Specifications

and Operator Manual of antenna

RLA4

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Specifications

Single loop dimensions:	360 mm x 360 mm
Amplifier dimensions (W x H x D):	85 mm x 50 mm x 127 mm
Frequency range:	50 kHz … 71 MHz, 50 kHz … 30 MHz from S/N 0153
Average noise level (without loops):	<= -139 dBm/Hz (at 10 MHz)
IP3:	>= +30 dBm (2x -6 dBm measuring tone at 10 MHz)
IP2: MHz	>= +78 dBm (10.0 MHz + 10.2 MHz -6 dBm measuring tone, 0.2 measured difference tone)
Output voltage:	>= 1.1 V_{eff}, 1 dB compression
Supply via DC jack:	+12.0 V ±0.1 V, **maximum +14.4 V!**
Supply via HF cable:	+7.0 V … +13.8 V, **maximum +14.4 V!**
Power supply:	max. 100 mA
Power supply socket:	Female pin 2.5 mm
HF output:	BNC 50 ohms
Weight:	<= 1 kg (depending on loop material)
Environmental conditions:	0 ... +50 °C ambient temperature, <=90 % rel. humidity non-condensing, indoor application, limited outdoor application
Compliance:	CE according to DIN EN 55013, EN 55020, EN 60065 RoHS / WEEE Directive, ear-Reg. 27676700

All specifications are subject to design changes!

Safety precautions

Please always keep the following safety precautions in mind!

Never connect the device to any other voltage than indicated in the specifications. Under no circumstances should the device come into contact with the mains voltage of 230 V ~!

The device is intended for indoor use. Do not expose it to moisture. If moisture (e.g. spilled drinks) has accidentally come into contact or even got into the device, immediately take it out of operation (remove power supply) and send it back to the supplier for verification!

If you use the device outdoors (observe temperature and humidity restrictions!), please observe the lightning protection regulations for the outdoor operation of electrotechnical systems! In case of lightning hazard, immediately take the device out of operation and disconnect it safely from other devices (remove HF connection)!

Observe the permitted temperature range for starting up the device! Do not switch the device on or off again if this range is exceeded or fallen below!

Always provide a safe placement on a flat, straight and solid base of sufficient carrying capacity! Always transport the device either in solid cardboard or wooden boxes (e.g. the delivery packaging), or transport it by firmly gripping the amplifier housing! The device may cause injury in the event of a fall due to its own weight!

Do not expose this equipment to mechanical stress caused by impact, pressure, vibration or shock which exceed that commonly used in the home with the use of electronic devices! Never carry or attach the device to the antenna element.

If you notice any damage to the device, immediately take it out of operation (remove power supply)! If necessary, send it to the supplier for repairs.

Would you like to dispose the device due to damage or because you do not use it anymore, send it back to the supplier or return it to your local waste collection center. Never dispose of the appliance elsewhere, such as household waste. It pollutes our environment!

Only use soft, lint-free and dry cloths to care for and clean the device! Do not use aggressive solvents, but at most a slight moistening swab with distilled water or a damp piece of cloth or microfiber! Make sure that no moisture reaches the inside of the device!

Operator's Manual

The RLA4 is a small loop receiving antenna for indoor or portable outdoor use. It operates broadband as a non-tuned active antenna with an integrated amplifier. The antenna can be powered via the RF cable or a DC socket directly on the amplifier. The receiver element consists of 2 etched copper loops on FR4 board material for symmetrical modulation of two differential current amplifiers with very low impedance input. The utilization of the latest components in the two amplifier branches guarantees low intrinsic noise values and high intermodulation resistance. The two reception loops are arranged at an angle of 90° to one another. They can be switched by switching the respective amplifier on or off.

The RLA4 also provides fine-step control of the amplifier to achieve electronic rotation of the receiving direction. In versions 4A to 4C, the amplifier can be switched to high-impedance input asymmetrical to ground. The entire loop design then no longer operates as a loop ("magnetic") antenna but as a "whip" antenna for all-round reception of the electric field component.

The amplifier operates within an anodized aluminum profile housing. The connection to the RX is made via a BNC socket. A female pin DC socket is available for local supply (for usual plugs of universal power supply units). The anode lies on the pin (2.5 mm). Power can also be supplied via the HF cable (remote supply). To feed the DC voltage into the cable, a feed switch is required (not included in delivery) or a receiver with the option to feed preamplifiers directly from the receiver input.

Up to version 4C, the antenna is switched on by a lighted toggle switch and switched over in receiving mode (magnetic "loop" / electrical "whip").

The RLA4's connectors and switches

When operating the RLA4 via the normal circuit as a loop, the loop is active from the front right (via jack "RX") to the rear left. Its main reception direction lies in this direction (in the loop plane, corresponds to 0°). To change the receiving direction, the antenna must be rotated. This can be done mechanically by turning the housing together with the loop construction, or electronically by using the control unit for the RLA4 (see separate description). In loop mode, the receiving loops are grounded by the rod in the middle.

As a result, and due to the generally low noise sensitivity of loop antennas, a good suppression of local disturbances (emissions from PC, TV, switching power supplies, cabling, etc.) is achieved. In addition, the performance of the antenna is relatively independent of the installation site. It requires neither a particularly increased construction, nor special grounding measures or the like (however, overvoltage protection must be observed!).

– When operated as a whip, the entire construction including the center rod is electrically separated from the chassis ground ("ground"). In addition, due to the now high-impedance circuit of the amplifier (almost) no current now flows in the loops. Instead, the potential difference of the loop construction is strengthened against earth. It thus acts as a probe for the electric field component of the received EM field.

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This results in an all-round reception without pronounced main receiving direction or suppression in one direction. In addition, the reception power is highly dependent on the installation of the antenna. A high installation location as well as a large distance to conductive and / or noise emitting parts should be chosen. In whip mode, the antenna easily picks up local noise. It is also more sensitive to overvoltages (e.g. static discharge when touching the receiving loops or nearby transmitters). Always touch the housing or other grounded conductive parts in the vicinity before touching the loop construction!

The antenna is not protected against direct lightning and must not be operated in lightning-prone environments!

Caution! The switch consists of only a small operating lever made of plastic and may only be used cautiously! Do not use forces greater than necessary for direct switching!

In operation, the lever lights red in loop mode and green in whip mode. When switched off, there is no display and the power consumption is completely zero.

The antenna elements (loops) are easy to disassemble. Each loop consists of 2 sections screwed to the amplifier with one screw and two screws to the common mounting and grounding point. After unscrewing the screws with a suitable screwdriver, the element is removable. The center rod can be turned out after loosening the lock nut on the housing. When the receiving elements are removed, the antenna can be packaged and transported easily.

Caution! During assembly work on the antenna, torque must never be transferred to the 5 connection bolts of the amplifier! This can damage the inner PCB! Always keep the bolts firmly in its correct position, e.g. with a suitable nut key!

Versions for loop operation

The RLA4 is available in 3 versions:

- RLA4A: Normal version with 2-layer black coated loop material.
- RLA4B: "Blue version" with 4-layer blue coated loop material.
- RLA4C: Special version with loops made of flexible stainless steel.

In version B, the outer layers of the loops are connected to ground and only the inner layers carry power to the amplifiers. This results in an additional shielding of the receiving loops against interference voltages. Depending on the environment and on the reception frequency an increased attenuation can be achieved.

Version C includes spring steel loops. They are attached by knurled nuts, which allows a quick disassembly and assembly. This allows the antenna to be transported space-saving. In addition, the loop straps are very robust and rustproof, so that the RLA4C is well suited for portable use (housing is not completely waterproof). The stainless steel bands offer up to approx. 10 MHz the same receiving power as the copper loops of the RLA4A and B, only above the performance drops slightly.

In whip operation, the material of the loops is irrelevant. All versions give the same reception performance.

Remote supply / direction control

The previous description refers to the supply of the antenna directly to the housing with 12 V DC. The RLA4 can also be supplied with operating voltage via the HF cable (remote supply). The local supply via the DC socket should then be removed. The switch is now no longer active and does not light up, even if the antenna is receiving power via the remote power supply!

Caution! The antenna should always be supplied via a well-stabilized, interference-free power supply ("analogue" or "linearly controlled"). This is especially true for the local supply via the DC socket.

For remote supply, various methods for controlling the antenna are available:

- Supply with > 8 V (observe permissible maximum!): The RLA4 operates in loop mode.
- Supply with <= 8V (observe the required minimum!): The RLA4 operates in whip mode.

- Supply with 6 V and modulation of an RS-232 signal with active level of min. 7 V and maximum 8 V: Control of the RLA4 in all available operating modes.

For complete control of all available modes, the remote supply voltage must be modulated with a logically negative RS-232 signal (start bit = increased supply voltage, stop bits = supply voltage). The data format is 125 Baud 8N2 (8 data bits, no parity bit, 2 stop bits). Only one data word (8 bits = 1 byte) is transmitted. The control of the antenna depends on the received byte as follows:

- Value 0 to 126: Loop operation by setting the receiving direction from 0° to 180° in 127 steps.
- Value 127: Whip operation.
- Value 128 to 255: No reaction (reserved for further developments).

After switching on the remote power supply with a voltage of 6 V (up to a maximum of approx. 8 V), the antenna is initially in whip mode. As soon as a data byte has been successfully received, the antenna switches to the desired operating mode. The direction switching in loop mode is not possible linearly to the control word. The main receiving directions of the two loops are largely preferred, as are the intermediate stages (each 45° to the loops if both loops are equally active). In these directions, the antenna also reaches its highest gain and works with the least distortion.

The effective rotation of the receiving direction between the 45° main directions is temperature and voltage dependent. The corresponding control bytes result in a more or less large offset to this or more or less fast panning between the main directions. In any case, it is possible to set clearly defined directions of reception between the 45° main directions by varying the control bytes.

The purpose of such a fine-grained directional adjustment is not to detect a station to be received with a maximum level. The "eight" characteristic of the loops with a very wide "reception lobe" allows optimal reception with barely perceptible attenuation outside the exact main reception direction, even if the antenna is not precisely aligned. Rather, the purpose lies in the most accurate possible positioning of the zero point (minimum reception) with high suppression in this direction. The zero point has a sharp directional characteristic and must therefore be set relatively accurately. In most cases, there is a matching control byte for the RLA4 for exact positioning of the zero point in the desired direction. However, this is different for varying operating conditions (voltage, temperature).

The optional control unit for the RLA4 allows the generation of all possible control bytes via a setting potentiometer. Thus, by manually "tuning", the appropriate byte can be found by observing the reception on the receiver.

The control bytes 0 and 126 are equivalent. They switch the 1st loop (see switch on the antenna for loop operation) either in phase, or directly opposite (180°) to the amplifier. Since the loop characteristic is bidirectional, this corresponds exactly to the same reception conditions.

Tips for an ideal RLA4 operation

- The antenna is highly sensitive in spite of its small design and delivers very high reception levels in broadband. Sensitive receivers can be overmodulated. In such a case, you should place an attenuator or better a preselector between the antenna and the RX.

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- Even if you are tempted to position the antenna near the RX: Check its noise emissions and those of other nearby devices, and place the antenna at a distance from it. Especially personal computers and their peripherals (monitor, printer / scanner, SDR, network connection lines ...) as well as televisions and the like often generate very high levels of interference.

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- Prefer loop operation as often as possible. The whip operation usually only offers advantages at low frequencies except when omnidirectional reception is desired.

Expansion of the direction control

In certain cases, the direction control's 127 steps allow (rapid change of the direction of reception between the 45° main receiving directions) only a relatively coarse setting (about 3° per step). This is often too inaccurate to adjust the antenna to high suppression of a certain signal (positioning of the receiving zero). Especially in the lower frequency range, the RLA4 reaches a suppression value of 50 dB and more at

exactly the zero point. The zero is very narrow. Even a turn of 1° reduces the attenuation. Therefore, the direction control's resolution has been increased for the following antenna types:

- RLA4A from S/N 0095
- RLA4B from S/N 0097
- RLA4C
- Individual boards RLA4 from version F2

The number of steps for a 180° rotation now amounts to 232, with step 232 enabling the "Whip" mode. Steps 0 - 231 set the loop operation from 0° to 179°. Thus, a rotational accuracy of less than 1° can be achieved in the "less sensitive" areas around the 45° main receiving directions (planes of the loops and 45° each between the loop planes). In the "more sensitive" areas between the main reception directions, the resolution is even better than 2°.

In order to be able to set the increased number of steps accurately, the associated control unit RSW2 has been updated (see RSW2 description). Now, no potentiometer with a fixed rotation angle of approx. 270° is used, but a pulse rotary encoder with an "infinite" rotation angle. For each pulse, exactly one step is made forward or backward. This ensures that every possible step can be set accurately. Turning to the left or to the right of "Omni" is not limited, but has no effect.

To increase the transmission reliability and expansion of control options (additional switching in antennas, simultaneous control of multiple or combination antennas, etc.), the control unit now sends a 9-bit data word with one parity bit. The corresponding setting of serial transmitters ("UART", "COM port", "RS-232" ...) is now "9E2": 9 data bits, 1 parity bit with even parity, 2 stop bits. The data rate is still 125 baud.

Versions RLA4D, E and F

The versions D and F match the previous versions A to C:

- RLA4D: Normal version with 2-layer black coated loop material.
- RLA4E: "Blue version" with 4-layer blue coated loop material.
- RLA4F: Special version with loops made of flexible stainless steel.

In contrast to the older versions, the newer versions no longer have a circuit for omnidirectional reception in "whip mode". This operating mode has proven to be barely usable with the usual installation of the antenna (interior). Due to the omission of the circuits for this operating mode, the versions D - F now achieve slightly better values for the IM suppression and the inherent noise in loop mode. The version of the boards for homemade purposes is now called 4G. This board is also installed in the antenna versions 4D – 4F.

Assembly and disassembly

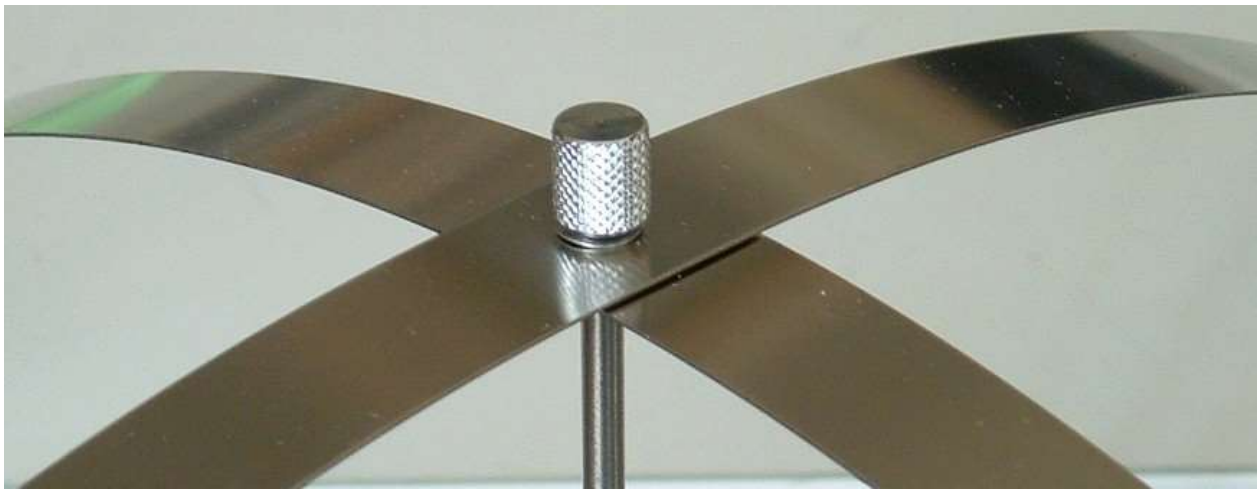
The RLA4 is usually shipped in partially disassembled condition. In this condition, it can be packed and transported to save space. For mobile use, disassembly for transportation is ideal. Especially the RLA4F can be assembled very easily and without tools. To do this, proceed as follows:

- Unscrew the knurled nuts from the connecting bolts of the amplifier and the upper side of the threaded rod (if unscrewed during transport, so as not to lose them).
- Two corrugated shims are provided for the bolts on the amplifier. First put one on each of the 4 connecting bolts (with threaded pin).
- Now screw the threaded rod with the large knurled nut down in the middle bolt (with internal thread). Tighten the knurled nut slightly to lock the thread.
- At the top of the threaded rod sits a normal nut. Put a corrugated shim on top.
- Place one end of a steel strip on a connecting bolt so that it points away from the amplifier at a 45° angle. Place the second corrugated shim for this bolt on top, screw on the knurled nut and tighten slightly.
- Bend the other side of the strip over the amplifier and secure it to the opposite pin with corrugated shim and knurled nut. **Caution!** Do not bend the strip sharply, just bend it evenly! **Caution!** The strips are very thin and **can cause cutting** when there is heavy pressure on their edges (**risk of injury, danger of damaging other things**)!
- Place the middle of the strip on top of the threaded rod.

- Attach the 2nd strip just as described above. Both strips should form an angle of 90° to each other and each 45° to the amplifier housing.
- Place the second corrugated shim on top of the threaded rod and screw on the knurled nut.
- Carefully tighten all knurled nuts hand-tight. **Caution!** Do not use any tools (like pliers)! The connection bolts of the amplifier must not be twisted!

The following images illustrate the position and mounting of the individual components.

Connection bolt of the amplifier with an installed steel strip



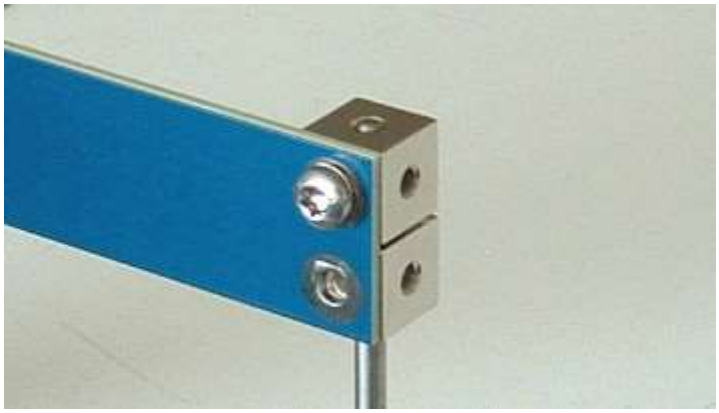
Connection of the steel strips with the threaded rod

The RLA4 versions D and E possess individual elements made of printed circuit board material (FR4) instead of the stainless steel loops. Each closed loop consists of 2 elements, each of which must be screwed on using short M4 screws (Torx) and a corrugated shim. For this purpose, the connecting bolts of the amplifier have vertical flat surfaces with threaded holes. At the top of the threaded rod 2 mounting cubes with 4 internal threads each are installed. In total, 3 screws with corrugated shim are required for each loop section (one for the connecting bolt, two for the mounting cube of the threaded rod).

The following images illustrate the assembly of the loop elements.

Connection bolt of the amplifier with a screwed-on loop half

The loop elements possess different contact surfaces on each side. On the back a square for installation of the connecting bolts, in the front a round for contact with the shim. The sides must not be confused, otherwise the proper function can not be guaranteed.



Installing a loop half to the assembly cubes (2nd screw is still missing)

The threaded rod has a normal nut at its lower end. To counter against the middle bolt of the amplifier, a suitable open-end wrench is required. Hold the bolt with a second wrench! It is important to ensure that the mounting cubes are at a 45° angle with their surfaces to the amplifier housing.

The loop elements also have a large contact surface at the top connection and round contact surfaces at the front. To ensure good contact, the element must rest on the mounting cube with the right side.

Caution! It is absolutely necessary to avoid twisting the bolts on the amplifier! If the flat surfaces of the connecting bolts deviate significantly from the 45° direction to the housing, then a careful turning to the correct position with the aid of an open-end wrench can be attempted. If this requires a great deal of effort, or if the bolt loosens, the amplifier must be dismantled and the internal screwed connections must be re-fastened.

Amplifier from version 4J

The RLA4 is equipped with the new amplifier "RLA4J" from serial number 0153 (see also documentation "RLA3C_4J.PDF"). This amplifier has higher intermodulation immunity with reduced power consumption. This makes the RLA4D - F even more suitable for mobile operation, especially in the vicinity of transmitters.

The upper cutoff frequency was reduced to 30 MHz. The 4J amplifier has enhanced filtering for frequencies above 30 MHz. This avoids interference that can occur when setting up antennas near VHF / DAB / DVB transmitters, mobile phone masts, TV towers, etc.

Note: If interference still occurs in close proximity to strong VHF / UHF transmitters (audibility of FM broadcast stations, spurious tones or increase in broadband noise), it is helpful to mount the loop antenna as close to the ground as possible.