HF Reader System Series 6000

Gate Antenna RI-ANT-T01A

Reference Guide

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TI-RFid
A TEXAS INSTRUMENTS TECHNOLOGY

Edition Two - August 2001

This is the second edition of this manual. It describes the Series 6000 Gate Antenna:

RI-ANT-T01A

The only change with respect to the first edition is that Dimensions in Section 1.3.1 and Figure 3 have been changed.

Read This First

About This Manual

This reference guide for the Series 6000 Gate Antenna is designed for use by TI partners who are engineers experienced with Radio Frequency Identification Devices (RFID).

Regulatory, safety and warranty notices that must be followed are given in Chapter 5.

Conventions

WARNING:

A WARNING IS USED WHERE CARE MUST BE TAKEN, OR A CERTAIN PROCEDURE MUST BE FOLLOWED IN ORDER TO PREVENT INJURY OR HARM TO YOUR HEALTH.

CAUTION:

This indicates information on conditions which must be met, or a procedure which must be followed, which if not heeded could cause permanent damage to the equipment or software.

Note:

Indicates conditions which must be met, or procedures which must be followed, to ensure proper functioning of the equipment or software.

Information:

Indicates information which makes usage of the equipment or software easier

If You Need Assistance

For more information, please contact the sales office or distributor nearest you. This contact information can be found on our web site at:

http://www.ti-rfid.com

Document Overview

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CHAPTER 1

Introduction

This chapter introduces you to the Series 6000 gate antenna (RI-ANT-T01A).

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1.1 General

The HF Reader System Series 6000 works at a frequency of 13.56 MHz. It comprises a reader, antenna, and transponders. This reference guide provides details about the gate antenna shown in Figure 1.

The Antenna (RI-ANT-T01A) is a single-loop antenna with pre-set matching electronics and has been optimized as a transmitting and receiving antenna for the S6500/6550 Readers. Furthermore, it can be used with other readers having a transmitter frequency of 13.56 MHz and an output impedance of 50 Ω.

The antenna has been factory calibrated on a wood block for an impedance of 50 Ω. If the antenna is installed it may need to be re-tuned for a defined range with the help of jumpers.

The preferred direction of a transponder (for example: a smart label) is parallel to the antenna. The best position to obtain a maximum range is above the centre of the antenna.

Figure 1: Antenna (RI-ANT-T01A)

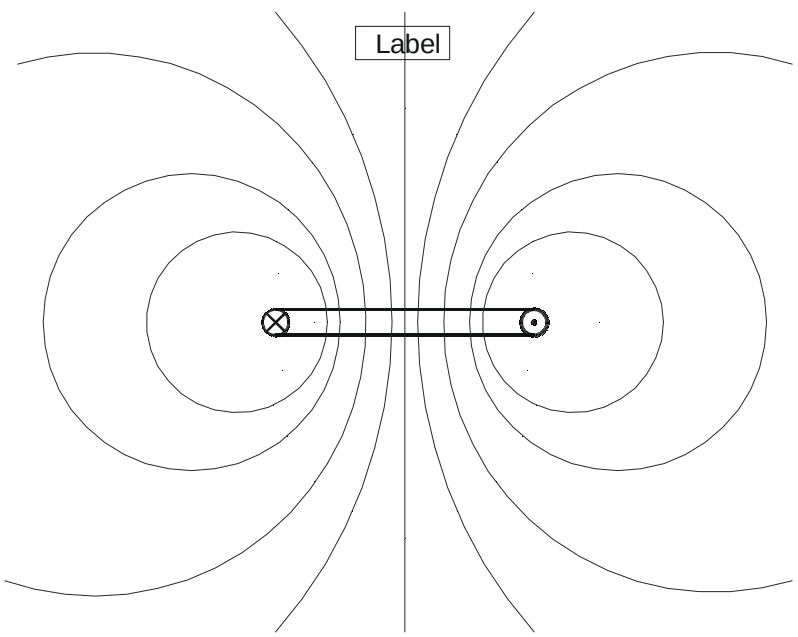
The terms and abbreviations used in this manual can be found in the Terms and Abbreviations Manual - document number 11-03-21-002. This manual can be found via our home page:

http://www.ti-rfid.com

1.2 Shape of the Antenna's Magnetic Flux Lines

The working range of an antenna depends very much on the position and alignment of the transponder. A single loop antenna has the highest range in the centre of the antenna and if the transponder is aligned parallel to the antenna.

Figure 2: Magnetic Field Distribution of a Single Loop Antenna



1.3 Specifications

1.3.1 Mechanical Data

Housing	Plastic ABS
Dimensions (L x W x H)	322 x 337 x 38mm 322 x 337 x 40mm (incl. screw heads)
Weight	0,7 kg
Protection class	IP 65
Color	Black

1.3.2 Electrical Data

Maximum transmit power	8 W
Permissible transmitting power (without shielding)	4 W - EU (according to EN 300 330) 1.5 W - US (according FCC Part 15)
Operating frequency	13.56 MHz
Impedance	50 Ω ± 10 Ω ∠ 0° ±13º
Antenna connection	1 x SMA plug (50 Ω)
Antenna connection cable	RG58, 50 Ω, length of 3.6 m

1.3.3 Ambient Conditions

Temperature range - operation - storage	 -25°C to +55°C -25°C to +60°C
Vibration	According to EN60068-2-6 10 Hz to 150 Hz: 0.075 mm / 1 g
Shock	According to EN60068-2-27 Acceleration 30 g

CHAPTER 2

Installation

This chapter provides you with the information that you need to know in order to install the antenna.

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2.1 Mounting

The antenna has been designed for installation using holding devices made of non-conductive materials (for example: plastic or wood). It can be used both indoors and outdoors.

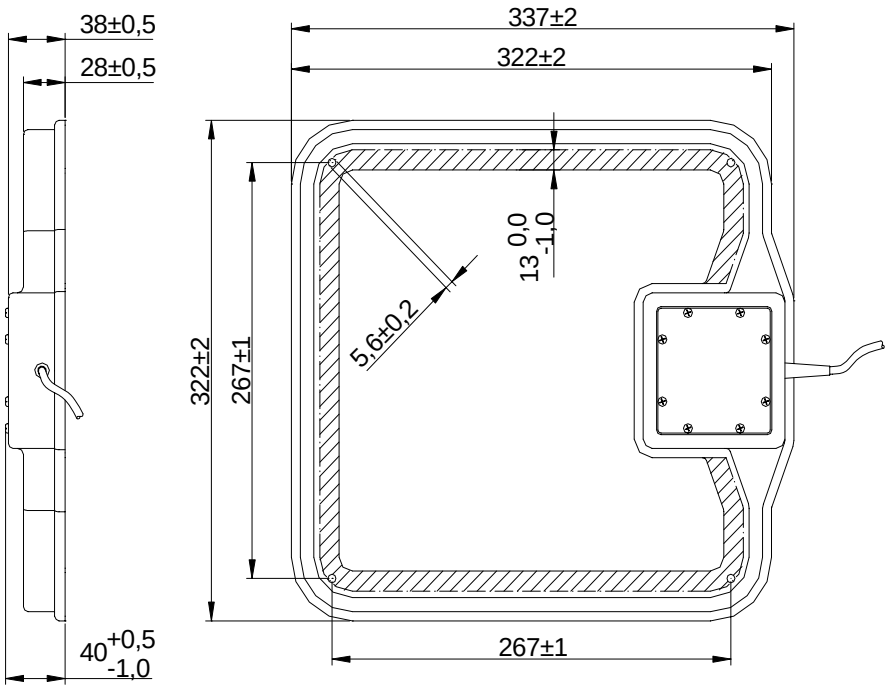
Four mounting holes (diameter = 5.4 mm) spaced 264 mm apart are located on the antenna (see Figure 3) in order to facilitate mounting. We recommend that you use a wood screw (like DIN 96) or a machine screw (like DIN 7985) with a pen head diameter between 10 mm and 12 mm. The maximum tightening torque of the screws is 2 Nm.

If these existing holes are not sufficient you can drill additional holes within the hatched area shown in Figure 3. Make sure that you keep far enough from the edge to avoid the holes “breaking” through.

Note:

Please keep a minimum distance of 10 cm between the antenna and any metal parts! Even a distance of 50 cm to metal parts will still lead to a reduction in the reading range.

Figure 3: Installation Dimensions



All dimensions in Figure 3 are in mm.

In order to tune the antenna, open the housing by removing the four screws on the cover. The maximum tightening torque for these cover screws is 0,2 Nm - 0,25 Nm.

2.2 Connection and Tuning

2.2.1 Connecting

The antenna should be connected directly to the reader using the connecting cable and the SMA-plug on the reader.

The S6500/S6550 Reader comes with 2 toroidal cores to help with the suppression of interference. One of these toroidal cores should be integrated into the antenna connection cable. Do this by pulling the coaxial cable through the core four times as shown in Figure 4. The maximum distance between reader and toroidal cores should be 10 cm.

Figure 4: Integrating the Toroidal Core and the Coax Cable

Please also observe the following recommendations:

- The antenna cable should always be led at a right angle away from the antenna and permanently secured for a distance of 50 cm.
- In order to obtain an optimum reading range, the antenna connection cable should not be shortened or extended. If an extension is absolutely necessary, please use a 50 Ω cable with a length of $\lambda/2$ (half the wavelength at 13.56 MHz, RG58=7.20 m). However, this may lead to a minor reduction in the reading range.
- Please keep a minimum distance of 30 cm between the antenna cable and all power cables running parallel.

2.2.2 Measuring the Voltage Standing Wave Ratio (VSWR)

Once an antenna has been tuned, the question is: how good is the matching between reader and antenna? The VSWR -meter is a very useful aid to checking this adjustment, it measures the ratio between supplied and reflected energy. A VSWR of up to 1.3 : 1 is considered to be sufficient, Table 1 shows the power loss relative to the SWR. A wattmeter is often integrated into these devices.

If, after tuning, the VSWR exceeds 1.3 : 1 it may be slightly re-adjusted with the help of the trimming capacitors as described in section 2.2.3. The antenna tuning may be checked at any time using this device. This method could also be used at any time to check if the antenna has become detuned because of changes in the environmental conditions.

Figure 5: Inserting a VSWR Meter into the Antenna Cable

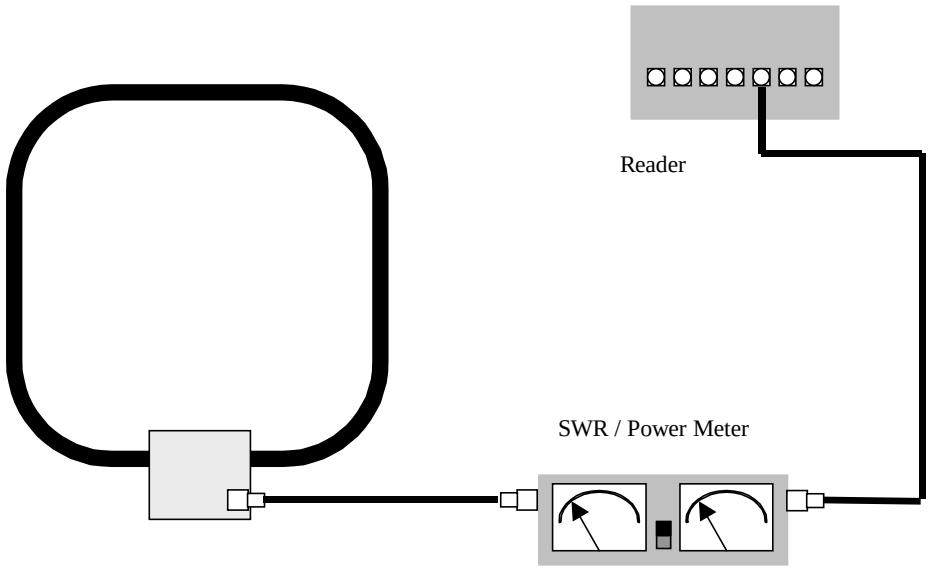


Table 1: Power Loss - SWR Ratio

SWR	Power loss
1 : 1	0 %
1.3 : 1	2 %
1.5 : 1	3 %
1.7 : 1	6 %
2 : 1	11%
3 : 1	25 %

2.2.3 Antenna Tuning

The antenna has been factory-tuned on a wood block at an impedance of 50 Ω. If it is installed at a minimum distance to metal or other magnetically conductive materials, no adjustment or re-adjustment will be necessary.

After installation in different ambient conditions, the antenna may be re-tuned for a limited range with the help of jumpers and trimming capacitors. For this purpose you will either need an SWR - meter or other appropriate measuring device in order to determine the impedance at 13.56 MHz.

If metal is brought close to the antenna, the impedance curve (Figure 6) shifts to the right and slightly downwards. This means that as the metal approaches, the impedance value will decrease and then increase more and more. During this process, the antenna will once again pass the value of 50 Ω. However, this operating point does not lead to optimal reading ranges. The optimal operating point always lies on the serial resonance, which in this case equals the minimum value on the impedance curve.

Figure 6: Antenna Impedance Relative to the Frequency

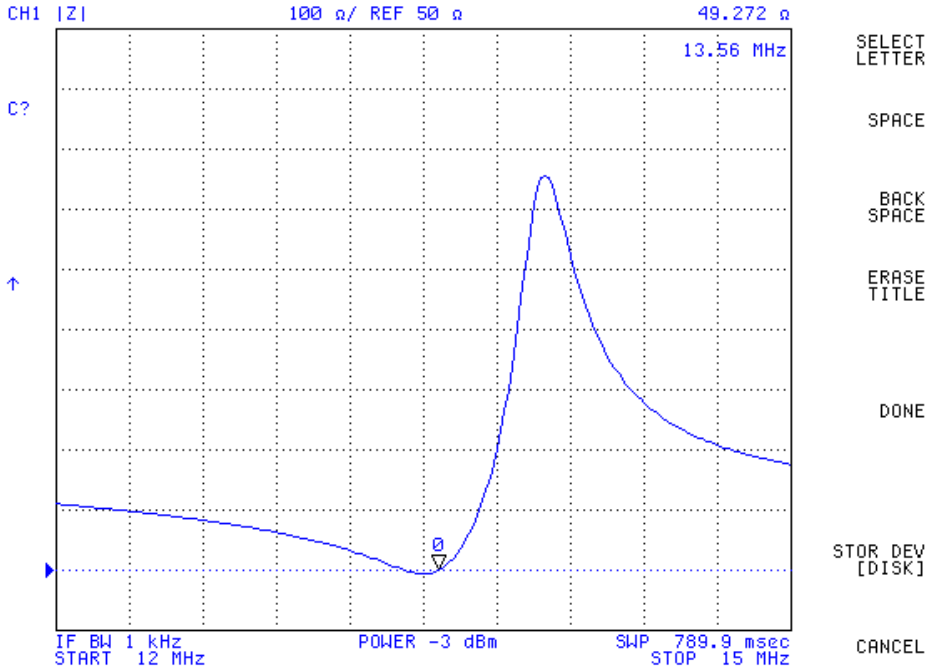
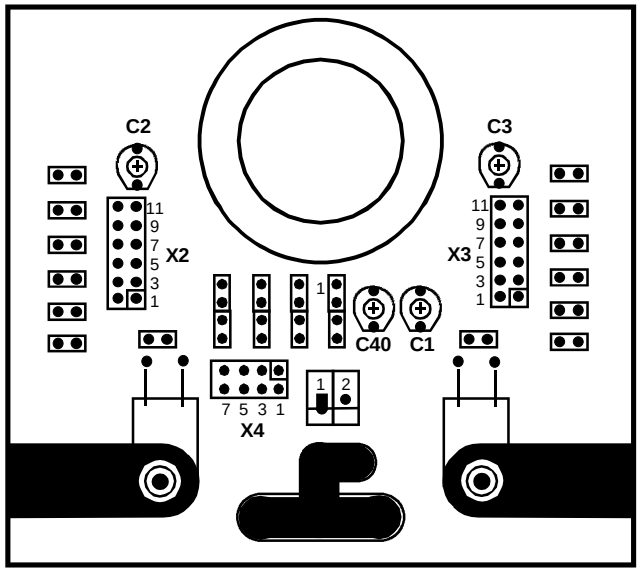


Figure 7: Circuit Board - Top View



The trim capacitor pairs (C2,C3 and C1,C40) should always to set to approximately the same capacitance. Maximum capacitance is reached when both dots point to the tip (up in this example), and minimum capacitance is set when both dots point towards the flat side.

Figure 8: Trimming Capacitor at Neutral Position	Figure 9: Two Trimming Capacitors With Equal C-values
	

Trimming capacitors C1, C2, C3 and C40 may be used to trim the antenna to 50 Ω. Should the setting range of the trimming capacitors be insufficient, jumper terminals X2, X3 and X4 may be used for a coarse pre-adjustment.

Proceed as follows:

First open the cover on the antenna to gain access to the circuit board (see Figure 3).

- Adjust capacitors C1,C2, C3 and C40 to the neutral position (see Figure 8)
- Adjust capacitors X2, X3 to the optimal value close to 50 Ω (see Table 2)
- Adjust capacitor X4 to the optimal value close to 50 Ω (see Table 2)
- Trim capacity C2 and C3 (fine tuning to 50 Ω)
- Trim capacity C1 and C40 (fine tuning to 50 Ω)

We recommend that you use a non-metallic screwdriver to trim the capacitors.

WARNING:

VOLTAGES AS HIGH AS 1000 V MAY BE PRESENT ON THE ANTENNA WIRE OR ON COMPONENTS ON THE TUNING BOARD. THEREFORE MAKE SURE THAT THE READER IS SWITCHED OFF OR DISCONNECTED FROM THE ANTENNA WHEN YOU CHANGE ANY JUMPER SETTINGS OR PERFORM ANY TUNING ACTIONS AT THE ANTENNA.

Table 2 has been provided as a guideline to help you set the capacitors X2, X3 and X4.

Table 2: Reference Values for Tuning the Antenna

Distance to metal plate	Jumpers inserted		
	X2	X3	X4
10 cm	5-6,7-8,11-12	5-6,7-8,11-12	1-2,3-4,5-6,7-8
20 cm	1-2,7-8,11-12	1-2,7-8,11-12	3-4,5-6,7-8
30 cm	7-8,11-12	7-8,11-12	3-4,5-6,7-8
Without metal plate	7-8,11-12	7-8,11-12	3-4,5-6,7-8

CHAPTER 3

Factors Influencing the Reading Range

This chapter provides you with additional information that may be useful when you are using the antenna.

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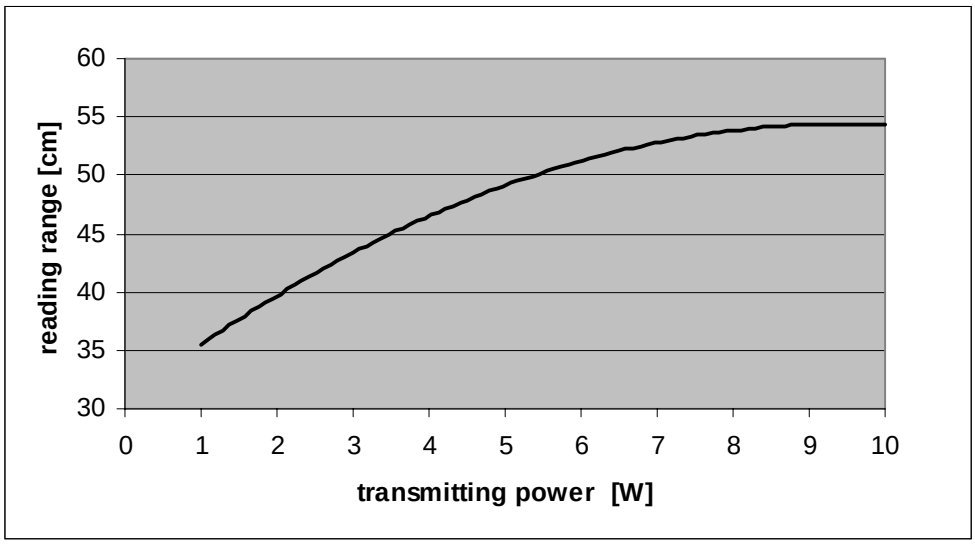
3.1 Influence of the Transmitted Power on the Reading Range

The antenna's working range is dependent on the antenna itself, the reader, the transponder and the level of the output power of the reader (adjustable). because the transponder gets its energy from the magnetic field produced by the antenna and that the field intensity decreases at higher distances, the radiated transmitting power has strong influence on the range.

Figure 10: Reading Range Relative to the Output Power

Measured example: Label, 45 x 76 mm, over the center of the antenna, oriented parallel to the antenna



Note:

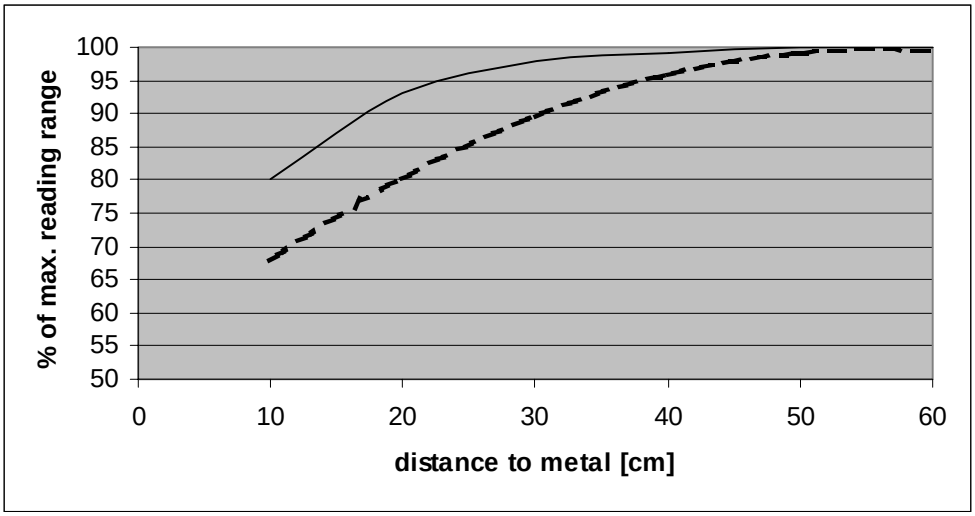
A transmitting power of more than 8 W could, depending on the ambient temperature, cause the antenna to heat up; or even destroy it.

3.2 Influence of Metal on Reading Range

A magnetic field cannot penetrate metal or other magnetically conductive materials. The course of the lines of electric flux and the inductivity of the antenna is changed and has therefore a considerable influence on the reading range. Furthermore, the field is weakened by the mutual inductance response to the eddy current within the metal.

The change of inductivity can often be compensated for with the help of the tuning electronics. Figure 11 illustrates the influence of a metal plate on the antenna with (upper line) and without rebalancing.

Figure 11: Reading Range Relative to the Distance to Metal



If you cannot avoid having metal parts close to the antenna, observe the following:

- The minimum distance between metal and antenna must be 10 cm. A distance of 30 cm will lead to a considerable reduction in the reading range. At a distance of 50 cm or more to metal parts, there will be almost no measurable influence.
- Metal parts must not form closed loops or electric circuits. These have to be electrically separated at some point.
- Metal parts in close vicinity to the antenna have to be grounded in star configuration with a good HF-connection.

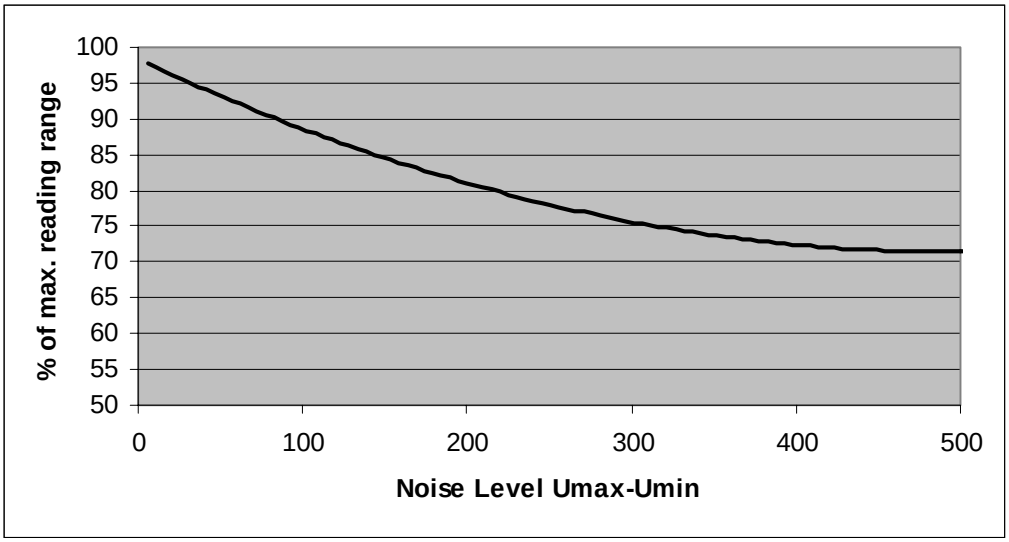
3.3 Influence of Noise Level on Antenna Working Range

Interference must be avoided if at all possible, so that the transponder can be read by the receiver even at low transponder signal levels. The amplitude of the interference levels can be found out with the S6500/S6550 Reader (noise level). It is not the absolute measured values that are critical, but rather the difference between Umax-Umin.

This has been simulated at 4W and represented graphically in the Figure 12.

A good value for Umax-Umin with a basic antenna is 20 mV.

Figure 12: Reading Range Relative to Noise Levels



Possible reasons for excessive noise levels are:

- Bad (HF) connections between reader and antenna
- Improper installation of the antenna cable between antenna and reader
- Badly tuned antenna
- Interfering signals from other electronic appliances or transmitting stations.
- Interference signals on the power supply lines
- Interference signals coming from other cables close to the cables leading to and away from the reader
- Metal parts close to the antenna

CHAPTER 4

Regulatory, Safety and Warranty Notices

This chapter provides important information about regulatory constraints and safety precautions.

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4.1 Regulatory Notes

An RFID system comprises an RF transmission device, and is therefore subject to national and international regulations.

The design and transmitting power of antennas are mostly influenced by country-specific radio regulations. There are uniform limiting values according to EN 300 330 for the whole of Europe. In Northern America, this is regulated by the FCC, Part 15, further regulations may apply in other countries.

The most important limiting value for antennas, the maximum permissible magnetic field intensity at 13.56 MHz at a distance of 10 m is 42dBµA/m for Europe and 38dBµA/m for the U.S. Since FCC Part 15 prescribes for the U.S. a separation of 50 dB between the carrier and the sidebands, the Reader may only be operated in “1 out of 256 coding mode” in the US

When putting the antenna into operation, please make sure that the admissible limiting values of the national radio regulations are not exceeded.

Under optimal ambient conditions and in connection with S6500/S6550 Reader, the antenna can be operated with maximum 4 W in Europe and maximum 1.5 W in the US. If either higher or lower limiting values are applicable, either adjust the transmitting power or reduce the magnetic radiation by using a radio shield.

It is the responsibility of the system integrators to get their complete system tested and to obtain approvals from the appropriate local authorities before operating or selling this system.

4.2 Warranty and Liability

The “General Conditions of Sale and Delivery” of Texas Instruments Incorporated or a TI subsidiary apply. Warranty and liability claims for defect products, injuries to persons and property damages are void if they are the result of one or more of the following causes:

- improper use of the Antenna
- unauthorized assembly, operation and maintenance of the Antenna
- operation of the Antenna with defective and/or non-functioning safety and protective equipment
- failure to observe the instructions during transport, storage, assembly, operation, maintenance and setting up of the Antenna
- unauthorized changes to the Antenna
- insufficient monitoring of the Antenna's operation or environmental conditions
- improperly conducted repairs
- catastrophes caused by foreign bodies and acts of God.

APPENDIX A

Useful Tools

We recommend the following devices for trouble shooting and initiation of the antennas:

- SWR and power meter including adapters to SMA connectors
- Amber screwdriver with a 2.4 x 0.5 mm plastic blade

Optionally, the following tools will be useful:

- HF impedance analyser (for 13.56 MHz)
- Oscilloscopes: 2 channels, time base min. 10ns/Div resp. analog band width of 100 MHz
- 2 measuring loops, length: 1.5 m (comprising 50 Ohm, RG58 cable with BNC plug and wire coil (diameter approximately 80 mm) at the other end (usually self-constructed)