Choosing Antennas for your UHF RFID application

Introduction:

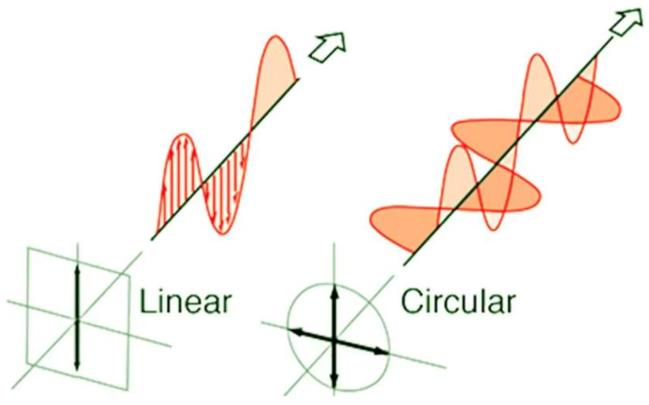
The information below is specifically relevant to Ultra High Frequency (UHF) RFID antennas. Antennas are required for any fixed UHF RFID reader application and can include the following examples: Conveyor belts, doorways, warehouse dock doors, portals etc.

Types:

- Antennas are typically available as Linear or Circular Polarized and Monostatic or Bistatic.

Linear vs Circular Polarized:

- Linearly polarized RFID antennas emit radio waves with an electric field oscillating in a straight line.
  - Linear polarization is often used in RFID systems where the orientation of the tag concerning the reader is relatively constant. For example, if the tags are always positioned with a consistent alignment concerning the reader, linear polarization may be suitable.
  - However, if there are variations in tag orientation, linear polarization can lead to signal degradation due to the mismatch between the polarizations of the reader and the tag.
- Circularly polarized RFID antennas emit radio waves with a rotating electric field, either right-handed (clockwise) or left-handed (counterclockwise).
  - Circular polarization is advantageous in RFID systems where the orientation of tags may vary. The rotating field allows for better coverage and a more robust link between the reader and the tag, irrespective of tag orientation.
  - Circularly polarized RFID antennas are often used in applications where tags can be randomly oriented or in environments where reflections and multipath effects are prevalent.
- In summary, the choice between linear and circular polarization in RFID antennas depends on the specific requirements of the application. Linear polarization may be suitable when tag orientation is consistent, while circular polarization is preferred in situations where tag orientation is unpredictable or when dealing with challenging RF environments. Note, a loss of approximately 3 dB can be experienced when using Circular Polarized compared to Linear Polarized antennas.



Source: encstore.com

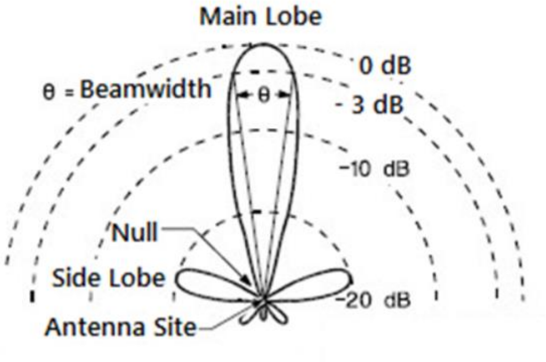
Bistatic vs Monostatic Antenna:

- In a monostatic UHF RFID system, a single antenna is used for both transmitting and receiving signals. This is the most common type.
    - The same antenna is responsible for both sending out the radiofrequency signal to power the RFID tags and receiving the backscattered signals from the tags.
    - Monostatic systems are often simpler to set up and require fewer components since there's only one antenna involved.
- In a bistatic UHF RFID system, separate antennas are used for transmitting and receiving signals.
    - One antenna is dedicated to transmitting the RF signal to power the RFID tags (transmitter), while another antenna is dedicated to receiving the backscattered signals from the tags (receiver).
    - Bistatic systems can offer advantages in terms of increased read range and improved isolation between the transmitting and receiving functions, which can be beneficial in certain environments with challenging RF conditions.

- When choosing antennas, please consider the following:
    - Complexity: Monostatic systems are generally simpler and have fewer components since there's only one antenna. Bistatic systems involve separate transmitting and receiving antennas.
    - Read Range: Bistatic configurations can potentially offer improved read ranges compared to monostatic configurations. This can be advantageous in scenarios where longer communication distances are required.
    - Isolation: Bistatic systems inherently provide better isolation between the transmitting and receiving functions, potentially reducing interference and improving overall system performance.
- The choice between monostatic and bistatic configurations depends on the specific requirements of the RFID application, such as read range, environmental conditions, and desired system complexity. Both configurations are used in various RFID implementations based on their respective advantages and trade-offs.

Beam Width:

- Antenna beam width refers to the "width" or coverage of the radiofrequency signal emitted by an RFID antenna.
    - As an example, imagine the RFID antenna is like a flashlight. The beam width is like the spread of light that comes out of the flashlight. A narrow beam covers a smaller area, and a wide beam covers a larger area.
    - A narrow UHF beam width focuses the RFID signal on a specific direction, useful for targeting RFID tags in a precise area. A wider beam may cover a broader space, capturing tags over a larger zone.



Source: everythingrf.com

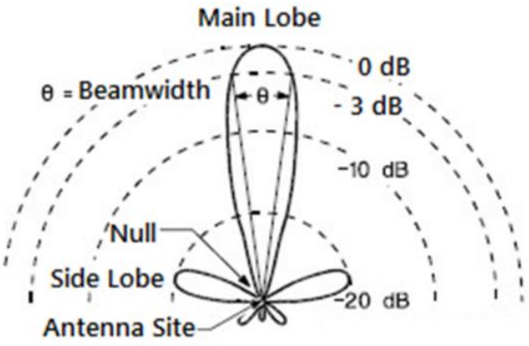
Antenna Gain:

- UHF antenna gain measures how effectively an RFID antenna can transmit and receive signals in a specific direction compared to a theoretical ideal antenna.
    - As an example: think of antenna gain like a megaphone. A higher gain means the megaphone is better at directing sound in a particular direction, making it louder and more effective in that area.
    - A higher UHF antenna gain helps focus the RFID signal on a specific direction, improving communication range and performance. It's like making the RFID signal stronger in the direction it's needed, which can be crucial in reading tags at a distance.

- In essence, UHF beam width is about how wide or narrow the RFID signal coverage is, like the spread of light from a flashlight. UHF antenna gain is about how effectively the RFID antenna focuses and strengthens the signal in a particular direction, similar to a megaphone directing sound. These concepts are essential in designing RFID systems to optimize communication with RFID tags in various applications.

Main Beam and Side Lobes:

- Think of the Main Beam of an RFID antenna as the primary direction where the antenna is pointing and where it's most effective in transmitting or receiving signals. It's like the main focus or spotlight of the antenna.
- Sidelobes are additional, unintended lobes or beams that can emerge at angles other than the main beam. These can be thought of as weaker or secondary directions where the antenna radiates or receives signals to some extent.
- In RFID systems, sidelobes can be both a challenge and an opportunity.
    - Challenge: Sidelobes may cause interference or unintended communication with RFID tags in directions where it's not desired. This can lead to issues such as reduced system accuracy or increased susceptibility to external interference.
    - Opportunity: Skilful design can leverage sidelobes for specific purposes. For example, they might be intentionally used to broaden the coverage area of the RFID system or enhance tag reading in multiple directions.
- In summary, sidelobes in RFID antennas are secondary radiation patterns that occur in directions away from the main beam. Minimizing unwanted sidelobes and, when applicable, strategically using them can contribute to optimizing the overall performance and efficiency of an RFID system



Source: everythingrf.com

Axial Ratio:

- The axial ratio is a measure of how well an antenna maintains the polarization of its transmitted or received signals. It's expressed as a ratio of the major and minor axes of the antenna's radiation pattern.
    - Polarization: Think of polarization as the orientation of the electric field in the electromagnetic wave. It can be linear, where the electric field oscillates in a straight line, or circular, where it rotates like a corkscrew.
    - In UHF applications like RFID, the orientation of the antenna's polarization is crucial for effective communication. RFID tags and readers are designed with specific polarization characteristics, and a well-matched polarization between them ensures optimal signal transfer.
- Low Axial Ratio: A low axial ratio means that the antenna has a good polarization purity. It maintains a consistent and well-defined polarization, which is desirable in applications where maintaining a specific polarization is critical for performance.
- High Axial Ratio: A higher axial ratio indicates that the antenna's radiation pattern has variations in polarization. In some cases, this may lead to signal degradation, especially if there's a mismatch between the antenna's polarization and the polarization requirements of the RFID tags or readers.
- In summary, axial ratio in UHF antennas is a measure of how well the antenna maintains the purity of its polarization. A low axial ratio is preferable in applications like RFID to ensure effective and reliable communication between tags and readers, where polarization compatibility is essential.

VSWR:

- VSWR, or Voltage Standing Wave Ratio, is a term used in RFID to assess the efficiency and performance of the radiofrequency (RF) transmission between the RFID reader and its associated antenna. It is a ratio that quantifies how much of the RF signal is reflected back from the antenna due to impedance mismatches. Simply put, it is a measure of how well the energy is transferred from the RFID reader to the antenna, and how much is bounced back.
    - Ideal Conditions: In an ideal scenario, all the power from the RFID reader is transferred to the antenna without any reflection. The VSWR would be 1:1. This indicates a better match between the RFID reader and the antenna, suggesting a more efficient power transfer
    - Non-Ideal Conditions: In real-world situations, reflections may occur due to impedance mismatches, cable issues, or other factors. A higher VSWR indicates a less efficient power transfer and more energy being reflected back. A high VSWR can lead to signal loss, reduced read range, and potential damage to the RFID reader.