Technical Documentation and Integrations-Guide

for metraTec Echo-5P and Echo-8P UHF Patch Antennas

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1 General Information / Security Advice

1.1 Notes on the use of this documentation

This user manual and integration guide uses different symbols to point out potentially dangerous situations. The following signs and symbols are used throughout the document.

ATTENTION

Declares a potentially hazardous situation. If this is not avoided, the product or something in its surrounding could be damaged.

NOTE

Declares notes for the user as well as other useful information, where no harmful or dangerous situations can be expected.

1.2 Further Documentation

This documentation refers at different points to the EN ETSI 302 208-1 where important parameters and limits for the use of UHF RFID systems in the territory of the European Union are defined. The system integrator (the person or company who combines this product with other devices, e.g. UHF readers) is responsible for the compliance with these limits. The document is available for free at the website of the ETSI (www.etsi.org).

2 Product Description

The metraTec Echo-5P and Echo-8P are circularly polarized UHF RFID antennas for the European UHF RFID frequency range around 868 MHz. The housing is made from POM (polyoxymethylene) which has excellent mechanical properties and is resistant to many chemicals. Common applications are for UHF RFID Gates (especially Echo-8P with narrow angular width and a gain of 8 dBic), as well as in systems with limited available space, e.g. forklifts: underneath for scanning tags on the floor or inside the fork lift's mast.

2.1 Intended Use

The Echo-5P and Echo-8P are UHF patch antennas developed for the use in UHF RFID systems using the European frequency range (around 868 MHz). All technical specifications in this document are given with this intended use in mind. The performance of this product for any other use cannot be guaranteed by metraTec.

2.2 Technical Specification

Operating Principle	Circular polarized UHF patch antenna
Resonance Frequency	865 MHz (UHF RFID, ETSI)
Impedance Bandwidth (-10 dB)	858 – 877 MHz
Polarization	RHCP (right-handed circular polarized)
3dB Angular Width	Echo-5P: 100° Echo-8P: 62°
Antenna Gain	Echo-5P: 5 dBic Echo-8P: 8 dBic
Nominal Impedance	50 Ohm
Axial Ratio	< 3 dB
Max. RF power permitted (acc. to EN ETSI 302 208-1)	Echo-5P: 500mW ERP (see Ch. 4) Echo-8P: 2W ERP (see Ch. 4)
Operating Temperature	-40°C to +85°C
Dimensions	Echo-5P: 90 x 105 x 30 mm (without R-TNC connector) Echo-8P: 90 x 300 x 20 mm (without SMA connector)
Antenna Connector	Echo-5P: R-TNC, male Echo-8P: SMA, female, gold plated
Protection (IP-Code)	IP 40

2.3 Product Drawing

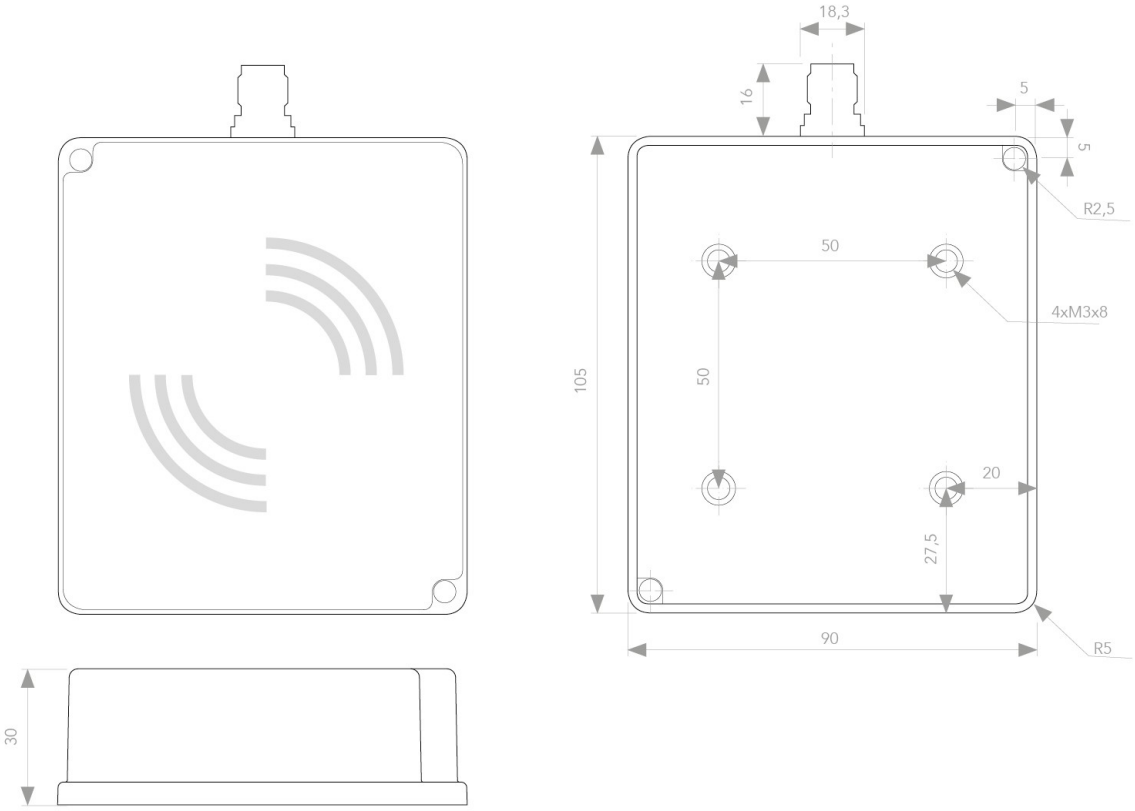

Fig. 1: Drawing of Echo-5P (all dimensions in mm)

Fig. 2: Drawing of Echo-8P (all dimensions in mm)

2.4 Accessories

Besides the Echo-5P and Echo-8P antennas metraTec offers all the necessary accessories, e.g. coaxial cables with R-TMC/SMA connector on the one side and (almost) any other antenna connector on the other side. For this we can use standard coaxial cables or special low loss coaxial cable with a loss of only 0,3 dB/meter (for applications with cable length up to 15 m without problems). Depending on your requirements we can also build high temperature cables, cables with protection against certain chemicals, etc.

Another accessory we offer is the wall mounting bracket for increased flexibility in adjusting antenna alignment using a ball joint.

3 Installation / Integration

3.1 Distance to Metal

To ensure the full performance of the antenna certain minimal distances between the antenna and all metal parts should be observed. Our recommendations are:

- Keep bigger metal parts at least 6cm away from the sides of the antenna.
- Don't place any metal parts in front or to the side of the patch antenna in the main lobe (see radiation pattern, section 5.1).
- Installing the antenna on a bigger metal plane should be avoided since all antenna parameters can shift extremely in this case. It is no longer certain that all regulations are fulfilled and a new measurement would be necessary in this case, requiring special knowledge as well as appropriate equipment, i.e. at least a spectrum analyzer. You can avoid this by using a mounting kit that ensures a minimum distance of 6 cm between antenna and metal plane. We would like to recommend the optional available wall mounting bracket for this purpose, as mentioned in 2.4(Accessories).

3.2 Distance to Non-Metallic Materials

Also non-metallic materials can influence the performance of the antenna in a negative way. Especially mounting the antenna close to containers with fluids (even if they are made from plastics) as well as near human bodies (e.g. if used for wearable computing applications) will influence the circular polarization of the antenna (ref. to 5.3"Axial Ratio"). The read performance for tags which lie in the affected polarization will decrease significantly. In extreme cases the antenna can be de-tuned in such a way that it is no longer able to radiate in the RFID frequency band (ref. to 5.2"Antenna Bandwidth").

3.3 Note on Cable Routing

Besides minimal distance to objects near the antenna, also the cable routing can have a big influence on the performance. Following the next few tips will give you the best performance:

- Lay the cable straight to the bottom of the patch or to the back (using a 90° connector).
- Do not lay the cable around the sides of the antenna.

- Do not lay the cable in front of the antenna, directly in the radiation field.
- Keep cables as short as possible and use low loss cables for best performance. If needed, these can be purchased from metraTec.

4 Maximum Input Power and Antenna Gain

Antennas in connection with RFID systems for use in the European Union are covered by the R&TTE Directive (Radio and Telecommunications Terminal Equipment Directive; 1999/05/EG). This means that numerous norms regarding maximum output power of such a system have to be considered. For UHF RFID systems this is mainly the EN ETSI 302 208-1. Depending on the type of antenna the following power limits are allowed:

- For systems with antennas with an angular width of more than 70° (e.g. the Echo-5P) an effective radiated power (ERP) of 500mW (27 dBm) is allowed.
- For systems with antennas with an angular width below 70° (e.g. the Echo-8P) an effective radiated power (ERP) of 2W (33 dBm) is allowed.

The corresponding reader output power to the maximum values of 500mW resp. 2W ERP depends on the losses of the cables as well as the antenna gain (being a measure for the concentration of the energy). The next section shows an example for such a calculation.

4.1 Introduction to formulas and units

The antenna gain of a circular antenna is measured in dBic. This values describes the capability of the antenna to concentrate the radiated power in the main coil compared to an isotropic radiator. It combines the radiated power of both polarizations. The antenna gain of a single polarization (given in dBi) is 3dB lower. Antenna gain of a single dipole (given in dBd) is 2.15 dB lower.

The maximum power allowed for a UHF reader is calculated with the following formula:

$$P_c = P_{erp} - GIC + 5.15 + C_L$$

Where the symbols mean:

P_c = Maximum output power allowed at the UHF reader in dBm

GIC = The antenna gain of a circular antenna in dBic

C_L = Cable loss in dB

P_{erp} = max. allowed ERP according to the ETSI 302 208-1 in dBm, being 27 dBm (500mW) for the Echo-5P and 33 dBm (2W) for the Echo-8P

4.2 Calculations for Echo-5P

The Echo-5P has an antenna gain of approx. 5dBic.

The maximum reader output power P_c will be calculated for the following example:

Maximum ERP P_{erp} =27 dBm (since the angular width is > 70°)

Cable loss C_L =0,3 dB (1m cable with low loss cable)

This leads to:

$$P_c = 27\,dBm - 5\,dBic + 5.15 + 0.3 = 27.35\,dBm = 540\,mW$$

Mobile UHF readers with a typical maximum output power of 500mW may be operated with the Echo-5P. Fixed readers with typically more than 500mW have to be limited to 540 mW.

4.3 Calculations for Echo-8P

The Echo-8P has an antenna gain of approx. 8dBic.

We will calculate the maximum reader output power P_c for the following example:

Maximum ERP P_{erp} =33 dBm (since the angular width is < 70°)

Cable loss C_L =1,5 dB (5m cable with low loss cable)

This leads to:

$$P_c = 33\,dBm - 8\,dBic + 5.15 + 1.5 = 31.65\,dBm = 1460\,mW$$

Thus, fixed UHF reader with a typical output power of 2W have to be limited already (this holds for every UHF antenna with 8dBic or more!)

You can see that antenna with a very high gain (e.g. 10 dBic) do not have a real advantage when used in the EU since the power of the reader has to be limited in every case so that the maximum read distance stays the same. Only the beam becomes narrower which makes it harder to "target" transponders.

The Echo-8P has an optimized radiation pattern for both polarizations (horizontally narrow, vertically wide).

NOTE

The Echo-8P has to be installed horizontally when it is used with more than 540mW output power.

The Echo-5P can be mounted in any orientation or be used in a mobile application, since the output power of the reader should always stay below 540 mW.

5 Further RF Characteristics

5.1 Directional Characteristics

The radiation pattern/directional characteristics of the Echo-5P is identical for both polarizations and is shown in Fig. 3. The radiation pattern also shows the radiation of the Echo-8P in the vertical polarization. Fig. 4 shows the radiation of the Echo-8P in the horizontal polarization.

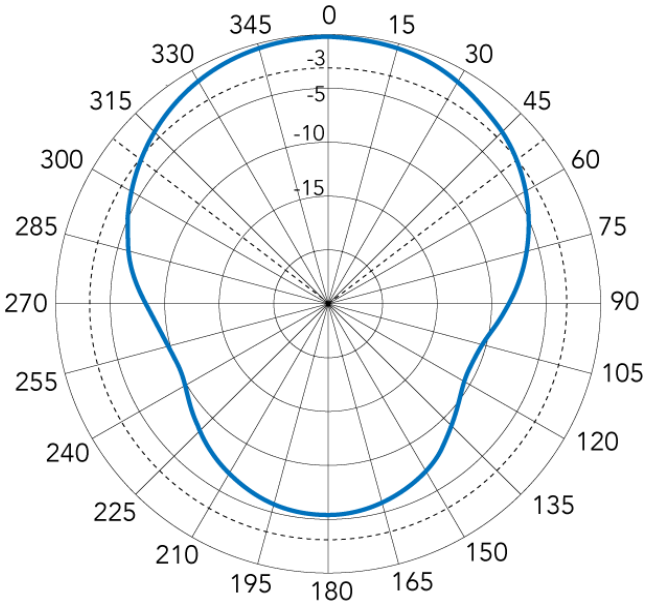

Fig. 3: Directional characteristics of the Echo-5P (both polarizations) and Echo-8P, vertically

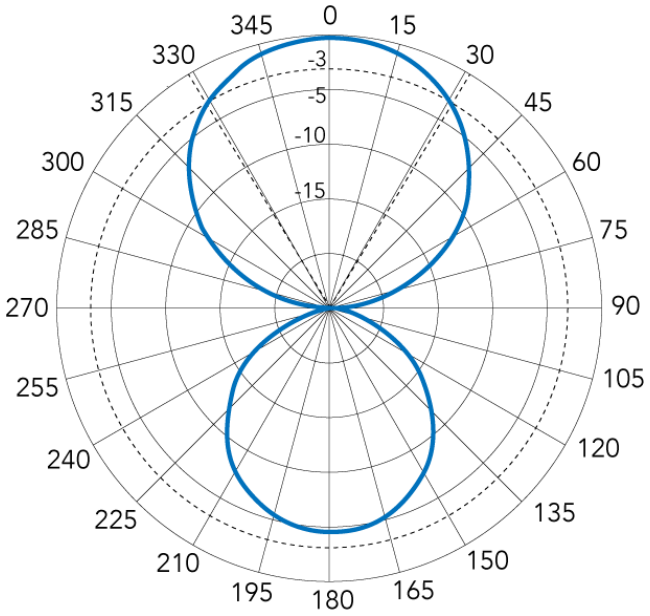

Fig. 4: Directional characteristics of the Echo-8P, horizontally

5.2 Antenna Bandwidth

Figure 5 shows the input impedance of the antenna at the operating frequency of 868 MHz including antenna bandwidth at 10 dB. The minimum of the reflexion is at 865 MHz (-28 dB). The 10dB-bandwidth is 12 MHz (858 MHz to 877 MHz).

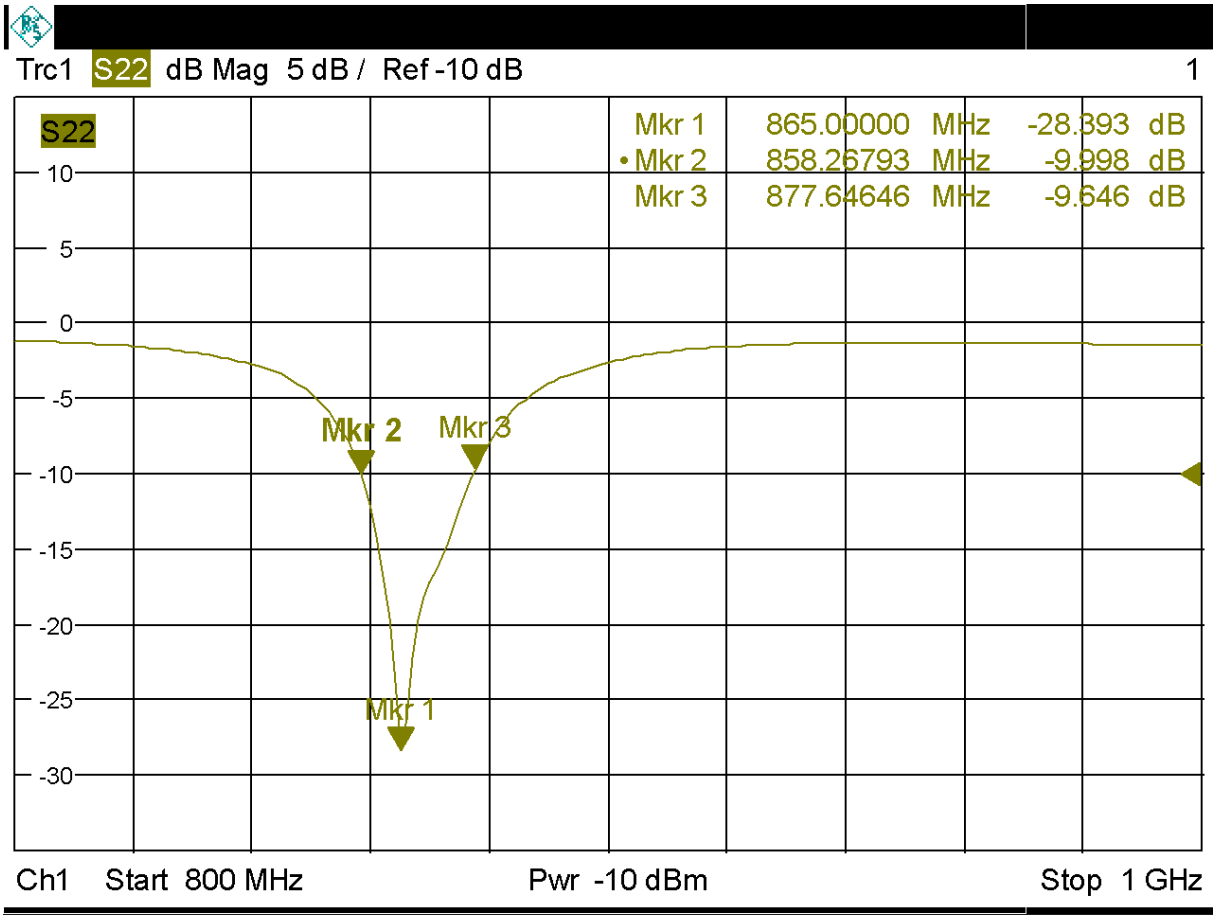

Fig. 5: Input impedance of the antenna around 868 MHz

5.3 Axial Ratio

The axial ratio is the ratio of the radiated power of the two polarization planes. A circular antenna should distribute the power of the reader evenly between both planes to read RFID transponders at any polarization.

The axial ratio of the Echo-5P and Echo-8P is typically 1-2 dB.

6 Version Control

Version	*Change*	*edited by*	*Date*
1.0	created	KD	10.09.09
1.1	minor edits	CS	09.07.14
1.2	update: antenna dimensions, minor corrections, layout	CS	07.10.14
1.3	update address and image	KS	07.12.16
1.4	update technical sketch Echo-5P, update technical specifications Echo-5P	KS	06.07.17

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