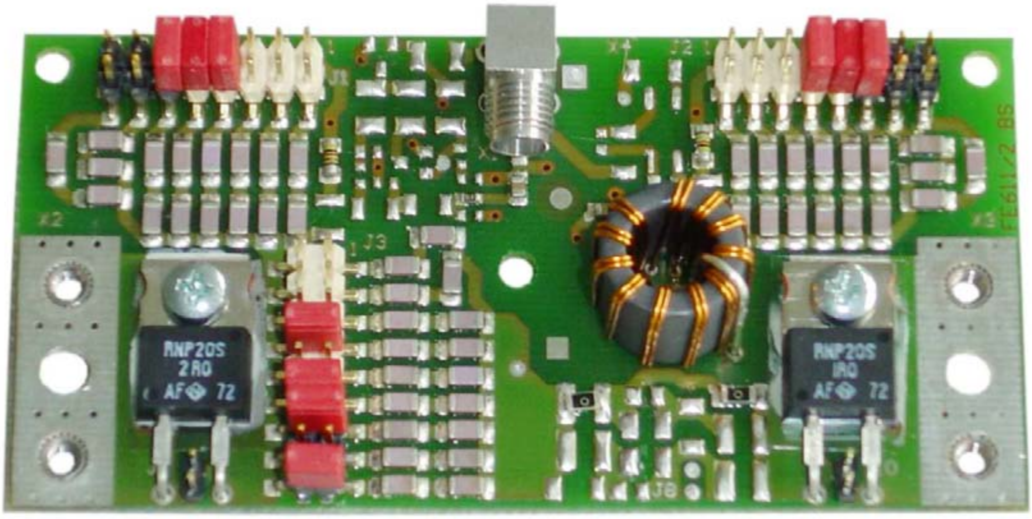
OBID i-scan®

MONTAGE

INSTALLATION

ID ISC.MAT-B

Manual Antenna Tuner



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Note

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Content

1 Safety Instructions / Warning - Read before start-up !

- The device may only be used for the intended purpose designed by for the manufacturer.
- The operation manual should be conveniently kept available at all times for each user.
- Unauthorized changes and the use of spare parts and additional devices which have not been sold or recommended by the manufacturer may cause fire, electric shocks or injuries. Such unauthorized measures shall exclude any liability by the manufacturer.
- The liability-prescriptions of the manufacturer in the issue valid at the time of purchase are valid for the device. The manufacturer shall not be held legally responsible for inaccuracies, errors, or omissions in the manual or automatically set parameters for a device or for an incorrect application of a device.
- Repairs may only be executed by the manufacturer.
- Installation, operation, and maintenance procedures should only be carried out by qualified personnel.
- Use of the device and its installation must be in accordance with national legal requirements and local electrical codes .
- When working on devices the valid safety regulations must be observed.
- Note that various parts of the device can become hot.
- Before touching the circuit board always be sure power is turned off or disconnected. Use a meter to verify that the device is unpowered. The fact that a power LED is off is not to be used as an indication that the device is disconnected from the mains or unpowered.

⚠ **Attention! Voltages of up to 1kV are present on the antenna tuner and antenna conductor.**

Special advice for carriers of cardiac pacemakers:

Although this device doesn't exceed the valid limits for electromagnetic fields you should keep a minimum distance of 25 cm between the device and your cardiac pacemaker and not stay in an immediate proximity of the device respective the antenna for some time.

2 Performance characteristics of the ID ISC.MAT-B Manual Antenna Tuner

The ID ISC.MAT-B tuner board is a manually adjustable tuning circuit for constructing custom antennas with a carrier frequency of 13.56 MHz and an input impedance of 50 Ω.

In conjunction with an antenna conductor (e.g. aluminum strip, CU tube or the outer jacket of an RG213 cable) it is very simple to construct antennas in various sizes and shapes.

After assembling the antenna conductor, the antennas are tuned using individually selectable capacitors. Then antenna is then permanently tuned for its local conditions. If it is moved to a different position under different local conditions, retuning of the antenna may become necessary.

3 Required components

The following are required for constructing an antenna :

- Qty. 1 Manual Antenna Tuner ID ISC.MAT.C
- Qty. 1 50 Ohm coax cable, cable length depending on the reader
- The following may be used as antenna conductors:

  Outer jacket of a coax cable, e.g. RG58, RG59, RG213, RG214

  Aluminum strip 20 x 2 mm

  Copper tube ∅ = 18 mm

The following components are required for tuning the antenna:

- Impedance meter or SWR meter, network analyzer, VHF monitor, comparable instruments
- Jumpers with 2.54mm spacing (included in the scope of delivery)
- Jumpers with 2 mm spacing (included in the scope of delivery)

More detailed specifications for the devices can be found in the section Appendix: Helpful tools for constructing and testing antennas

4 Wiring and installation

4.1 Circuit board dimensions and installation

Three 3.2mm mounting holes are provided on the circuit board for attaching the Manual Antenna Tuner, see Fig. 1. The antenna loop is attached to X2 and X3 using M3 threaded inserts.

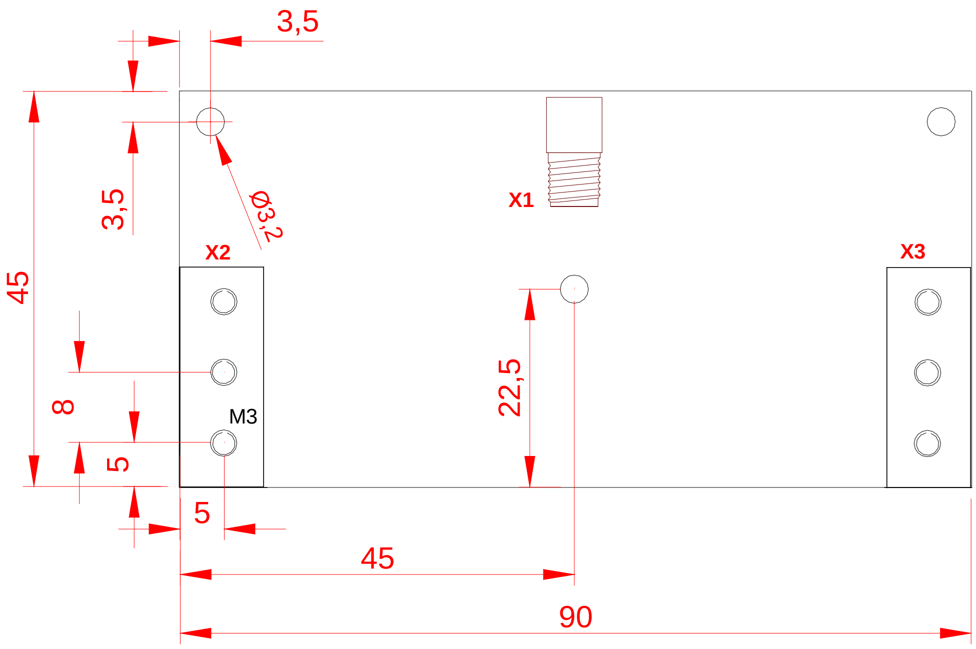


Fig. 1: Dimensions and mounting holes

The maximum installed height of the circuit board is shown in Fig. 2:

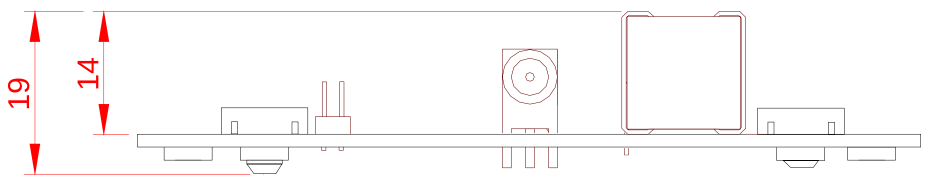


Fig. 2: Maximum installed height

4.2 Pin headers and HF connection sockets

Fig. 3 shows all headers J1 to J3 as well as the HF connection sockets.

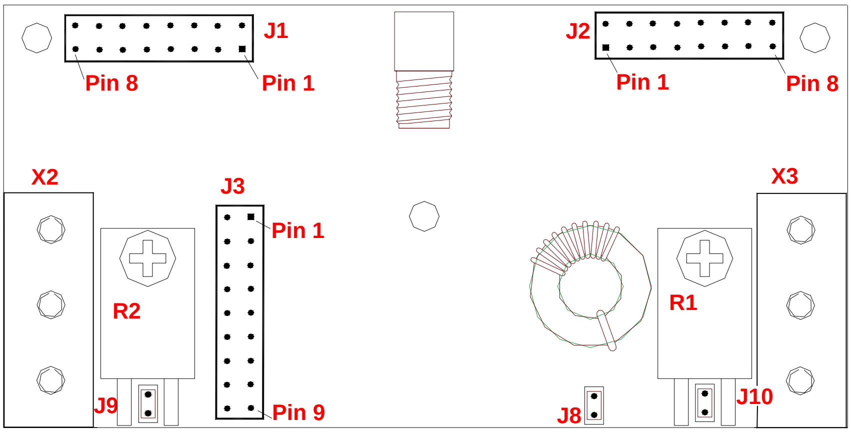


Fig. 3: Headers and HF-sockets

The HF cable is connected through the SMA socket X1 as shown in Fig. 4.

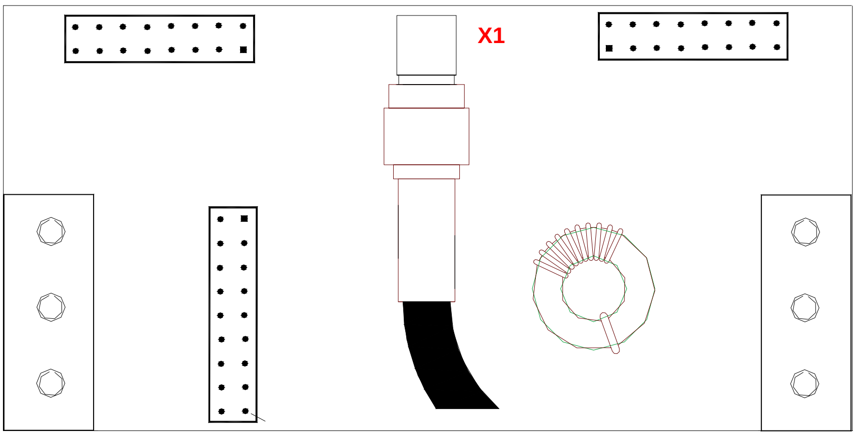


Fig. 4 HF cable connection

4.3 X2, X3 Connecting the antenna conductor

The antenna conductor is connected to the circuit board at terminals X2 and X3. Fig. 5 shows installation of an aluminum strip antenna conductor, Fig. 6 an antenna constructed of coax cable (RG214) and Fig. 7 a copper tube antenna.

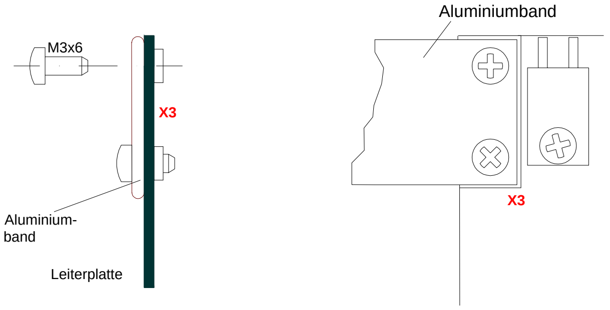


Fig. 5: Antenna connection (aluminum strip)

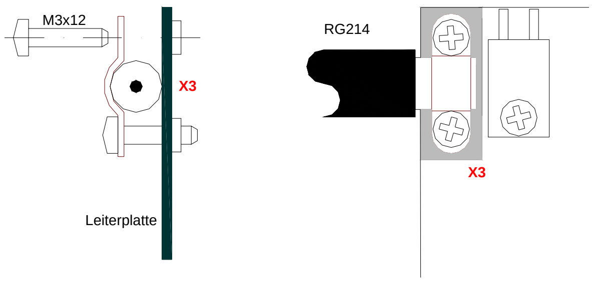


Fig. 6: Antenna connection (coaxial cable RG214)

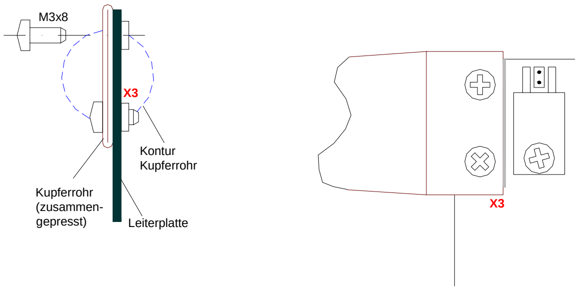


Fig. 7: Antenna connection (copper tubing)

Note:

Ensure that there is good electrical contact between the antenna conductor and the contact surfaces.

5 Operating elements

5.1 Jumpers JP9 and JP10 for setting Q

When using the semiconductor switch be sure not to exceed the maximum permissible antenna current. The highest antenna current is a function of the inductance, Q and the HF power.

$$I \approx \sqrt{\frac{P*Q}{\omega * L}}$$

$$P \approx HF - Power \qquad \omega \approx 2 \cdot \pi \cdot f$$

$$L \approx Inductance$$

$$Q \approx Signalquality \qquad Q \approx \frac{2 \cdot \pi \cdot f_0 \cdot L}{R} = \frac{\omega \cdot L}{R}$$

Jumpers JP9 and JP10 are used to set the antenna Q using the series resistors. For setting the Q see Table 1.

The following table shows the respective maximum permissible HF power for various Q settings and various antennas up to which the antenna tuner can be operated.

Table 1: Maximum HF power in continuous operation

Antenna	Inductance	Series resistor	max. HF power
ID ISCANT300300 (Single-Loop: 300mm x 300mm)	0.7µ	0Ω	3.5 W
		3Ω	7 W
ID ISCANT800600 (Single-Loop: 800mm x 600mm)	1.9µH	0Ω	6 W
		3Ω	6.5 W
ID ISCANT1400700 (8-Loop: 1400mm x 700mm)	1.1µH	0Ω	8 W
		3Ω	8 W

The maximum permissible HF power increases if the power is not continuously present.

6 Startup

6.1 Setting the tuning capacitances

Antenna tuning uses a compensation circuit consisting of capacitors $C_{1/1}$, $C_{1/2}$ and C2 and a transformer (ratio=2), configured as a balloon for balancing the antenna current. The capacitors are divided symmetrically into $C_{1/1}$ and $C_{1/2}$ and must be of equal value. An equivalent schematic of the compensation circuit with balloon is shown in Fig. 8. Jumpers can be used to switch capacitors $C_{1/1}$, $C_{1/2}$ and C2 into the circuit.

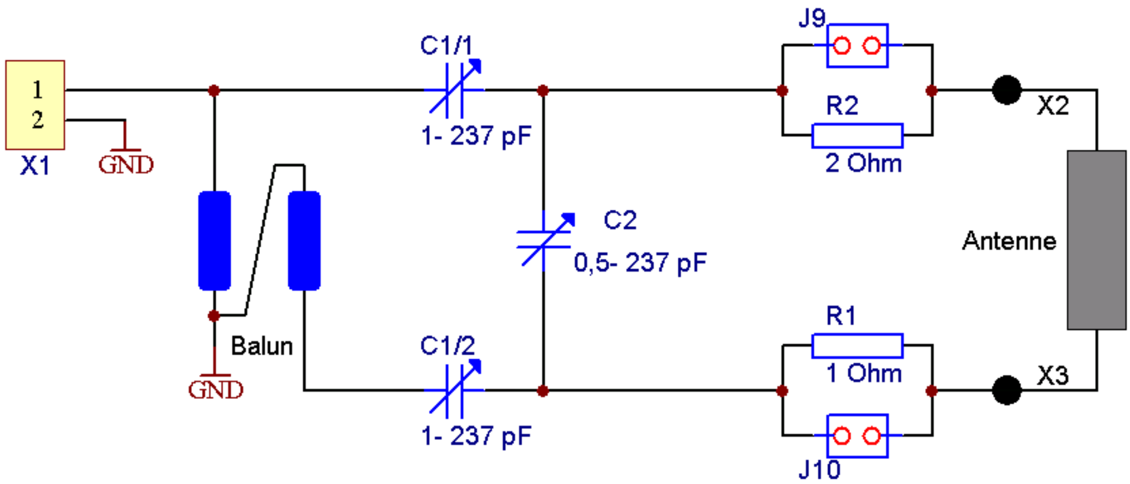


Fig. 8: Equivalent schematic for compensation circuit with balloon circuit

6.2 Determining the inductance

Before determining the compensation capacitances you must first measure the inductance of the antenna conductor. This depends mainly on the conductor length, antenna shape and the antenna conductor (diameter, shape). The inductance of the antenna conductor should be measured in a similar environment (distance to metal and floor) in which the antenna will be operated.

The inductance of an antenna can be determined approximately from the geometric dimensions of the antenna. It should lie in a range of 0.6µH to 2.5µH in order to be able to tune it using appropriate capacitors. Equation 1 applies only for an area free of metal or other conducting materials.

$$L_P \approx 0.008 * N^2 * l \cdot \left(\ln\left(\frac{1.4142 * l * N}{(N+1) * d} \right) + 0.37942 + \frac{0.1348 * (N+1) * d}{l * N} \right)$$

Equation 1

where:
- L_P = Inductance of the antenna in nH
- l = Side length of the antenna cm
- d = Diameter in cm [here CU tube 1.8 in cm]
- N = Number of turns

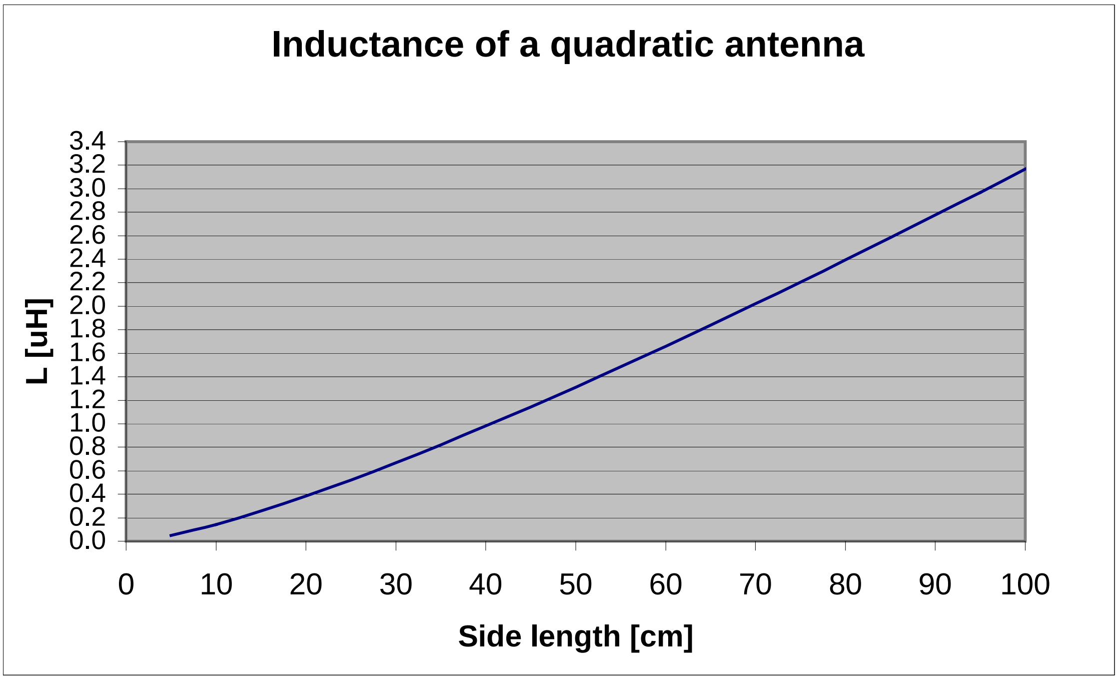
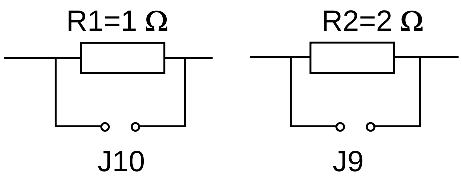


Fig. 9: Inductance of a quadratic antenna

6.3 Determining Q

The antenna Q is set using the series resistors R1 and R2 before tuning using solder jumpers on the solder side to 0, 1, 2 or 3 Ω.



The antenna Q affects the antenna current, the bandwidth and the sensitivity of the antenna to changes in the surroundings. It depends on the desired read range and the national RF regulations. In the standard setting the series resistance is 3 Ω. The series resistors can be enabled and disabled using jumpers or a solder jumper on the underside of the circuit board.

Tab. 2 lists the possible series resistance settings.

Tab. 2: Series resistors

Jumper	R_{series}
J10 and J9 in	0 Ω
J10 offen, J9 in	1 Ω
J10 in, J9 out	2 Ω
J10 and J9 out	3 Ω

Fig. 10 shows insertion of the solder jumpers J9 or J10 on the solder side of the circuit board:

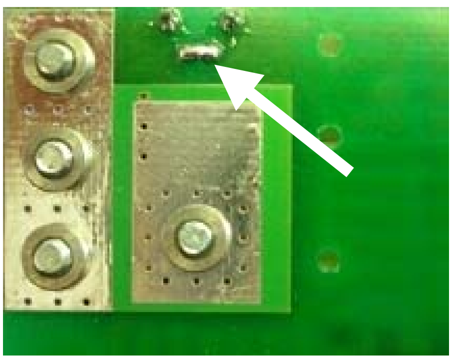


Fig. 10:Solder jumpers J9 and J10 in

6.4 Tuning the antenna

At the start of a tuning process you must first know the inductance of the antenna conductor. The inductance can be determined using Fig. 9. It is also possible to use an appropriate impedance meter or an analyzer to measure the inductance. The inductance value of the antenna should not lie outside the limits indicated in the Technical Data. Tab. 3 uses examples to show in which range the compensating capacitors should lie for various inductance values. The figures refer to a conductor of 1.8 cm diameter (copper tube) and a series resistance R_{series} of 3 Ohms.

Following are 3 examples:

Tab. 3: Inductance and compensation capacitors for 3 square antennas

s [cm]	L_P [nH]	$C_{1/1}$= $C_{1,2}$ [pF]	C_2 [pF]
30	700	52	157
70	1900	15	47
90	2200	12.4	33.4

s : Side length of the square

With the help of Fig. 11 you can set the jumpers for headers J1, J2 for capacitors $C_{1/1}$ and $C_{1/2}$ as well as Jumper J3 for capacitor C_2 on the circuit board. By setting several jumpers on J1 J2 and J3 you can arrive at the necessary capacitance value. If the particular value cannot be achieved, use the next possible value.

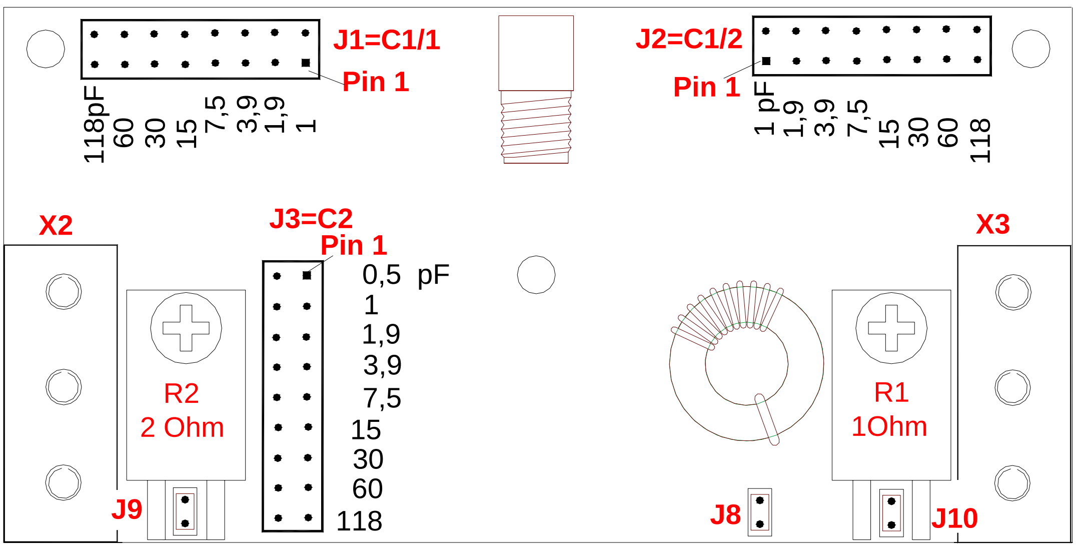


Fig. 11: Configurable capacitances on the circuit board

The objective of the tuning process is to tune the antenna as close as possible to 50 Ω. Maintain the following tolerances:

R = 50 +/- 3 Ω and X = 0 +/- 5 Ω

(or Z = 50 +- 3 Ω and phase angle Phi = 0° +/- 3°)

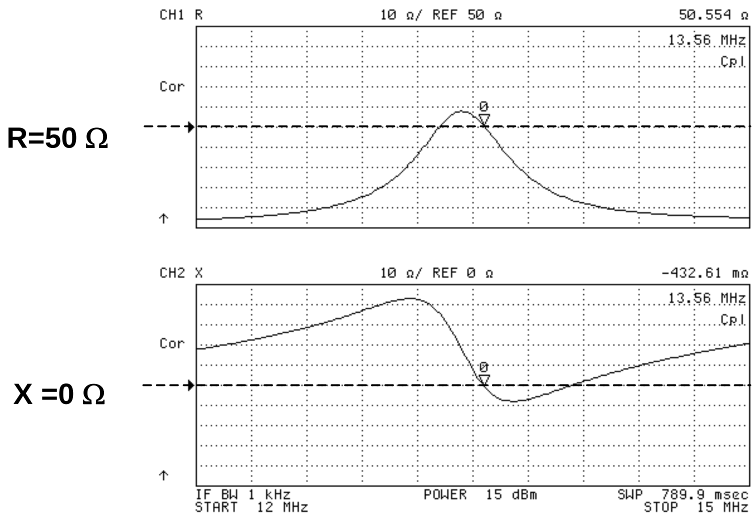


Fig. 12: The resistance (R) and inductance (X) of the antenna as a function of frequency

Procedure for tuning an antenna in individual steps:

1. Connect tuner board (with antenna attached) to impedance analyzer.
2. At $C_{1/1}$ and $C_{1/2}$ enable the same capacitance of 15pF or 30pF.
3. Change capacitance C_2 to the value closest to R=50 Ω using the jumper strip J3
4. Change capacitances $C_{1,1}$ and $C_{1,2}$ to the value closest to X=0 Ω and γ = 0° +/- 3° on J3
5. Use capacitance C_2 (on J3) to recalibrate to the value closest to R=50 Ω and Z = 50 Ω.
6. If necessary repeat steps 5 and 6 until the working point 50 Ω lies within the specified tolerance (+-3Ω) and no more improvement is possible.

The antenna is sufficiently tuned when the impedance is R = 50Ω ±3Ω and X = 50Ω ±3Ω. After tuning is complete all system components (RF Reader, any Power Splitter, Multiplexer) should be connected, see Fig. 13. Connect an SWR meter to the HF Reader output and check the tuning again.

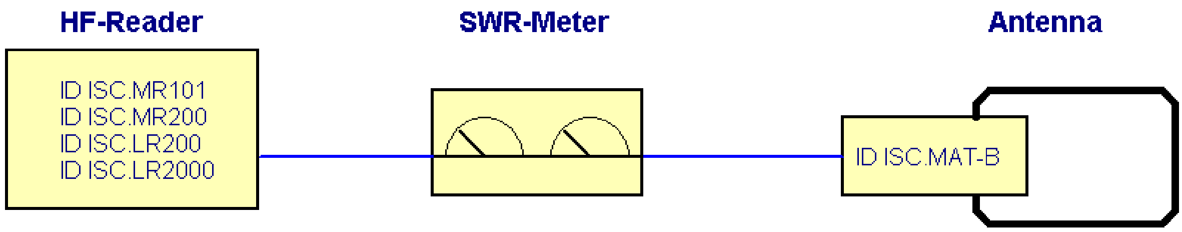


Fig. 13: Block schematic of HF-Reader with antenna

Retuning the antenna

9. Change the capacitance C_2 in small steps using jumper strip J3 until a minimum is reached on the SWR meter.
10. Change $C_{1/1}$ and $C_{1/2}$ in small steps on J1, J2 until a minimum is reached on the SWR meter.
11. Repeat both steps until the SWR is ≤ 1.3

Note the following when tuning the antenna:

- The curve for resistance R has two points where the 50 Ω line is intersected.
- For very small values of R (R < 10 Ω) the capacitance C_2 must be increased or decreased in large steps.
- The curve for impedance X also has two points where the 0 Ω line is intersected.
- For every change of the capacitances note whether the working point runs in the correct direction.
- Increasing the capacitance C_2 shifts the curve (see Fig. 12) for resistance R to the left, and both intersections with the 50 Ω line move towards a lower frequency.
- Increasing capacitances $C_{1/1}$ and $C_{1/2}$ shifts the curve (see Fig. 12) for the impedance towards lower values.
- Changes in the distance from metals, magnetic materials or to the floor detune the antenna after the fact and must be compensated for after installing the antenna.

Note: Voltages of up to 1000V may be present on the antenna conductor or various components on the tuning boards.

Tuning the antenna using an SWR meter is also possible according to the same procedure, but is much more difficult since there is always only one measured value (SWR instead of R&X) available.

The impedance of the antenna should always be set in the intended area of use, since metal or other conducting materials have an effect on the inductance and therefore on the antenna impedance.

7 Technical Data ID ISC.MAT-B

Mechanical Data

• **Construction**	Single-sided board
• **Dimensions (W x H x D)**	90 mm x 45mm x 17 mm ± 1 mm
• **Weight**	approx. 35g

Electrical Data

• **Maximum transmission power**	8 W [x]
• **Reader connection**	SMA HF socket RG58
• **Antenna conductor connection**	Double-sided solder surface with hole for screw attachment (M3 screw)
• **Antenna parameters**	
- **Transmitting and receiving frequency**	13.56 MHz
- **Impedance**	50 Ω
- **Inductance tuning range**	0.6 – 2.5 µH
- **Q factor**	10 – 30

Ambient Conditions

• **Temperature range**	
– Operating	–25°C to +55°C
– Storage	–25°C to +60°C
• **Vibration**	EN60068-2-6 10 Hz to 150 Hz : 0.075 mm / 1 g
• **Shock**	EN60068-2-27 Acceleration : 30 g

[*] Assuming appropriate heat dissipation at power resistors R1 and R2, using for example a heat sink or by the antenna conductor.

8 Appendix: Helpful tools for constructing and testing antennas

The following equipment is recommended for troubleshooting or starting up the antennas:

- MFJ HF/VHF SWR analyzer including adapter for the antenna plug
- SWR and power meter including adapter for the antenna plug

8.1 Recommended equipment and sources

1. VSWR – Meter

Alan VSWR & Power – Meter KW 220

Supplier:

- CB Funkshop Rößner, 91637 Wörnitz, Tel.09868/932945, http://www.cb-funkshop.de
- AEA, Vista, California 92083, USA

RadioShack CB/High-Frequency Ham Power SWR Meter

3 – 30 MHz

210-0534

Supplier:

- Radio Shack, USA, www.radioshack.com

2. Antennen Analyzer

MFJ HF/UHF SWR Analyzer

Model MFJ-259B, 1.8 – 170 MHz

Supplier:

- Austin Amateur Radio Supply, USA 1-800 423 2604
- VHT – Impex, Ecke, Deutschland, Tel.: 05224/9709-0

CIA – HF Complex Impedance Analyzer 0,4-54MHz

Supplier:

- AEA, Vista, California 92083, USA
- Garant – Funk, Kommerner Str. 119, 53879 Euskirchen, Tel. 02251/55757, www.garant-funk.de
- HEINZ BOLLI AG, Rütihofstrasse 1, CH-9052 Niederteufen, Tel. +41(0) 71 335 0720 www.hbad.ch

3. Adapter : UHF-> BNC, BNC-SMA, SMA-SMA, Abschlußwiderstand 50 Ω

Supplier:

Bürklin OHG, http://www.buerklin.com

Conrad.com AG, http://www.conrad.de

Farnell Electronic Components GmbH, 82041 Oberhaching, http://www.farnell.com