New Antenna Concepts for Digital TV

UHF Antenna Panels for Circular, Elliptical or Slant Polarisation

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Basics about the polarisation of electromagnetic waves

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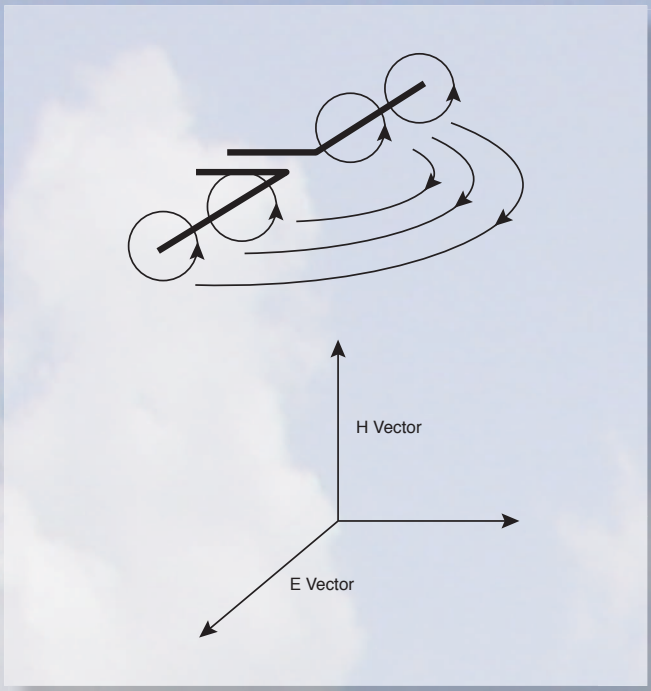
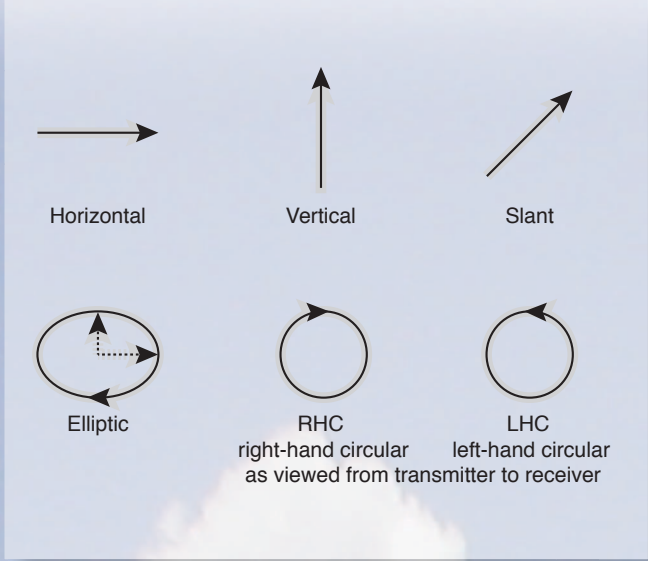
The polarisation of an electromagnetic wave is defined as the direction of the electric field vector. Distinction is made between linear and elliptical polarisation.

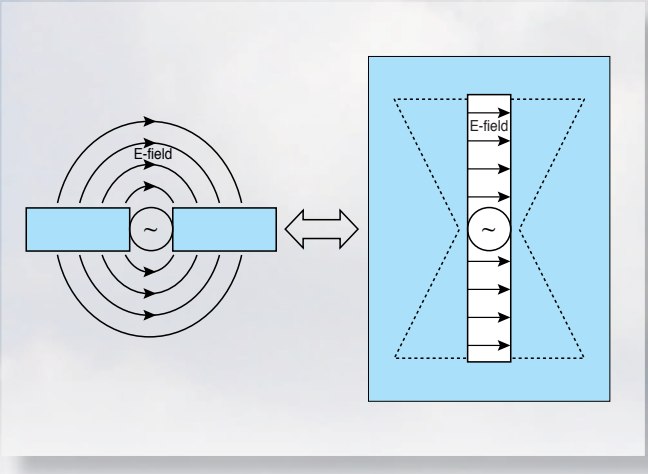




Linear polarisation occurs when the oscillation direction of the electric field vector lies in a plane in relation to the earth's surface, for example a horizontal plane (= horizontal polarisation) and vertical plane (= vertical polarisation); also conceivable, however, is a so-called "slant polarisation" with a horizontal and a vertical component.

Elliptical polarisation occurs when the electric field vector rotates time-dependently about the axis of propagation, while in a plane perpendicular to the propagation direction of an ellipse described. The field vector rotates at the transmission frequency.
If the field strength vector rotates clockwise, then one speaks of clockwise elliptical, and conversely from anti-clockwise elliptical polarisation.
A special case of the elliptical polarisation is circular polarisation, in which the ellipse is actually a circle (as described above). The direction of rotation is named using the English terminology "RHC" (right-hand circular) and "LHC" (left-hand circular) which are often used in conjunction with this.

In a typical half-wave dipole for broadcasting applications, the position of the E-field vector and thus the polarisation, is established in the direction of the dipole axis. Thus, a horizontal-lying dipole radiates a horizontally polarised wave.
If a slim rectangular slot (aperture) is cut in a conductive surface and the short opening fed with a signal source, then an electrical field is formed over this slot.
This means a vertically arranged fed slot antenna, e.g. a superturnstile antenna also radiates a horizontally polarised wave.



Effect of polarisation on the propagation characteristics of electromagnetic waves in the VHF and UHF band

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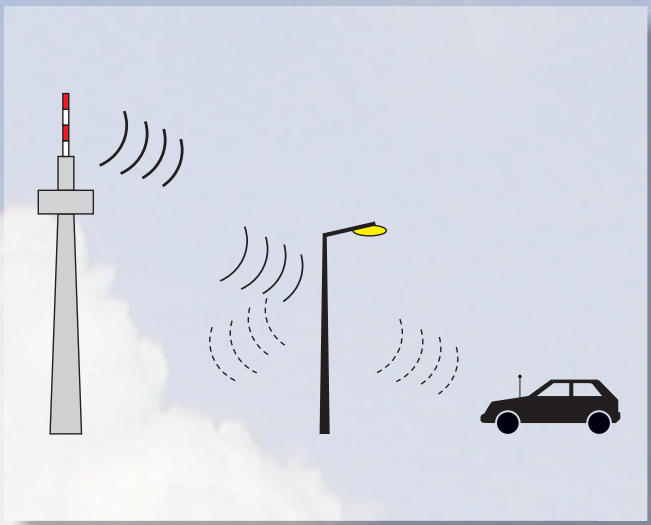
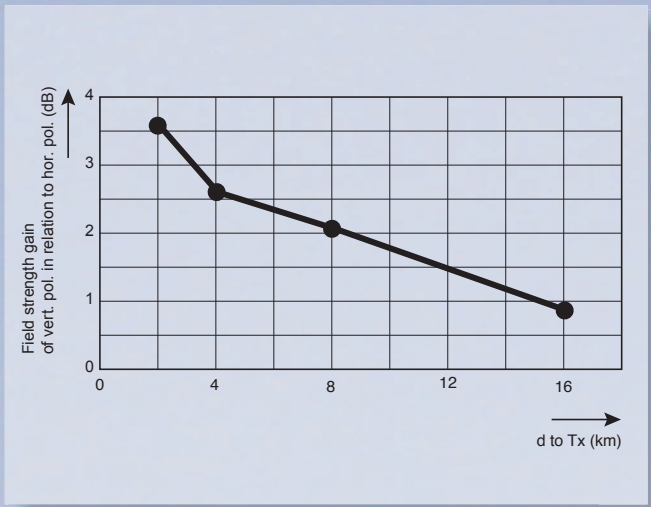
There are numerous studies about the propagation characteristics of VHF and UHF waves in different polarisations. The general findings can be summarised as follows.

- Vertically polarised waves undergo a greater attenuation on long transmission paths than horizontally polarised waves [1, 2].
- Vertical polarisation favours so-called multipath propagation through numerous reflective vertical elements in nature, such as lampposts ... [1, 2].



- Vertically polarised waves generate higher field strengths near the ground [3].
- Antennas for portable receivers are often oriented vertically out of habit, and therefore favour the reception of vertically polarised waves [4].
- Circularly polarised radiation on mobile receivers generates less amplitude variation, i.e. it increases the likelihood of usable field strength, and at the same time serves all forms of linearly polarised receiving antennas [6].

Results from a field test of UHF DVB-T radiation show the relationship between signal strength in both vertical and horizontal polarisation as an alternative for the same radiated power, in the vicinity of a local transmitter [5].



Relation of the field strength of a local transmitter, vertical to horizontal polarisation, as a function of the distance Tx – Rx (Rx antenna 1.5 m above ground, polarisation matched).

Theoretically, a linearly polarised antenna receives no waves in the direction orthogonal to their polarisation. Therefore a horizontally polarised receiving antenna would almost definitely show infinite attenuation for a vertically radiated wave.
However, due to diffraction, refraction or reflection of the radiated waves, it results in the rotation of the polarisation vector. Therefore, one can expect that in spite of orthogonal alignment of the transmitting and receiving antenna, a small part of the signal can be received in practice. Typical values can range from about –20 dB (in a rural area) to –5 dB (in a big city) [5].

Implications on the emission of television and radio signals in the VHF and UHF bands

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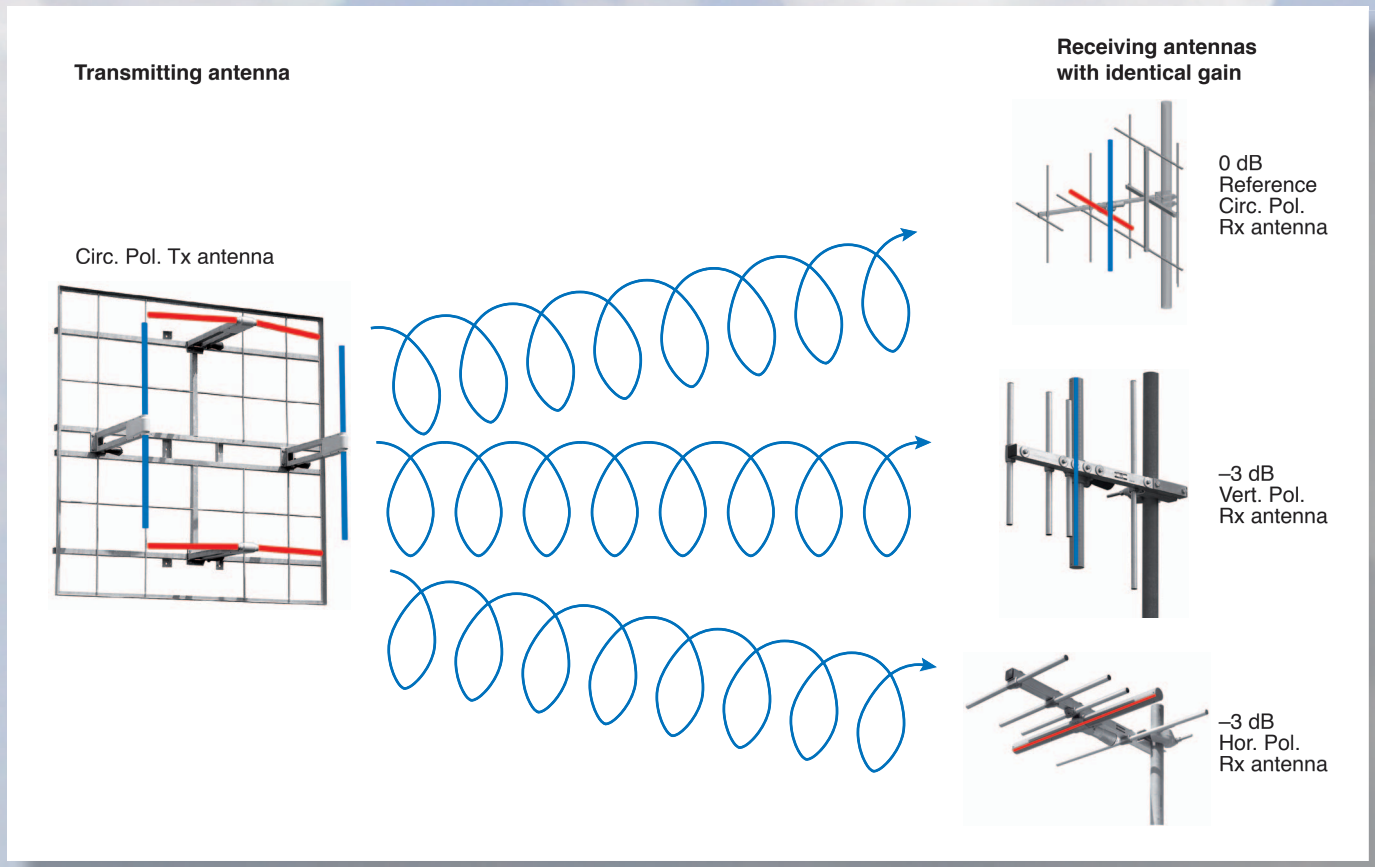
There are following practical consequences for the emission of digital TV and radio signals:

- If a large area is to be covered by one transmitter, then one would choose horizontal polarisation; losses in the supply of mobile/portable receivers are to be accepted.
- If the special aim is portable receivers served in major cities, then vertical polarisation should be chosen; area coverage losses are to be accepted.
- If stationary, mobile and portable reception devices are supplied from one transmission antenna in a large area, then it is possible to choose either elliptical or circular polarisation.

However, since the vast majority of receiving antennas (both stationary and mobile/portable) are linearly polarised, they can receive only a part of the energy from the elliptical or circular wave.
This "loss" is often included in the transmitting antenna gain, although it is actually physically wrong to attribute this to the transmitting antenna. If this effect must be compensated for, then more elliptical/circular radiated transmitter power can be used to offer the receiver the same signal strength as in the case of appropriate linear radiation.



In the case of circular or elliptical radiation only a circular or elliptical polarised antenna is optimally able to receive the energy of the wave. Standard linearly polarised receiving antennas can incur a "loss", which is often erroneously deducted from the transmitting antenna gain.

The evolution of digital TV standards – DVB-T2 and ISDB-T

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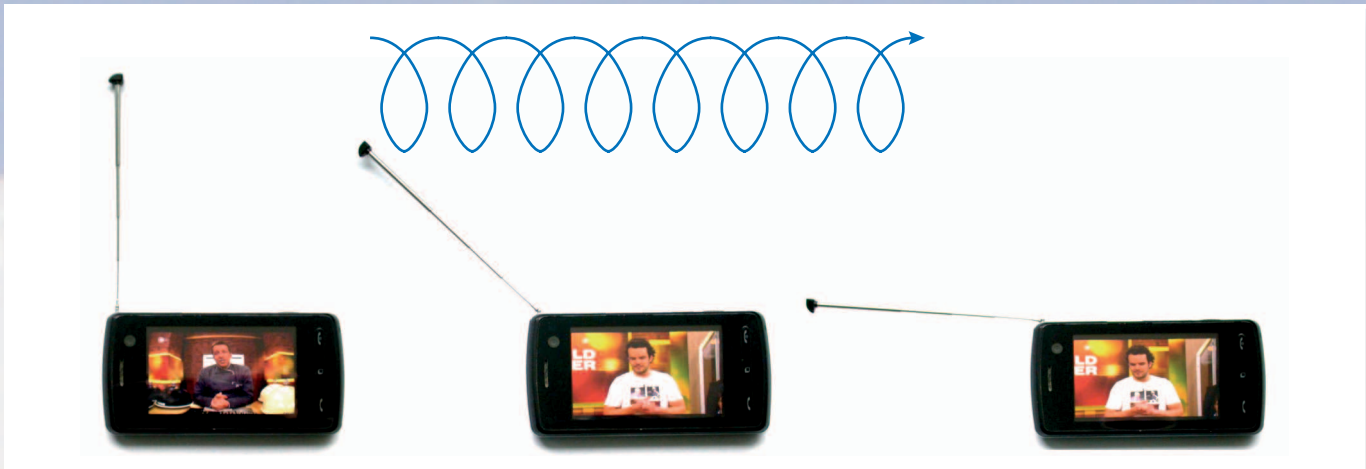
When the introduction of DVB-T digital TV initially began, the use of portable receivers was indeed intended, however the DVB-H and T-DMB standards were also planned for purely mobile TV.

In this case, the emission of the respective signals in each of the separate networks is possible with optimal polarisation.

Meanwhile, the digital television standards have been advanced. DVB-T2, ISDB-T and SBTVD offer the possibility to integrate programs for both stationary and mobile TV within a television channel multiplex.



The receiving antenna can only receive independently of its position if circular or elliptical polarisation is used.

Consequently both stationary and mobile receivers should be served by one single transmitting antenna. As indicated above it would be ideal if the radiated wave could have a horizontal and vertical component.

A slanted polarised radiation would be convenient; however it cannot be avoided that in the case of orthogonal orientation of the receiving antenna respective the wave, a strong signal fall-off would occur. Such a drop in received signal strength for mobile reception is very annoying and can be avoided only by radiating elliptical or circular waves.

However attractive the emission of elliptically polarised waves may now appear, one must also illustrate the limits of the possibilities:

- Elliptically polarised transmitting antennas are significantly more expensive than horizontally, vertically or slant polarised antennas. The reason is that two complete dipole systems have to be integrated into a single housing and an additional distribution network (either in the panel or external) is required.
- Elliptically polarised transmission antennas, with good radiation pattern and return loss characteristics can be realised on a segment of the UHF band, that is not complete broadband 470–862 MHz

What percentage of energy is invested in the respective plane of polarisation depends on the coverage objective, broadcasting license, as well as the business model of the broadcast company.

Because of practical investigations, a power ratio of H70% / V30% using elliptical polarisation is now widespread in South America.
Emission of slant polarised waves was used in the introduction of digital television in Argentina. Dipoles which are rotated 15 degrees from the horizontal were used in the antenna arrays. The ratio of horizontal to vertical field strength proportion raised here is H80% / V20% and this corresponds to a power ratio of H93% / V7%.

In Sweden, tests are running for DVB-T coverage areas on the southwest coast, which are strongly affected by overreach interference from foreign broadcasters. The UHF transmitting antennas used enable the switching of various linear and elliptical polarisations to allow viewers a low-interference reception.

New Kathrein UHF antenna panels for circular/elliptical and slant polarisation

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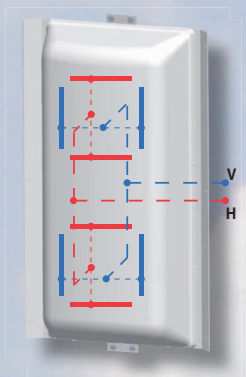
The Kathrein Broadcast Division has extended the product range of UHF antenna panels to new types of circular/elliptical and slant polarisation. During the development, special attention was paid to making sure that constantly good omni-directional patterns could be achieved for the polarisation planes in the entire specified frequency range.

Series 75010322

- Horizontal and vertical dipole system in one antenna housing.
- Separate inputs for H and V provide flexible external cabling.
- All types of elliptical and linear polarisation can be realised by appropriate feeding by external power dividers and phase cables.
- Building block for antenna systems with excellent omni-directional radiation patterns and VSWR in the range 470–654 MHz.
- In special configurations they can be used in antenna systems up to 694 MHz.

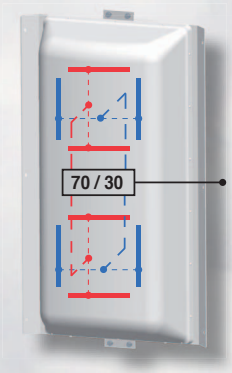
Input	2 x 7-16 female
Max. power	Horizontal: 1 kW Vertical: 500 W (at 40 °C ambient temperature)
Frequency range	470 – 654 MHz (694 MHz)
VSWR	< 1.2
Polarisation	Horizontal, vertical, circular, elliptical, slant



Series 75010325

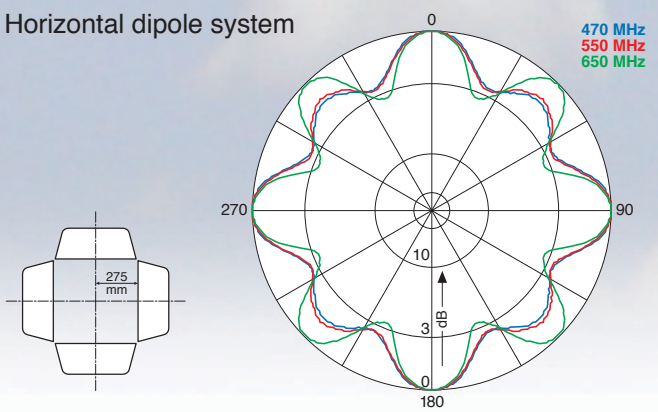
- Horizontal and vertical dipole system in one antenna housing.
- A single input and integrated power splitter enable compact design of antenna systems with simple distribution network.
- Internally set power division for elliptical polarisation with a power ratio of 70% H and 30% V.
- Building block for antenna systems with excellent omni-directional radiation patterns and VSWR in the range 470–654 MHz.
- In special configurations they can be used in antenna systems up to 694 MHz.

Input	1 x 7/8″ EIA flange
Max. power	1.5 kW (at 40 °C ambient temperature)
Frequency range	470 – 654 MHz (694 MHz)
VSWR	< 1.15
Polarisation	Elliptical polarisation with power ratio 70% horizontal / 30% vertical

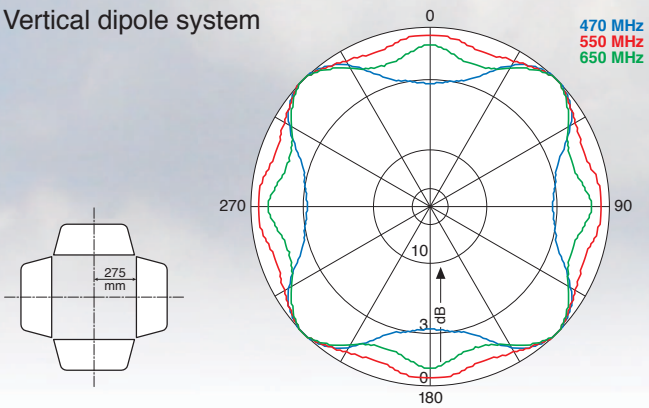


Horizontal Radiation Patterns – Series 75010322 and 75010325

Horizontal dipole system



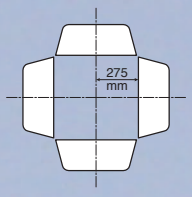
Vertical dipole system

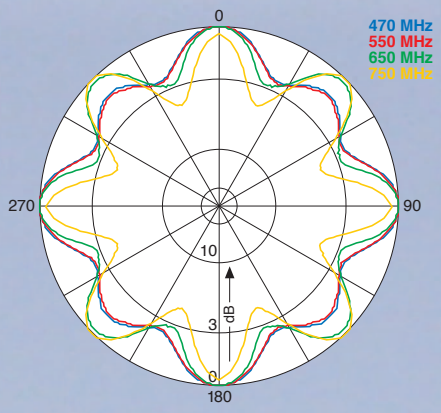


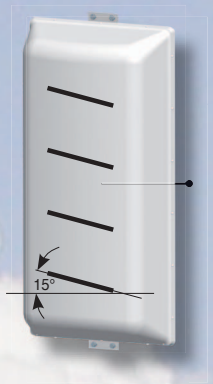
Series 75010329

- 15 ° inclined dipole systems are built in an upright antenna housing allow compact design of antenna systems (panels need not be mounted twisted!).
- Slant polarisation with a polarisation ratio (field vector) 80% H and 20% V.
- Component for antenna systems with good omni-directional radiation patterns and VSWR in the range 470–806 MHz.

Input	1 x 7/8″ EIA flange
Max. power	1.5 kW
Frequency range	470 – 806 MHz
VSWR	< 1.1
Polarisation	Slant 80% horizontal / 20% vertical







References:

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2 D. Hühn, Einfluß der Polarisationsrichtung (hor. oder ver.) auf die Funkwellen-Ausbreitung im Frequenzbereich II, Institut für Rundfunktechnik, Feb. 1968

3 R. Kretzschmann, UKW-Rundfunkversorgung mit horizontal und vertikal polarisierten Sendern, LfK Baden-Württermberg, Mai 2000

4 Stephen J. Blank, Vertical Polarization and FM Transmitter Antenna Performance Optimization, New York, Sept. 1998

5 G. Schneeberger, R. Schramm, Wahl der Polarisation von DVB-T-Sendern, Institut für Rundfunktechnik, Dez. 2002

6 Neues von Rohde&Schwarz Nr. 74, S. 19 – 21, L. Thomanek, Juli 1976

References for Kathrein UHF Antennas for circular, elliptical or slant polarisation, for example in the following countries:

Argentina
Brazil
Ecuador
Peru
Sweden
Uruguay

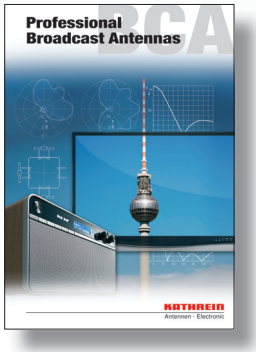
UHF Antenna HÖLLVIKEN
(Teracom, Sweden)

UHF Antenna ÄNGELHOLM
(Teracom, Sweden)

UHF Antenna
MONTEVIDEO
(Canal 4, Uruguay)

UHF Antenna SAO PAULO
(Faculdade Mackenzie, Brazil)

In addition to the products and solutions shown in this brochure, Kathrein's portfolio includes a full range of broadcast antennas and accessories for FM, TV, DAB and DTV.
Please contact us for further information or see our current broadcast catalogues:



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