

Space Passive Component Days, 1st International Symposium

ESA/ESTEC 24-26 September 2013

COBHAM

The most important thing we build is trust



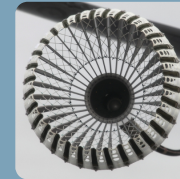
AEROSPACE AND SECURITY DIVISION

- Aerospace Communications
- Antenna Systems
- Commercial Systems
- SATCOM
- Tactical Communications and Surveillance



DEFENCE SYSTEMS DIVISION

- Defence Electronics



MISSION SYSTEMS DIVISION

- Aviation Services
- Life Support
- Mission Equipment

Space L-Band High Power Ferrite Isolator

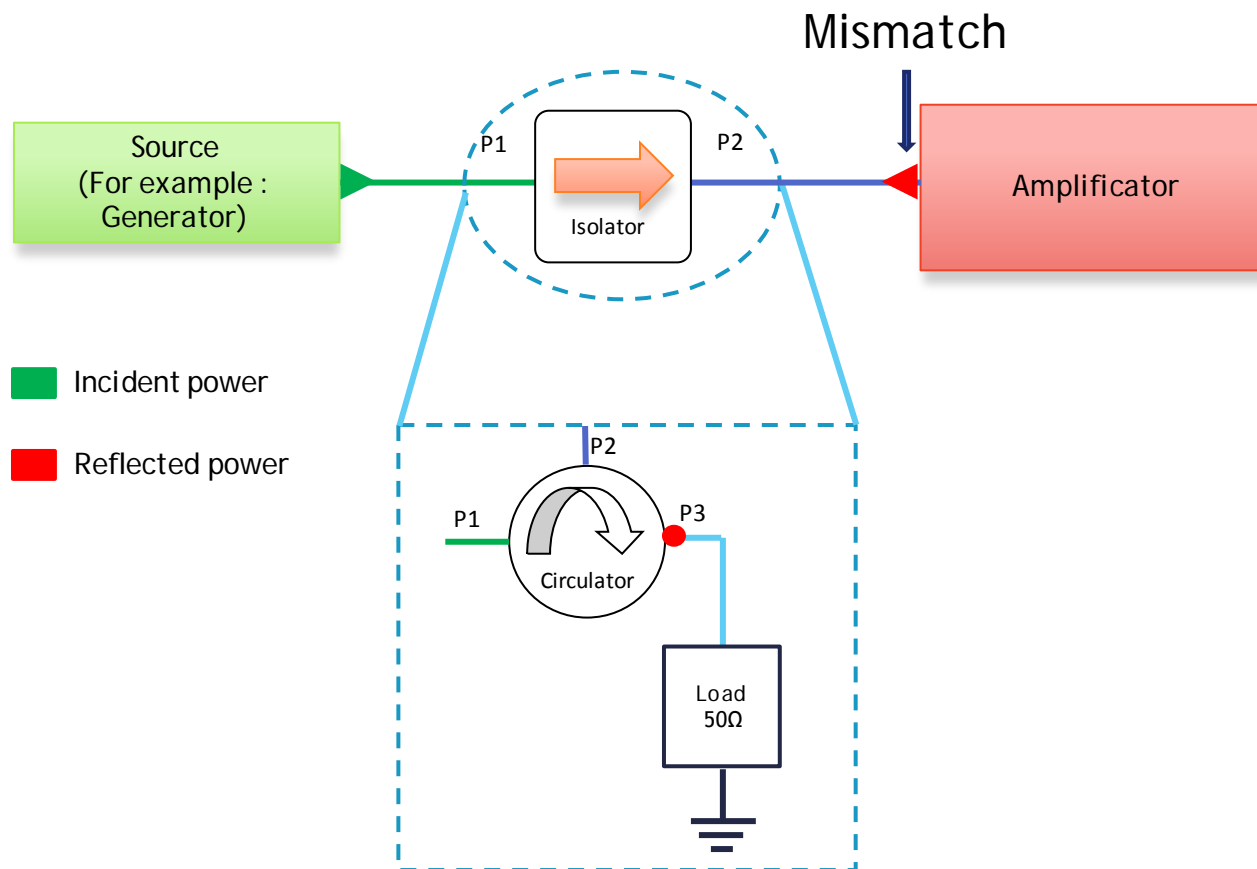
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¹ Cobham Microwave, France

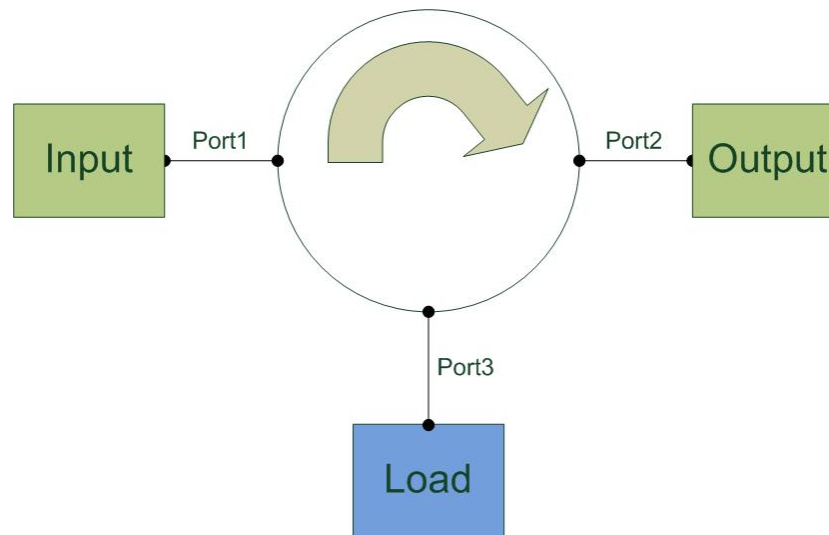
² CNES, France

- Ferrite Isolators
- Objectives of work
- Design
- Test results
- Conclusion

- Isolators are required at the output of the SSPA for protection
- Performance which must be able to handle the full output power



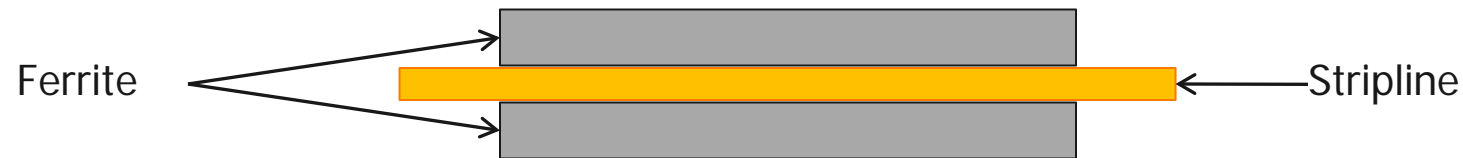
- The signal passes from port1 to port2 with low loss called "Insertion loss" : S_{21}
- In the reverse direction, from port 2 to port1, the signal passes with high loss. As such, it's used to "Isolate" one RF device from another: S_{12}
- The chip load is dimensioned to present a good VSWR within the operating frequency and temperature range



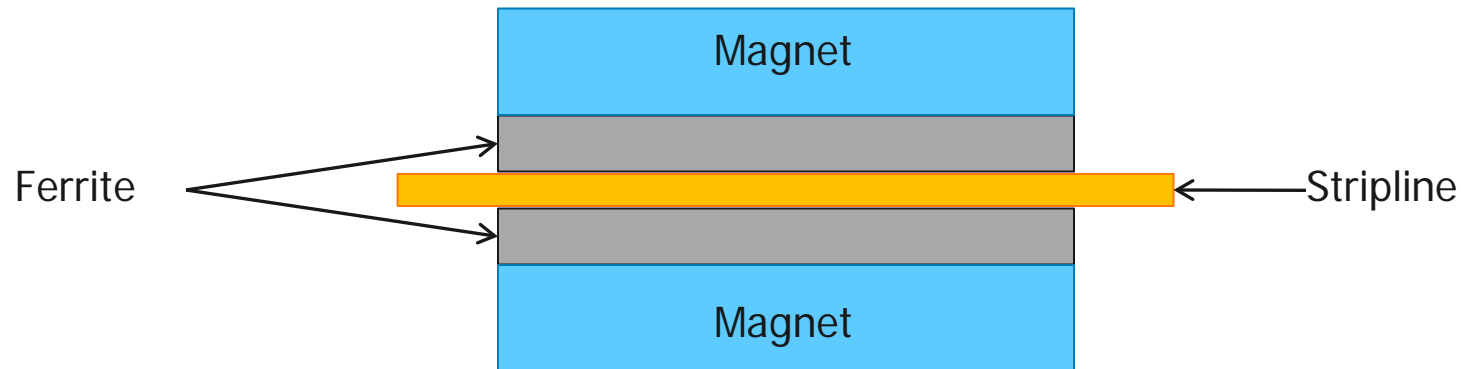
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- The three port junction function is made by a strip line structure
- Ferrite disks are used. The ferrite material used shows non linear effects, a good stability in the temperature range and low insertion losses.
- The gyromagnetism effect in ferrite material is a phenomena which does not need any power supply : only a permanent magnet included in the isolator provide the necessary field to create the circulation.



- In recent years, power capability of amplifiers used in telecommunication or GPS payloads increased continuously => Consequently, ferrite isolators, which protect amplifiers, must be designed to be used at such power levels
- This work belongs to a CNES funded R&T project which objective is to design, realize and evaluate L-band isolator with power as high as 200W-CW

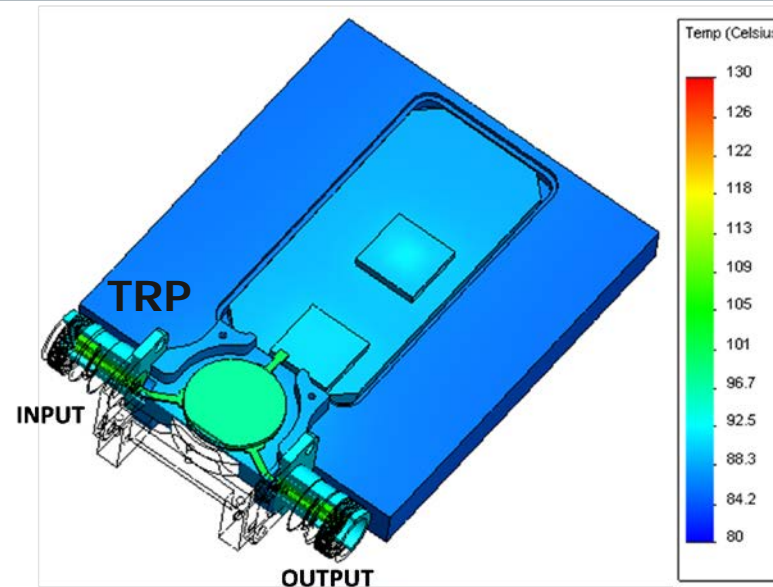
Frequency (MHz)	Bandwidth (MHz)	Power (W)
1150 - 1250	100	200
1150 - 1200	50	200
1550 - 1650	100	150
1550 - 1600	50	150

- TNC connectors
- Operating temperature: -30°C $+85^{\circ}\text{C}$
- Shielding effectiveness > 75 DBi
- Glitch free

- Insertion loss < 0.25 dB
- Isolation > 20 dB
- Return loss > 20 dB



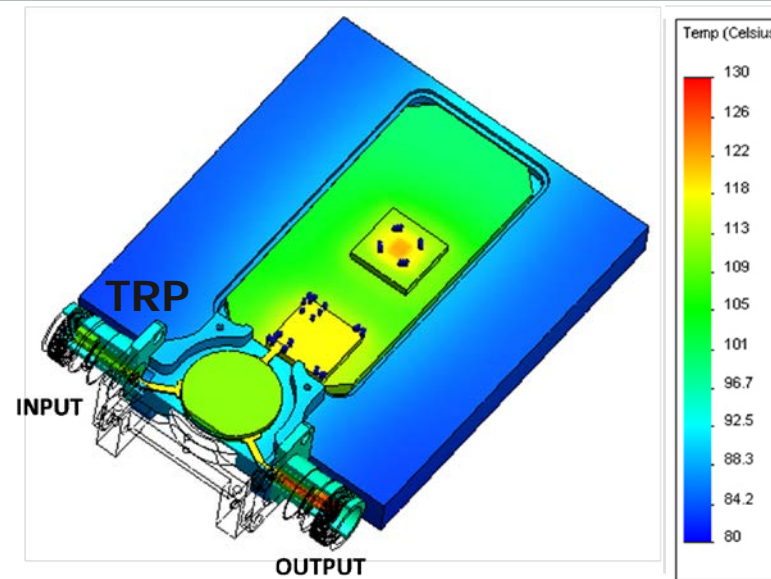
- Many aspects according to space requirements (**ESCC3202** and major payload manufacturers), are taken into account to design isolators that will give the best trade-off to users :
 - Electrical performances
 - Mechanical
 - Multipaction
 - Thermal



No cable flux considering

Surface	Temperature Max (°C)	Temperature Average (°C)	Maximum Allowable Temperature (°C)
TRP	85		
Chip	90.0	88.7	127
Ferrites	99.6	97.1	220
Stripline	102.2	100.4	300
Connector's central part	107.0	106.8	165

Thermal analysis: short circuit condition for 200W



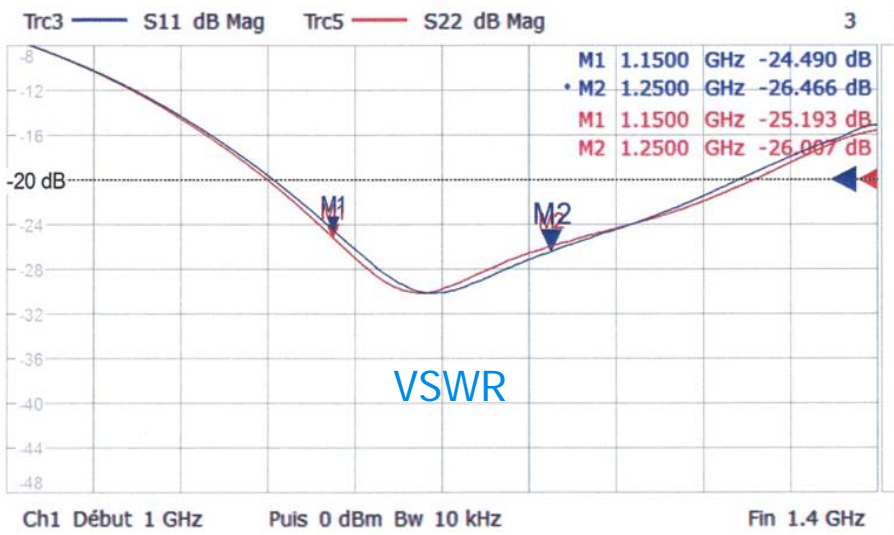
No cable flux considering

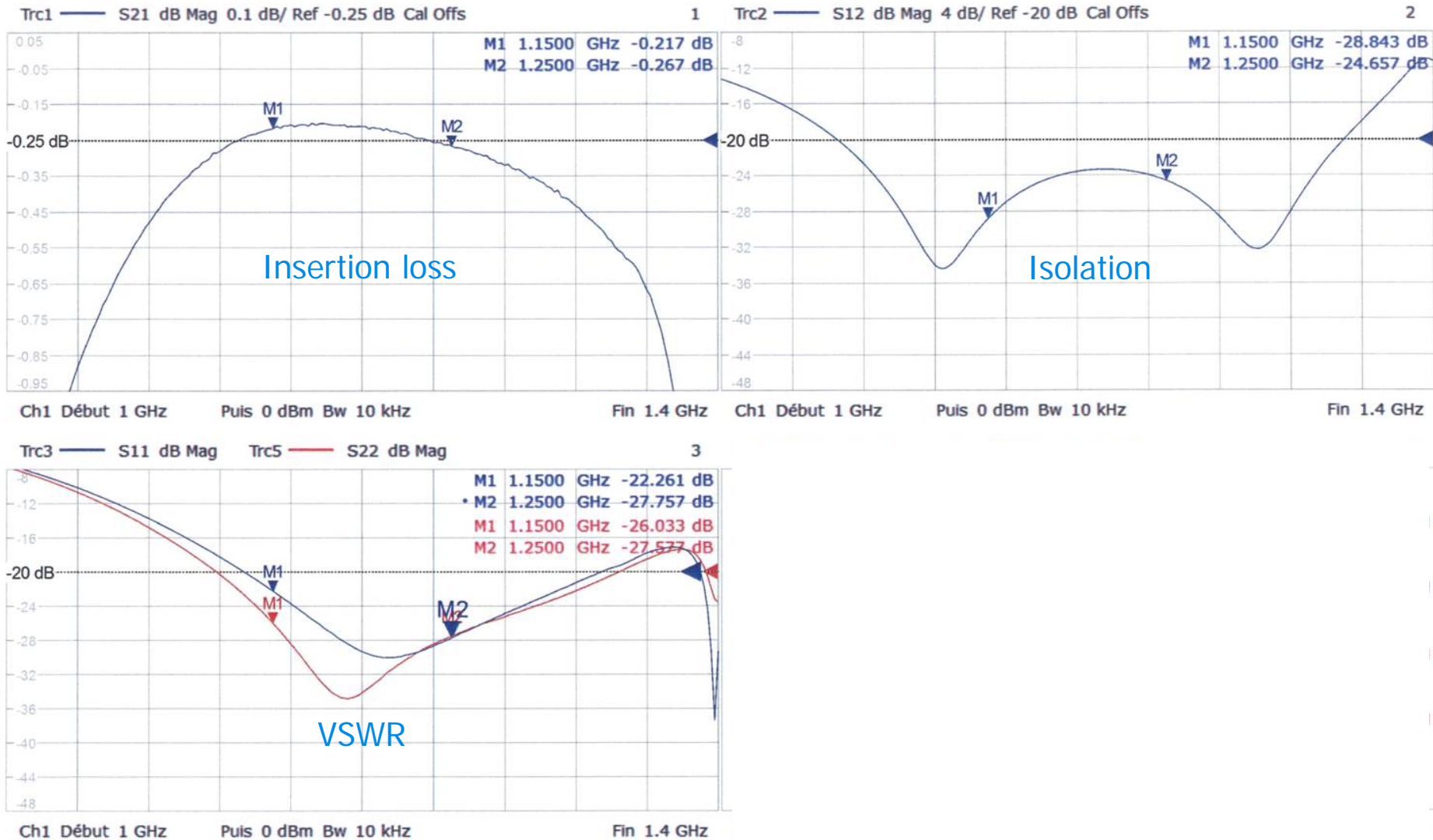
Surface	Temperature Max (°C)	Temperature Average (°C)	Maximum Allowable Temperature (°C)
TRP	85		
Chip	123.4	113.5	127
Ferrites	112.7	107.7	220
Stripline	117.8	114.4	300
Connector's central part	109.3 Input 126.5 Output	109.2 Input 126.4 Output	165



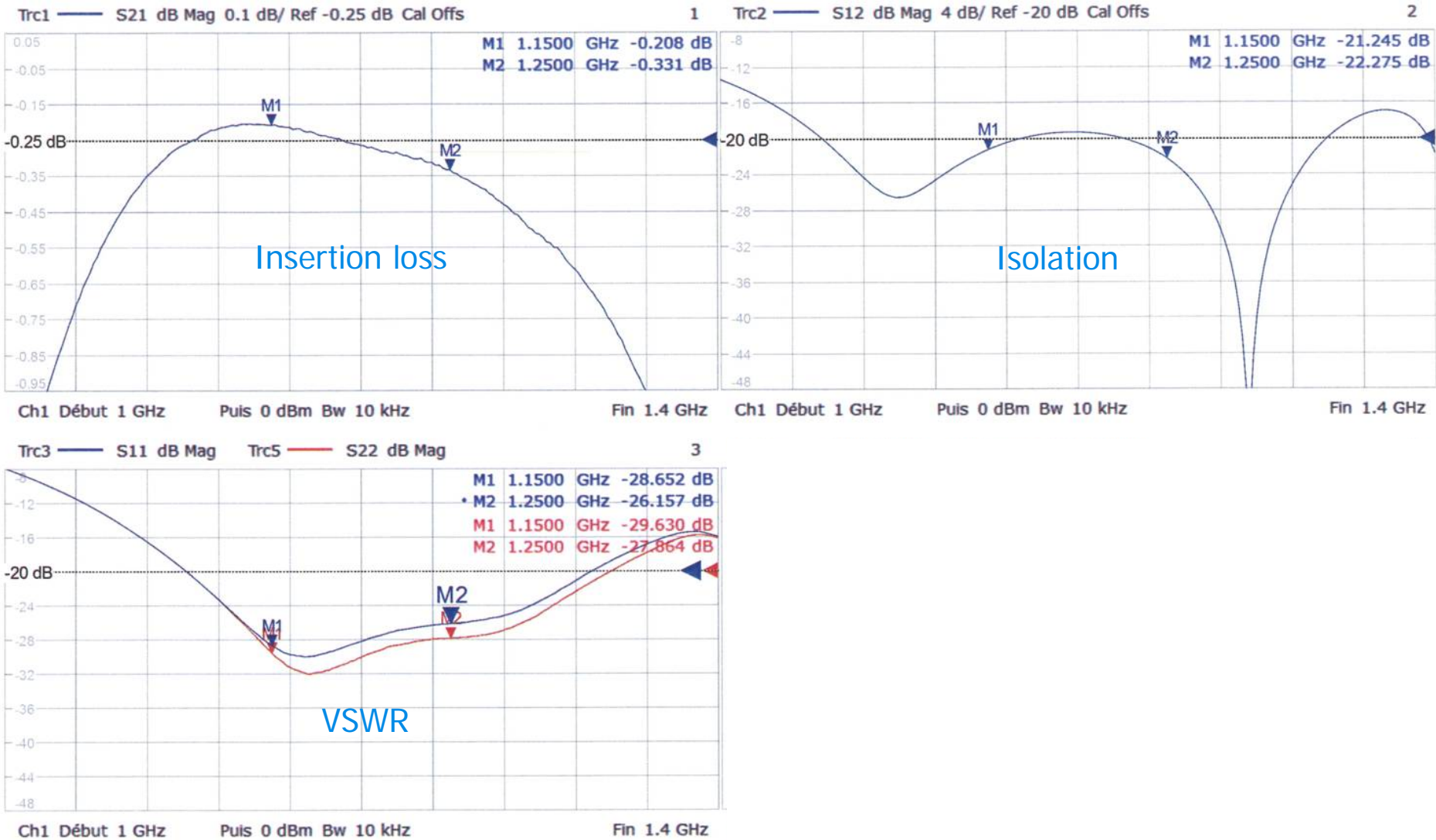
Frequency (MHz)	Bandwidth (MHz)	CW-Power (W)	Glitch test	Power test	Temperature cycling (200 cycles)	EMC
1150 - 1250	100	200	X			X
1150 - 1200	50	200		X	X	
1550 - 1650	100	150			X	X
1550 - 1600	50	150	X	X		

Electrical measurement at ambient temperature

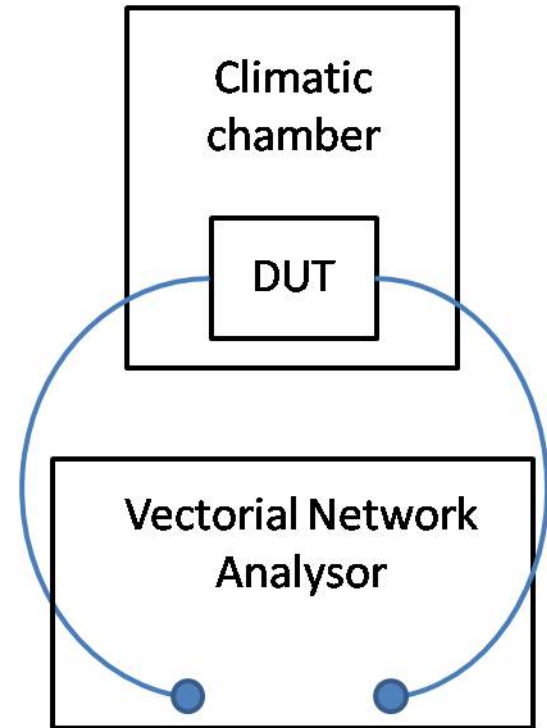


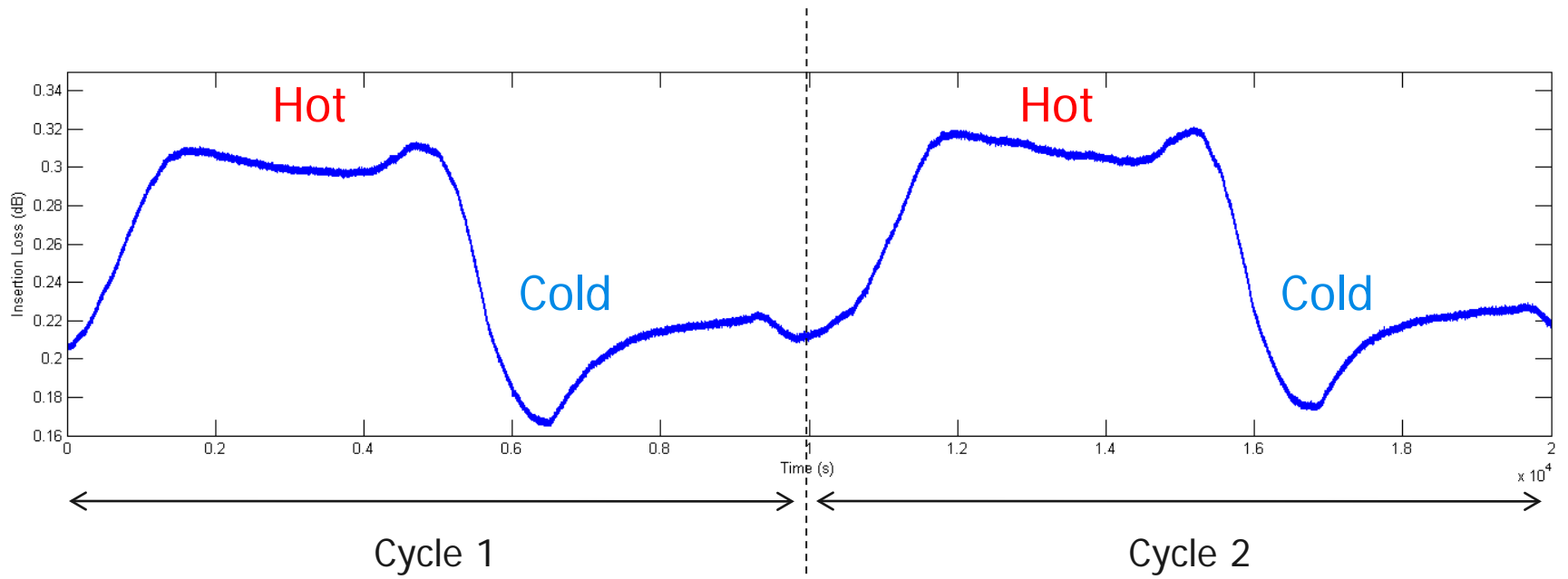


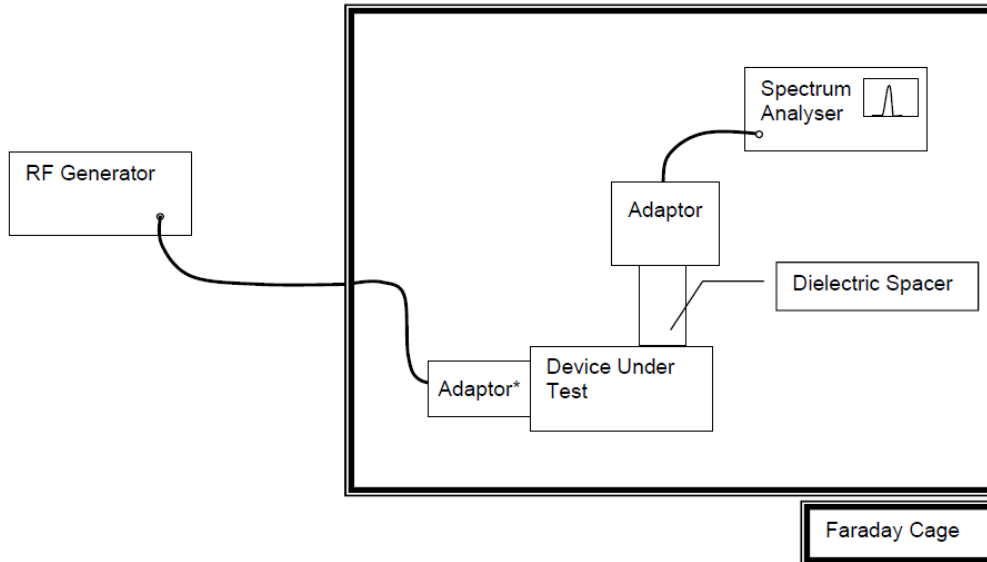
Electrical measurement at +85°C



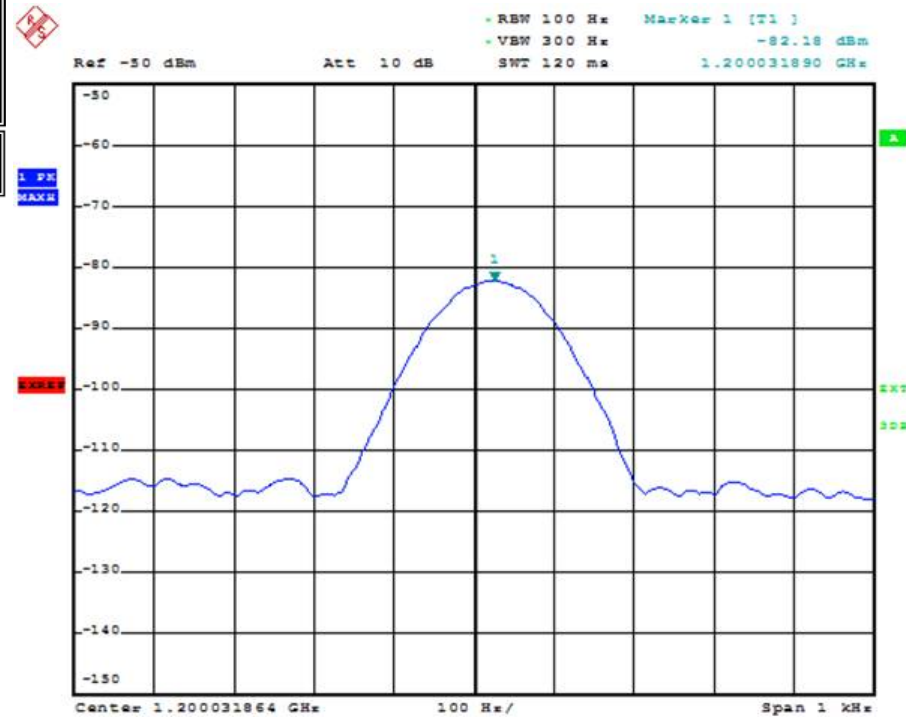
- Glitch phenomena:
 - Insertion loss discontinuity, step or spike shall exceed 0.05dB.
 - The sum of consecutive Insertion loss discontinuities, steps or spikes in any one temperature cycle shall not exceed 0.05dB in any direction.
 - Insertion Loss measurements shall exhibit a maximum change of 0.05dB during any given period of 1 minute during cycling. Gradual variation of Insertion Loss due to change of temperature shall be excluded when assessing this change.
- 2 cycles: +85°C/-30°C
- Dwell time at each extreme temperature: 15 minutes

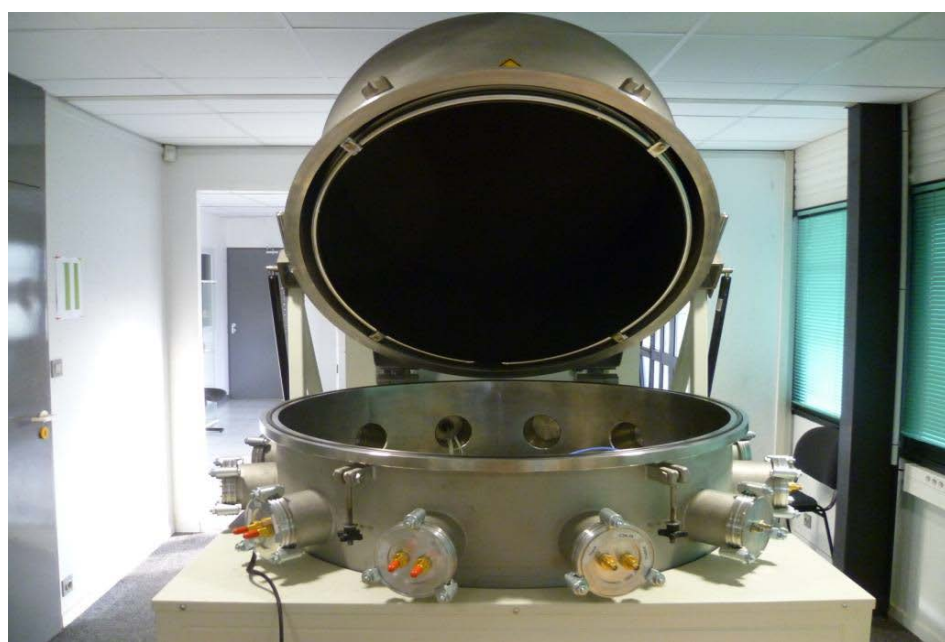






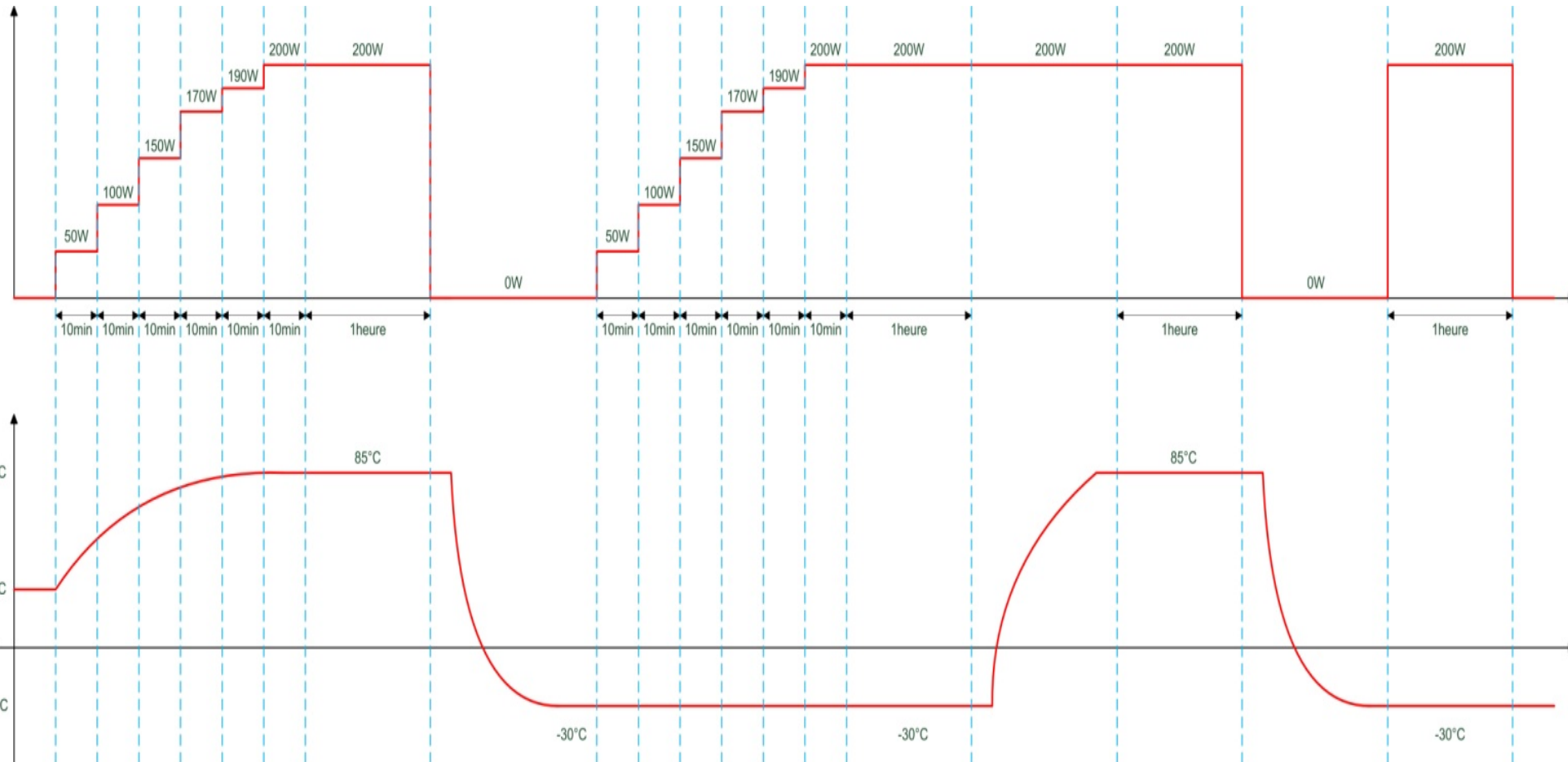
Shielding Effectiveness ≥ 77 dBi

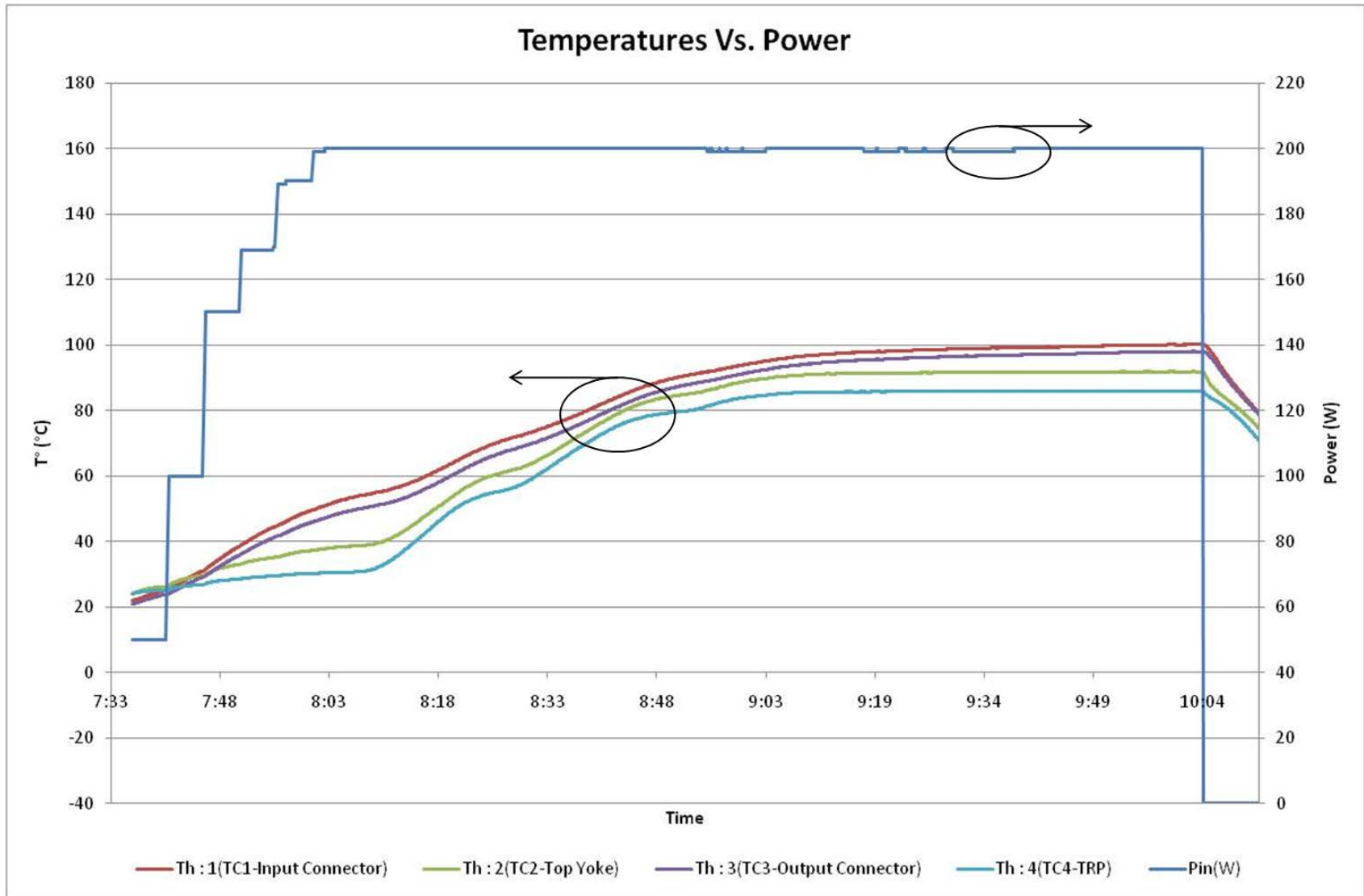


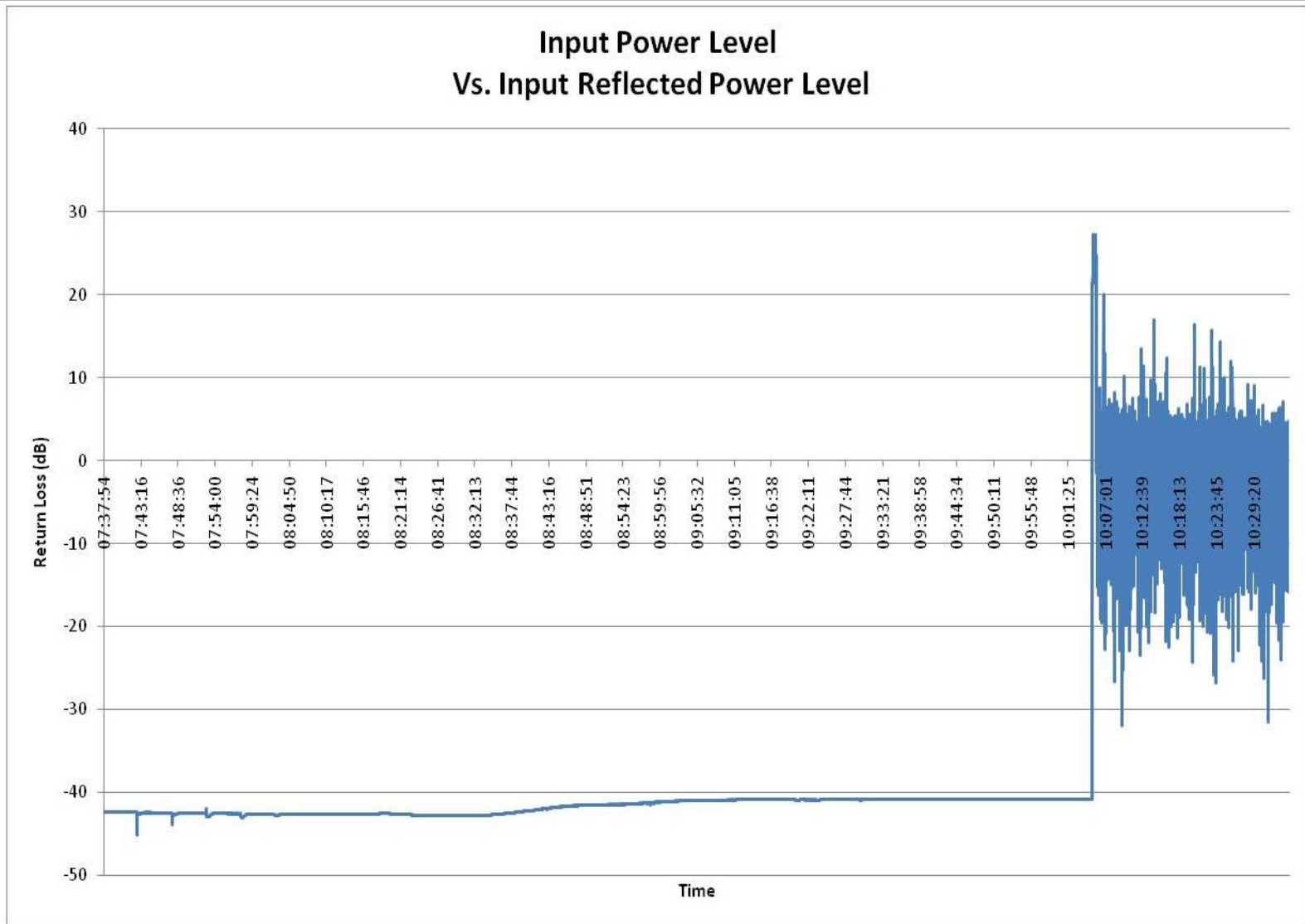


Frequency band	VHF-UHF 1 - 500 MHz	L-band 1 - 2 GHz	S-band 2 - 4 GHz	C-band 2.5 - 8 GHz	Ku-band 8 - 18 GHz	KA-band 18 – 21.7 GHz
Maximum power	25 – 50 W	500 W	110 W	500 W	250 W	250 W

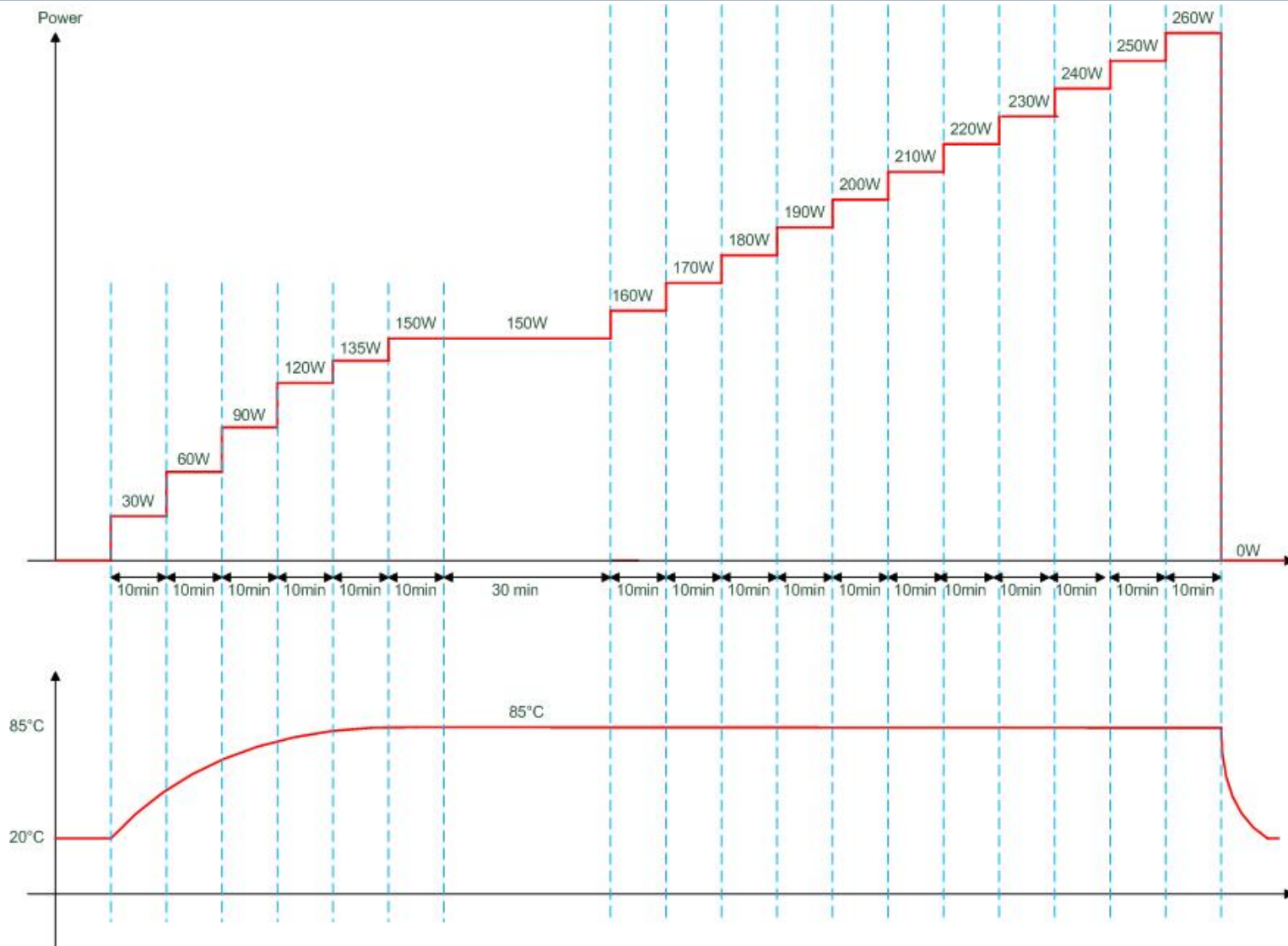
Power Test sequence





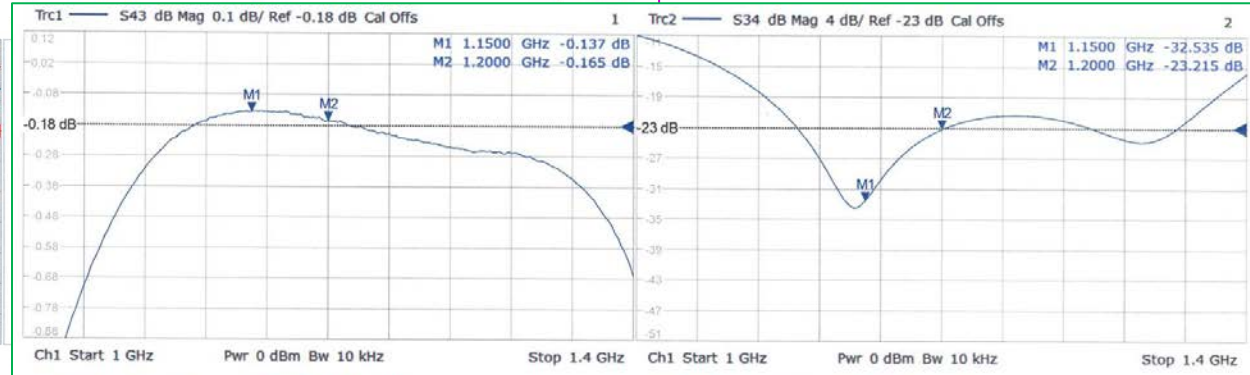
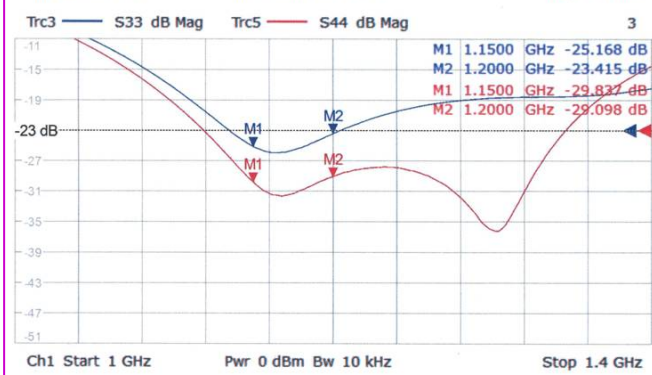
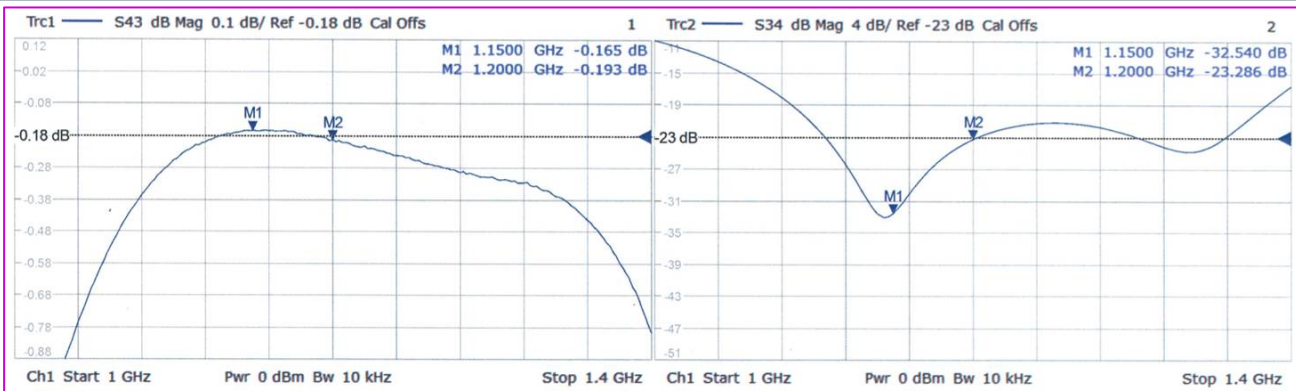


Power Test: short circuited



Temperature cycling

- 200 cycles
- -40°C to 90°C
- Ramp 3°C/min



Before cycling

After cycling

- Conception, Fabrication and Measurement of L-band High Power Isolator up to 200 W
- Objectives:
 - TNC connectors ✓
 - Operating temperature: -30°C $+85^{\circ}\text{C}$ ✓
 - Shielding effectiveness > 75 dbi ✓ ≥ 77 dBi
 - Glitch free ✓
 - Insertion loss < 0.25 dB ✓
 - Isolation > 20 dB ✓
 - Return loss > 20 dB ✓
- Next steps:
 - Evaluation of this isolators
 - Design of High Power Isolator in S- and C- band: ESA contract

Thank you for your attention