR FIELD TEST SET-UP

The objectives of the near field set test-up and trials were to measure the amplitude distribution, as well as the phase distribution of RLSA with random distributed and oriented slots (tangential, inclined and radial, fed by probes). The tests were performed in SG Near field test facility with standard equipment. The RLSA aperture – probe distance was 10 cm.

Hundred tests were performed in order to meet the objectives, mentioned above. The variable parameters in the different tests were:

- Frequency
- Slots lengths, coupling, distributions, inclinations and numbers
- RLSA high and permittivity

Some of the test results, provided by the Near Field set test-up, are shown in the figures below, as follows:

- Fig. 6. Near field amplitude distribution (LHCP, RLSA Φ 57 cm)
- Fig. 7. Near field phase distribution (LHCP, RLSA Φ 57 cm)

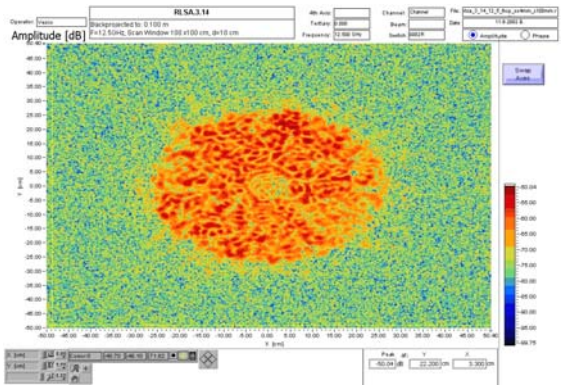

Figure 6. Near field amplitude distribution

The results, obtained in the last near field tests, show approximately uniform amplitude and random phase distributions in the RLSA aperture. The equipment resolution is less than half wavelength, which leads to not very correct results in the case of close distributed slots.

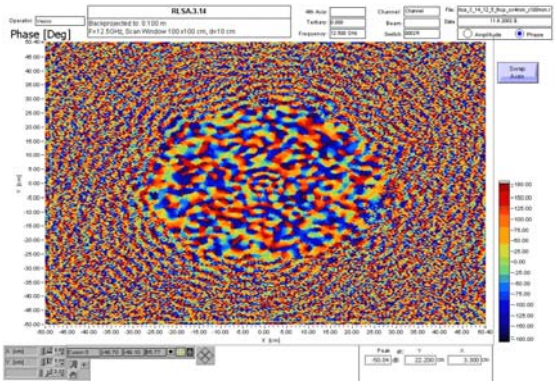

Figure 7. Near field phase distribution

References

[1] V. Demirev, "Review of SCP Test Set-up and Results - I", *CEMA,08 Conference Proceedings,* Athens, Grece, 2008.

[2] V. Demirev, A. Efremov, "SCP CDMA GSO,s system proposal", *ICEST, 04, Conference Proceedings,* pp.163-166, Bitola, Macedonia, 2004.