MLA-ER 2026 (20) – bottom tuning

Magnetic loop antenna for the 20 m band

User Manual

1. Intended use

The MLA-ER 2026 (20) is a single-band magnetic loop antenna (MLA) for the 20 m (14 MHz) amateur radio band, designed for a maximum usable power of 100 W. It is based on the MLA-ER design by OK2ER from 2018, described in the book 'Magnetic Loop Antennas Slightly Different Each Time'. The main loop forms both the inductance and capacitance of the resonant circuit; the antenna therefore does not have a conventional tuning capacitor.

The antenna is designed as an educational model: its simple construction helps to understand the physical principles of the MLA, while at the same time it is a fully functional antenna capable of establishing contacts over distances of thousands of kilometres using 100 W. It is intended for use in locations where a wire antenna cannot be installed – flats, balconies, attics, holiday cottages or temporary sites.

What you need to know beforehand:

- The antenna operates only in the 20 m band (for extension to higher bands by replacing the stub, see Chapter 10).
- It is very narrow-band (selective). If the transceiver is retuned by more than approximately 15 kHz, the antenna must be retuned (see Section 6.4). For FT8 and other fixed-frequency digital modes, its selectivity is not a limitation; however, it is a limitation for SSB operation involving frequent retuning.
- It is not rain-resistant and is not intended for use as a permanent outdoor antenna.
- An antenna analyser is primarily recommended for tuning (see Chapter 6). Tuning is also possible without one, but it is time-consuming.

Equipment required: an HF transceiver, ideally with an SWR meter, a 50 Ω coaxial cable with a BNC connector at the antenna end, and optionally a tripod with a camera tripod thread and an antenna analyser.

2. Safety

Please read these instructions before using the antenna for the first time.

Do not touch the antenna while transmitting, particularly at full power, when the RF voltage at the ends of the loop is in the order of kV. There is a risk of RF burns.

When transmitting, keep a safe distance from the antenna – the higher the power, the greater the distance required. The minimum distance during transmission is 1 m.

Do not transmit if there are people or animals near the loop. No one must have their head or any part of their body inside the loop.

People with a pacemaker or other implanted medical device must not operate the antenna or remain in its vicinity while transmitting without consulting a doctor.

Strong RF magnetic fields pass through walls and may interfere with, reset or even damage nearby electronic equipment (computers, chargers, network devices).

Always tune the MLA at low power (max. 5 W). Only increase the power to full after tuning and checking the SWR.

Do not use the antenna in the rain and protect it from moisture. Water on the loop will reliably detune the antenna.

3. Description of the antenna

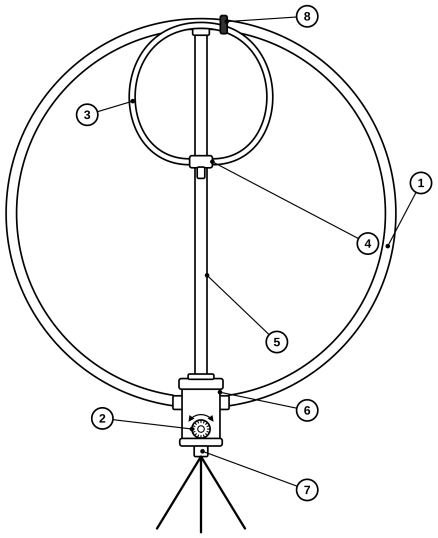


Fig. 1 – Main parts of the antenna

1 – main loop
2 – tuning knob
3 – FCL (coupling loop)
4 – FCL holder with BNC connector
5 – support rod
6 – base
7 – tripod thread
8 – FCL clip

No.	Part	Description
1	Main loop	Multi-layer PEX-AL-PEX tube, Ø 16 mm; the aluminium layer of the tube acts as the conductor. Loop diameter approx. 0.9 m.

No.	Part	Description
2	Tuning knob	A knob on the front of the base. Turning it moves the tuning segment inside the base, which is used to set the antenna's resonant frequency (Chapter 6). The knob has stops at both end positions.
3	FCL – coupling loop (FCL = Faraday Coupling Loop)	A loop of coaxial cable secured in a holder on the support rod. By rotating, shaping and sliding it along the rod, the antenna matching (SWR) is adjusted.
4	FCL holder with BNC connector	A holder on the support rod which can be rotated and slid along the rod. On its underside is a BNC connector for connecting the coaxial cable from the transceiver.
5	Support rod	A plastic rod slid into the base cap; it supports the FCL and, at its upper end, supports the top of the main loop. It can be slid out of the base.
6	Base	A plastic body in which the ends of the main loop are secured in cable glands and which contains the capacitive stub and the tuning mechanism. The base is opened only when replacing the stub (Chapter 10).
7	Tripod thread	At the bottom of the base; 1/4" camera tripod thread.
8	FCL clip	A clip that holds the FCL against the main loop in its initial position (Section 6.1).

Inside the base, **a capacitive stub** (a piece of coaxial cable) is **inserted symmetrically** into both ends of the main loop. Together with the tube, this forms the capacitance of the resonant circuit. The ring in the centre of the stub defines its position so that it is inserted to the same depth at both ends of the tube. The stub is set by the manufacturer and should not be interfered with without good reason.

Package contents: antenna, user manual. The tripod and coaxial cable are not included.

4. How the antenna works

A magnetic loop antenna is, in principle, an L/C resonant circuit with a very high quality factor (Q). The inductance L is provided by the main loop, while the capacitance C in the MLA-ER is provided by a capacitive stub inside the tube, where the aluminium layer of the tube and the coaxial cable shield act as the capacitor plates, and the coaxial cable jacket and the inner wall of the tube act as the dielectric. The tuning segment in the base, controlled by a knob, adds a small variable capacitance to this circuit, which is used to fine-tune the antenna to the exact frequency set on the TRX.

A high Q factor (approx. 200 for the MLA-ER 2026) implies a very narrow bandwidth – selectivity. Measurements of the prototype using an analyser show that the SWR remains below 1.5 only within a range of approximately ±15 kHz from the tuned frequency, and below 2.0 within a range of approximately ±30 kHz (Fig. 2). Away from the tuned frequency, the SWR rises rapidly and losses increase – the antenna must be retuned. Selectivity is an advantage in reception, as the antenna suppresses strong signals and some of the interference outside the tuned segment.

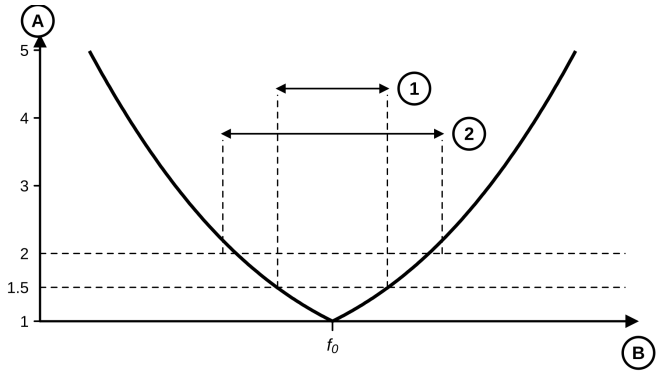


Fig. 2 – SWR curve around the tuned frequency f_0 (schematic, based on prototype measurements)
A – SWR
B – frequency
1 – ±15 kHz, SWR < 1.5
2 – ±30 kHz, SWR < 2

Energy from the transceiver is transferred to the main loop via inductive coupling through the FCL. Its position (orientation) and shape determine how well the antenna is matched to the 50 Ω cable impedance. With the MLA, good matching is essential and critical: if the SWR is poor, part of the power is converted into heat and the antenna 'does not work', even if it is tuned to the correct frequency. When correctly set up, the MLA-ER 2026 achieves an SWR of 1.0–1.1.

The antenna is directional: within the band, it radiates and receives most strongly in the plane of the loop, and weakest perpendicular to it (in the direction of the loop's axis), see Fig. 3. By rotating the antenna, one can 'amplify' the desired station or, conversely, suppress a source of interference.

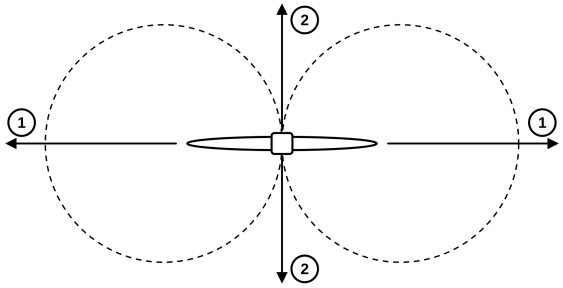


Fig. 3 – Antenna directivity on the band, top view (dashed lines indicate approximate radiation pattern)
1 – maximum (plane of the loop)
2 – minimum (loop axis)

5. Positioning

- The antenna is most commonly mounted on a tripod (the thread is at the bottom of the base), but the base can also stand on its own – the antenna can be placed on a table, the floor or the ground. Unlike dipoles, magnetic loop antennas work even at a low height above the ground.
- It is advisable to leave some free space around the loop. Metal objects in the vicinity – window and door frames, railings, radiators, metal furniture, other antennas including other MLAs – detune the antenna and impair its matching.
- The antenna is tuned at the location where it will be operated. After any movement, rotation or change in the surroundings (a person near the antenna, rearranged furniture, etc.), the SWR must be checked and, if necessary, the antenna retuned and its matching readjusted.
- MLA operation indoors is possible; however, efficiency is lower in reinforced concrete buildings. The safety instructions in Chapter 2 apply.

- When operating outdoors, the antenna must be protected from the weather (e.g. rain). Humidity and dew affect the tuning.

6. Tuning

6.1 Principle

Tuning and matching the antenna involves two steps, which must always be carried out in this order:

1. **Frequency** – turning the tuning knob sets the resonance to the required frequency. When viewing the knob from the front: turning anti-clockwise (to the left) moves the tuning segment away from the ends of the loop, the additional capacitance decreases and the frequency increases; turning clockwise (to the right) decreases the frequency. There is a stop at both end positions. Do not attempt to force the knob beyond the stops. Tuning is not equally sensitive across the entire range. The closer the tuning segment is to the ends of the loop (lower frequencies, knob turned to the right), the greater the change in frequency caused by the same amount of rotation. The range between the stops covers the entire 20 m band; each antenna is tested from one end of the band to the other before dispatch.
2. **Matching** – the minimum SWR is achieved by rotating, shaping and sliding the FCL along the support rod. The initial position of the FCL is a circular shape in the plane of the main loop, moved up the rod so that the top of the FCL lies at the top of the main loop; in this position, the FCL can be held against the main loop with the clip (Fig. 5a). From this position, the FCL is gradually adjusted while monitoring the SWR: it can be shaped (e.g. compressed into an oval), rotated about the rod using the holder, slid down the rod after removing the clip, bent out of the plane of the loop, or these adjustments can be combined. This is not a prescribed sequence of steps, but rather a matter of finding the position where the SWR is lowest – in some environments, slight shaping is sufficient, while in others, a combination of all adjustments is required with the same antenna. Significant deformation is generally not necessary. Changing the FCL usually shifts the resonant frequency slightly; it is therefore advisable to check the tuning using the knob after adjusting the FCL.

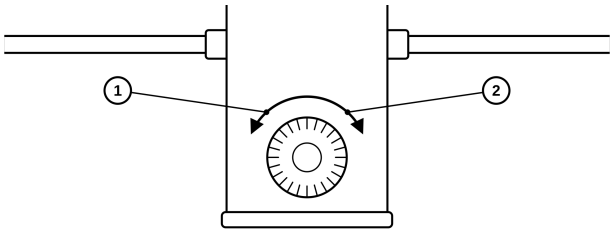


Fig. 4 – Tuning knob (front view)
1 – turning anti-clockwise: the frequency increases
2 – turning clockwise: frequency decreases

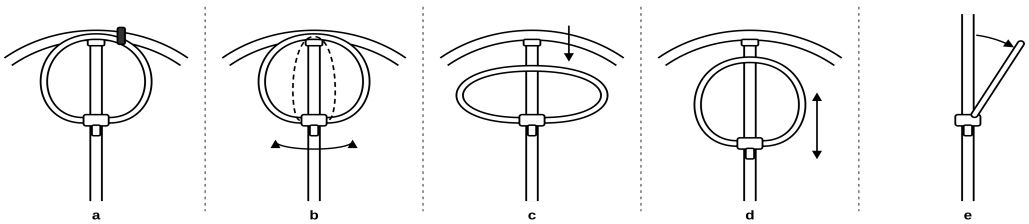


Fig. 5 – FCL adjustments
a – initial position: circle in the plane of the main loop, top against the main loop, held with the clip
b – rotation about the support rod (dashed line indicates rotated position)
c – shaping, compressed into an oval
d – sliding along the support rod
e – bending out of the main loop plane (side view)

Important: a person standing near the antenna may cause it to go out of tune simply by being there – particularly if they touch it or stand very close to the loop. A hand on the tuning knob at the base has little effect on the tuning; the knob can therefore be turned smoothly while monitoring the SWR. However, after releasing the knob and stepping away from the antenna, the SWR must be checked again and, if necessary, the antenna retuned and its matching readjusted (FCL).

6.2 Tuning with an antenna analyser (recommended procedure)

1. Position the antenna at the operating site and connect it to the analyser.
2. On the analyser, select the SWR curve display, centre it on the desired frequency and set the range to a wide setting initially, e.g. 1 MHz (e.g. 13.5–14.5 MHz), so that the minimum of the curve is visible even with significant detuning. For fine-tuning, narrow the range to approx. ±100 kHz.
3. Turn the tuning knob to move the minimum of the curve to the desired frequency.
4. If the SWR value at the minimum is higher, the FCL must be adjusted: its rotation, shape or height on the rod. The target is an SWR of 1.0–1.2.
5. After adjusting the FCL, check that the frequency of the minimum has not shifted; if necessary, repeat steps 3 and 4.
6. Disconnect the analyser, connect the transceiver and check the SWR at low power.

6.3 Tuning without an analyser (transceiver with SWR meter)

This method is feasible but slower. Without an analyser, it is not possible to see whether the resonance is above or below the desired frequency, nor in which direction to turn the knob.

1. Tune the transceiver to the desired frequency and listen. Turn the knob until the noise and signals from the band are at their strongest – the maximum noise level corresponds to resonance. The S-meter is a useful aid. On a closed band, the maximum is less distinct.
2. Reduce the power to a maximum of 5 W and briefly transmit a carrier (CW mode) while monitoring the SWR.
3. Turn the knob in small increments, only while the transmitter is not keyed (in RX mode); after each increment, key the transmitter briefly, read the SWR and look for its minimum. Once the minimum has been reached, step back from the antenna and check the SWR again.
4. If the minimum SWR remains high, adjust the FCL (orientation, shape, height) and find the minimum again using the knob.
5. Repeat steps 3 and 4 until the SWR drops, ideally to 1.2 or less.
6. Only then increase the power.

6.4 In-band retuning

After changing the transceiver's frequency, the SWR will deteriorate (typically when changing by more than approx. 15 kHz) and the antenna must be retuned using the knob; it is usually no longer necessary to change the FCL setting. In practice, this means: for FT8 and other digital modes on a fixed frequency, no retuning is required at all; for CW, occasionally; for SSB, frequently (depending on the width of the frequency segment used). This is because greater detuning reduces efficiency and increases the SWR – there is no point in transmitting with a detuned MLA.

7. Operation

- Maximum usable power 100 W, even under continuous load (e.g. FT8).

- Always check the SWR before increasing the power; if the SWR is above 1.5, do not proceed and retune the antenna as close as possible to an SWR of 1.0.
- Check the SWR occasionally during prolonged operation – changes in temperature, humidity or the environment may cause the tuning to shift.
- Rotating the antenna can improve the signal-to-noise ratio: rotate the antenna towards the maximum signal from the other station or towards the minimum interference.

8. Troubleshooting

Symptom	Probable cause	Solution
The knob is at the stop and the SWR dip (minimum) is still outside the 14 MHz band.	The main loop is deformed after transport (not circular). Metal objects or other antennas nearby.	Check the shape of the loop and carefully restore it to a circle (Chapter 9). Change the location, moving it away from metal objects and other antennas.
The SWR minimum is high, even though the frequency is set correctly.	The FCL is incorrectly oriented or shaped. There are metal objects or other antennas nearby.	Adjust the FCL as described in Section 6.1. Move the antenna away from metal objects and other antennas.
The SWR has changed spontaneously.	A person near the antenna. Humidity, dew, rain. Changes in the surroundings.	Move away from the antenna. Allow the antenna to dry out. Retune.
Band noise is ‘weak’ on reception.	The antenna is not in resonance – out of resonance, the high Q strongly suppresses signals. Alternatively, the band may not be open.	Check the tuning (Chapter 6). Verify propagation conditions.
The SWR does not drop below 1.5 after retuning with the knob.	The resonance is at a different frequency to that indicated by the transceiver, or the FCL is not properly matched.	Check with an analyser. Return the FCL to its initial position and start again.
The knob cannot be turned any further.	The knob is in the end position (at the stop).	Do not force it past the stop; turn it back. If the minimum SWR is still out of band, follow the instructions in the first row of the table.

9. Transport, storage, maintenance

- The loop is made of a malleable material which may become deformed if the package is handled carelessly during transport. Deformation will result in a shift in resonance. Before the first tuning, it is therefore necessary to check that the loop is circular; minor deformations can be carefully restored to their original shape by hand without causing damage.
- When transporting the antenna yourself, protect the loop from pressure and bending; the knob, support rod and FCL must not be subjected to any load. For transport, the FCL can be pulled upwards off the support rod and the rod slid out of the base.
- Store in a dry place. If it becomes damp, allow it to dry thoroughly before use.
- Cleaning: use a dry or slightly damp cloth; do not use solvents.

- There is no need to interfere with the base or the capacitive stub without good reason (for replacing the stub for a different band, see Chapter 10). Incorrect intervention (e.g. shortening the stub) may permanently detune the antenna.

10. Experiments: custom stub and higher bands

The MLA-ER 2026 (20) is single-band solely due to the length of the capacitive stub. Anyone who is familiar with the antenna and has an antenna analyser to hand can make their own stub and operate the same loop on other bands – 17, 15, 12 m and 10 m (including CB). On higher bands, the efficiency of a loop of the same diameter increases significantly.

The stub is a length of coaxial cable with a diameter of approx. 10 mm (RG213, RG214) inserted symmetrically into both ends of the main loop inside the base; the capacitance is formed between the cable shield and the aluminium layer of the tube. A shorter stub = lower capacitance = higher resonant frequency. The length of the stub determines the coarse tuning, while the tuning knob provides the fine tuning. Knob at the anti-clockwise stop = the lowest additional capacitance = the highest frequency; turning it clockwise only lowers the frequency. To access the stub, carefully open the cap of the base using a flat-bladed screwdriver or another suitable tool, loosen the cable gland and pull the PEX-AL-PEX tube out on one side. Approximate lengths of a new stub, relative to the length of the original stub for the 20 m band:

Band	**Stub length (proportion of original length)**	**Example for an original stub of 1.3 m**
17 m	approx. 0.60	approx. 78 cm
15 m	approx. 0.41	approx. 53 cm
12 m	approx. 0.28	approx. 36 cm
11 m (CB)	approx. 0.22	approx. 29 cm
10 m	approx. 0.18	approx. 23 cm

These values are merely a starting point – calculated from the resonant circuit of the main loop. The actual length of the stub depends on the type of cable, the insertion depth and the surrounding environment, and the relative uncertainty of the stated values is greater on higher bands.

Procedure:

1. Cut the new cable deliberately longer than specified in the table. Mark the centre (with a ring or tape) so that it can be inserted to the same depth at both ends of the tube.
2. Insert the stub and close the base; turn the knob anti-clockwise to the stop (lowest capacitance) and use the analyser to find the resonance – it will be below the target band (because the stub is longer).
3. Gradually shorten the stub (by the same amount from both ends, approx. 1–2 cm at a time) and measure after each step until the resonance, with the knob at this stop (turned anti-clockwise – minimum additional capacitance), lies just above the upper edge of the target band. Shortening is irreversible – it is better to take several small steps than one large one.
4. The band is then covered by turning the knob (Chapter 6). On higher bands, the tuning range of the knob in kHz is greater and tuning is proportionally more sensitive. If the upper edge of the band cannot be reached even with the knob at the anti-clockwise stop (lowest capacitance), the stub has been shortened too little – shorten it by one further step. If the lower edge of the band cannot be reached even with the knob at the clockwise stop (highest capacitance), the stub has been shortened too much.
5. Readjust the FCL – it will be different on a different band.

Keep the original stub for the 20 m band; replacing the stub is the only adjustment required when changing bands. The safety instructions in Chapter 2 apply to all bands without modification. If the stub is cut too short, the antenna cannot be tuned to the band; the manufacturer accepts no liability for modifications carried out by the user.

11. Technical Specifications

Parameter	Value
Band	20 m (14 MHz)
Tuning range	the entire 20 m amateur band
Maximum usable power	100 W (continuous)
Impedance / connector	50 Ω / BNC (on the FCL holder)
SWR after tuning	typically 1.0–1.1
Bandwidth for SWR < 1.5	approx. ±15 kHz
Quality factor Q	approx. 200 (indicative, based on prototype measurements)
Main loop diameter	approx. 0.9 m
Loop material	PEX-AL-PEX Ø 16 mm
Weight	approx. 1 kg
Tripod thread	1/4" (camera tripod thread)
Use	indoor, balcony, temporary location; not waterproof

12. Further information and contact details

- O. Burger, M. Dvorský: Magnetic Loop Antennas Slightly Different Each Time, 5th edition (ISBN 978-80-270-6987-3).
- O. Burger, OK2ER: MLA-ER 2026, a magnetic loop antenna for PWR 100 W. Hamíkův koutek No. 470, 2026.
- www.loop2er.cz

LOOPER SYSTEMS s.r.o., Náměstí 63, 742 83 Klimkovice · robert.scepko@loop2er.cz