

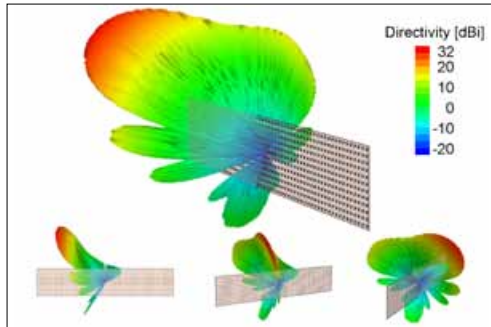


Hans-Dieter Lang

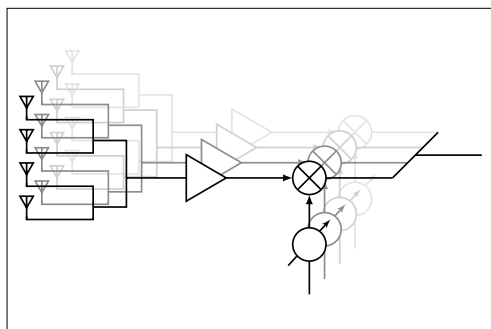
Graduate Candidate	Hans-Dieter Lang
Examiner	Prof. Dr. Heinz Mathis
Co-Examiner	Stefan Hänggi, RUAG Electronics AG, Bern
Master Research Unit	Sensor, Actuator and Communication Systems (SAC)
Project Partner	Institute for Communication Systems ICOM, HSR, Rapperswil SG

Array Antenna for DVB-S Applications

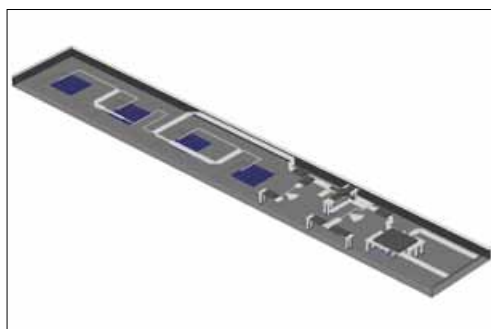
15 An Invisible Antenna for Satellite Broadcast Reception



720-element patch antenna array (actual dimensions ca. 16 × 82 cm), with a maximum directivity of 32dBi



Schematic of the «embedded LNB» principle



4-element aperture coupled patch antenna subarray, followed by low noise amplifier (LNA) and mixer

Satellite dish antennas are omnipresent in various places. They are among the most common parts of every satellite broadcast receiving system and satellite broadcast TV is quite common in Switzerland. Nevertheless, people generally think of dish antennas as eyesores. In some municipalities and regions their installation is even prohibited by law, because it is thought that they would impair the overall appearance of the locations and negatively affect their attractiveness for tourism.

This is one of the main reasons why it would be interesting to have a planar satellite antenna; for example built right into the outside wall of a building, with a beam pattern aimed directly at the required satellite(s). Besides familiarization with the current possibilities, the scope of the work also included research into the question of why no such antenna are available today.

In a first step, the relevant theories and principles of antenna arrays were investigated. It was found that, to provide the same antenna properties as dish antennas, such a planar antenna array would have to be rather large and feature a few hundred antenna elements. Also, for practical and economic reasons, it would be advantageous to use common general purpose PCB materials as the substrate material; however, in the satellite broadcast frequency range of 10.7 to 12.75 GHz, microstrip lines on common PCB materials suffer high loss, mostly due to dielectric imperfection, spurious radiation and surface-wave excitation. If so many antenna elements were connected over large distances, the antenna efficiency would be gravely reduced and the necessary gain could never be reached.

In a second step, alternative options were studied and a concept for an antenna including an embedded LNB was outlined. An LNB (Low Noise Blockconverter) for satellite broadcast reception is a combination of amplifier and downconverter, positioned at the focal point of every common dish antenna. Generally, the satellite signal is captured by the dish, reflected to the LNB and therein amplified and mixed down (to 0.95 to 2.15 GHz) to avoid high loss during transfer from outside the building to the receiver inside. This principle was adopted for the planar array: the satellite signal is received by four-element subarrays, amplified and mixed down into the low-band. Finally, all processed subarray signals are combined and led to the receiver. Prototypes of these subarrays were designed and optimized by simulation, then built and measured. Their performance was then compared to the simulation results.