TM-001 Device Manual

Product Model Name:TM-001

FCC ID: QYL320RFID

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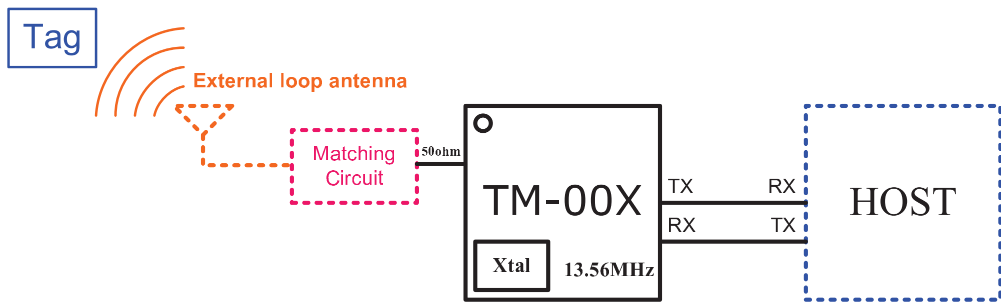
1 Product Overview

1.1 General Description

The TM-001 is an OEM HF compact RFID reader module for integration into label printers, label applicators, handheld devices and in general any fixed or mobile short and medium range device requiring HF tag programming and reading. TM-001 , Its simplified UART interface, low power consumption and superior performance, make it easy to integrate any device with RFID technology.

1.2 Application Diagram:



1.3 Features

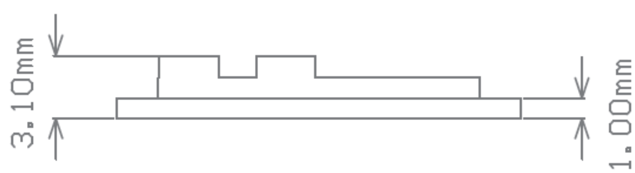
- Multi protocol HF RFID Tag support including : ISO15693, ISO14443A/B, Mifare and Tag-it
- **Full Mifare 1k & 4k functionality**
- **Full Read and Write functionality**
- **Full SR176 and SRIX4K functionality**
- Automatically Antenna sleep mode
- 200 mW maximum output power (Adjustable output power 33mW, 100mW or 200mW without external amplifier)
- Tiny profile and Footprint 20(mm)x20(mm)x3.1(mm)
- With 2.7~5.5V DC input voltage
- Ultra low power consumption
- Standard 50 Ohm antenna output port
- External antenna option with 50 Ohms output
- Host Interface: UART (TTL)
- Enhanced Noise Filtering for better RF performance
- Reads and writes multiple tags simultaneously
- Easy Connection to Flex antenna

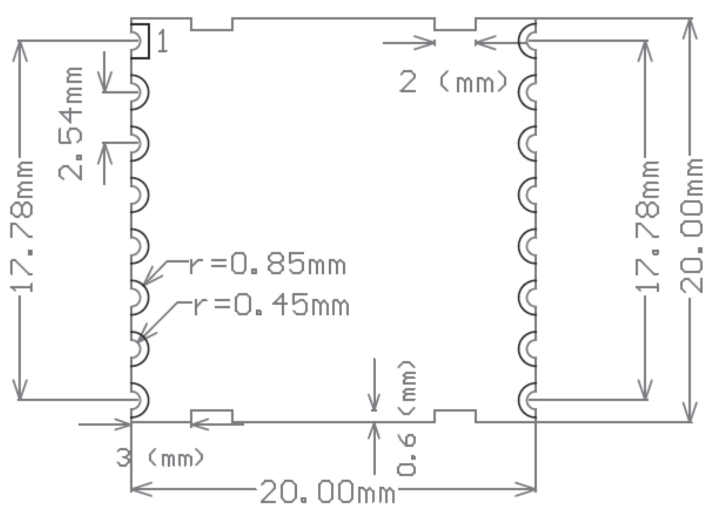
1.4 Applications

- 13.56MHz RFID reader or HF EPC systems
- Proximity & Vicinity RFID systems
- Handheld devices
- Multiregional Label Printers
- Point of sales devices
- Voice operated gloves
- Vehicle access control systems
- Patron Management
- Product Authentication
- Access Control
- Embedded System
- Item-Level Inventory
- other possible applications.

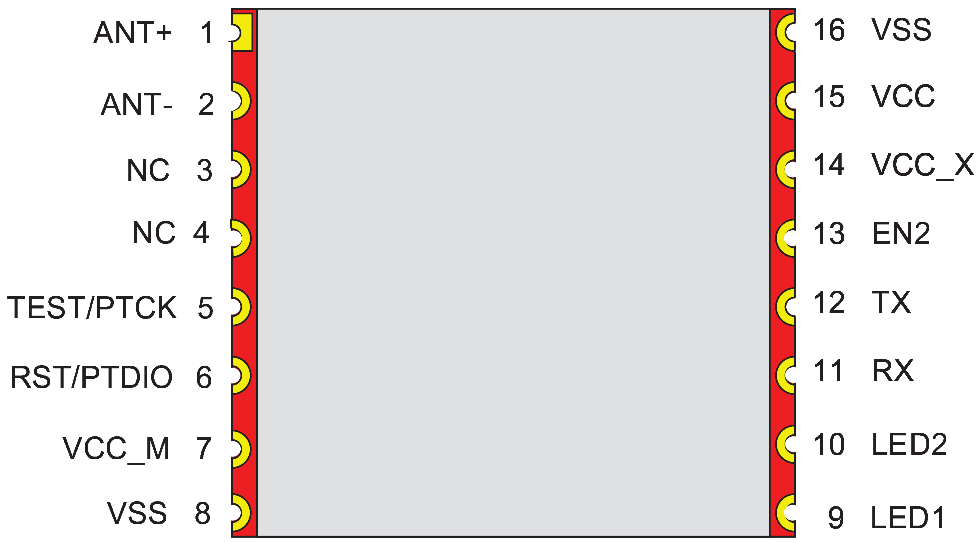
2 Mechanical Characteristics

2.1 Dimensions: 20(mm)x20(mm)x3.1(mm)



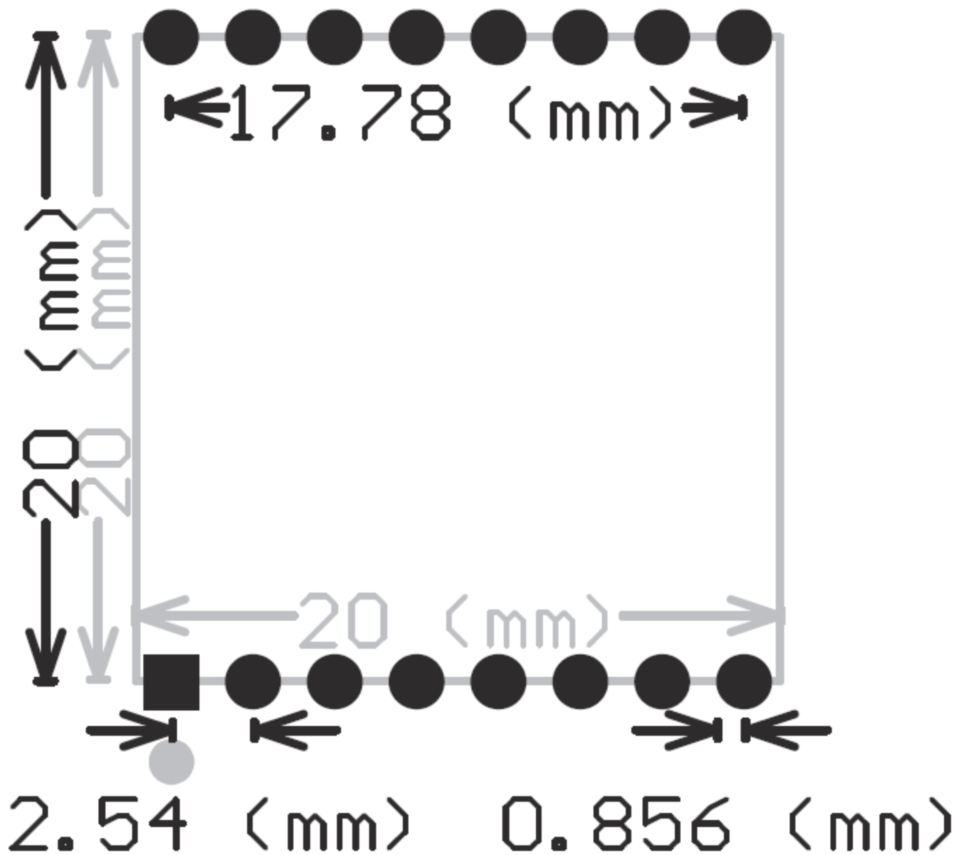


2.2 Terminal Functions



Port	Pin No	I/O	Description
ANT+	1		For external loop antenna (50 Ohms @ 13.56MHz) positive
ANT-	2		For External loop antenna (50 Ohms @ 13.56MHz) negative
NC	3		NC
NC	4		NC
TEST/PTCK	5	I	Test input / programmer test clock input
RST/PTDIO	6	I	Reset input / programmer test data input/output
VCC_M	7	PWR	Supply for MCU. Normally connected externally to VCC_X (pin 14)
VSS	8	PWR	Module substrate ground
LED1	9	O	Power LED (high active)
LED2	10	O	Tag detected LED (high active)
RX	11	I	Receive data (UART)
TX	12	O	Transmit data (UART)
EN2	13	I	Connected to VCC
VCC_X	14	PWR	Internally regulated supply (2.7 V–3.4 V) for external circuitry (MCU)
VCC	15	PWR	External supply input to module (2.7 V–5.5 V)
VSS	15	PWR	Module substrate ground

2.3 TM-00X footprint



3 Electrical Characteristics

3.1 Operating Conditions

Operating Temperature Range: 0°C to +70°C

Storage Temperature : –20°C to +85°C

Input Voltage Range: 2.7V to 5.5V

Continuous total current consumption: 120mA 5V

Supply Current: 120mA scanning, 4mA Antenna Off, 120uA idle, <1uA sleep

4 RF Characteristics

4.1 Operating Conditions

RF operating frequency	13.56MHz +/- 7kHz (nominal)
Aging	< 5ppm/year
RF output power	100 or 200 mW
RF output impendence	50 Ohm

5 Schematic and Host Interface

5.1 Reference circuit

We provide the TM-001 pins defined and its ambient circuit design (see Fig2). And highly recommend using this diagram for reference design.

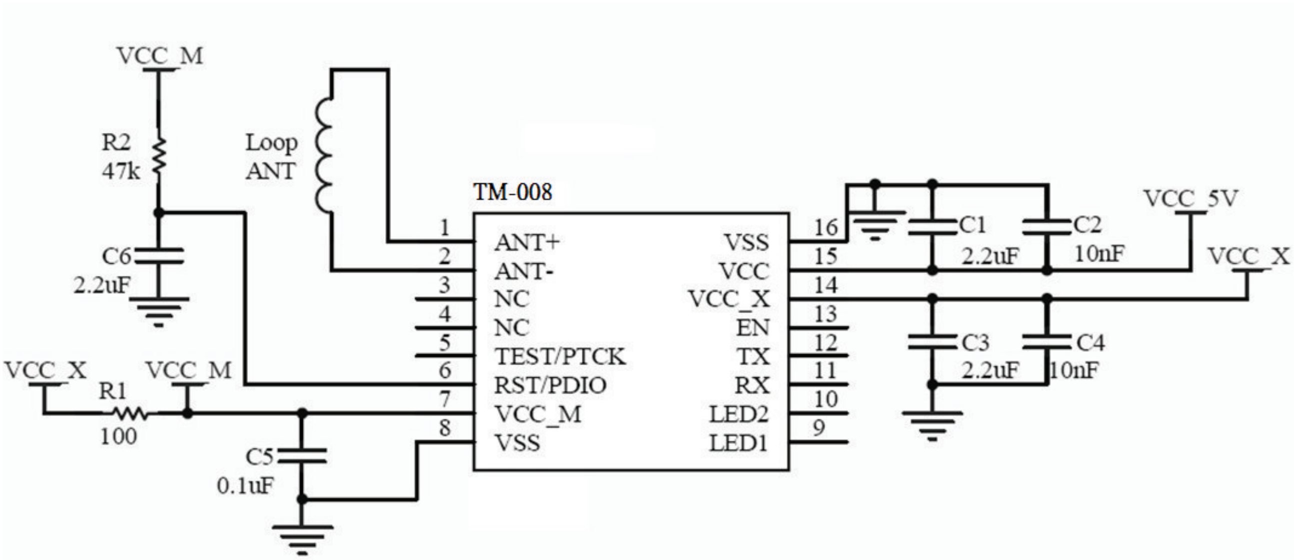


Fig2. Schematic diagram

5.2 Reference Diagram and Schematic for PDA

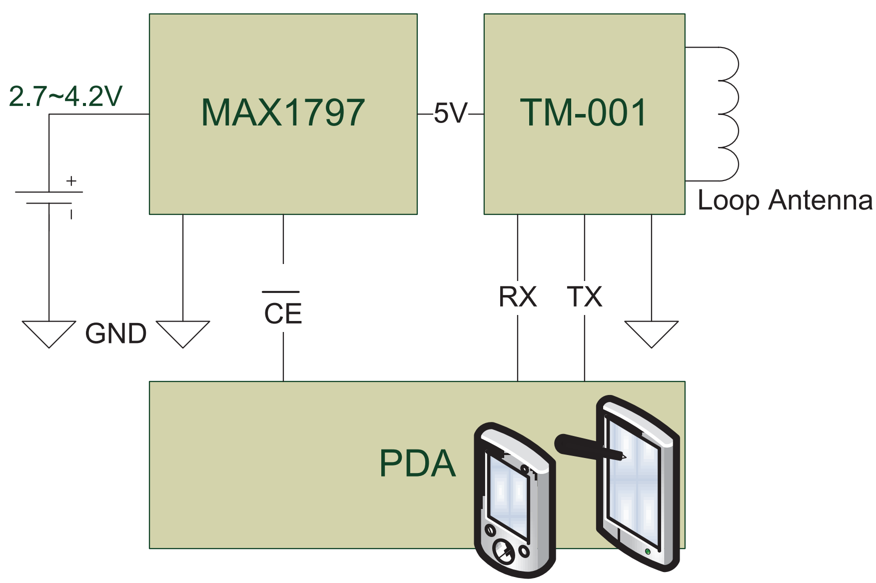


Fig3. Schematic diagram for PDA

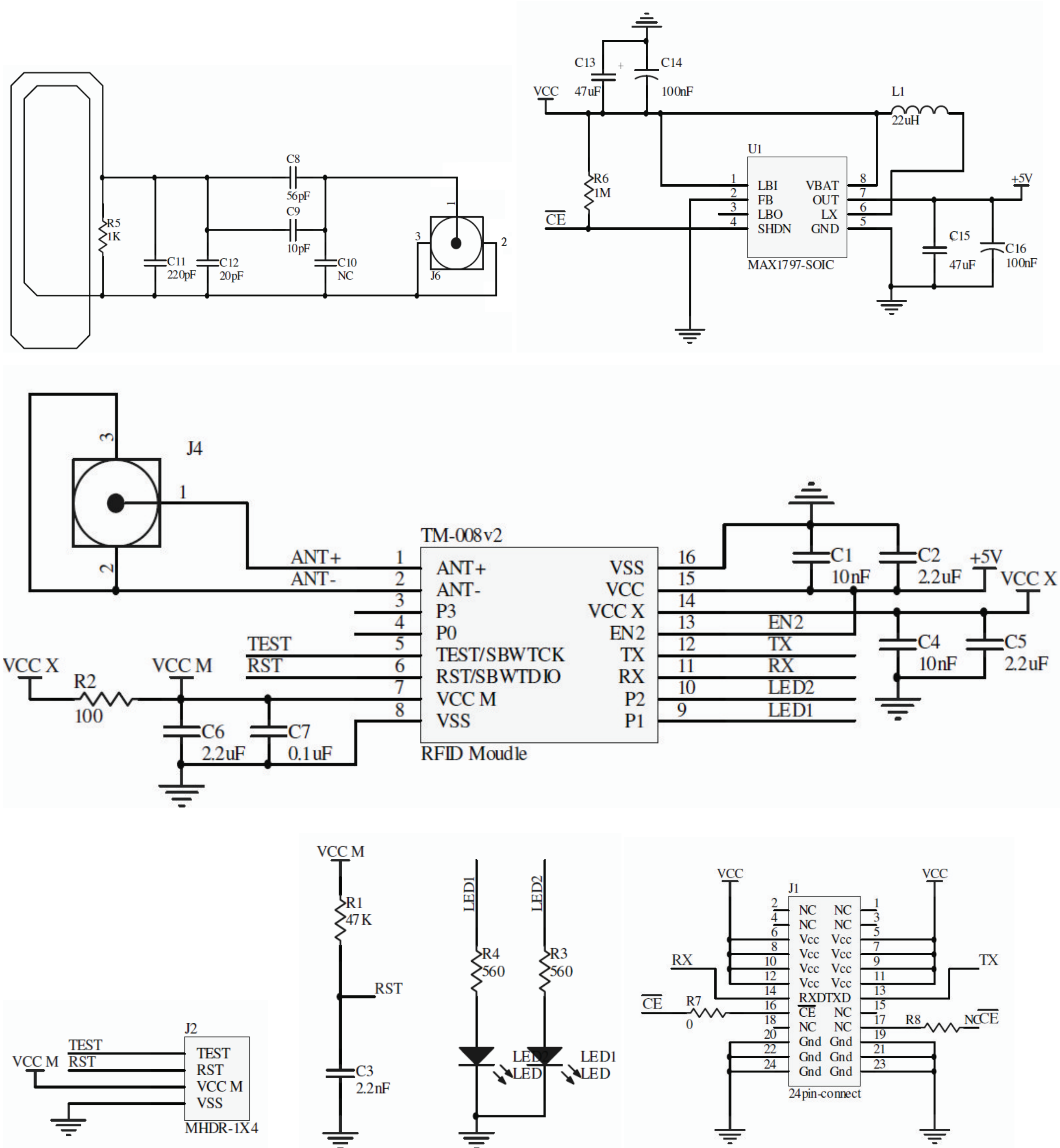


Fig4. Reference Schematic for PDA

5.3 TM-001 Layout Guide

In the TM-001 there are 2 kind of single, analog and digital. Pin1 and pin2 are analog signals which are RF signals and the other pins are digital signals. We highly recommend not to cross the two kind of signal.

Digital signals

Series ports

Signal TX & RX must be put apart from any other signals trace.

TEST&PTCK, RST/PTDIO, VCC_M & VSS

Those pins for programming, we command keep those pins for further use.

RF signals

ANT+ & ANT-:

For internal antenna the traces must be as short as possible, and go directly to the antenna coil via the matching circuit. For external antenna we highly recommend using standard 50 Ohm SMA header to avoid power loss and flexible.

LED port

Suggest to connect the LED light to the pin9 and pin10. When the power input TM-001 the pin9 will active high so it could light the LED and the RF power is also on. If the TM-001 detect the tags in the auto mode(only supply power and not using host to control it), the pin10 will active high so the LED will turn on and twinkling. So it could be easily to judge if the tags were read correctly.

Synthesis

We suggest place the ground under the TM-001 and do not through the trace line under the TM-001.

5.4 Power and Interface

VCC & VSS

Input 5VDC into pin 15(see Fig2) and the capacitors C1 &C2(see Fig2) must be closer to VCC pin for bypass. VSS is the module substrate ground and it should be connect the host or system ground.

VCC_M & VCC_X

The R1(see Fig2) separate VCC_M and VCC_X(pin7 & pin 14) which supply power for MCU and Transceiver . You could ignore input external power for both because the TM-001 include LDO inside which provide both powers by VCC. The bypass capacitors C3,C4 & C5(see Fig2) must be closer to VCC_M and VCC_X pin. Please see Fig.2 the bypass capacitors are very close to the power pins. And we highly recommend the ground via must near the IC component's ground so that could reduce the noise effect.

In the active mode RF output power in 100mW(+20dBm) the current consumption is 70 mA, in 200mW(+20dBm) the current is 120mA. When in the standby mode the current consumption is only 120uA. In the power down mode the current is only need less than 1uA. And all those power modes could be adjustable by programming .

5.4.1 UART

The communication between the host and the module can take place at 9600bps, 19200bps, 38400bps, 57600bps or 115200bps N, 8, 1. Module communicates at 115200bps,N,8,1 as default. Once the baud rate is changed using the change baud rate command, successful communication will only occur with the new baud rate.

The host first sends the command and the module executes the operation and replies with a response to the command. The host can analyze the reply to check if the operation was successful or if any error occurred during the operation.

The TM-001 should be connected to a COM port configured to the following settings:

baud rate	data bits	stop bit	parity	flow control
115200	8	1	no	no

5.4.2 TTL

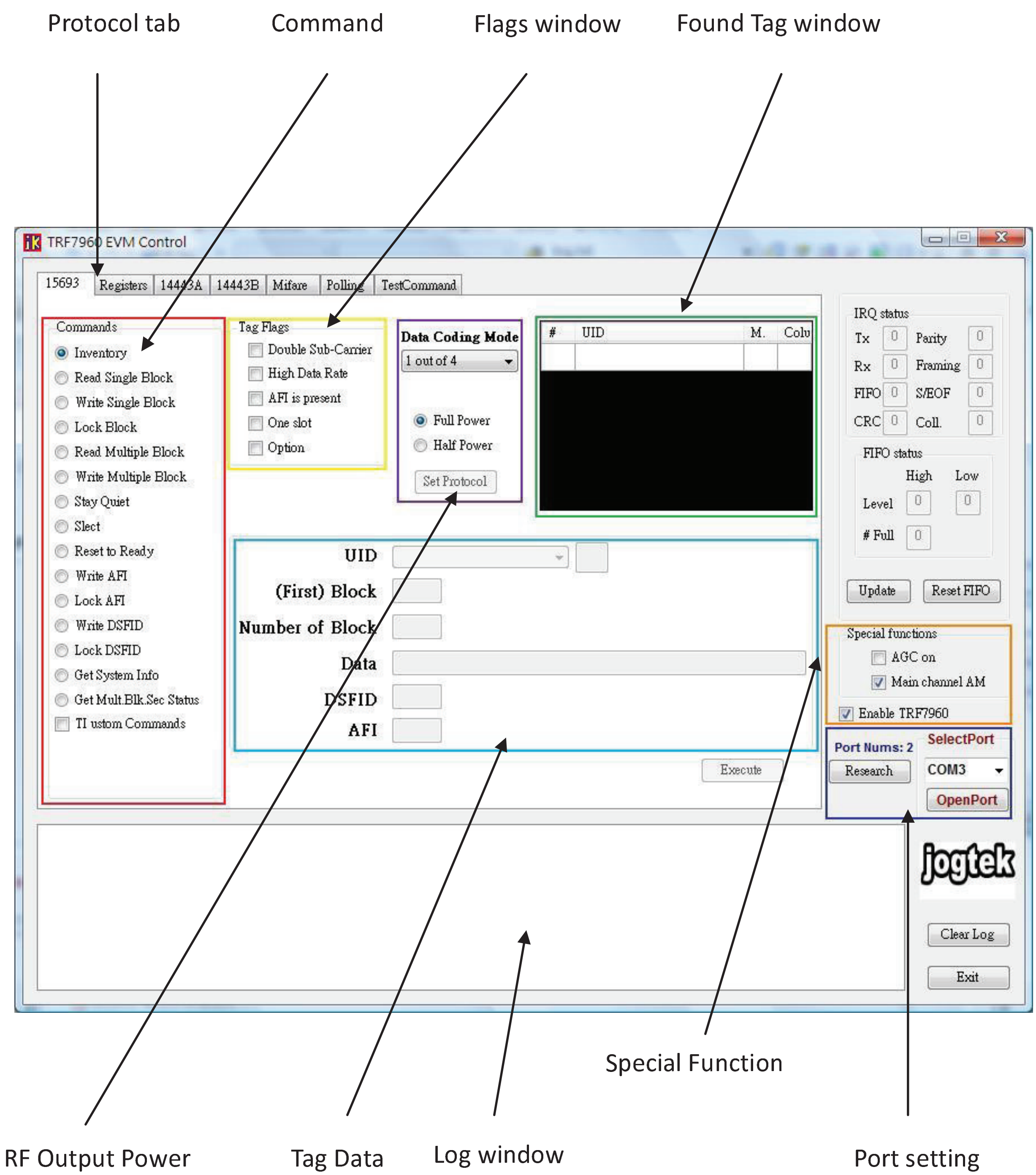
TTL signal levels of 0 to 3V are used to interface the TM-001 to a host device. A simple 3 wire serial connection is provided. The TM-001 does not support RTS and CTS handshaking signals therefore Hardware Flow Control is not available. The TM-001 uses a Risc microcontroller whose UART's Rx and Tx pins connect directly to pins 11 and 12. There are no pull-up resistors on the Rx and Tx lines internal to the TM-001.

The Pin 11 &12 (TX & RX) are for connection for host. Its provide baud rate up to 115200 bps and with setting parity bit and 8 data bits and 1,1.5 or 2 stop bits. We recommend not to cross the two lines when connect to the host keep trace parallel and away power line and harmonic line.

VIH	1.35~2.25V
VIL	0.75~1.65V
VOH	2.4~3V
VOL	0~0.6V

6 Graphical User Interface for Windows

ISO15693:



Protocol Tabs Window:

The protocol tabs window selects between tag protocols and program functions. Available options are:

(ISO/IEC) 15693 – vicinity cards, which has slightly longer read range

Flags window:

This window allows the user to set flags for the 15693 and Tag-it protocols. Different flags may be available for different commands – see Appendix A.1. The tag window automatically updates available flags depending on the request chosen.

Tag Data window:

The *Tag Data* window is where the user enters addresses, data, number of bits, and other information required by certain commands. Checking certain flags in the *Flag* window may activate more fields for data entry.

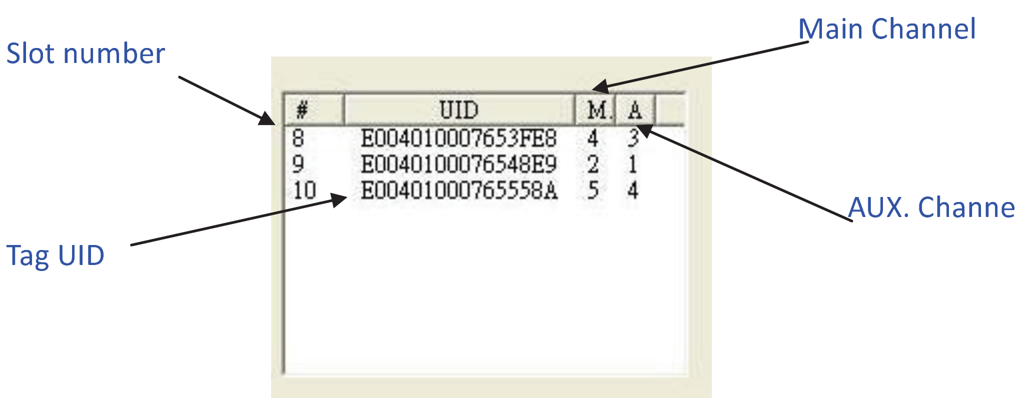
Found Tag window:

The Found Tag field displays the slot number, UID and the Found Tag values of the corresponding tag. If there was a collision and the reader performed a second anticollision procedure, the slot numbers are indicated with an additional character:

A = second procedure

B = third procedure

And so on the main channel, which is AM, is used as the primary one, and PM is the auxiliary channel. The Found Tag maximum value is 7 and minimum value is 0. The corresponding Found Tag values depend on the system design (antenna + reader), and the levels can vary based on the quality of the reception. The specifics of the corresponding input voltage levels to Found Tag levels are defined in the product data sheet.



In the preceding example, one can see that for the tag in slot #10, the Found Tag value is higher for the AM (main) channel, whereas for the tags in slots #8and #9, the Found Tag value is higher for the PM (auxiliary) channel.

Port setting:

When start the program, the program run search COM port at first. The User will see the message in the Log window. If the message is "can't found the COM port ", you should see the COM port block that is enabled. The user could type COM number in that block and press the "select port" button by oneself. After that, the program can connect to the reader.

RF Output Power:

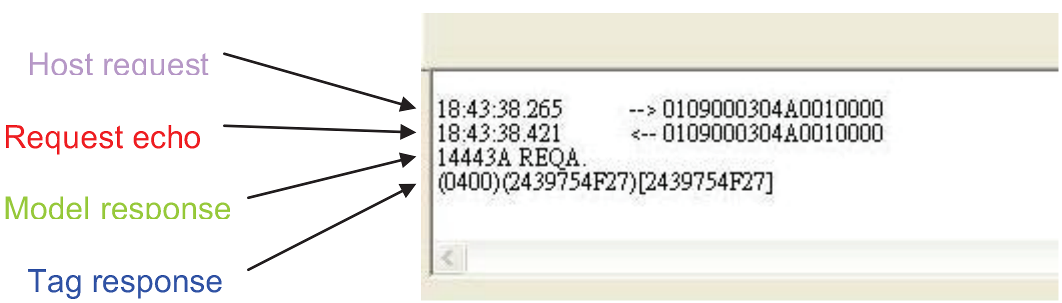
The RF output power selection enables the user to switch between FULL power (200mW) and half power (100mW), however the antenna matching circuit is tuned to operate with FULL power selection and performance will not be optimal in HALF power selection.

Select power

Log window

In the log window, that shows all communication frames from the host to reader board. (This information is also stored in the *"rfid-reader.log"* file which can be opened by a normal text editor (Notepad).) The model echoes the received request back to the host. This enables the user to control the reader from a normal terminal emulator like a *Hyper Terminal*.

There are two side messages in the log window. First side, the received data (tag response, register content) is always in brackets to distinguish it from the host to reader data exchange. The other side, the log window is used to display all the messages and data sent commands from host to reader board. The log file is typically generated in the same directory as the executable for the GUI.



Other functions:

Other functions on the main Test AP control panel are:

Set protocol, which configures the program for the selected protocol once theprotocol tab, has been selected.

Execute button, which runs the selected protocol

Data coding mode, which is used in conjunction with the 15693 protocol

Host to Reader Protocol

The communication is organized into frames from host to reader. Each frame is consisted of 6 fields:

SOF(0X01)	Number of bytes	0x00	0x0304	Command + parameters	EOF(0x0000)

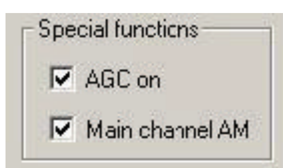
The communication starts with SOF (0x01). The second byte defines the number of bytes in the frame including SOF. The third byte should be kept at 0x00, fourth byte at 0x03 and the fifth byte at 0x04. The sixth byte is the command code, which is followed by parameters or data. The communication ends with 2 bytes of 0x00.

Meaning	command	parameters	Example
Write single register	0x10	Address, data, address, data….	01 0A 00 03 04 **10 15 67** 0000
Write continuous	0x11	Address, data, data…	01 0C 00 03 04 **11 13 67 46 A4** 0000
Read single register	0x12	Address, data, data…	01 0B 00 03 04 **13 05 03** 0000
Read continuous	0x13	NR. Of bytes to read, start address	01 0A 00 03 04 **14 06 01 00** 0000
Inventory (ISO 15693)	0x14	FIFO data	01 0B 00 03 04 **14 06 01 00** 0000
Direct command	0x15	Direct command code	01 09 00 03 04 **15 0F** 0000
Write raw	0x16	Data or commands	01 10 00 03 04 **16 91 3D 00 40 AA BB CC DD** 0000
Request command ISO15693,	0X18	Flags, Command code, data… (as	01 0B 00 03 04 **18 06 20**

Tag-it, 14443B Halt		specified in ISO and Tag-it)	**01** 0000
SID poll(Tag-it)	0x34	Flags, command code, mask (as specified in Tag-it)	01 0B 00 03 04 **34 00 50 00** 0000
Direct mode	0x0F	/	01 08 00 03 04 **0F** 0000
AGC selection	0xF0	0x00-AGC enable 0xFF-AGC disable	01 09 00 03 04 **F0 FF** 0000
AM/PM input selection	0XF1	0X00-FM input 0XFF-AM input	01 09 00 03 04 **F1 00** 0000
TM-00X enable/disable	0x03	0x00-reader enable 0XFF-reader disable	01 09 00 **03 FF** 0000
Begin round(EPC)	0X54	No. of slots	01 09 00 03 04 **54 03** 0000
Close slot sequence(EPC)	0X55	/	01 08 00 03 04 **55** 0000
REQB(14443B)	0xB0	/	01 08 00 03 04 **B0** 0000
REQA(14443A)	0XA0	/	01 08 00 03 04 **A0** 0000
Select (14443A)	0XA2	CID	01 0D 00 03 04 **A2 11 22 33 44 44** 0000

Special Functions

These functions allow the user to enable the Automatic Gain Control (AGC) feature and also allows for the switching from the AM to PM input.



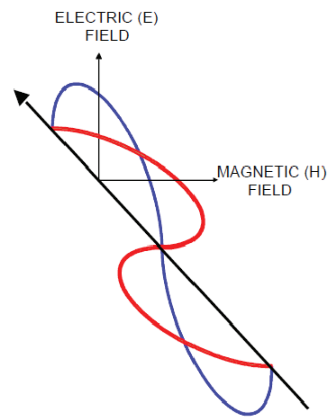
The AGC is turned off after the power on reset (POR) and can be enabled when desired (Especially in noisy environments). By default the input channel is AM and can be switched to PM if the RSSI value for the PM channel is higher than the AM.

7 Antenna Design Guide

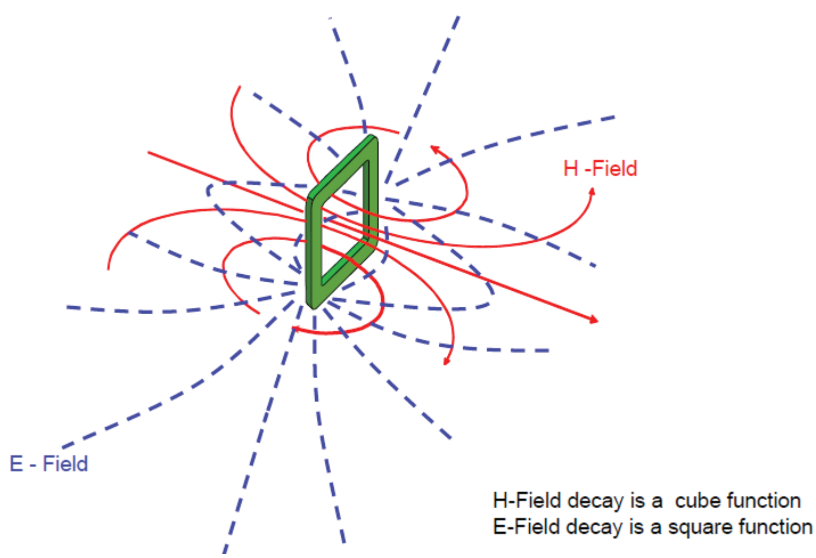
7.1 Fundamentals

Radio Waves

- Radio signals are electromagnetic waves, having a magnetic component (H-Field) and an electric component (E-Field)
- HF systems use the Magnetic field to transfer power by induction but the strength of this field falls off quickly.
- The magnetic field results from current flow and is measured in A/m or more commonly dBµA/m.
- The Electric field results from the voltage changes occurring in the antenna and is measured in V/m or more commonly dBµV/m



Distribution of the Magnetic (H) and Electric (E) fields of an RFID antenna:



HF Frequency

The frequency is 13.56 MHz and is classified as being in the HF region. The wavelength is given by:

$$\lambda = \frac{C}{f}$$

Where λ ………. Wavelength (meters)

C ……… Speed of light (299792500 m/s)

ƒ ……….. Frequency (Hertz)

Frequency (MHz)	Band m	λ /2 m	λ /4 m
13.56	22	11	5.5

Impedance

Ordinary DC resistance is easy to measure with an Ohmmeter but in an AC circuit the resistance (impedance) becomes a complex measure including capacitive and inductive components. In RF circuits, impedance is not a constant parameter but changes with frequency and phase. Impedance is made up of DC resistance and two types of AC (frequency dependant) resistances called reactance. A pure capacitance exhibits capacitive reactance and a pure inductance exhibits inductive reactance

Capacitive Impedance

Capacitive impedance is the sum of the DC resistance and the capacitive reactance. The DC resistance is a constant, whilst the capacitive reactance is determined by the capacitance value and the applied frequency:

$$X_C = \frac{1}{\omega C}$$

Where ω = 2πƒ

ƒ = frequency (MHz)

XC = Capacitive reactance (Ohms)

C = Capacitance (μFarads)

π = Constant (3.142)

As frequency increases, capacitive reactance decreases.

Inductive Impedance

– Inductive impedance is the sum of the DC resistance and the inductive reactance. The DC resistance is a constant, whilst the inductive reactance is determined by the inductance value and the applied frequency:

$$X_L = \omega L$$

Where ω = 2πf
ƒ = frequency (MHz)
XL = Inductive reactance (Ohms)
L = Inductance (μHenrys)
π = Constant (3.142)

As frequency increases, inductive reactance **increases.**

Total AC Impedance

– Total AC impedance is the vectorial sum of all 3 components R, X L and X C The capacitive reactance (X C) is always 180º out of phase to the inductive reactance (X L).

$$Z = \sqrt{R^2 + (X_L - X_L)^2}$$

Where: Z = total impedance
R = dc resistance
XC = Capacitive reactance
XL = Inductive reactance

Tuned LC Circuit

If a capacitor (C) and inductor (L) are used in combination, they form the electrical equivalent to a mechanical pendulum. The pendulum moves backwards and forwards at a set frequency using little energy. For any LC circuit, the inductive reactance (XL) and capacitive reactance (XC) will be equal at some frequency. This frequency is called the resonant frequency and if the values of L and C are known, can be calculated:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

In general, larger values of L and C produce relatively low frequencies, whereas smaller values produce higher frequencies.

For large ISO15693 loop antennas, the inductance should be less than 5 µH or matching will prove difficult.

Skin Depth

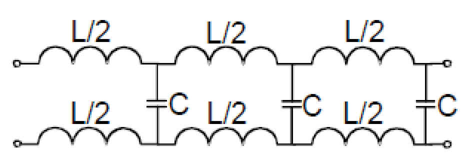
When a DC current flows through a cable it uses the whole cross-section of the wire but when an RF signal is travelling along a cable, it flows through the outside skin as the centre of the cable is disturbed by eddy currents. At mains frequency (e.g. 50 Hz) this effect is minimal but as frequency increases the depth of the 'skin' gets less. The following formula applies:

$$\textbf{Skin Depth}_{(mm)} = \frac{2}{\sqrt{\dfrac{f_{(hertz)}}{1000}}}$$

At 13.56 MHz frequency, the skin depth is 0.017 mm

Transmission Line Impedance

A transmission line can be considered as an infinite network of inductors and capacitors that make up the characteristic impedance (**Z0**)

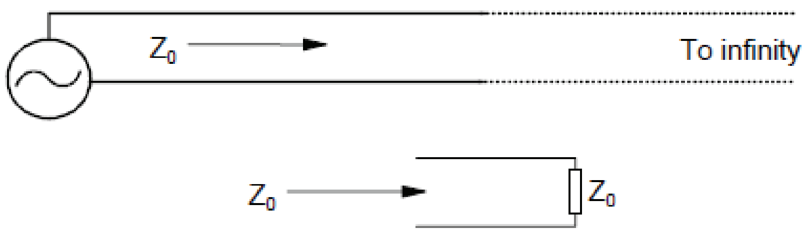


For HF RFID coax cable with a characteristic impedance of 50 Ohms is required (e.g. RG58/U). The relationship between inductance, capacitance and the characteristic impedance (if dc resistance is ignored) is given by:

$$Z_0 = \sqrt{L/C}$$

Characteristic Impedance

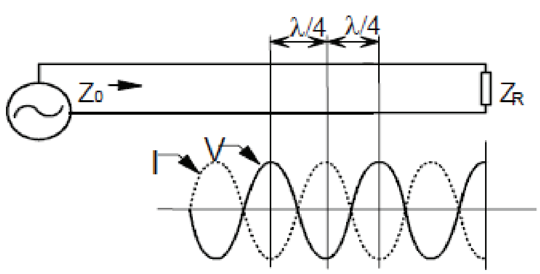
This is a value based on the inherent conductance, capacitance and resistance of a cable and represents a cable of infinite length.

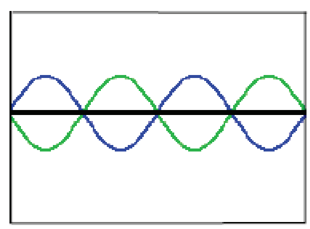


But no line is infinite and terminating the line with Z0 will make it behave as if it were.
Where a line is terminated by an impedance (ZR) other than the characteristic impedance Z0 then reflections of the transmitted signal will arise as the power is not completely absorbed.

Reflections and Standing Waves

Maximum output from an antenna can only occur when its impedance is matched to that of the the transmitter. Under the condition Z0 = ZR the transmitter is matched to the load and maximum energy is put into the load. When an antenna is not matched, instead of being absorbed the power has nowhere to
go and reflections occur.





– These reflections are known as waves and the ratio of the maximum to minimum voltage on an antenna is known as the **S**tanding **W**ave **R**ation (SWR)

Velocity Factor

The speed that electromagnetic waves travel through a transmission line, is less than the speed in free space (3 x 10 8 m/s). Each cable has a correction value that is called the velocity factor. For RG58 cable it is around 0.66.
So a ¼ wavelength cable is (22 ÷ 4) × 0.66 = 3.6 m (11.9 ft)

7.2 Antenna Matching for the TM-001 RFID Reader Module

Introduction & Antenna Fabrication

This section describes the design method for determining an antenna matching circuit. While there are an infinite number of possible impedance matching networks, this application example focuses on a 50 ohm three element match. A three element match is recommended as it allows the designer to select the required antenna "Q" for the application.

The PCB design used in this application is based on FR4 material, Er = 4.5, with a material thickness of 0.62 inches. The board design is 2 layer design (layer 1 top, & layer 2 bottom), with 2 oz copper. A schematic of a typical antenna circuit is given in Figure 1. The antenna trace width together with the trace spacing, will determine the antenna impedance and "Q" (quality factor) respectively.

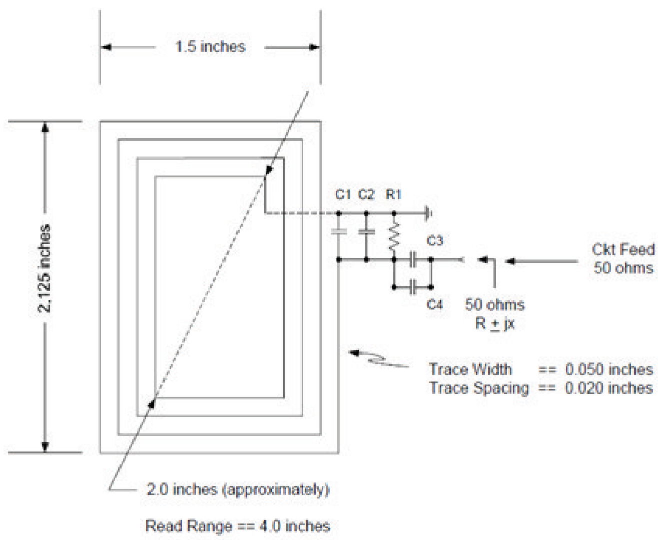


Figure 1 RFID Antenna (typical)

In this application, the antenna is fabricated on the top side of PCB. Some antenna designs will have antenna traces on both top and bottom layers; which is OK. In either case, it is important to keep ground planes away from antenna traces or elements. Notice that the antenna drawing (Figure 1) shows a diagonal measurement of approximately 2.0 inches. A rule of thumb is that the expected read range is twice the antenna diagonal measurement.

Figure 2a. Antenna Bottom Layer

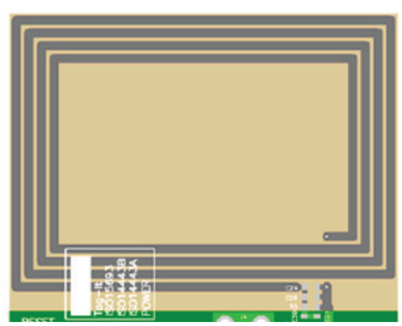


Figure 2b. Antenna Top Layer

Antenna Impedance Matching

A three element match is used as it has the added advantage of allowing the circuit "Q" to be a chosen value. As the circuit $Q = \frac{Fo}{BW} = \frac{13.56\,MHz}{2\,MHz} = 6.78$; where the required operating bandwidth is chosen at 2 MHz.

The first step in impedance matching is calibrating the network analyzer. This is done by connecting a RF test connector on three blank circuit boards, one with a 50 load, second with a short (0 ohm resistor), and third with an open. By using the application board in the calibration, PCB parasitic effects are accounted for.

Following the calibration step, the antenna trace is connected to the test connector as required by zero ohm resistors. The antenna trace is measured as shown in Figure 3; the resulting measurement is the starting impedance which will be matched to 50 ohms.

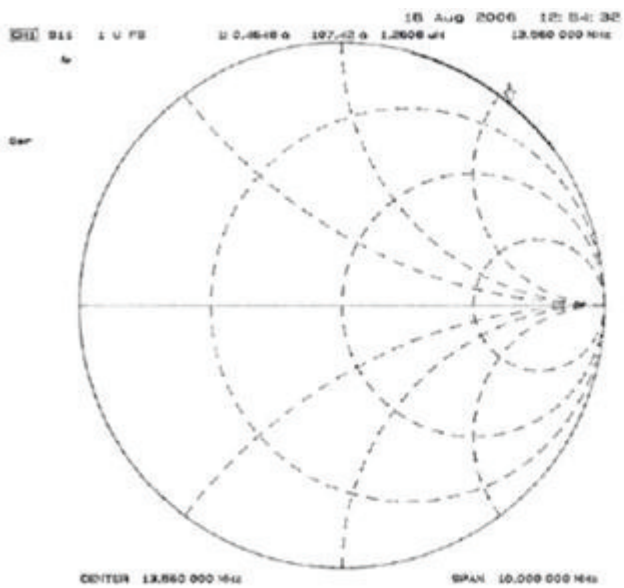


Figure 3. Antenna Impedance = = (0.4648 ohms + j107.42) = = 1.2608 uH

Shown in Figure 3 is the measured antenna impedance (0.4648 + j107.42) @ 13.56 MHz. Note that in this application the antenna impedance is at the Smith Chart's outer limit; or other wise stated the starting impedance is up against the rail. This makes the impedance matching a little more difficult.

A minimum BW of 2 MHz is chosen in order to accommodate the upper & lower RFID sidebands for various data rates given in ISO15693 & ISO14443 A/B. Hence the approximate resistor value needed is determined as follows:

$$Q = \frac{Fo}{BW} = \frac{13.56\,MHz}{2\,MHz} = 6.78$$

$$Q = \frac{Rp}{X_L} = \frac{R}{2 * \pi * 13.56\,MHz * 1.2608\,uH} = \frac{R}{107.42}$$

Note that the "X_L" value is the same as the measured Smith Chart value (107.42) from Figure3.

$$Rp = Q * X_L = 6.78 * 107.42 = 728\ ohms$$

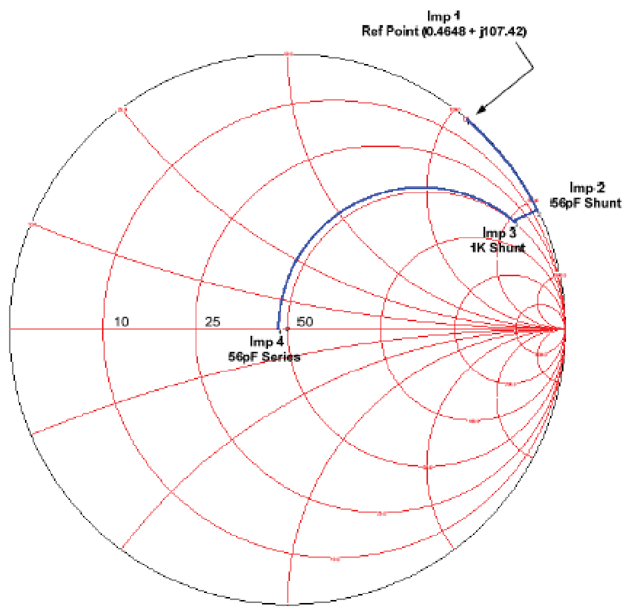


Figure 4 Smith Chart Impedance Match Simulation

The measured impedance from Figure 3 is shown in Figure 4 as Imp 1. A shunt 56 pF capacitor rotates the impedance to Imp 2. Next a shut resistor (which sets the antenna Q or BW), rotates the impedance from Imp 2 to Imp 3; where the impedance is now on the 50 ohm circle. The final matching element is a 56 pF capacitor, which rotates the impedance from Imp 3 to Imp 4 (46.6 + j0.3). This capacitor is split into two parallel caps (47 pF + 10 pF) to allow fine tuning of the antenna frequency while also reducing component parasites. Note earlier the shut resistor was calculated to be 728 ohms whereby it is now rounded to up to 1.0 K ohms in order to yield a match with standard capacitor values. Final circuit values for the antenna circuit given in Figure 1 are as follows:

C1 = = 56 pF

C2 = = DNP (Do Not Place)

R1 = = 1 .0 Kohms

C3 = = 47 pF

C4 = = 10 pF

Antenna Performance

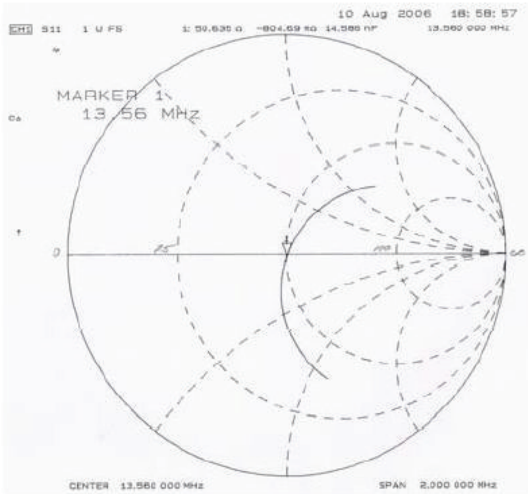


Figure 5. (Smith Chart) (50.635 – j804.67) = = 14.586 nF

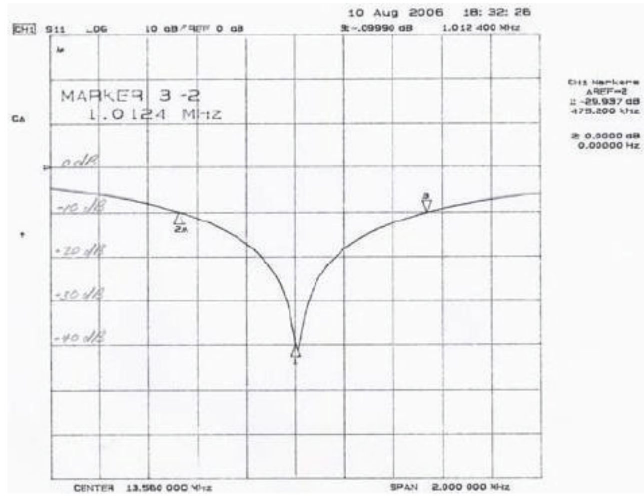


Figure 6. (Return Loss) (RL = 40 dB @ 13.56 MHz)

Note that Figure 6 shows a 10 dB return loss over a 1.0124 MHz BW (Mkr 3-2). A rule of thumb is that the antenna 3 dB BW is twice the 10 dB return loss bandwidth. Appling the rule to this application would yield an antenna bandwidth of 2.248 MHz.

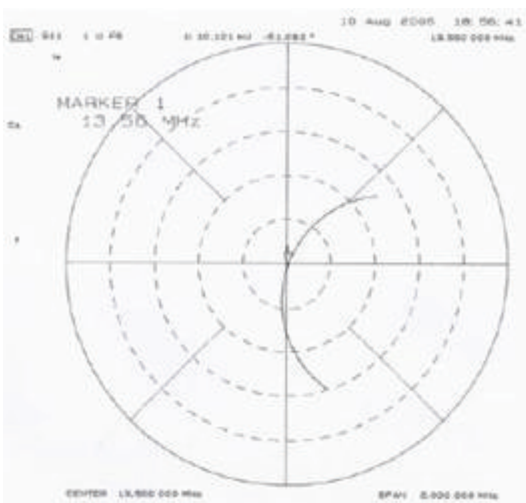


Figure 7. Polar Plot

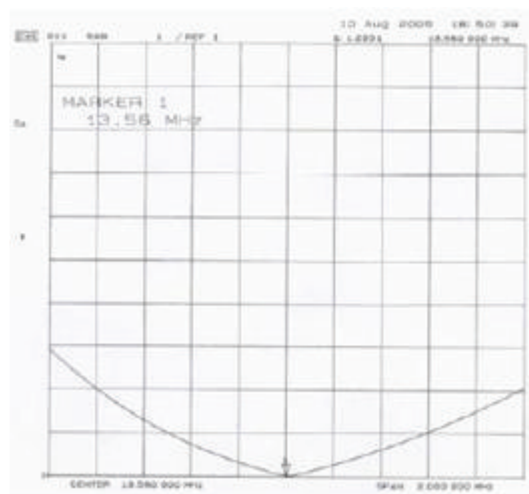
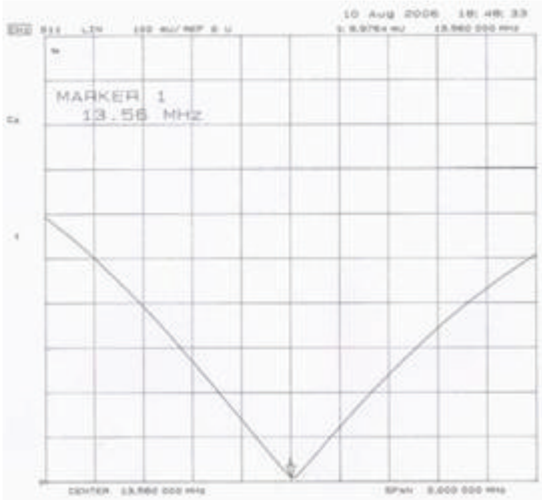
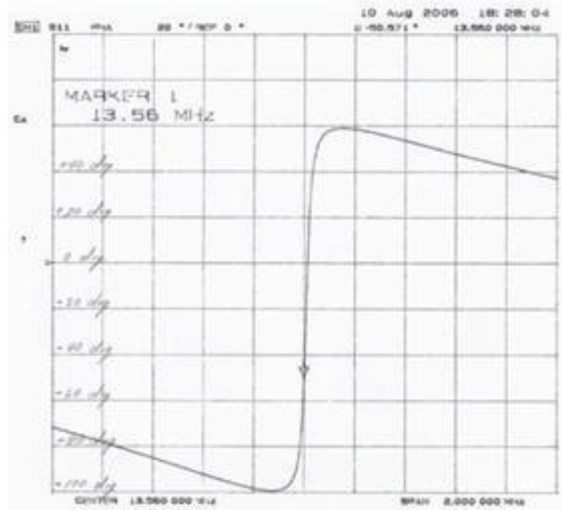


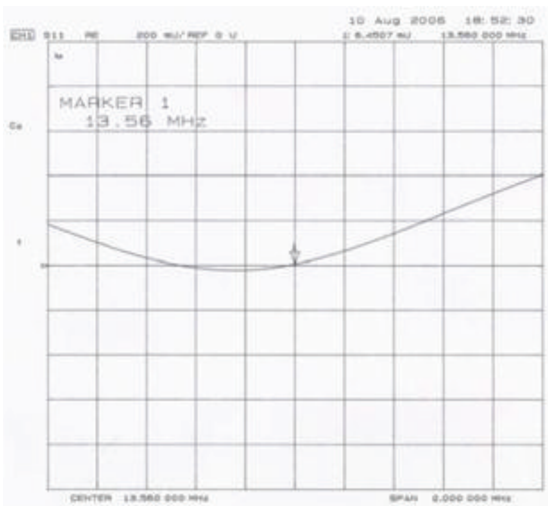
Figure 8. VSWR Plot



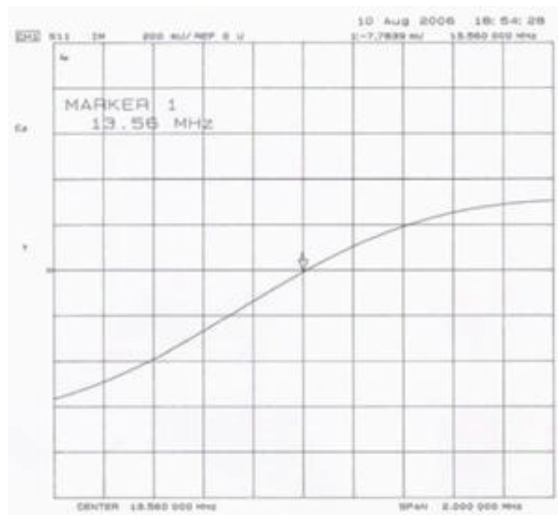
Linear Plot



Phase Plot



Real Part



Imaginary Part

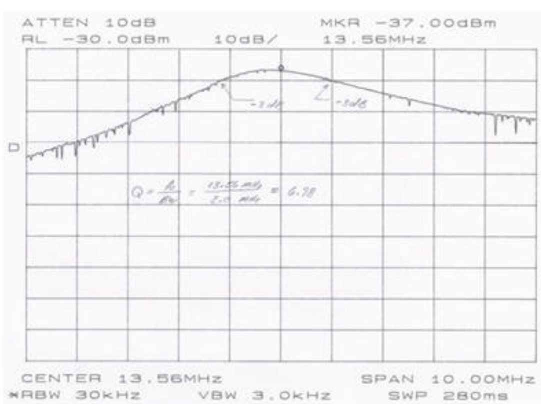


Figure 9. Measured Antenna Bandwidth & Q

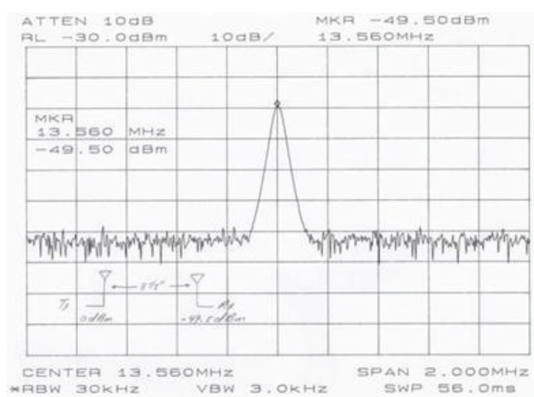


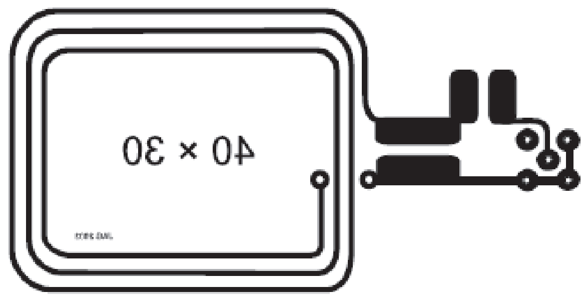
Figure 10. Antenna Transmission Test

As a final test to ensure the antenna elements will radiate, a test set up was established. A 0 dBm CW signal is applied to the Tx antenna; the Rx antenna is placed 8.5 inches from the Tx antenna (the width of a standard piece of office paper). The output from the Rx antenna is measured on a spectrum analyzer which shows a -49.5 dBm signal level. Both Tx & Rx antenna are PCB RFID reader antennas.

Small Antenna (40mm x 30mm)

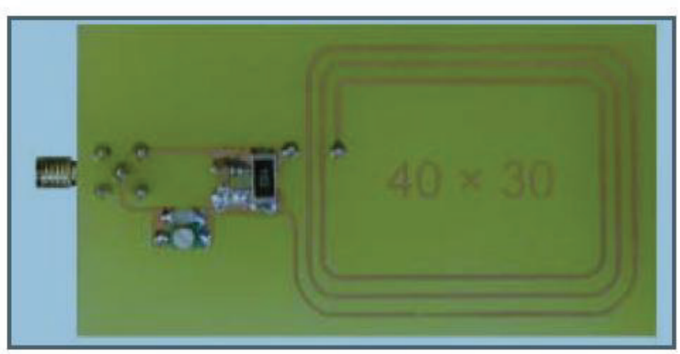
Circuit Layout

The antenna uses a printed circuit and the artwork for the board is given in the figure below.



40 mm x 30mm Antenna Artwork

If this artwork is used, check that it has not been 'scaled' by your printer by measuring the holes for the SMA connector. The distance between centers for the outside pins should be 5 mm.



Completed Antenna

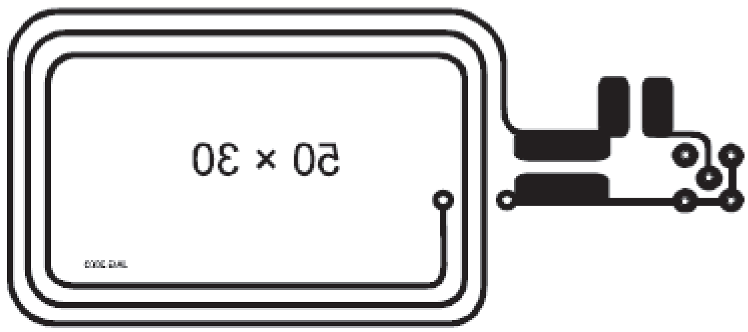
The Matching Components

Across the parallel pads are a 10K Ohm, 1W resistor to reduce the Q to 27 and 177 pF (150 pF + 6 to 30 pF variable,100V) resonance adjusting capacitance. In series is 33 pF (10 pF + 5 to 30 pF variable, 100V) capacitance to match the antenna to 50 Ohms. The SMA connector is optional as the coax cable could be solder directly to the pads to reduce cost.

Small Antenna (50 mm × 30 mm)

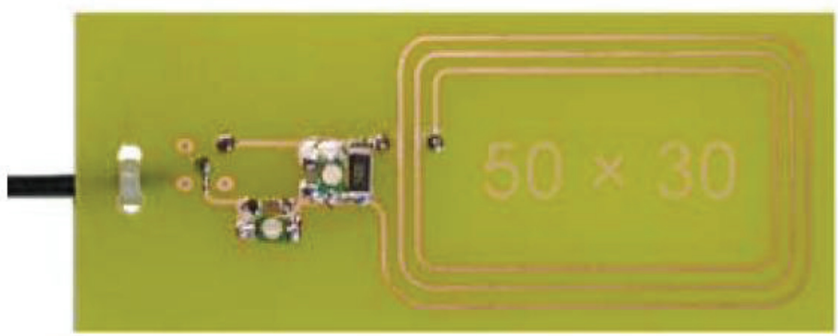
Circuit Layout

The antenna uses a printed circuit and the artwork for the board is given in the figure below.



50 mm × 30 mm Antenna Artwork

If this artwork is used, check that it has not been 'scaled' by your printer by measuring the holes for the SMA connector. The distance between centers for the outside pins should be 5 mm.



Completed Antenna

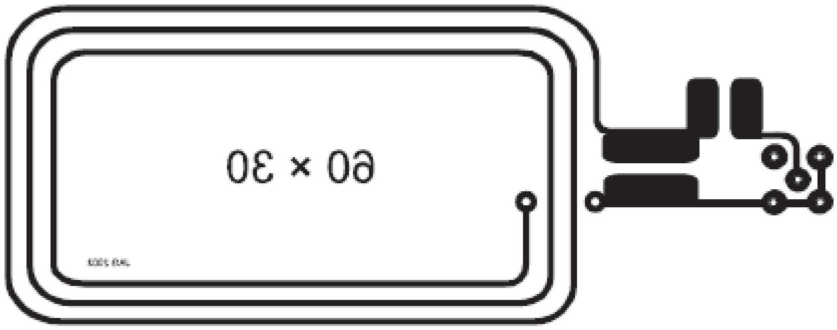
The Matching Components

Across the parallel pads are a 10K Ohm, 1W resistor to reduce the Q to 22 and 148 pF (120 pF + 6 to 30 pF variable, 100V) resonance adjusting capacitance. In series is 31 pF (10 pF + 6 to 30 pF variable, 100V) capacitance to match the antenna to 50 Ohms. The SMA connector is optional and in the figure above, the coax cable is soldered directly to the pads to reduce cost.

Small Antenna (60 mm × 30 mm)

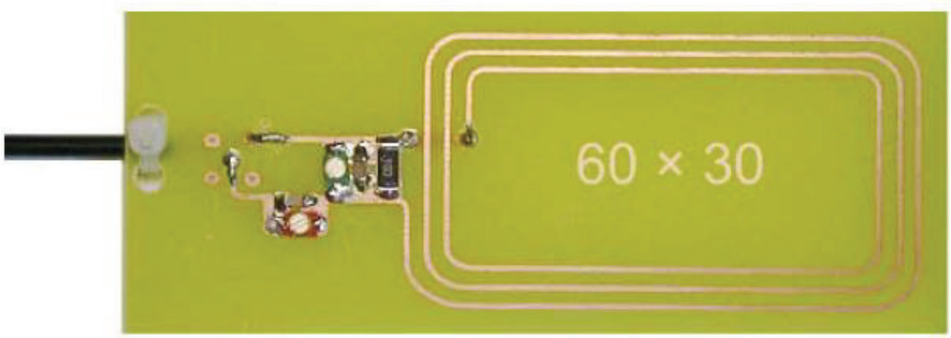
Circuit Layout

The antenna uses a printed circuit and the artwork for the board is given in the figure below.



60 mm × 30 mm Antenna Artwork

If this artwork is used, check that it has not been ‘scaled’ by your printer by measuring the holes for the SMA connector. The distance between centers for the outside pins should be 5 mm.



Completed Antenna

Matching Components

On the rear of the board, a wire link is inserted to complete the loop. Across the parallel pads are a 10K Ohm, 1W resistor to reduce the Q to 21 and 132 pF (100 pF + 10 pF + 6 to 30 pF variable, 100V) capacitance for the resonant frequency adjustment. In series is 27 pF (10 pF + 5 to 20 pF variable, 100V) capacitance to match the antenna to 50 Ohms. The SMA connector is optional and in the figure above, the coax cable is soldered directly to the pads to reduce cost.

7.3 TM-001 external Antenna Elements & Tuning

Range is determined by a number of factors:

– Standard ISO14443 has a lower read range vs. ISO15693

– Size and type of reader antenna

• PCB = repeatable, low cost, etched, antenna on pcb has planar performance

• External wire antenna = variable, more cost, less repeatability, no planar effects

– Size of transponder (tag)

– Rule of Thumb: (For ISO15693) the diameter of the reader antenna will be the read range with respective to a "badge" size transponder.

7.3.1 Antenna Port

TM-001 Pin1 and Pin2 are standard 50 Ohm output port at 13.56MHz, it could connect external loop antenna with 50 Ohm.

7.3.2 Antenna Quality Factor (Q)

Quality factor (Q) is a measure of the efficiency of an antenna.

• Higher the Q -> greater the antenna gain

• Higher the Q -> narrower the band width

• Lower the Q -> broader the band width

Q-factor considerations:

Q=12-25 for bit rates up to 424kbps

Q=8-12 for 848kbps bit rates

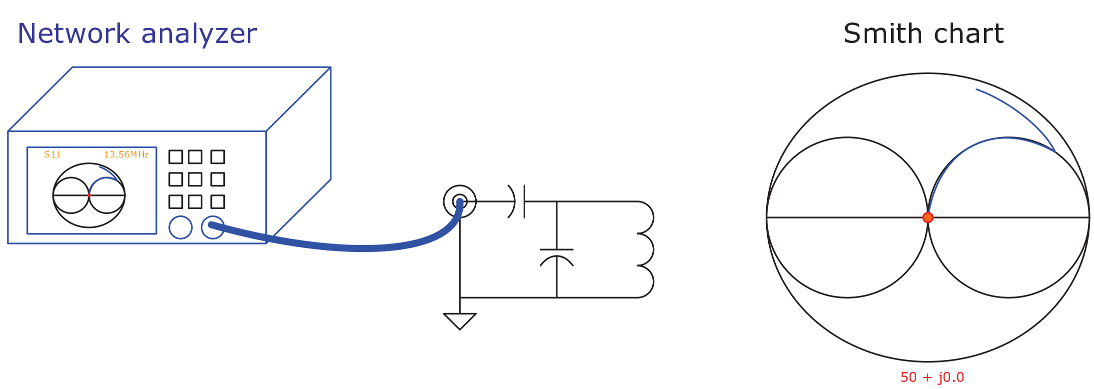
7.3.3 Tuning Impedance

Connect antenna to a network analyzer and measure the impedance = 50 ohm @ 13.56MHz

Antenna Matching Example: (L Matching)

Add shunt capacitance to match to the 50ohm impedance circle

Add series capacitance to match to the Real axis and 50ohm point.



Impedance measurement

Note: an additional resistor in parallel to the shunt capacitor in order to set the antenna Q

The antenna is used for data and energy transfer to the tag or cards. For optimum performances, the antenna must have its impedance matched to the Ant+ and Ant- port(pin1 & pin2 ,see Fig.3). We use an inductive loop antenna, which is appropriate for the magnetic field generation. The antenna circuit is composed of an Inductor Coil, serial and parallel capacitors and an optional parallel resistor.

We provide the typical loop antenna matching circuit for you to reference design, see Fig.4

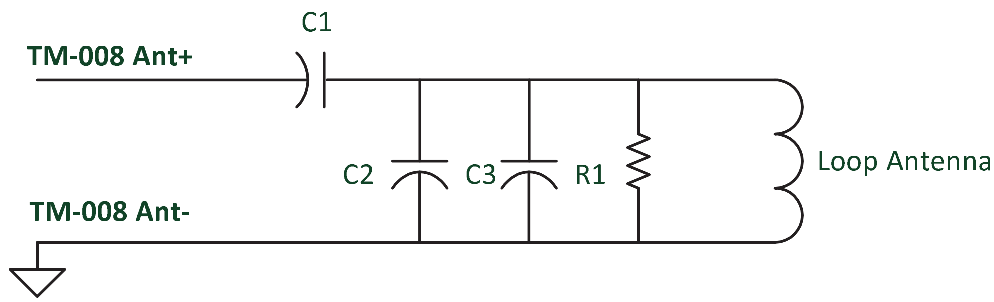


Fig 7.3.4 matching circuit

In Fig 7.3.4, C1 is serial capacitor and C2 and C3 are parallel capacitors and we recommend to use the adjustable capacitor for C2. In order to fine tune the antenna performance. R1 are parallel resistor which its value will effect the Q factor.

8 RFID Operation

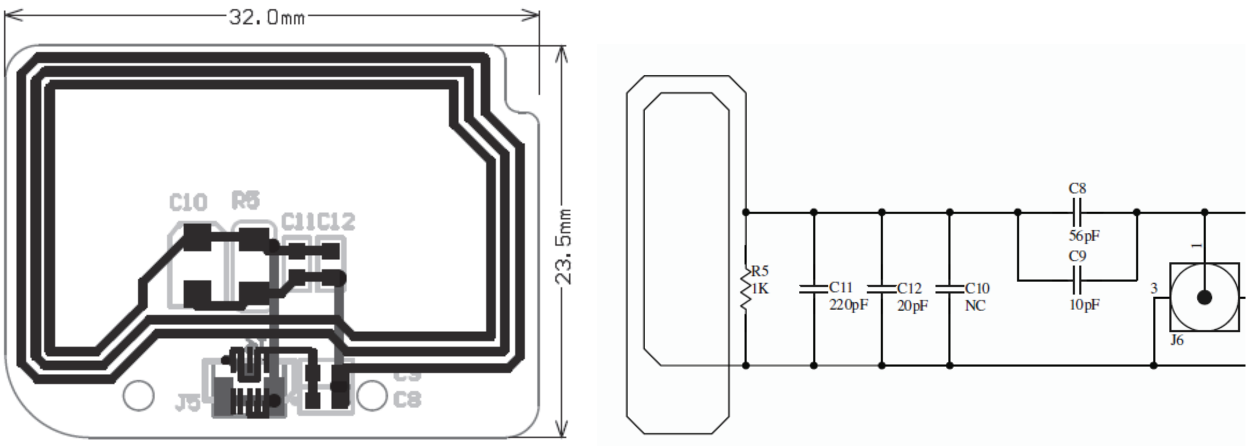
8.1 Read Range

Read range depends on the RFID Tag IC, the RFID tag antenna, the RFID reader and reader antenna, in addition to the system in which the RFID read/write distance is typically greater than or equal to 120mm for a Jogtek Reader Antenna 45mm * 65mm and Texas Instruments Tag-It HF-I ISO15693 RFID inlay with antenna dimensions 45mm x 76mm (TI p/n RI-I02-112A-03).

TM-001 with 45mm*65mm Reader Antenna (in open air environments)			
Inlay	TI Inlay RI-I02-112A	TI Inlay RI-I11-112A	TI Inlay RI-I03-112A
Inlay Antenna Size	45*76mm	45*45mm	22.5*38mm
Read range	12cm	9cm	7cm

8.2 PDA Antenna Testing Report

TM-001 with 32mm*23.5mm Reader Antenna (in open air environments)



Standard	Tag Chip	Tag Antenna Size	Tag frequency	TM-PA600
ISO15693	TI Tag-it 256bits	ISO Card Size	13.72MHz	80mm
	TI Tag-it Pro 256bits	ISO Card Size	13.74MHz	79mm
	TI Tag-it Plus 2kb	ISO Card Size	13.74MHz	79mm
	NXP ICODE SLI	ISO Card Size	13.96MHz	80mm
	ST LRi2K 2Kb	ISO Card Size	13.18 MHz	65mm
	ST LRi2K 2Kb	50mm x 50mm	13.88MHz	78mm
	Infineon My-d SRF55V10P_HC 10 Kb	ISO Card Size	13.54MHz	75mm
ISO14443A	NXP Mifare UL 0.5KB	ISO Card Size	16.12MHz	20mm
	NXP Mifare S50 1KB	ISO Card Size	15.1MHz	45mm
	NXP Mifare S70 4KB	ISO Card Size	15.8MHz	34mm
	NXP JCOP31 36KB	ISO Card Size	16.4MHz	28mm
ISO14443B	TI TMS37113	ISO Card Size	12.76MHz	20mm

8.2 Tag Compatibility

Transponder Communication Rate

ISO 15693: 26kbps ISO 14443A/B: 106kbps, 212kbps, 424kbps, 848kbps

Federal Communication Commission Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Radiation Exposure Statement:
The product is a low power device and its output power is lower than FCC SAR exemption level. This module can be used with **Getac Notebook PC: B320**.

This device is intended only for OEM integrators under the following conditions:

1) The transmitter module may not be co-located with any other transmitter or antenna. The co-transmitting with other radio will need a separate evaluation.
2) Module approval valid only when this module is installed in the tested host "**Getac Notebook PC: B320**".

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed

IMPORTANT NOTE: In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling
The final end product must be labeled in a visible area with the following: "**Contains FCC ID: QYL320RFID**". The grantee's FCC ID can be used only when all FCC compliance requirements are met.

Manual Information To the End User
The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.
The end user manual shall include all required regulatory information/warning as show in this manual.