Development of a Passive Intermodulation (PIM) Test System for the Chinese Space Industry

A 2 channel PIM tester for S-Band [~ 2.2 GHz]

Contents of this presentation

FHI RF Technology 2016

- Background
- PIM Basics
- Metallic Contacts
- Test system design

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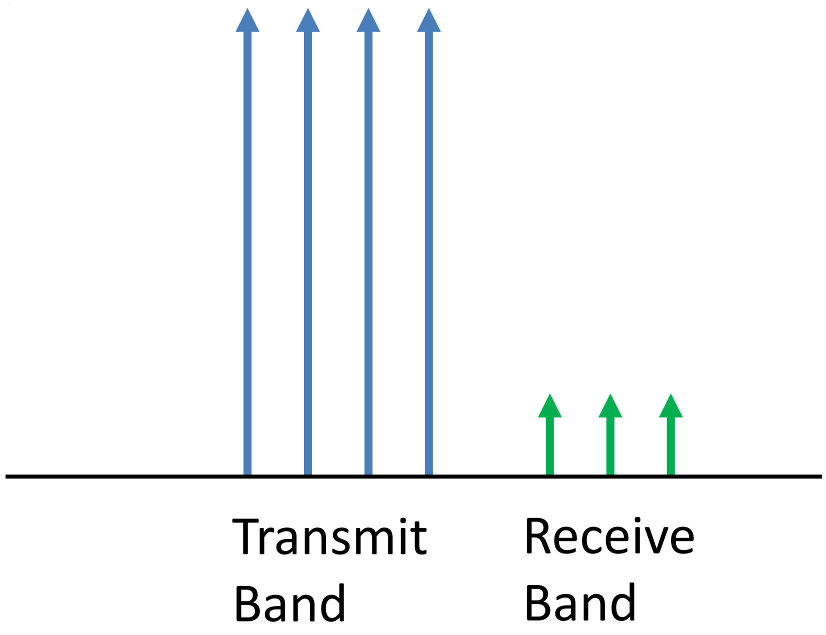
Background

Increasing Telecom Requirements

- Continuous increasing demands for higher data rates in Sat-Com systems.
- Resulting in more carriers and larger signal bandwidths.
- Compensate receiver noise power (kT**B**) with higher transmit power to maintain SN ratio at receiver input.

Background

Basic Satellite Operation



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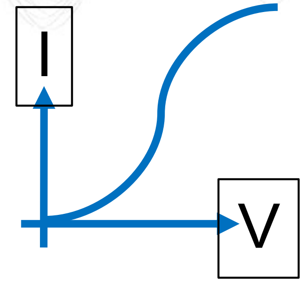
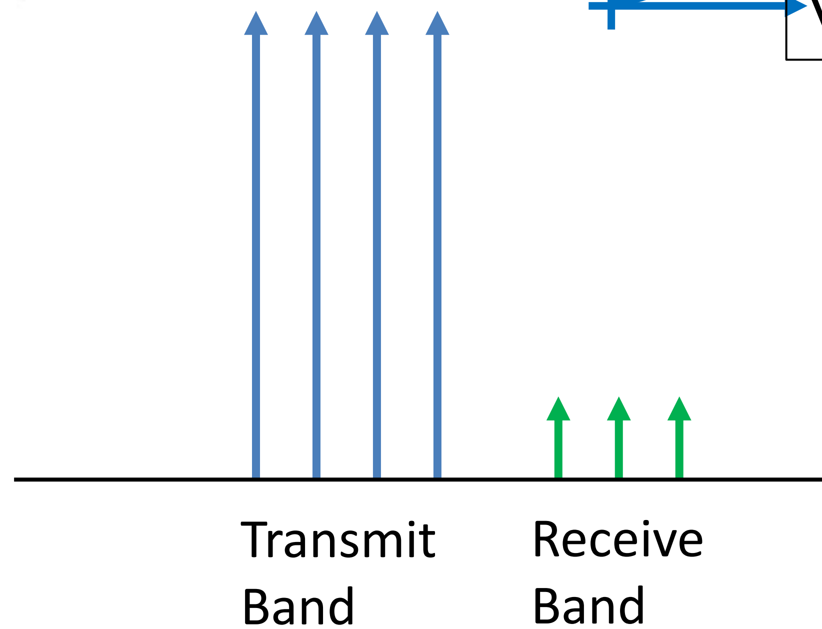
Background

Basic Satellite Operation

Any practical system :
Non Linear

$$I = a_0+a_1V+a_2V^2+a_3V^3+...$$





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Basic Satellite Operation

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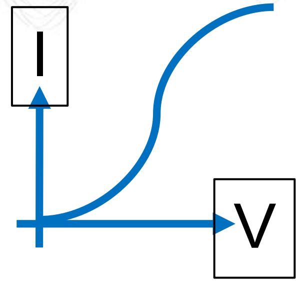
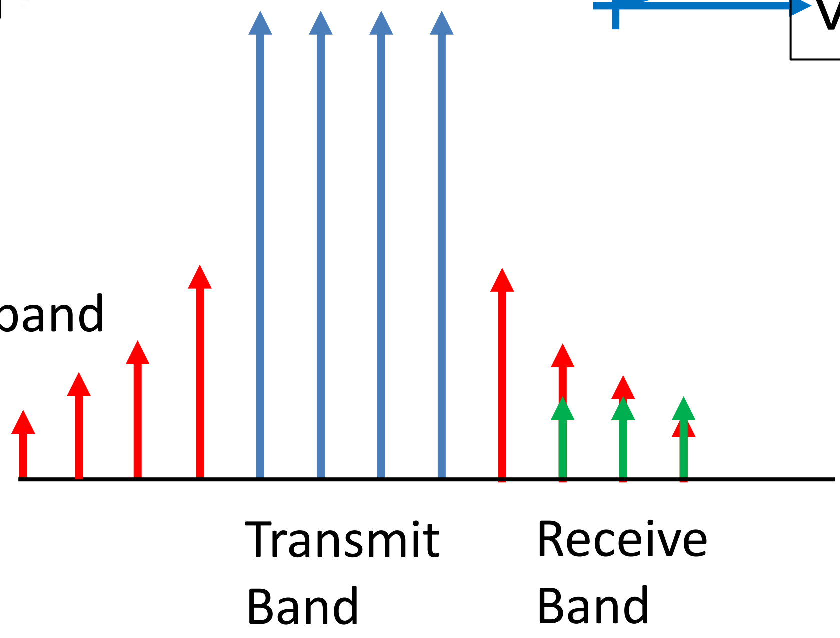


Generates Harmonics and

IM Products

The IM products distort
the signals in the receive band



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PIM Basics

Sources of PIM

PIM sources:

- Ferromagnetic materials
- Metallic contacts
- Voids or cracks discharges
- Thermal effects

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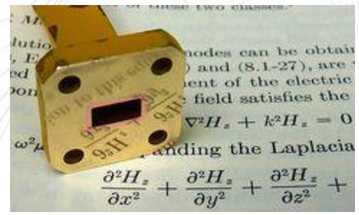
PIM Basics

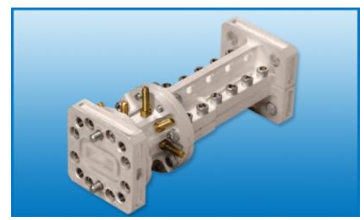
Sources of PIM

Examples of Metallic Contacts:

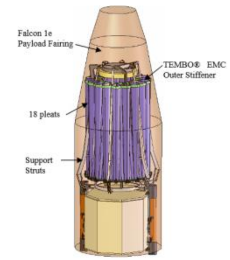
Flanges

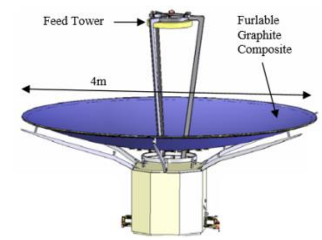


Tuning screws



Deployable reflectors





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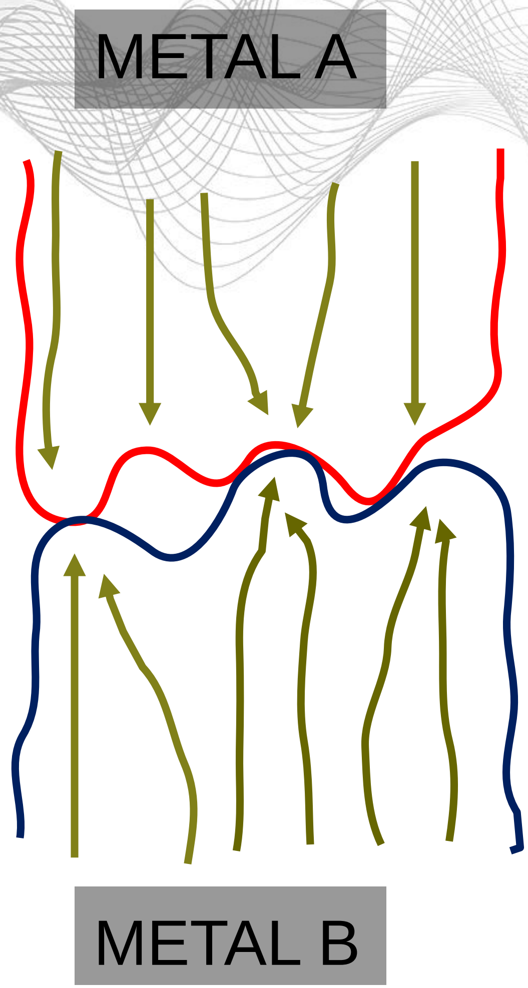
PIM Basics

PIM at Metallic Contacts



Irregularities reduce the total area of contact.

Contaminant layers on the surface prevent the formation of Ohmic contacts.

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Test Bed

Metallic Contacts

Various Sources

- Hard versus soft materials
  - Soft materials -> Lower PIM
- Thin versus thick oxyde layers
  - Thin Oxyde layers -> Lower PIM
- Cracks in the oxyde layers
  - Multi Material Junction -> Higher PIM
- Roughness of the contact area
  - Smooth contact area -> Lower Pim
- Contacting Pressure
  - Higher pressure -> Lower PIM

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More background information

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- **Background**
- PIM Basics
- Test Bed

Phd Thesis Dr. Carlos Vicente

http://tuprints.ulb.tu-darmstadt.de/598/

Passive Intermodulation and Corona Discharge
for Microwave Structures in
Communications Satellites

Vom Fachbereich 18
Elektrotechnik und Informationstechnik
der Technischen Universität Darmstadt
zur Erlangung der Würde
eines Doktor-Ingenieurs (Dr.-Ing.)
genehmigte

Dissertation

von Dipl.-Phys.

Carlos Pascual Vicente Quiles

geboren am 12. September 1976
in Elche

Referent:	Prof. em. Dr. Eng. Dr. h.c. mult. H.L. Hartnagel
Korreferent:	Prof. Dr.-Ing. V. Hinrichsen
Korreferent:	Prof. Dr.-Phys. B. Gimeno Martínez
Tag der Einreichung:	18. Mai 2005
Tag der mündlichen Prüfung:	29. June 2005

D17
Darmstädter Dissertationen

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PIM Basics

Motivations to measure

- Many fundamentals of PIM remain unknown
- Extremely difficult to assess quantitatively
- No existing models
- Becoming more important for future satelite missions
- MEASURING is very important

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S-Band High Power PIM Test bed

Test process for PIM testing

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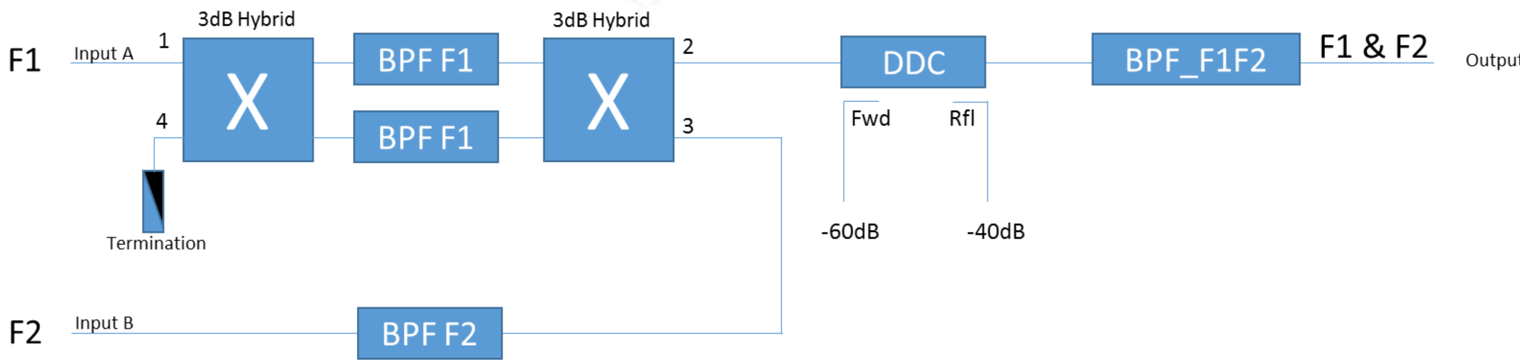
- Combine the two test tones without generating PIM.
- Apply the two clean test-tones to the DUT
- Separate the test tones and the PIM band without generating PIM
- Display the PIM band on a suitable receiver or receiver.

S-Band PIM Test bed

Step 1: Combing two high power carriers

Input Diplexer



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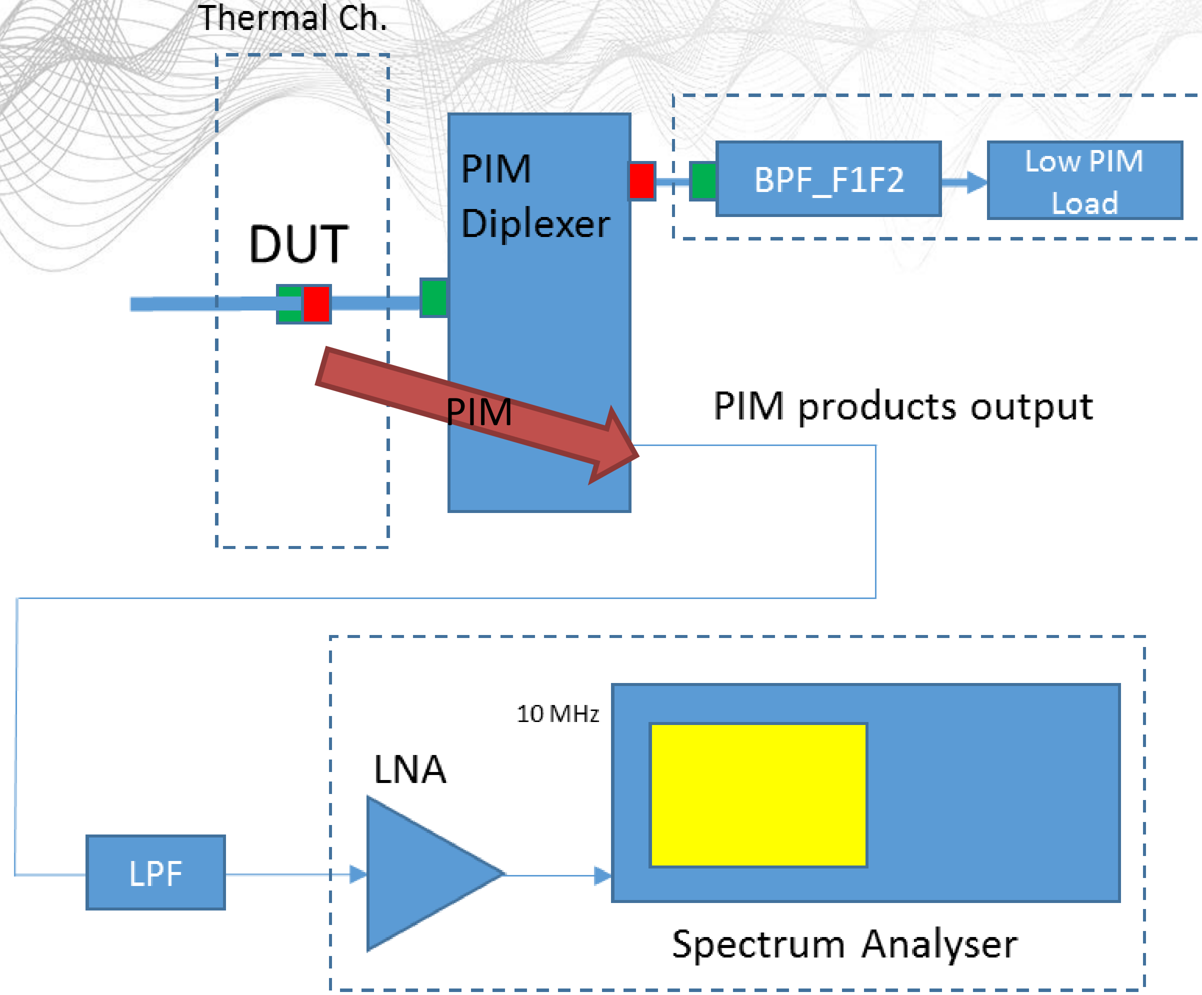
S-Band PIM Test bed

First test mode

- ***Transmitted*** test mode
  - High power signals pass through the D.U.T.
  - At the output of the DUT the test tones PLUS PIM appear.
  - PIM Band of interest is the LSB (lower sideband)

S-Band PIM Test bed

Step 2: Measure in transmitted mode



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S-Band PIM Test bed

Second test mode

- ***Reflected*** test mode
  - High power signals are applied to the D.U.T. input
  - At the input of the DUT reflected PIM products may appear
  - PIM Band of interest is the LSB (lower sideband)

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S-Band PIM Test bed

Step 3: Measure in reflected mode

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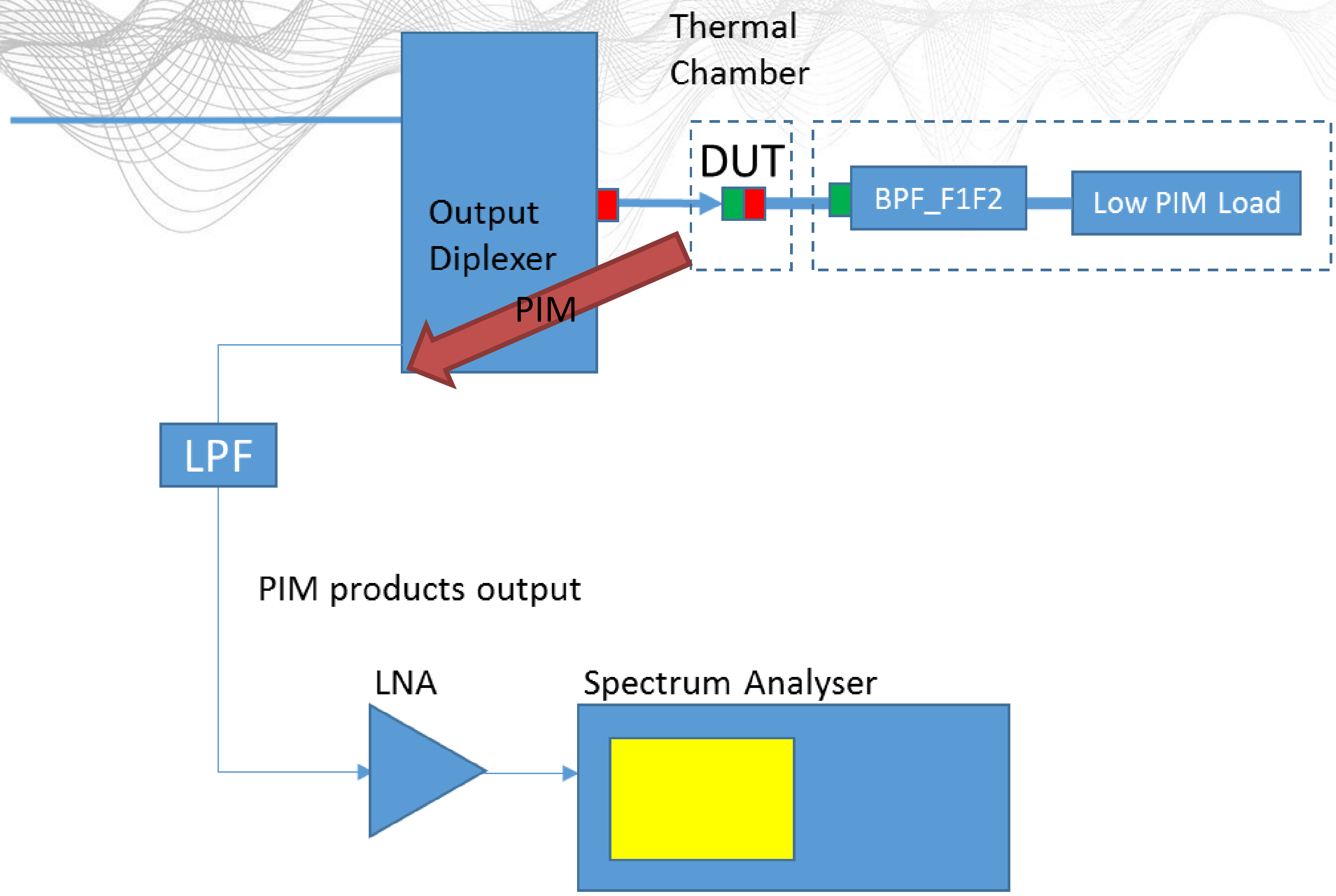

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S-Band PIM Test bed

The filters in the system are essential!

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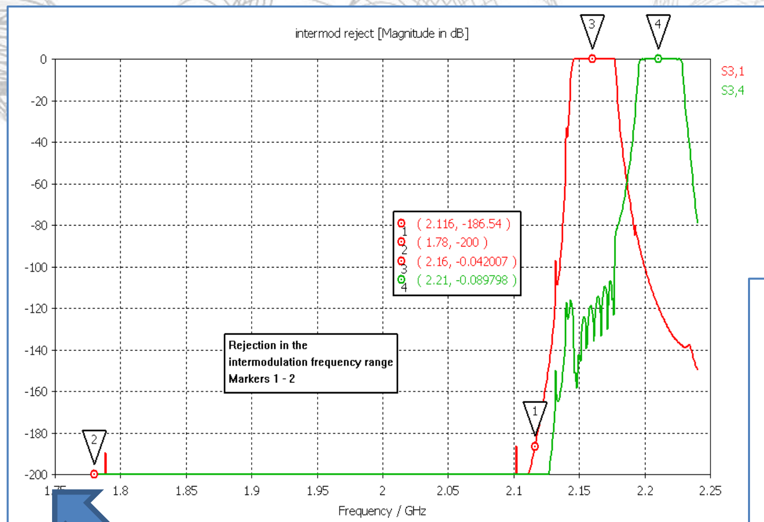
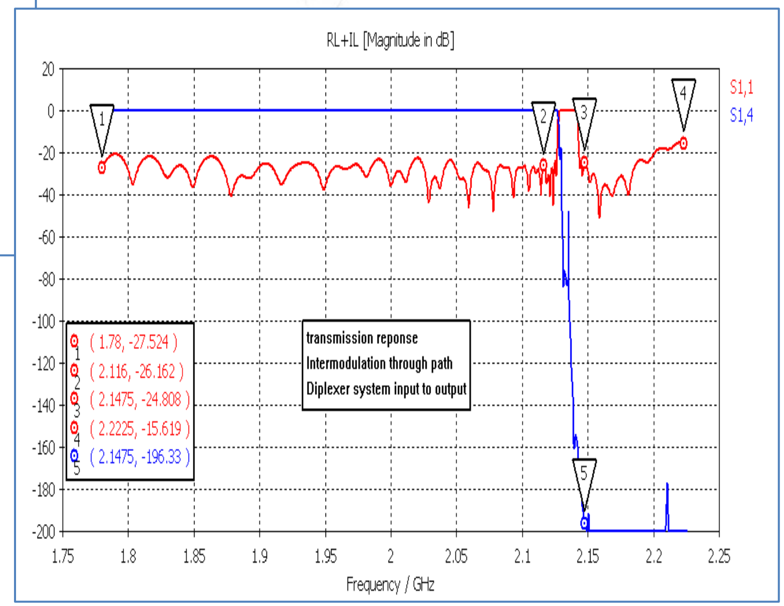


Front end filtering

-200 dB!!

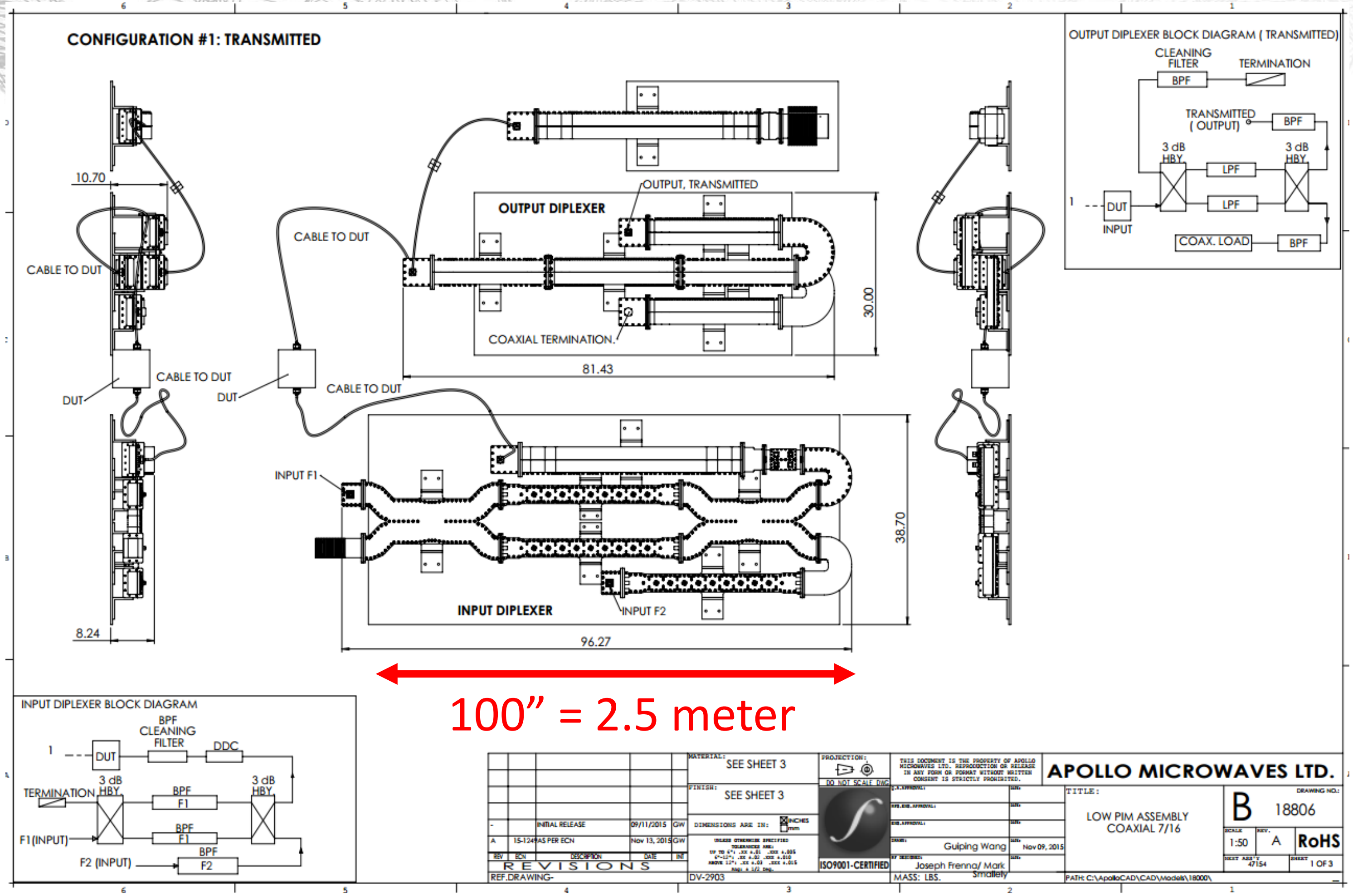


Output Diplexer

Test tones	+ 50 dBm
Lowest own PIM	-155 dBm
Signal Dyn Range	> 200dB

S-Band PIM Test bed

Practical realisation



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S-Band PIM Test bed

Some figures

- Input Diplexer: 255 lbs (116 Kg)
- Termination 85 lbs (37 Kg)
- Output diplexer: 264 lbs (120 Kg)

On Site Delivery in August

- On site installation August 2016
- At CAST in Xi'an, Central China

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S-Band PIM Test bed

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Thanks for your attention