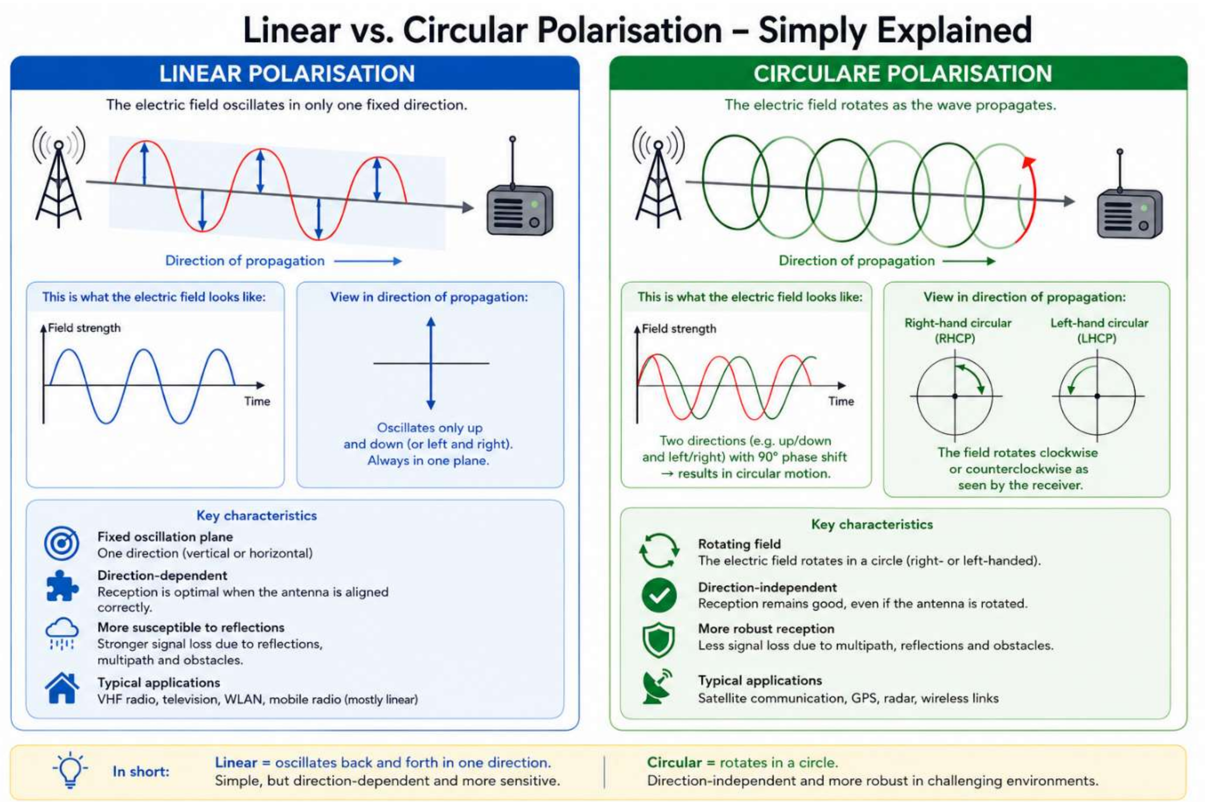
Antenna polarisation

There are two types of antenna polarisation: linear and circular polarisation. Both types have their own advantages and characteristics.

In linear polarisation, the radio waves travel either horizontally (sideways, as on a sheet of paper) from the antenna to the receiver, or vertically (from top to bottom, but not sideways).

With circular polarisation, the radio waves move alternately in both directions, i.e. sideways and then vertically, repeating this pattern continuously. This creates a circular rotation of the radio signal.

For those of us with a technical interest: this is achieved by an alternating 90° phase shift of the signal (see image below).



Both types of polarisation have their own characteristics, and it is for this reason that they are suitable for different applications.

Linear polarisation concentrates its radio energy in a single plane (put simply: vertical or horizontal). As a result, this type of antenna generally has a significantly greater reading range than circular antennas, as the latter radiate their energy alternately in the vertical and horizontal planes.

For the system to operate reliably and effectively with linear polarisation, the data carriers must be correctly aligned.

These must be aligned with the antenna plane in order to be read. If, for example, the antenna radiates horizontally and the data carriers (and thus also the small antenna on the data carriers) are positioned vertically, they are not aligned, which leads to numerous reading errors or even complete failure to read.

In that case, although the signal is transmitted with a lot of power (remember: linear antennas have more power because the available power is radiated on a single plane), it is simply in the wrong direction. It's like a loud shouter, but with the wrong accent 😉 which isn't much help.

If both parties (antenna and data carrier) are always aligned identically, then everything is fine and communication is possible even over greater distances.

Examples of applications for linear polarisation include:

- Automated production lines (robots, placement machines, etc.)
- Conveyor systems with fixed label placement (pallet or carton conveyors)
- Sorting systems
- High-speed manufacturing environments

Circular polarisation effectively radiates energy in a rotating corkscrew pattern (see image above). This enables communication with data carriers regardless of their orientation (whether the data carrier's antenna is vertical, horizontal or diagonal).

The antenna constantly distributes the energy across different planes through rotation (circulation), in contrast to linear polarisation (only one plane). Distributing the available energy across multiple planes naturally also means a shorter range.

The maximum range is reduced by around 3 dB compared to a linear antenna. That may not seem like much, but the techies among us know that 3 dB means a doubling or halving of the range! On the other hand, the data carriers can be oriented in any direction whatsoever, i.e. completely haphazardly (which is unavoidable in many applications).

Examples of applications using circular polarisation include:

- Inventory tracking in warehouses
- Item recognition in retail
- Dispatch and receiving bays
- Use of mobile RFID readers
- Objects carried or moved by people

Simple selection criteria:

Choose linear polarisation if you can control the orientation of the data carrier and require maximum range.

Choose circular polarisation if the orientation of the data carrier is variable or unknown.

And then there's the antenna's power and direction

In technical terms, gain and beamwidth directly influence an antenna's range and coverage.

Gain and beamwidth are inversely proportional to one another. If the gain (and thus the radiated power) is to increase, the beamwidth must become narrower. And this is for one simple reason: the power that can be radiated is limited by law.

Explained simply:

The maximum permitted power that an antenna is allowed to transmit is limited by law. This limit is based on a dipole antenna – essentially an omnidirectional antenna that radiates equally in all directions horizontally.

If you now 'build in' directivity – that is, rather than allowing the energy to radiate in all directions, you direct it specifically in a certain direction – then the energy in that direction is significantly higher and very low in the other directions. This results in what is known as 'antenna gain'.

The gain therefore always refers to the ratio of how many times better this antenna radiates in a specific direction compared to a standard dipole (standard rod antenna) when the figure is given in dB, or an isotropic (spherical) antenna when the figure is given in dB***i***.

<u>Conclusion:</u>

The more directional an antenna is, the higher the power output in the desired direction, but the narrower (more directional) the antenna beam also becomes. This principle determines the geometry of the read field. This means you achieve greater ranges, but at the same time reduce the coverage area. And that is often the intention 😉

Here are a few examples:

• High-bay warehouses:
A narrow antenna beam can, for example, be used to scan specific shelf levels without reading data carriers on adjacent levels.

• Lorry loading bays:
Focused beams penetrate deep into lorry trailers. The narrow field prevents accidental reading of traffic nearby or at adjacent gates.

• Conveyor systems:
Concentrated antennas track items passing a defined point without detecting other items in adjacent positions.

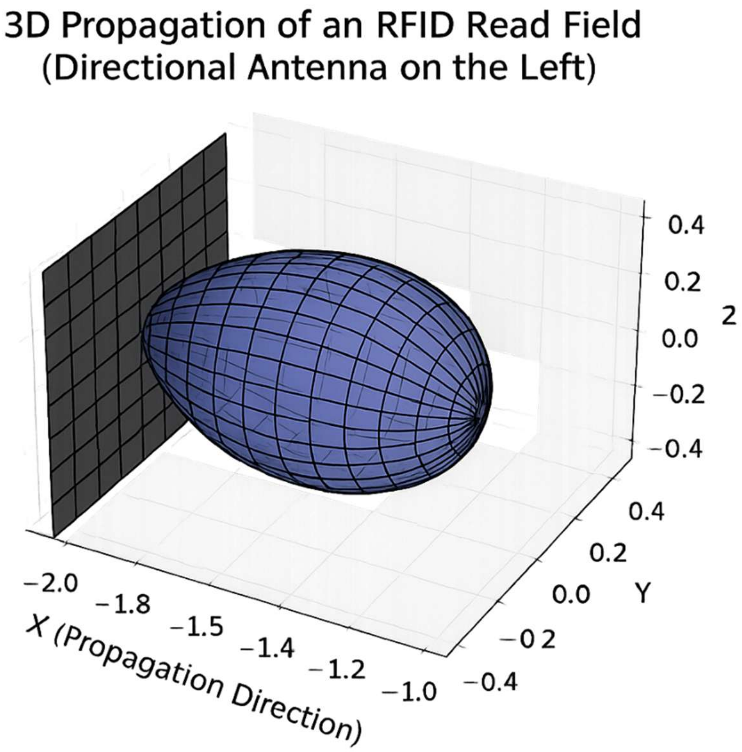
Counterexample for applications with a wide beam angle:

Antennas with lower gain distribute their energy over a wider radiation angle. This gives you a larger coverage area for the data carriers, but it also reduces the range. This is because the maximum permissible energy is radiated over a wider angle.

• In goods-in:
Wide beams can scan multiple data carriers on a pallet simultaneously without the need for precise positioning.

• Replenishment racks:
A wide coverage area can scan all items on a shelf. The shorter range is often not a problem in confined spaces.

The read field is the area within which data carriers can be reliably read. It takes the form of a cone extending out from the antenna surface.



The dimensions are determined by the antenna gain, power and sensitivity of the data carriers (primarily the antenna size of the data carriers).

Even more technical stuff for the nerds 😉

The **near-field** and **far-field** of a UHF RFID antenna

UHF RFID antennas generally operate in two ranges:

• The near field (within approx. 35 cm at ~900 MHz) uses **magnetic coupling** for very short, controlled read operations – perfect for PoS (point-of-sale) terminals, where you only want to read specific items on the counter and not everything on the counter.

• The far field (beyond 35 cm) utilises **electromagnetic propagation** for most RFID applications.