MaxID RM100 RFID reader User Manual

Version	*1.0*
Date	*17 Oct. 05*
Document Status	*Revision*
Document ID	*1170*

MaxID Limited, Quatro House, Lyon Way, Frimley, Surrey GU16 7ER, United Kingdom
Phone: +44 (0) 1276 80 4498, Fax: +44 (0) 1276 80 4499, URL: www.MaxIDcorp.com

Change History

Configuration Control

Project:	RFID
Title:	MaxID RM100 RFID reader User Manual
Document ID:	1170
Created by:	Riaan van den Berg
Creation Date:	6 July 2005

Document History

Version	***Date***	***Status***	***Who***	***Saved as:***
1.0	17 Oct. 05	revision	RvdB	MaxID RM100 User Manual

Revision History

Version	***Date***	***Changes***
0. 1	2005/07/06	Add unpacking and installation instruction chapters

Management Authorisation

Version	***Date***	***Status***	***Approval Minutes Reference***

Table of Contents

1. Scope 5
2. FCC Statement 6
WARNING ! 6
3. Limitation of Liability 7
4. Features 8
5. Typical applications 9
5.1 Automotive 9
5.2 Airline baggage 9
5.3 Consumables 9
5.4 Livestock tracking 9
5.5 Hotel room Access 9
5.6 Bin tracking 9
5.7 Valuable asset tracking 9
5.8 Vehicle access systems 9
6. Installing the RM100 RFID reader 10
6.1 Before You Start 10
6.1.1 Overview of the RM100 module – Front 10
6.1.2 Overview of the RM100 module – Back 10
6.2 Hardware Requirements 11
6.2.1 Power supply 11
6.2.2 Data Terminal Equipment (DTE) 11
6.3 Unpacking the RM100 KIT 11
6.4 Installing the software 12
6.5 Installing the Patch Antennas 12
6.5.1 Dual Antenna set 12
6.5.2 Single Antenna in handheld configuration 13
7. Functional Block diagram 14
8. Description 21
8.1 RFID Reader 21
8.2 Serial Interface 22
8.2.1 Physical: 22
8.2.2 Protocol: 22
8.2.3 Evaluation program 23
9. Specification 24

9.1 Performance _____ **24**
9.2 Physical _____ **24**
9.3 Environment _____ **24**

1. Scope

The RM100 from MaxID Ltd is a multi-protocol radio frequency identification (RFID) reader designed to support all electronic product code (EPC)-compliant UHF RFID tags.

The RM100 is an industrial-class OEM (Original Equipment Manufacturer) reader that provides all of the RFID control functions required to power and communicates with passive RFID tags. The RM100 was designed to integrate into handheld portable data terminals, printers, label applications, mobile computers and other OEM devices.

It is a high-performance reader that collects, writes, processes and communicates information from all classes of EPC RFID tags. The RM100 leverages advanced digital filter technology to deliver superior interference management and are optimized to read tags in both clean and noisy radio environments.

2. FCC 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) (2) this device must accept any interference received, including interference that may cause undesired operation.

WARNING !

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 radiated 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 or more 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.

Changes or modifications not expressly approved by the party responsible for compliance could void the user‘s authority to operate the equipment.

3. Limitation of Liability

In no event shall MaxID Ltd. or anyone else involved in the creation, production or delivery of the accompanying product (including hardware and software) be liable for any damages whatsoever (including, without limitation, consequential damages including loss of business profits, business interruption or loss of business information) arising out of the use of or the results of use of or inability to use such product, even if MaxID Ltd. has been advised of the possibility of such damages. Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

4. Features

- Support EPC class 0, class 1.0, class 1.19, class 1.0b, U-code 1.19 and IPX tags
- Can be used for fixed or semi-mobile or mobile applications
- Reads long range passive RFID tags
- Rugged metal housing
- DC powered via external power supply or Lithium-Ion Battery
- RS232 interface (standard)
- Easy to use serial interface protocol

5. Typical applications

5.1 Automotive

RF-ID is advancing pay at the pump with more speed and convenience; it has provided hassle free automated transactions provided by RF-ID based payment systems.

5.2 Airline baggage

British Airways have conducted trials of a paper label based RF-ID transponder, in Europe with over 225,000 pieces of luggage having been transferred successfully between airport hubs from Manchester and Munich to London's Heathrow Terminal 1.

5.3 Consumables

Beer kegs are tagged to automate the supply chain and to track the whereabouts of these valuable items. Other returnable items such as special pallets or other transport structures can similarly be tagged to ensure their safe return.

5.4 Livestock tracking

The Agriculture and Resources Department of Victoria, Australia announced that they would distribute 1 million tags free of charge to begin a wide scale cattle-monitoring program.

5.5 Hotel room Access

RF-ID door locks are installed at many European hotels to ensure not only customer safety but also assured and safe access.

5.6 Bin tracking

Product carriers can be tagged for order picking or for routing purposes to the next workstation.

5.7 Valuable asset tracking

Valuable assets such as Earthmoving equipments and other road working equipments do go 'missing' and are very hard to track down, when they are it is sometimes even harder to prove ownership if serial numbers have been removed/altered.

5.8 Vehicle access systems

A RFID reader can track and monitor the cities public transport system. As a bus approaches a traffic light it passes over an in-ground antenna that triggers the light to change depending on the priority status of the vehicle. The system can trigger green light wave-troughs for buses and other public transport as well as emergency vehicles such as police, ambulance and fire trucks.

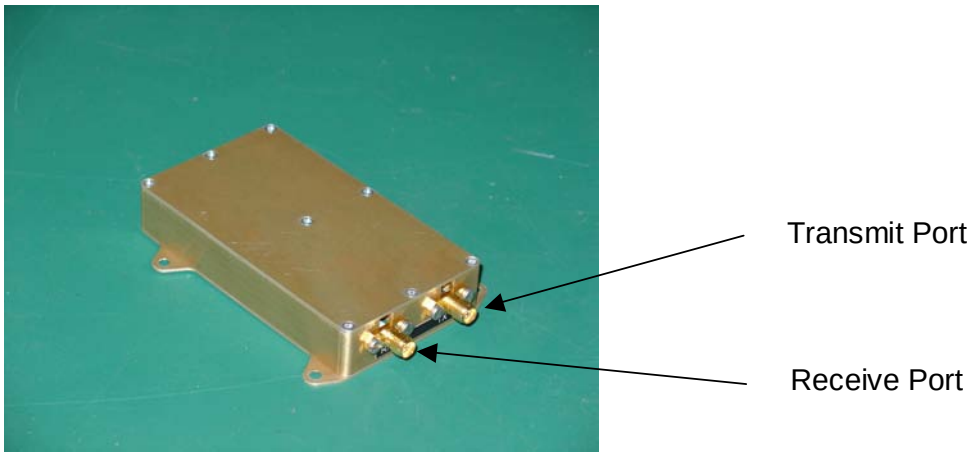
6. Installing the RM100 RFID reader

This chapter describes how to install and set-up the RM100 reader.

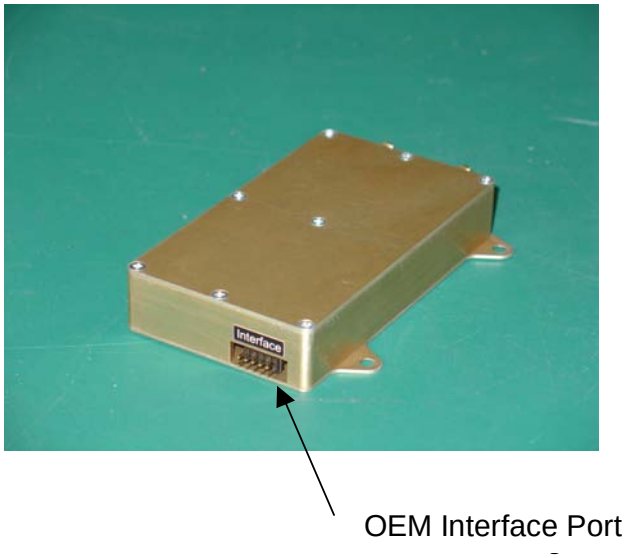
6.1 Before You Start

When first opening the packing carton, check the equipment for any visible signs of damage. Ensure that none of the connectors have loosened during shipping. If any damage is visible, please make a complete record and notify the shipper immediately. Save the packing material for possible use later.

6.1.1 Overview of the RM100 module – Front



6.1.2 Overview of the RM100 module – Back



6.2 Hardware Requirements

6.2.1 Power supply

The RM100 module was designed to run either from a 3.7V Lithium-Ion battery or from a 3.2V to 4.2Vdc power source. The maximum current requirement is 1.5A

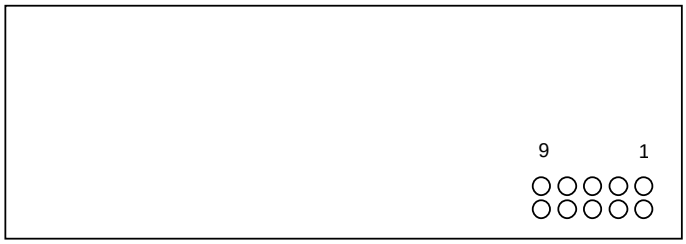
6.2.2 Data Terminal Equipment (DTE)

The RM100 module uses asynchronous communication to communicate to 3rd party equipment. The baud rate, parity and data bits are user selectable, with 38400,E,8 shipped as the default values.

Only RXD and TXD data lines are used, no hardware flow control necessary.

RXD and TXD electrical interface levels are TTL and not RS-232

It is up to the OEM to provide a carrier board for the RM100 module. This carrier-board must connect to the 10-pin connector on the RM100 module. This 10-pin connector is used for asynchronous communication, LED's and the for the power supply interface. See figure below for pin-outs.



As seen from back

See section 8.2.1 for Pin-out description

6.3 Unpacking the RM100 KIT

The following items should be included:

- RM100 RFID Module
- Two Circular Patch Antennas
- CD with Demo Software
- User manual
- Warranty & Test Certificate

6.4 Installing the software

Insert the CD-ROM into drive.

Under windows select “Run” “Browse” from the start menu

Choose setup.exe from the CD-ROM and follow the easy steps displayed on the PC

6.5 Installing the Patch Antennas

The RM100 Module can operate from a single antenna (combining with a circulator) or from a dual antenna set.

Studies show that, in order to be exposed to RF levels that approach the safety limits adopted by the FCC, it would be necessary to remain very close to a UHF RFID antenna for a significant amount of time.

For further information on this topic refer to the Web sites at **www.fcc.gov/cgb** or **www.fcc.gov/oet/rfsafety**.

A minimum separation distance of 30cm to 60cm has been suggested as a way to minimize exposure to the human body.

6.5.1 Dual Antenna set

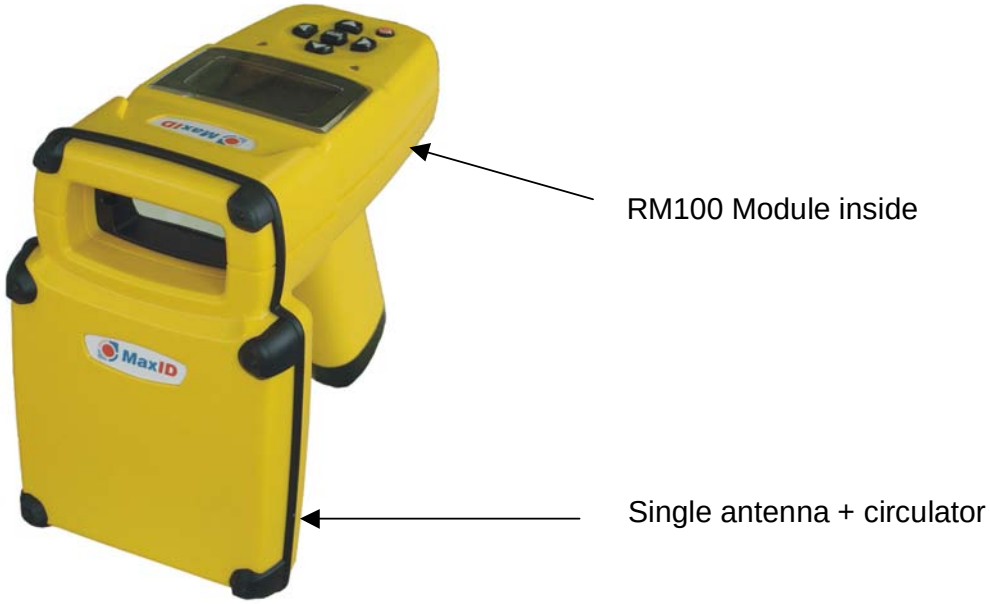
For the dual antenna configuration, mount the antennas 500mm apart (centre-to-centre). Mounting the two antennas closer or further apart will have a decrease in tag read range.

Never perform tests when the two antennas are facing each other with less than 50mm separation. It might cause permanent damage the module

6.5.2 Single Antenna in handheld configuration

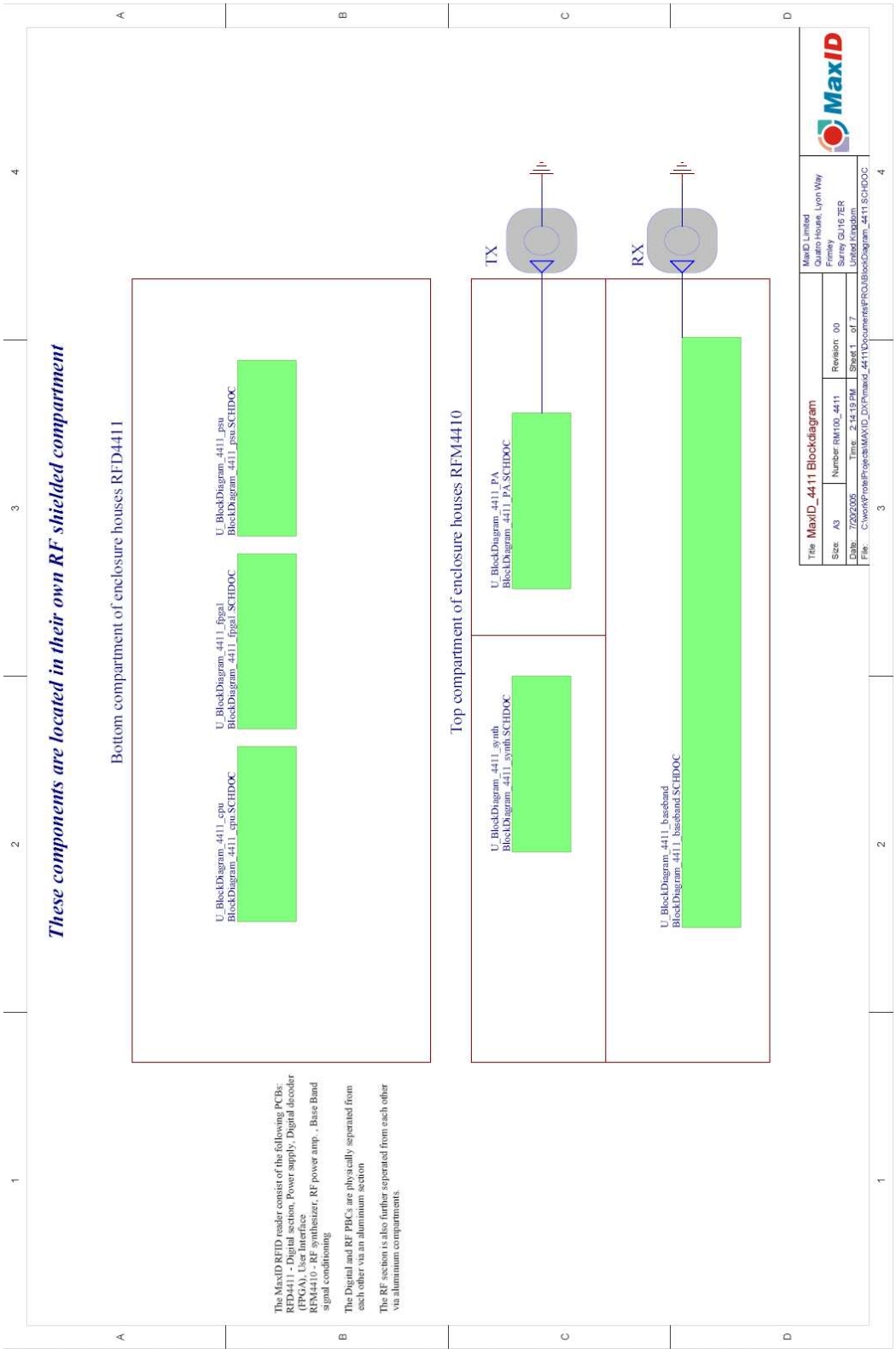
As mentioned before, the RM100 module uses a circulator to combine the transmitter and receiver RF ports to a single antenna port.

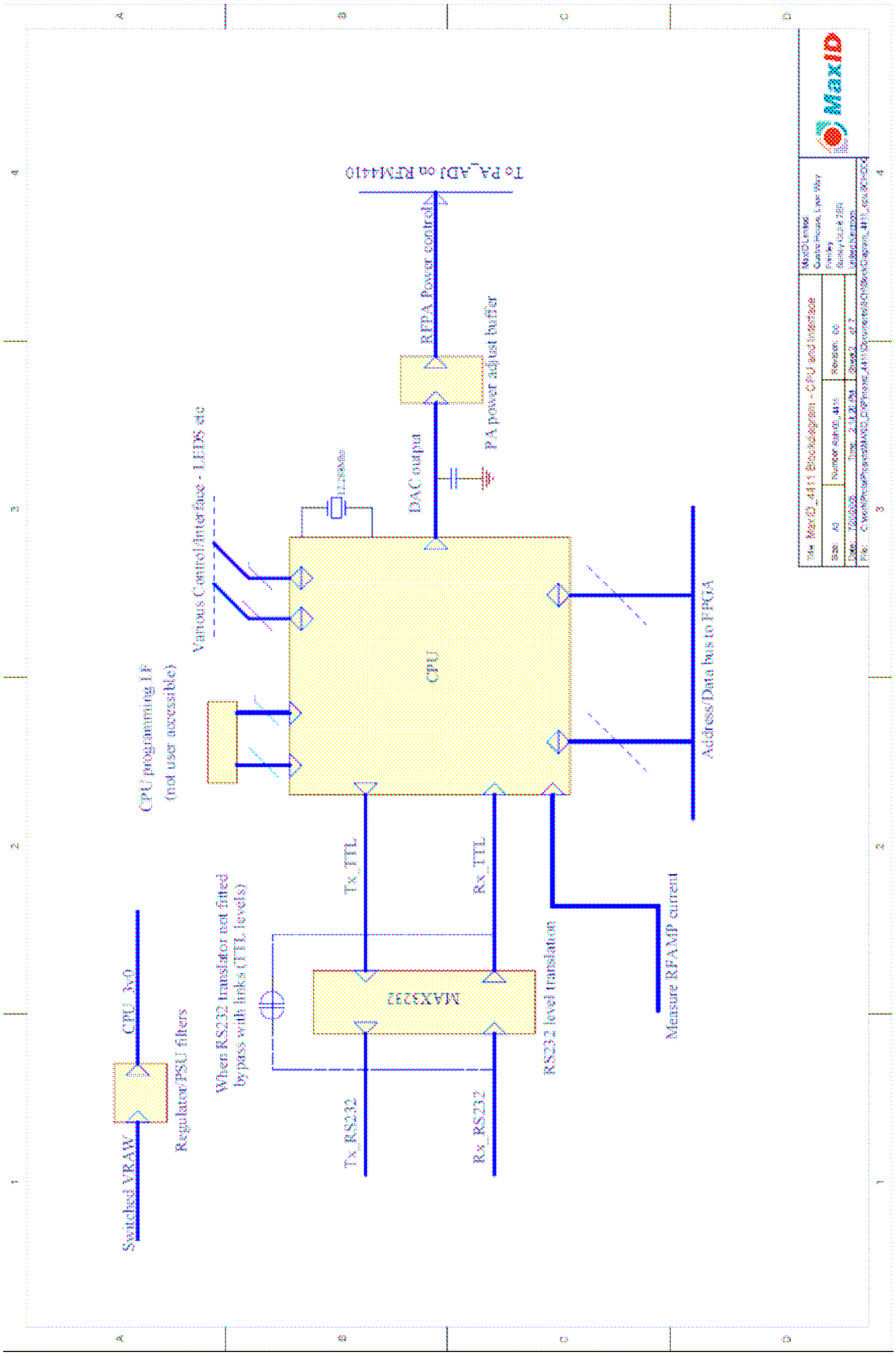
The same rules on minimum operation distance apply for the single antenna configuration

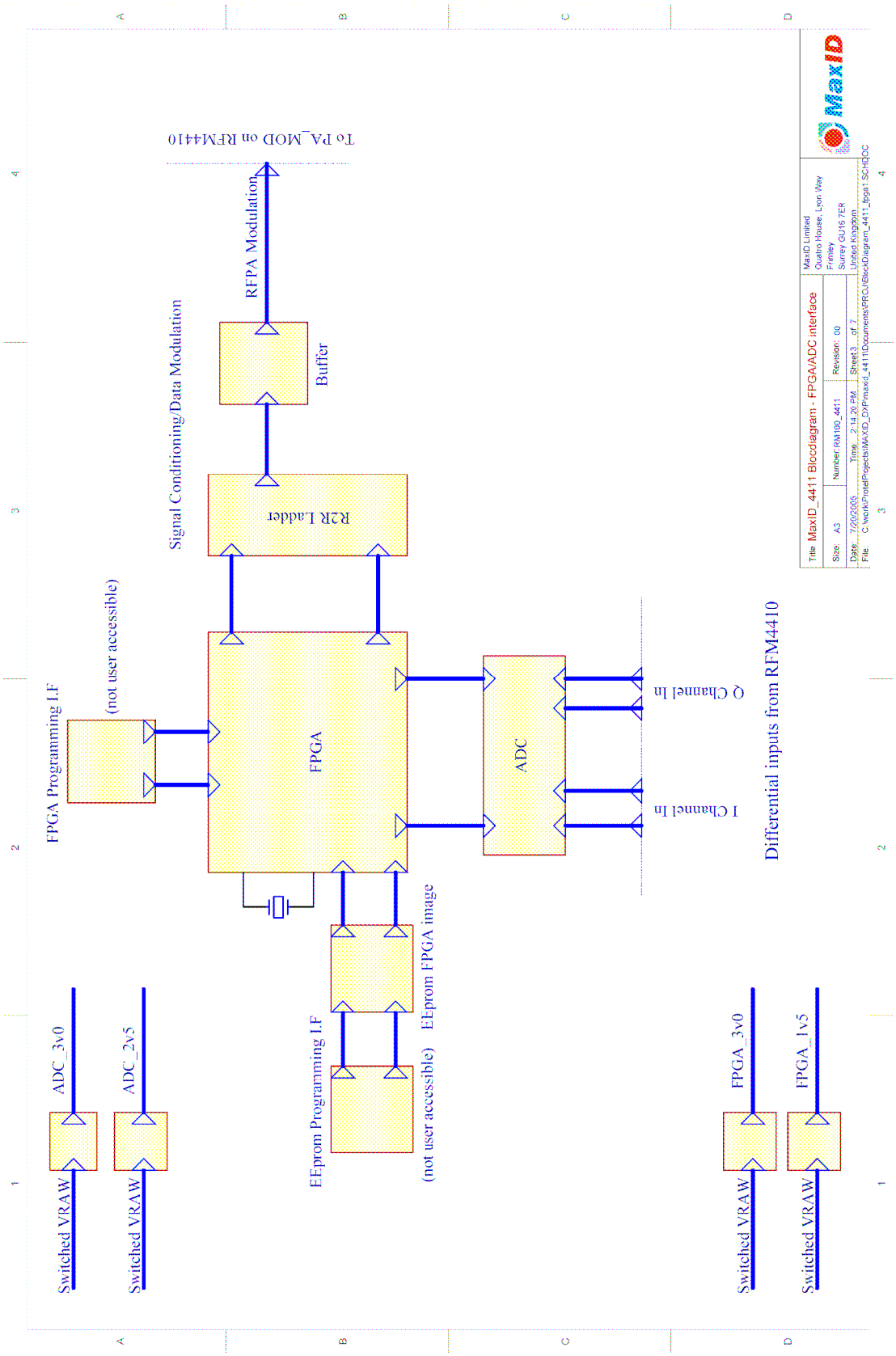


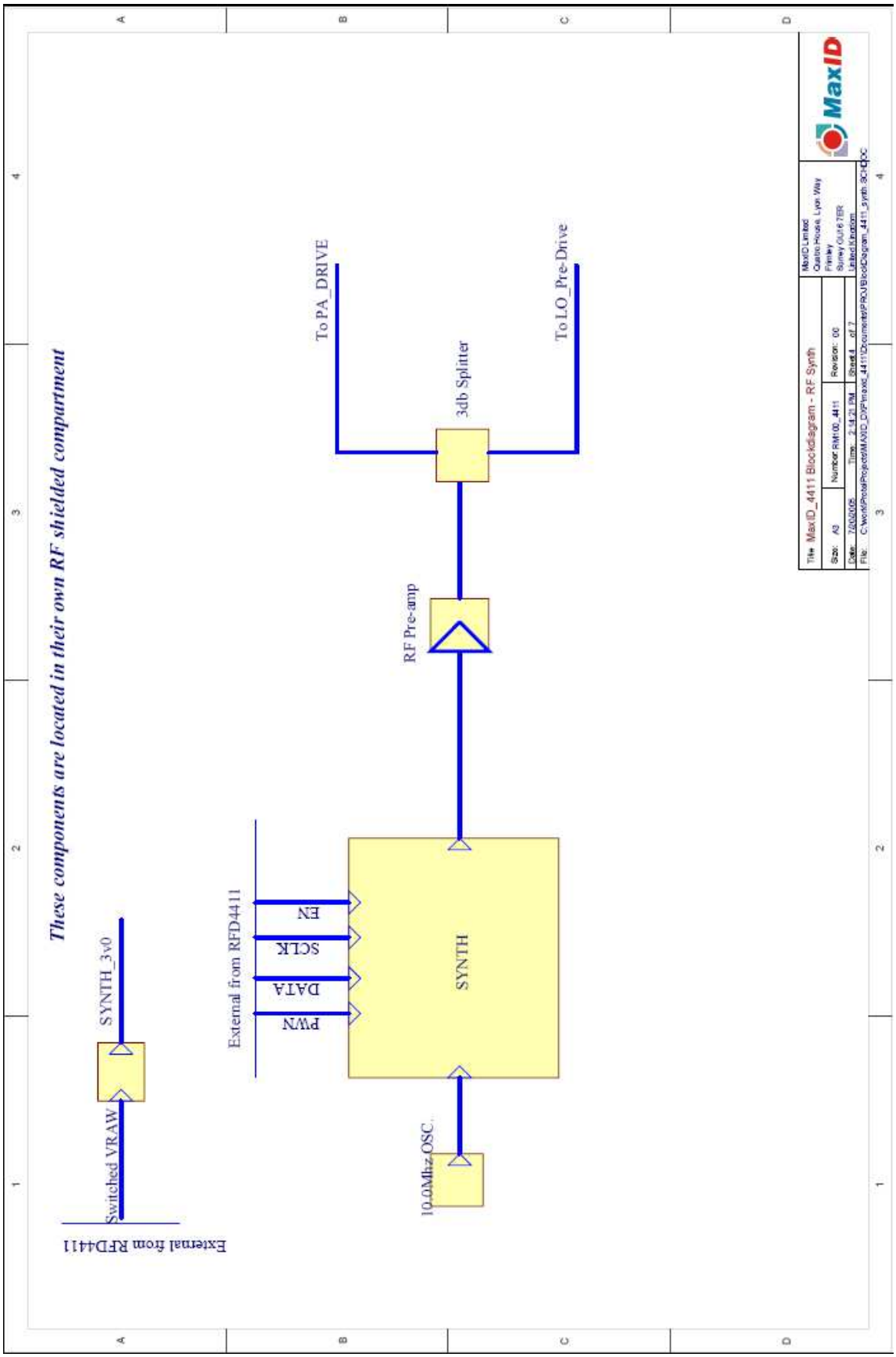
UHF RFID Handheld device

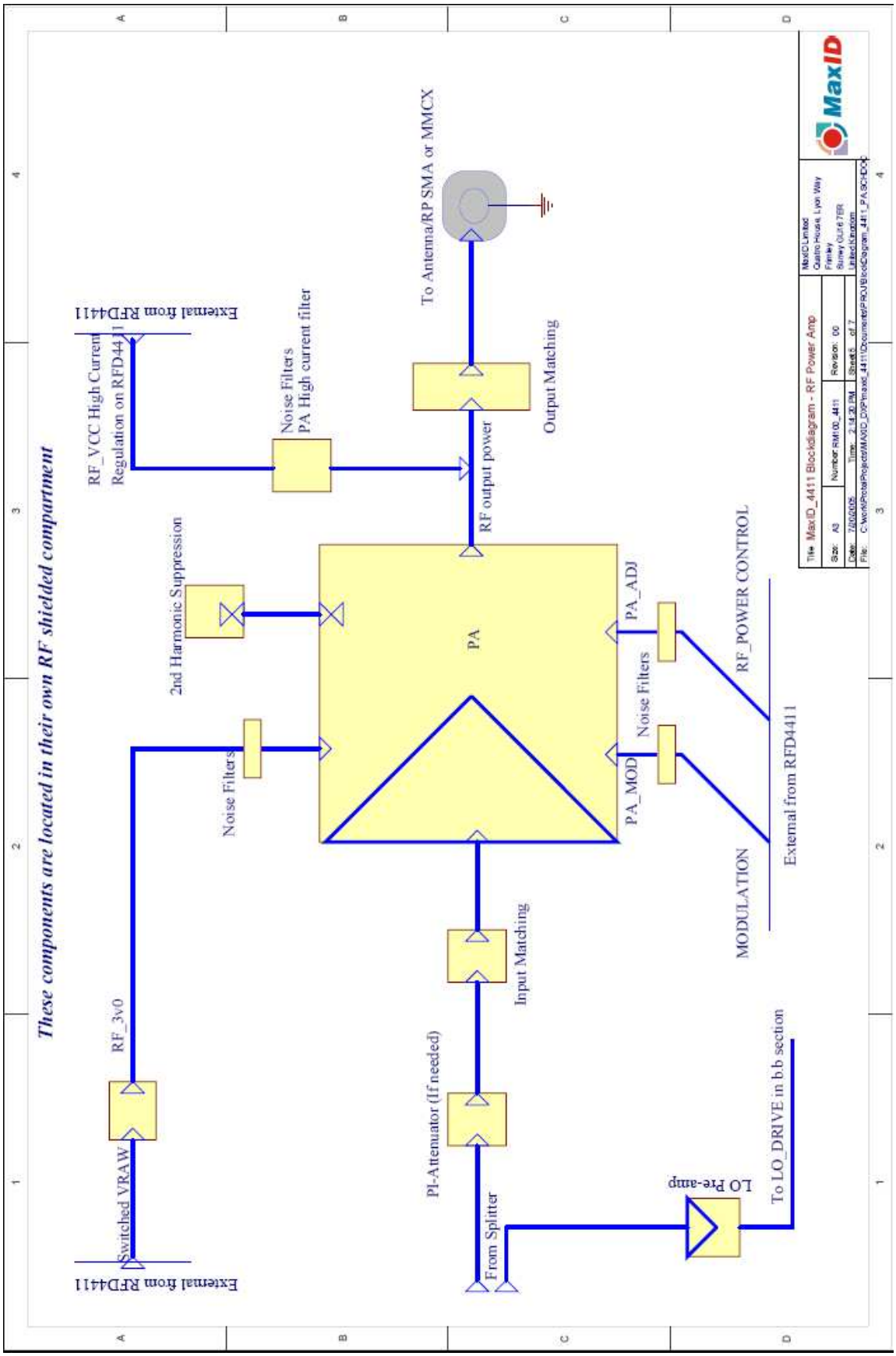
7. Functional Block diagram




To PA_ADJ on RFM4410
RFPA Power control
PA power adjust buffer
DAC output
Various Control/interface - LEDS etc
CPU
CPU programming IF
(not user accessible)
Address/Data bus to FPGA
Tx_TTL
Rx_TTL
When RS232 translator not fitted
by pass with links (TTL levels)
MAX3232
RS232 level translation
Measure RFAMP current
Tx_RS232
Rx_RS232
CPU_3v0
Regulator/PSU filters
Switched VRAW


To PA_MOD on RFM4410
RFPA Modulation
Buffer
Signal Conditioning/Data Modulation
R2R Ladder
FPGA Programming I.F
(not user accessible)
FPGA
ADC
Q Channel In
I Channel In
Differential inputs from RFM4410
EEprom Programming I.F
(not user accessible)
EEprom FPGA image
ADC_3v0
ADC_2v5
FPGA_3v0
FPGA_1v5
Switched VRAW
Switched VRAW
Switched VRAW
Switched VRAW
Title MaxID_4411 Blocdiagram - FPGA/ADC interface
Size: A3
Number: RM100_4411
Revision: 00
Date: 7/20/2005
Time: 2:14:20 PM
Sheet 3 of 7
File: C:\work\ProtelProjects\MAXID_DXP\maxid_4411\Documents\PROJ\Bloc\Diagram_4411_fpga1.SCHDOC
MaxID Limited
Quatro House, Lyon Way
Frimley
Surrey GU16 7ER
United Kingdom


These components are located in their own RF shielded compartment
To PA_DRIVE
To LO_Pre-Drive
3db Splitter
RF Pre-amp
SYNTH
EN
SCLK
DATA
PWN
External from RFD4411
10.0Mhz OSC
SYNTH_3v0
Switched VRAW
External from RFD4411
MaxID_4411 Blockdiagram - RF Synth
MaxID


These components are located in their own RF shielded compartment
To Antenna/RP SMA or MMCX
Output Matching
RF output power
Noise Filters
PA High current filter
RF_VCC High Current
Regulation on RFD4411
External from RFD4411
2nd Harmonic Suppression
PA
PA_ADJ
PA_MOD
Noise Filters
RF_POWER CONTROL
MODULATION
External from RFD4411
Noise Filters
RF_3v0
Switched VRAW
External from RFD4411
Input Matching
PI-Attenuator (If needed)
From Splitter
LO Pre-amp
To LO_DRIVE in b.b section
MaxID
Title MaxID_4411 Block diagram - RF Power Amp
Number RM100_4411
Revision 00
Size A3
Sheet 5 of 7
Date 7/20/2005
Time 2:14:20 PM
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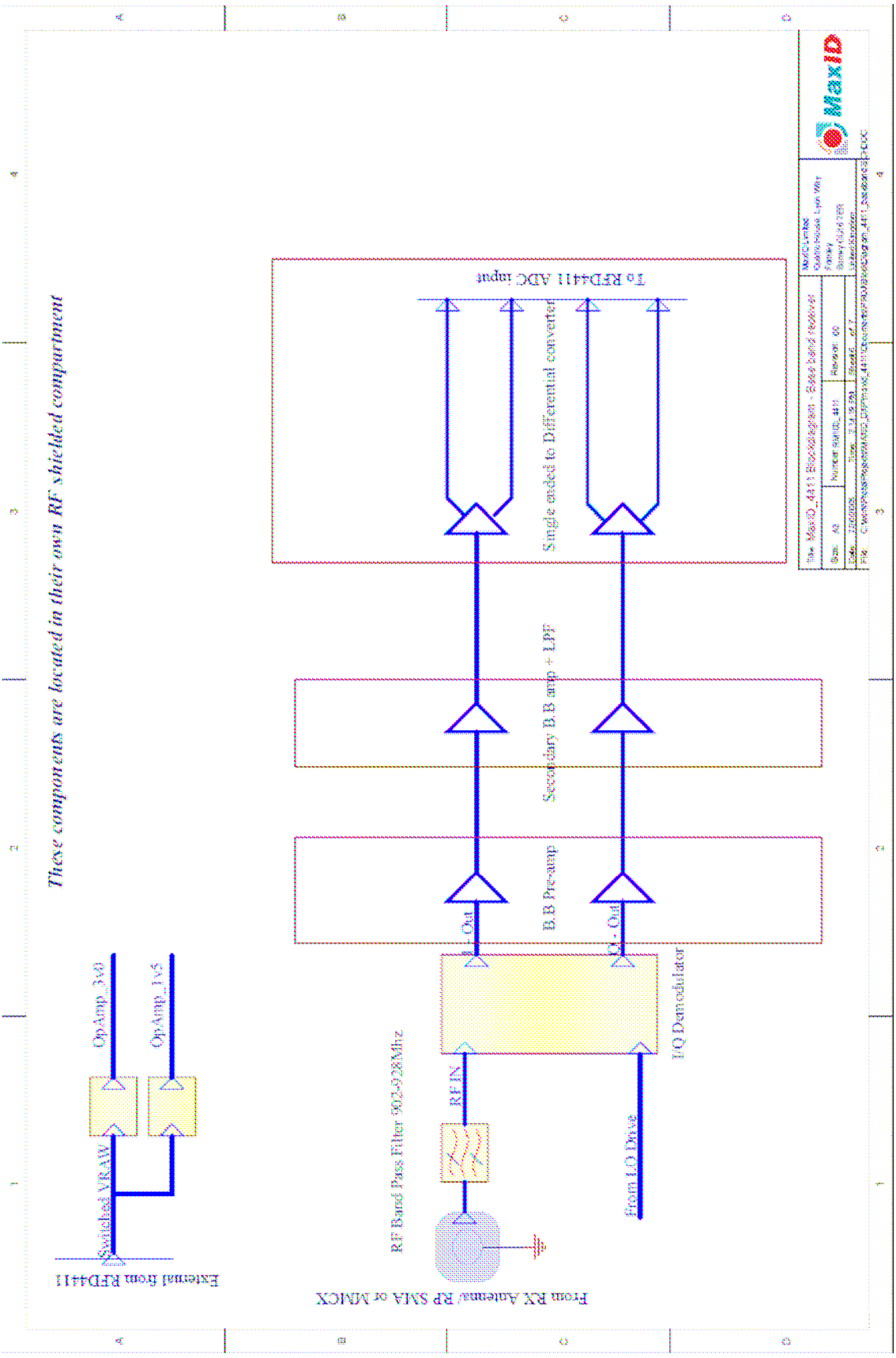
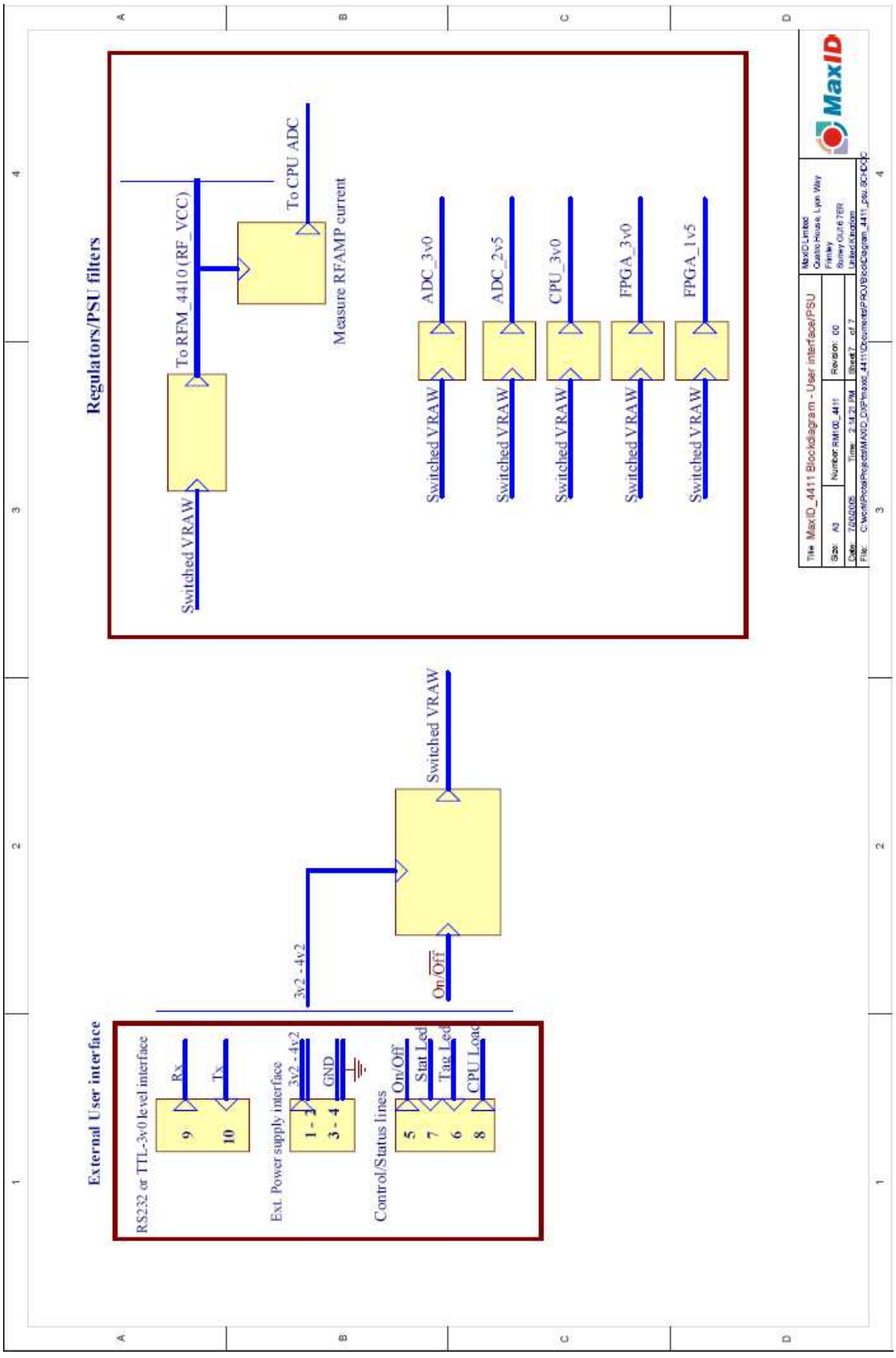
MaxID Limited
Castro House, Lyon Way
Frimley
Surrey GU16 7BR
United Kingdom


These components are located in their own RF shielded compartment
To RFD4111 ADC input
Single ended to Differential converter
Secondary B.B amp + LPF
B.B Pre-amp
I Out
Q Out
I/Q Demodulator
RF IN
RF Band Pass Filter 902-928Mhz
from LO Drive
From RX Antenna/ RP SMA or MMCX
OpAmp_3v0
OpAmp_1v5
Switched VRAW
External from RFD4111


Regulators/PSU filters
To RFM_4410 (RF_VCC)
To CPU ADC
Measure RFAMP current
Switched VRAW
ADC_3v0
ADC_2v5
CPU_3v0
FPGA_3v0
FPGA_1v5
Switched VRAW
External User interface
RS232 or TTL-3v0 level interface
Rx
Tx
9
10
Ext. Power supply interface
3v2 - 4v2
GND
1 - 3
3 - 4
Control/Status lines
On/Off
Stat Led
Tag Led
CPU Load
5
7
6
8
3v2 - 4v2
On/Off
Switched VRAW
MaxID
MaxID_4411 Blockdiagram - User interface/PSU
MaxID Limited
Castle House, Lyon Way
Frimley
Surrey GU16 7ER
United Kingdom
Size: A3
Number RM100_4411
Revision: 00
Date: 7/20/2005
Time: 2:14:21 PM
Sheet 1 of 7
File: C:\work\Protel Projects\MAXID_DXP\maxid_4411\Documents\PDJ\BlockDiagram_4411_psu.SCHDOC

8. Description

8.1 RFID Reader

The Reader can be divided into two sections namely:

1) Receiver and
2) Transmitter

Both the receiver and transmitter share a local oscillator drive to ensure that all signals are in phase with each other. The synthesiser is programmed by the CPU to hop between 902 and 928 MHz. The Synthesizer incorporates a phase lock loop as well as a local oscillator, with an output of –5dBm.

This local oscillator frequency is then amplified by 15dB and then fed to a in-phase splitter. The splitter provides a +7dBm drive to the receiver board as well as to the transmitter main amplifier. The amplifier has 2 functions:

1) Amplify the RF signal to +30.5dBm
2) Act as an AM modulator by switching between two power levels.

The PA has 2 bias inputs, One is used to adjust output power levels and the other is used to change the AM modulation index

Lastly the PA output is fed via a harmonic low pass filter to the antenna connector.

On the receiver circuit, the RF input is fed via a 902-928 band pass filter to the direct IQ demodulator. The demodulator uses the local oscillator to directly convert the received signals to base band signals.

The demodulator outputs Q and I base band signals. These signals are then fed to a 500 KHz low pass filter and 2-stage amplifier. These signals are then passed to a differential Analogue to Digital converter and then passed on to a FPGA. The FPGA use peak and level detection to filter out tag data and then pass the received tag data to a 16bit processor.

The processor is responsible for the following:

1) RS232 interface to host
2) Channel selection and frequency hopping
3) Reader to tag modulation
4) Transmitter power levels
5) Tag data decoding and CRC checking

8.2 Serial Interface

8.2.1 Physical:

Baud rate is set at 38400 b/s, 8 bits even parity, no hardware flow control.

Interface Port Pin-outs

Pin #	Description
1	Lithium-Ion Battery + (3.3Vdc to 4.2Vdc)
2	Lithium-Ion Battery + (3.3Vdc to 4.2Vdc)
3	Lithium-Ion Battery - (GND) *
4	Lithium-Ion Battery - (GND) *
5	On/Off Control (Bat+ for ON, GND for OFF)
6	Status output (can be connected to LED via transistor) **
7	NC
8	NC
9	Receive input (RS-232 level)
10	Transmit output (RS-232 level)

* Use this ground for RS-232 ground
** Can be used to bias a NPN transistor or N-channel FET to drive a LED or relay
3V on pin 6 indicate on or yes condition. 0V indicate off or no condition

8.2.2 Protocol:

The interface behaves in a similar manner to the AT command set used by modems. A command is a text string ended by a carriage return. A response is a text string ended with a carriage return and line feed. Typically the response is OK or ERROR n.

When switching on the device, the reader sends the following to the host:

Programming FPGA
Run mode

In this mode, the following commands are accepted:

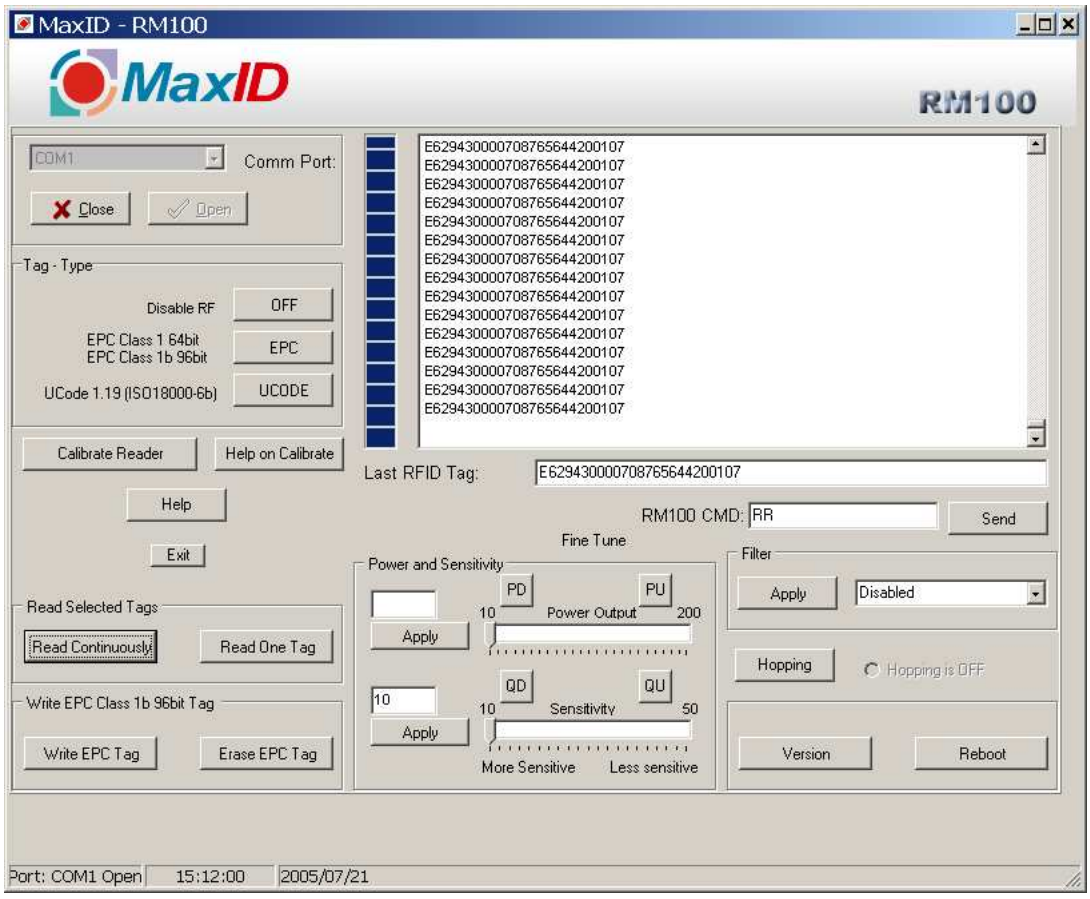
H or ?	Show help screen
I0	Switch transmitter off
I1	IPX at 915 MHz
I2	IPX at 868 MHz
I3	EPC class 1 at 915 MHz
I4	EPC class 1 at 868 MHz
I5	ISO18000-40 mode class 1.19 at 915 MHz
I6	ISO18000-40 mode class 1.19 at 868 MHz
I7	ISO18000-10 mode class 1.19 at 915 MHz
I8	ISO18000-10 mode class 1.19 at 868 MHz

I9	EPC at 868 MHz with FCC timings
D	RF Power down
U	RF Power up
H	Hopping (0 to disable) (255 hopp enable) (1-50 ch selectable)
J	Hopp speed (-1 to read) (20 default) (10-200 in mS steps)
F	Filter repeatable tags (1-9) seconds. 0 to disable
R	Read tag once
RR	Read tag continuously
Wdata	Write tag with \"data\"
Pval	Set output power (0 to 255)
Qnvalue	Write value (0 to 255) to FPGA port n (0 to B)
9	Show Q-values
V	Get version
^L	Loader
^C	Reboot

When tags are read, they are reported in the following fashion:

I123456789ABCDEF0	for IPX tags
E123456789ABCDEF012345678	for EPC Class 1 tags
U123456789ABCDEF0123456789ABNCDEF0	for EPC 1.19 1 tags

8.2.3 Evaluation program



9. Specification

9.1 Performance

Frequency band	902-928MHz
Frequency stability	<10 ppm
RF Type	Frequency hopping spread spectrum
Channels	50
Occupied freq. Bandwidth	<250kHz
Transmitter power output	1W (30dBm) max. At antenna port
Hopping rate	>10mS
Modulation Type	Amplitude Modulation
Modulation Index	10 to 90% adjustable
Data rate to Tag	160kbps
Receiver RF input	0dBm max
Receiver sensitivity	<-60dBm
Serial port data rate	38400 bps
Serial port interface	RS232 (3 wire, no flow control)
Operating voltage	3.3Vdc to 4.2Vdc (Lithium-Ion battery)
Operating current	1.2A on read, 240mA on Idle
Electrical emissions	FCC part 15, Class A pending
RF approval	FCC part 15.247

9.2 Physical

Height	17mm (max)
Length	103mm (max)
Width	69mm (max)
Weight	100 grams
Antenna ports	Reverse polarized SMA
Host interface	10 way male pin header (5 x 2)
Mounting	4 x 3mm mounting holes

9.3 Environment

Operating Temperature	-10ºC to +40ºC
Storage Temperature	-20ºC to +70ºC
Humidity	95% (non-condensing)
Shock	20Gs, 11ms, half sine pulse
ESD	+8KV(indirect), +4KV(direct)