Grenoble INP
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PIERS 2011

RFID Chip Impedance Measurement for UHF RFID Tag Design

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Plan

- Motivations
- RFID chip characteristics
- RFID chip measurement technique
  - Measurement bed description.
  - Upper and lower chip impedance state.
- RFID tag design for sensor application :
  - Antenna design methodology.
  - Measurement results.
- Conclusions

Motivations

- Passive RFID tag performance is based on the study of the link reader to tag.
- New constraints for semi active or sensor RFID tag :
  - Forward and backward link study.
  - Performance indicator : DRCS rather than Read Range.
- Only one state for chip impedance from datasheet :
  - Sufficient for passive tag design.
  - Need more information for sensor RFID tag.

RFID chip model from datasheet

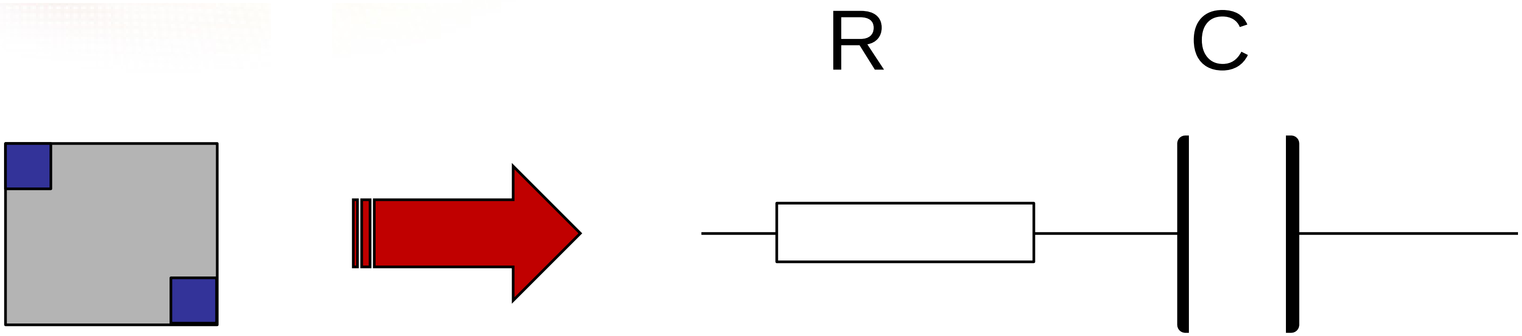
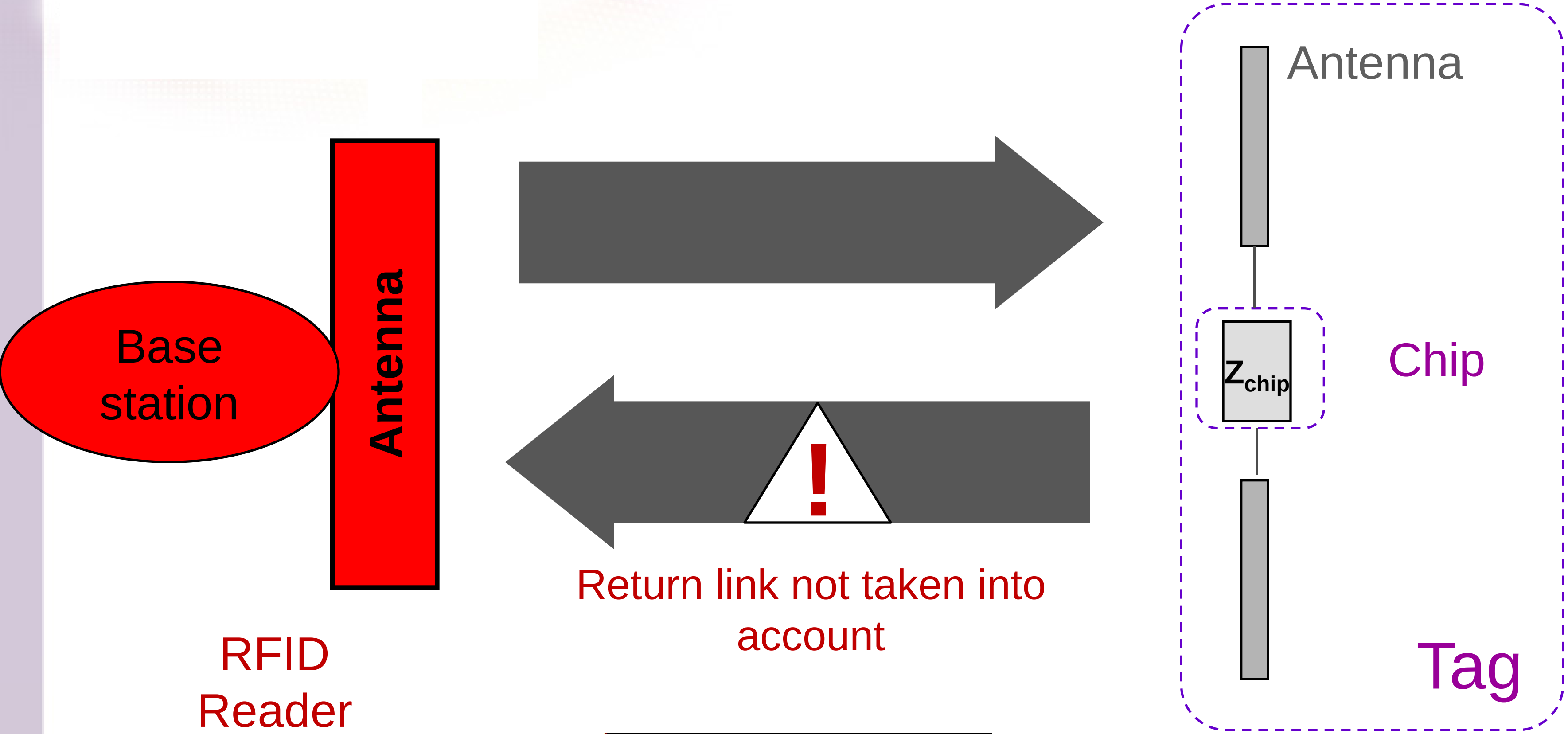


Table 7. Interface characteristics

Symbol	Parameter	Min	Typ	Max	Unit
f_{oper}	operating frequency	840	-	960	MHz
P_{min}	minimum operating power supply [1][2]	-	-15	-	dBm
C_i	input capacitance (parallel) [3]	-	0.88	-	pF
Q	quality factor (Im (Z_{chip}) / Re (Z_{chip})) [3]	-	9	-	-
Z	impedance (915 MHz)	-	22 - j195	-	Ω
-	modulated jammer suppression ≥1.0 MHz [4]	-	-4	-	dB
-	unmodulated jammer suppression ≥1.0 MHz [4]	-	-4	-	dB

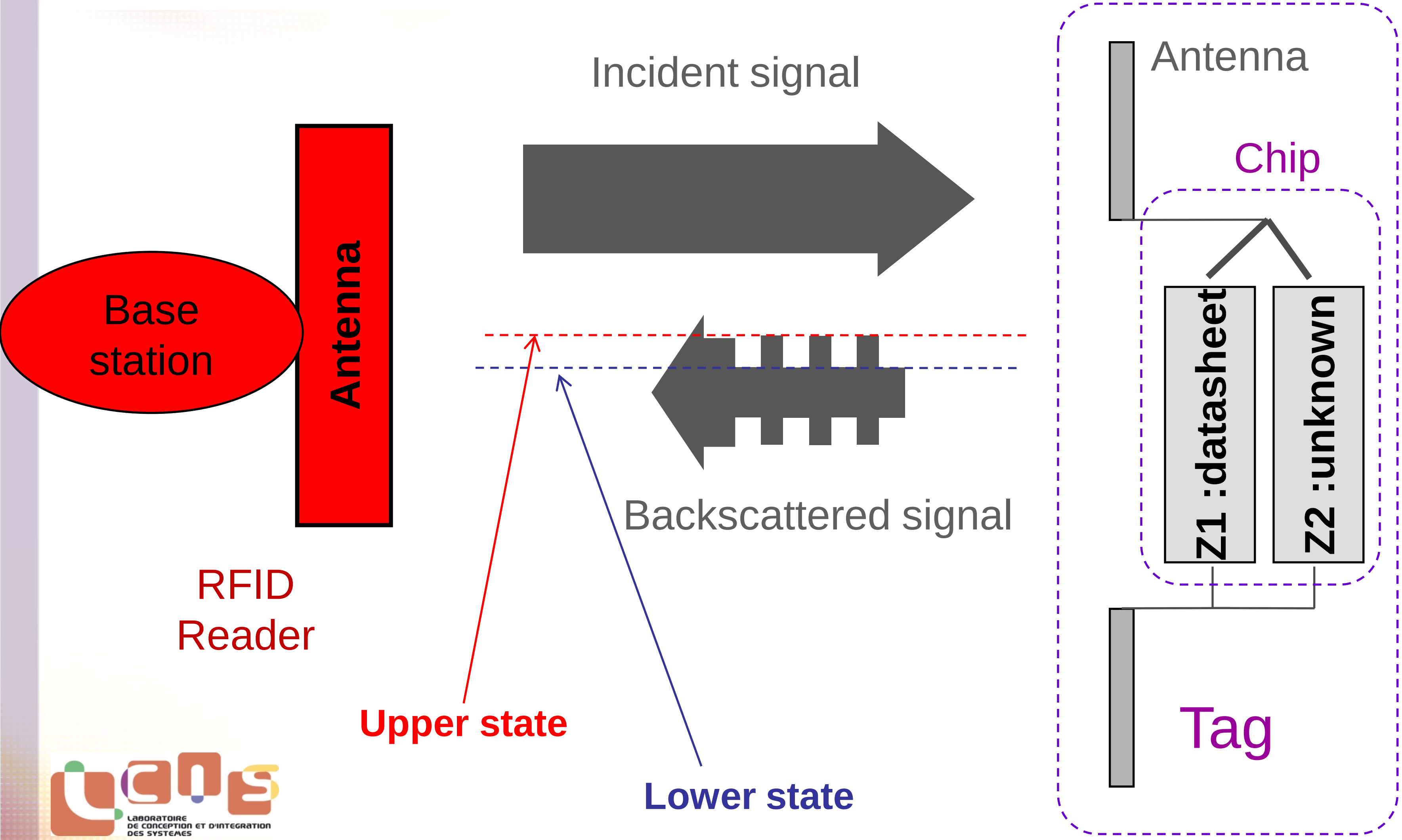
RFID communication



$$Read \quad Range = \frac{\lambda}{4\pi}\sqrt{\frac{P * G * (1 - \Gamma^2)}{P_{ic}}}$$

Impedance mismatch between Z_{ant} and Z_{chip}

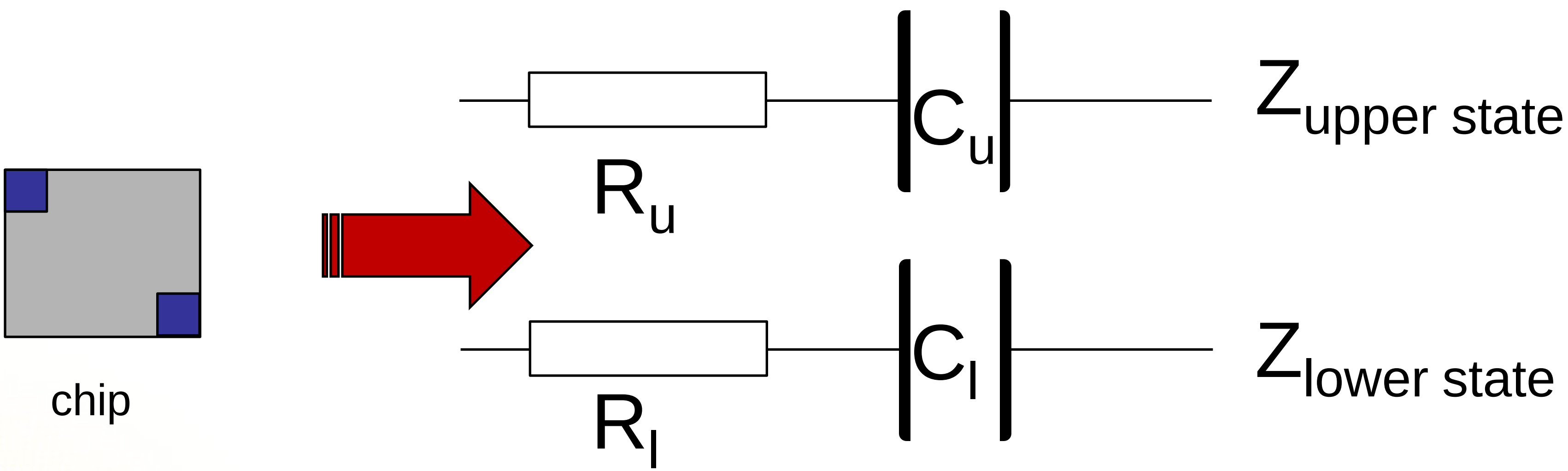
RFID communication



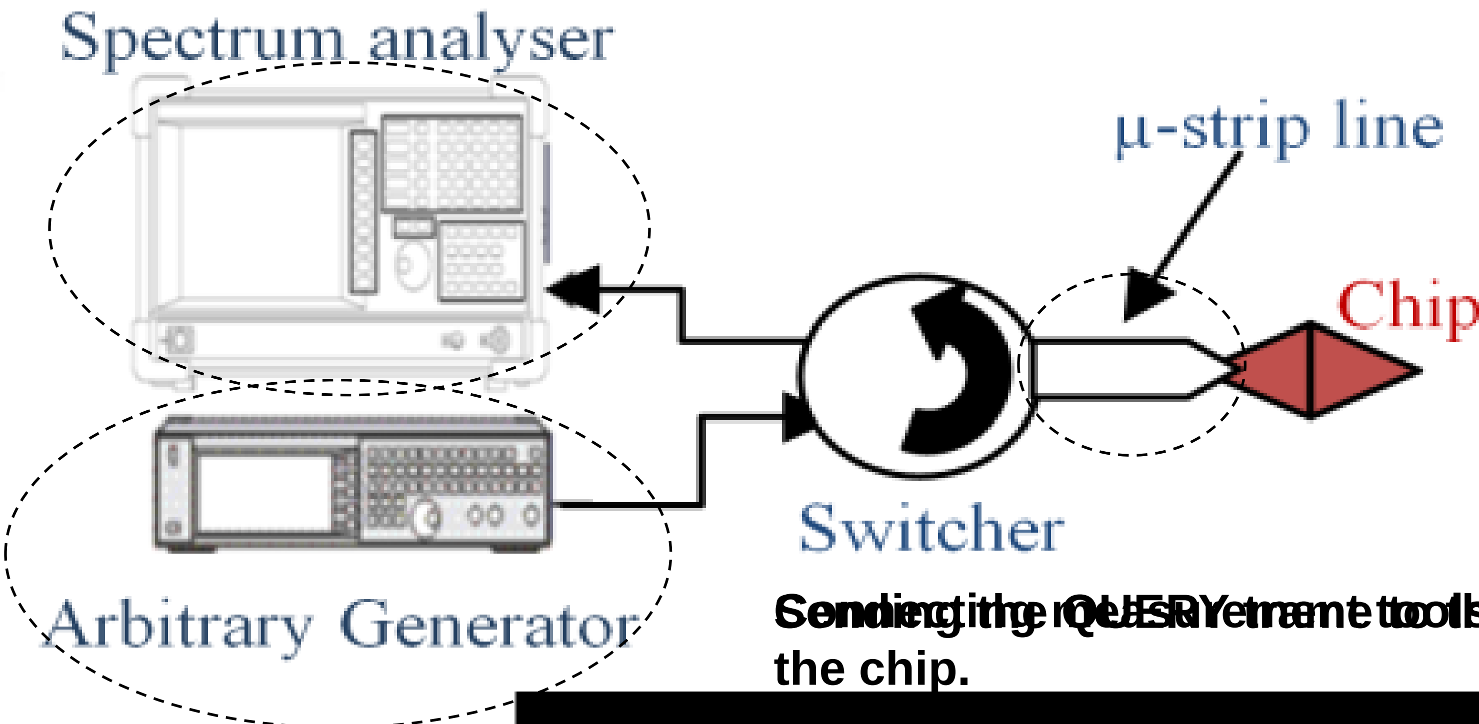
Delta RCS

- The delta Radar Cross Section is given by :

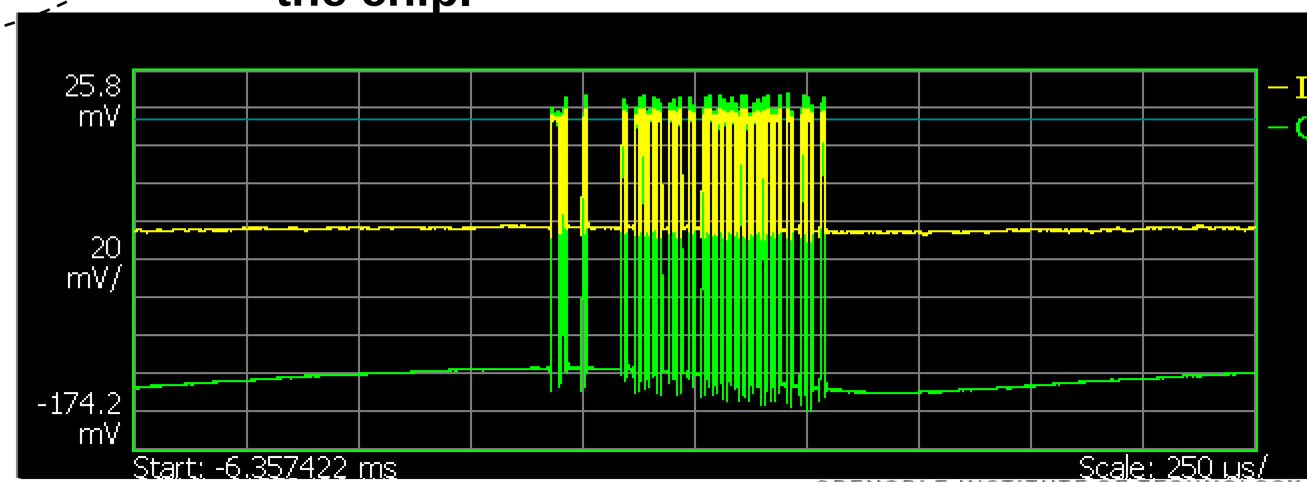
$$\Delta RCS=\sigma\ (|1-\Gamma_l|-|1-\Gamma_u|)$$



Measurement test bed

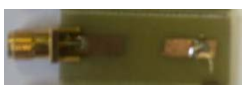


Sending the QUERY command to the chip.
Connecting the measurement tools to the chip.



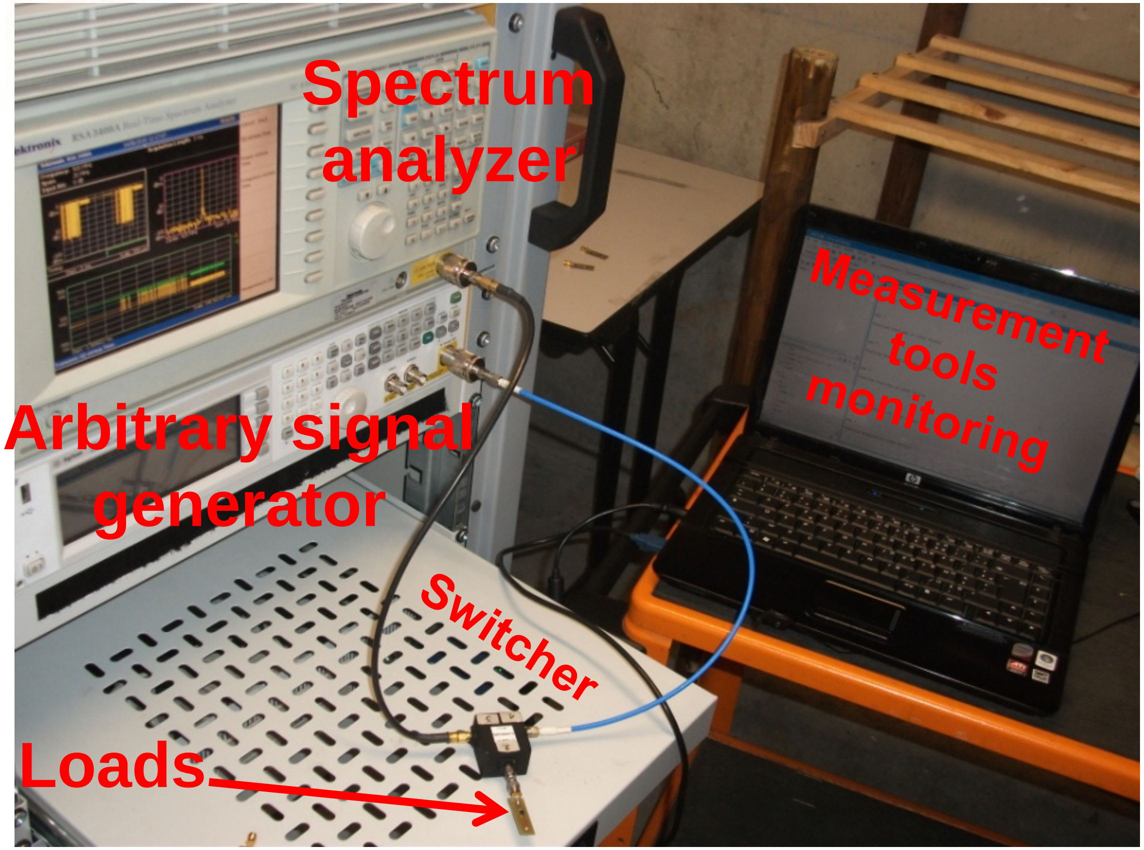
Measurement setup

chip



open

short



Measurement was done for two configurations :

For fixed frequency and power sweep.

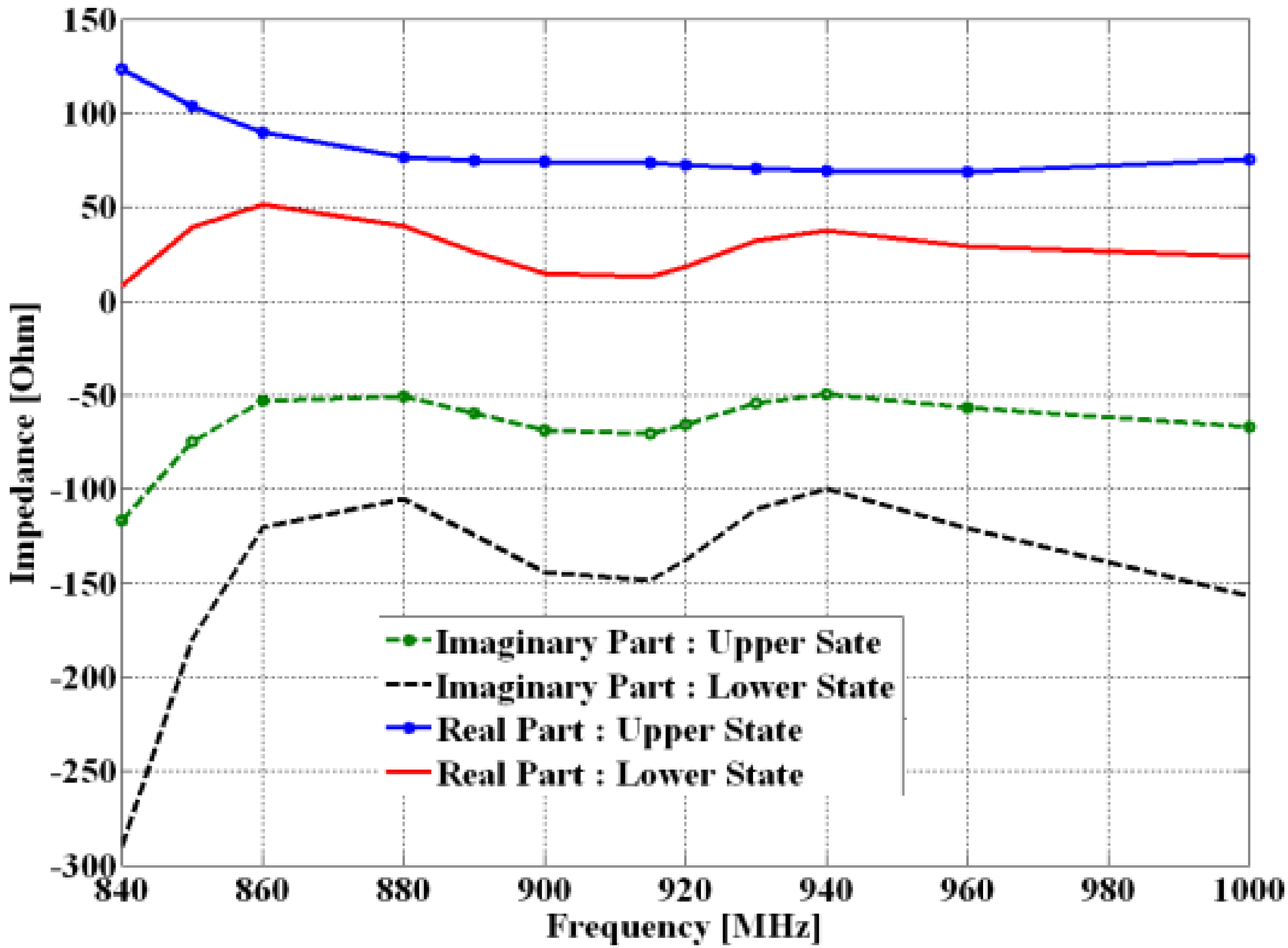
For fixed power and frequency sweep.

Results for fixed input power P= -2,6 dBm

NXP G2XL

P : -15 dBm

Z_{chip}= 22-j195 @ 915 MHz



Results for fixed frequency f=915 MHz

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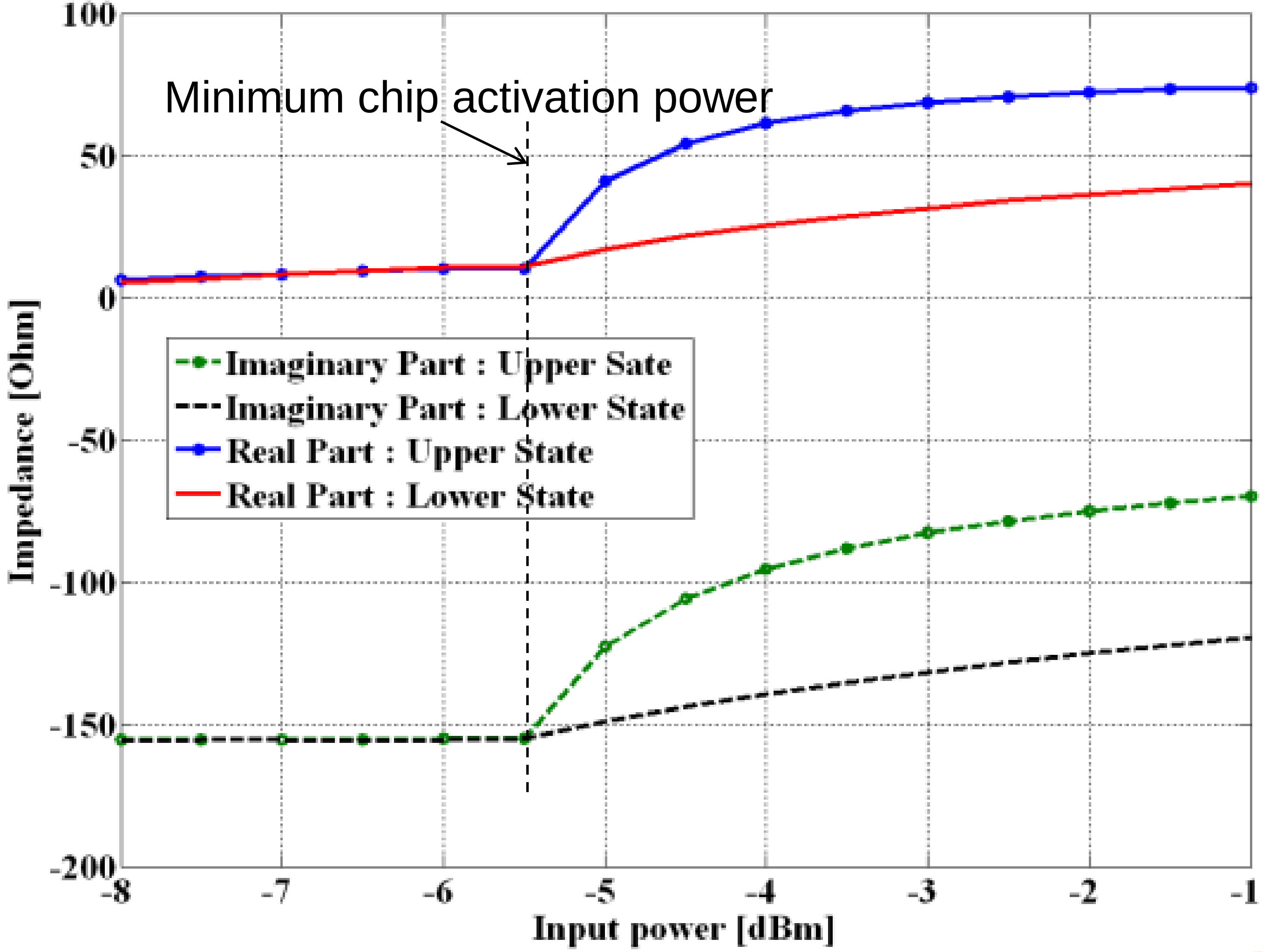


Comparaison Datasheet Vs Measurement

Impedance (915 MHz)		Datasheet	Measurement
Real part	Upper state	-	86,4 Ω
	Lower state	22 Ω	25,6 Ω
Imaginary part	Upper state	-	-54,72 Ω
	Lower state	-195 Ω	-147,79 Ω

Datasheet impedance corresponds to the upper state measured impedance.

The impedance mismatch is very high for the lower state.

Automated antenna design methodology

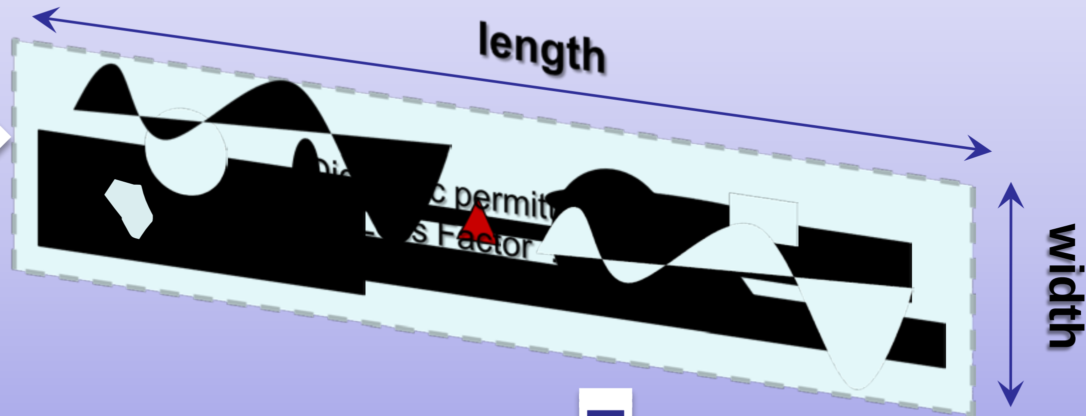
Constraints

Matetrial
- Size
- Pararameters

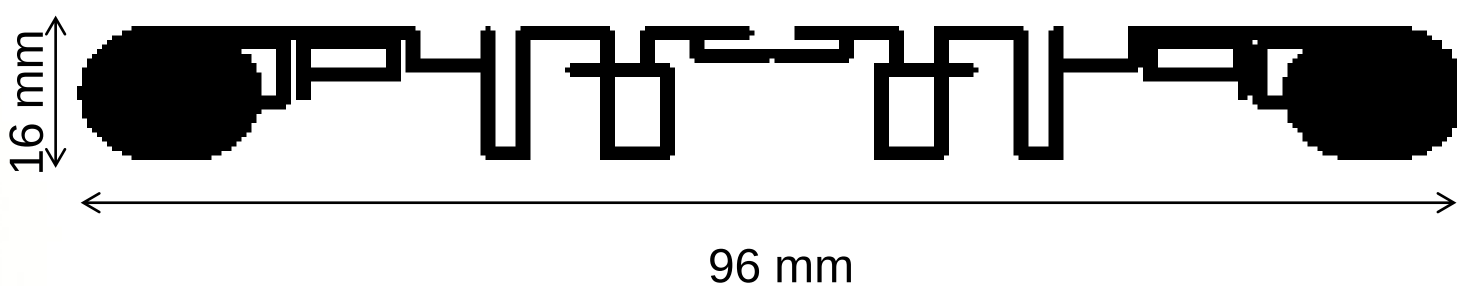
Chip
- Z_{chip} (f,p)

Frequency band

Antenna Shape Generation



• Adding elementary shapes



Measured tag performance

Read Range

Tag		EU (866 MHZ)	USA (915 MHz)	JAPAN (952 MHz)
Optimized	Air	2.8m	4m	5.5m
	PTFE	7.2m	6.3m	4.5m
NXP FFL 95-8	Air	6.7m	5.9m	6.15m
	PTFE	5.8m	6.6m	6.8m

DRCS

Tag		EU (866 MHZ)	USA (915 MHz)	JAPAN (952 MHz)
Optimized	Air	46cm^2	92cm^2	249cm^2
	PTFE	290cm^2	107cm^2	54cm^2
NXP FFL 95-8	Air	26cm^2	60cm^2	23cm^2
	PTFE	32cm^2	11cm^2	5cm^2

Conclusions

- Chip impedance measurement method for full characterization.
  - Upper and lower state impedance.
  - Impedance dependence to input power.
- Antenna design for high DRCS:
  - DRCS optimization
  - Improving return link performance (tag to reader)
- UHF RFID tag for sensor use :
  - High DRCS for two environment configurations.
  - Ability to use tag as environment sensor.