# Dual Polarized Base Station Antennas For Polarization Diversity Systems

It is well known that in a cellular network, mobile phones have considerably lower transmittal power than the transmitters of the base stations. This means that the transmission from the mobile phone to the base station (uplink) is much more unfavorable in relation to the transmission from the base station to the mobile phone (downlink). To compensate this, a way of improving the quality of reception at base stations had to be found.

Due to the multi-path signal propagation of radio signals, which occurs in urban areas, so called **Space Diversity Reception** has been introduced which provides the best results in the field.

### Space Diversity Reception is based on the following idea:

The signal transmitted by a mobile phone is reflected in the propagation field and reaches the base station via different paths and phase angles. As a result, the signal at the base station receiving antenna is the sum or various vectors with different amplitudes, phases and polarizations. If two receiving antennas are separated horizontally from each other, (preferable to vertical separation), then it is highly likely that one of them will provide the required signal strength (principle of uncorrelated signals). A logic unit ensures that the higher signal level of the two receiving antennas is fed into the receiving systems.

Depending on the characteristics in the propagation area, the use of a Space Diversity Receiving System will produce a diversity gain of 3 to 5 dB, as compared to using only one single receiving antenna.

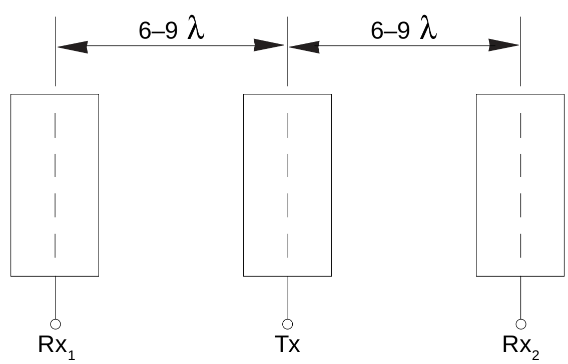


**Fig. 1:** Sector antenna system using Space Diversity Reception - 3 antennas, 3 feeders

The space diversity antenna configuration certainly provides good electrical results, but the number of antennas required is a negative factor with regard to the resulting optical appearance, the increased space requirements and the greater amount of mechanical hardware and feeder cables needed.

In view of the difficulties getting construction permits from the authorities concerned and approval from property owners for the installation of antenna systems, an advanced system with a low-level optical impact had to be found.

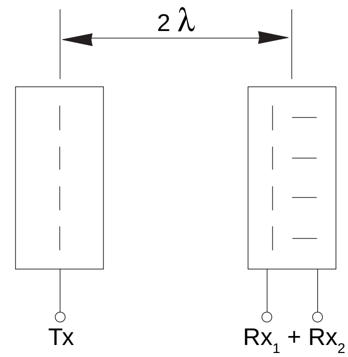


**Fig. 2:** Sector antenna system with Polarization Diversity Reception - 2 antennas, 3 feeders

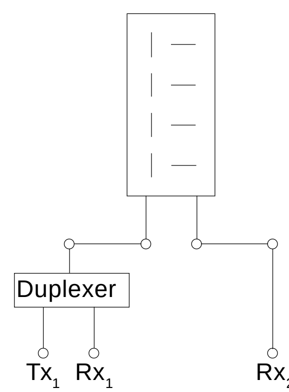


**Fig. 3:** Sector antenna system with Polarization Diversity Reception using a duplex filter 1 antenna, 3 feeders, 1 duplexer

It can generally be said, that the isolation between neighboring transmitting antennas, as well as between a transmit and a receive antenna must amount to at least 30 dB in order to avoid:

- interfering intermodulation products
- blocking of the receivers
- the activation of the transmitter's VSWR monitoring system by an adjacent transmitter

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This requirement for 30 dB isolation also applies to dual-polarized antennas. Initially dual-polarized antennas with horizontal and vertical polarization were preferred since this antenna concept easily provides the required 30 dB isolation figure between the horizontally polarized system and the vertically polarized system.

Practical results with horizontal / vertical dual-polarized antennas are fairly positive. However, there is also a weakness.

Since the mobile antennas (i.e. on cars or mobile phones) mainly operate in a vertically polarized mode, the propagation efficiency is more favorable to the vertical system of a horizontal/vertical dual-polarized base station antenna than to the horizontal system. Thus horizontal polarization is not really suitable for transmitting purposes.

However, with +45°/-45° dual-polarization antennas, both systems are equivalent with respect to their propagation efficiency. The two systems can therefore be used with good results for transmit and receive applications. Furthermore, this antenna concept allows simultaneous transmission from two transmitters without the use of a transmitter combiner.

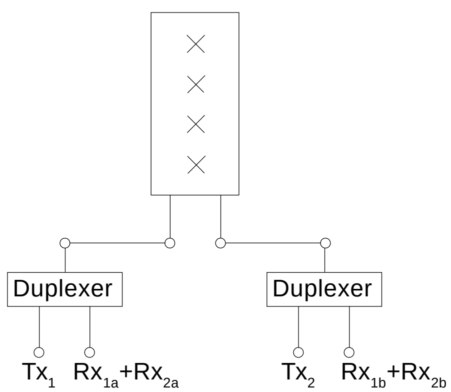



**Fig. 4:** X-polarized antenna for 2 transmitting and 2 receiving channels
1 antenna, 2 feeders, 2 duplexers

Isolation figures for various antenna arrangements are available from Kathrein Scala Division.

### Radiation patterns and half power beam widths of X-pol antennas:

Vertically or horizontally polarized antennas show constant polarization regardless of the azimuth angle from which the antenna is observed.

This concept is easy to understand if one considers the angles of orientation when a slanted dipole is viewed from different perspectives.

A dipole, which is set at a slant of +45° when viewed from the front, will appear to be vertically polarized when viewed from the side and will then appear at a slant of -45° when viewed from the rear.

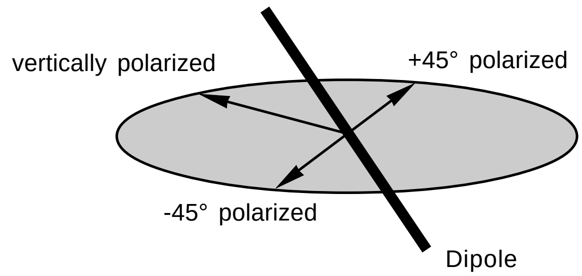
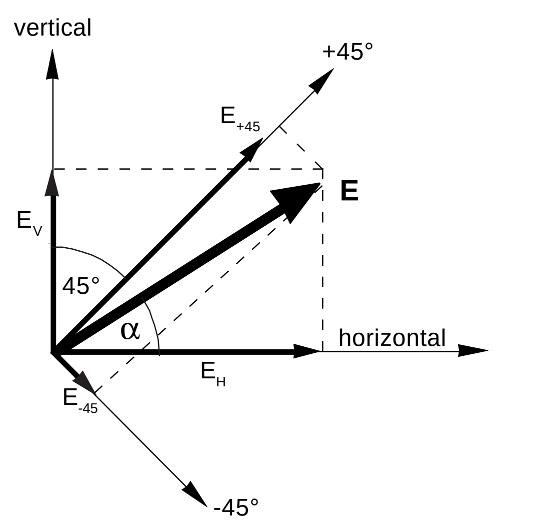



**Fig. 5:** Varying polarization of a dipole set at a slant of 45° The vector of the radiated electrical field strength is fully described by a pair of orthogonal vector components; in other words, the vector is described by a rectangular coordinate system.

According to Fig. 6, <u>any</u> field strength vector can be described either by a coordinate system, defined by the $E_v$ - vector and the $E_H$ - vector, or with the same preciseness by a coordinate system defined by the $E_{+45°}$ - vector and the $E_{-45°}$ - vector.




45°-polarization: $|E_H| = |E_V| = |E_{+45}|$ -3dB, $E_{-45}=0$

**Fig. 6:** Separation of a vector **E** into orthogonal components

This means that the exactness of the 45° polarization of an x-polarized antenna can be tested by measuring the radiation pattern in vertical polarization and in horizontal polarization or, alternatively by measuring the radiation pattern in +45° polarization and in -45° polarization (Fig. 7 and Fig. 8).

If the field strength vector is exactly +45°, the co-polar value is 100% and the cross-polar value is 0%.

In other words, if the polarization is almost 45°, the radiation patterns measured in vertical polarization $E_v$ and in horizontal polarization $E_H$ will also be quite close to each other, or referring to the second coordinate system, the cross-polar value $E_{-45°}$ of the field strength will be much smaller than the co-polar one $E_{+45°}$.

**If the polarization is exactly 45°, the half power beam widths of the radiation patterns measured in vertical polarization and in horizontal polarization are all of the same value.**

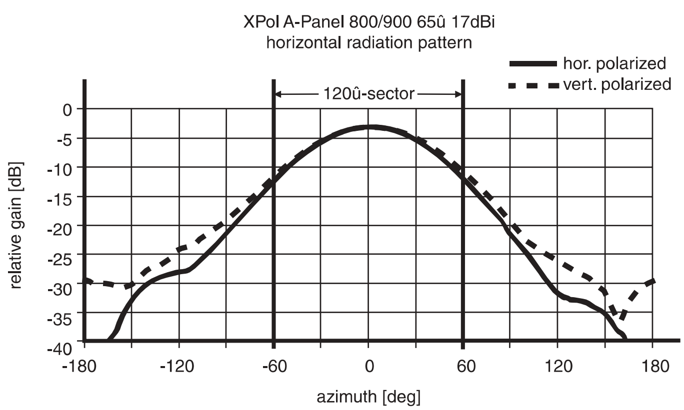



**Fig. 7:** Radiation pattern of a Kathrein Scala Division X-polarized 65° Antenna, measured with vertical and horizontal polarization.

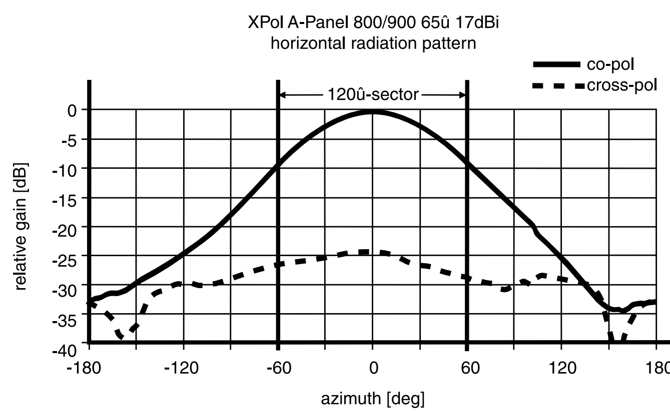



**Fig. 8:** Radiation pattern of a Kathrein Scala Division X-polarized 65° Antenna, measured with +45° and -45° polarization.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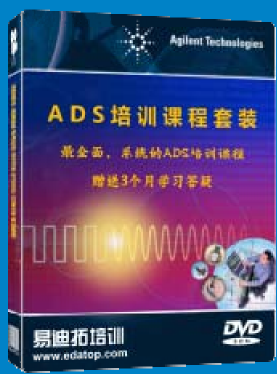


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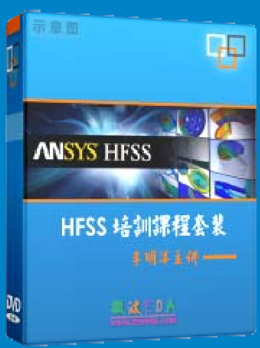


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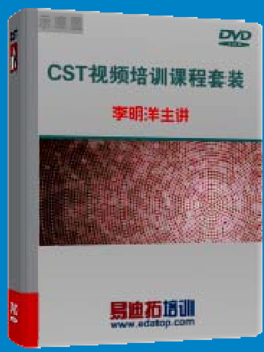


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