

Antenna matching and measurement report

Projet : NLG-US

XXI-Lab		Le client	
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			Historique
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1 Introduction

1.1 Type of service :

Tuning of antenna matching circuit at 2.4GHz (Ref XXI-Lab: Ant_dev)

1.2 Purpose of the study

Search for the optimal matching networks for the NLG-US product antennas - Wifi & Zigbee - at 2.4GHz.

1.3 Tools used


- Network analyser
- Anechoic chamber

1.4 Input data

One product in permanent transmission mode (Zigbee), one product in permanent transmission mode (Wifi) and one product without firmware for conducted tests only.

1.5 Delivery

This study report

	Document reference	Date	Version	Page
	Exp-NETATMO_Match_NLG-US_25-09-2020	25/09/2020	1.0	3

2 Wifi Antenna Performances

2.1 Antenna Matching

With the antenna matching circuit used by default the tuning is not good. The resonance frequency is too low.

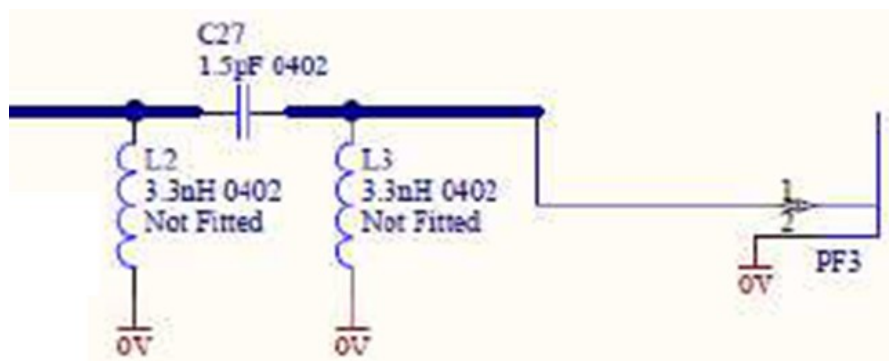


figure 1. antenna matching circuit "Ant-1.5pf serie" used by default

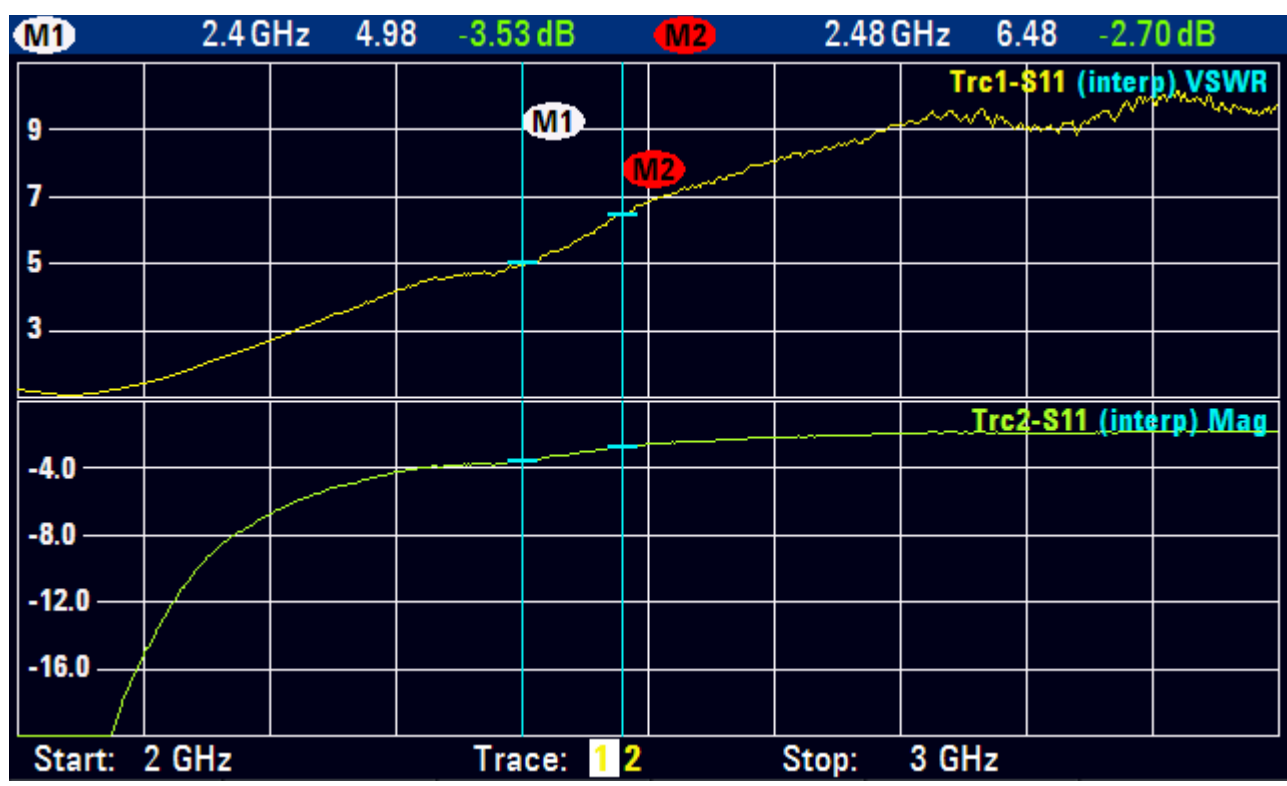


figure 2. Adaptation of the antenna with the matching used as default : "Ant-1.5pf serie"

A new matching circuit has been designed to improve the antenna tuning. This circuit is the following:

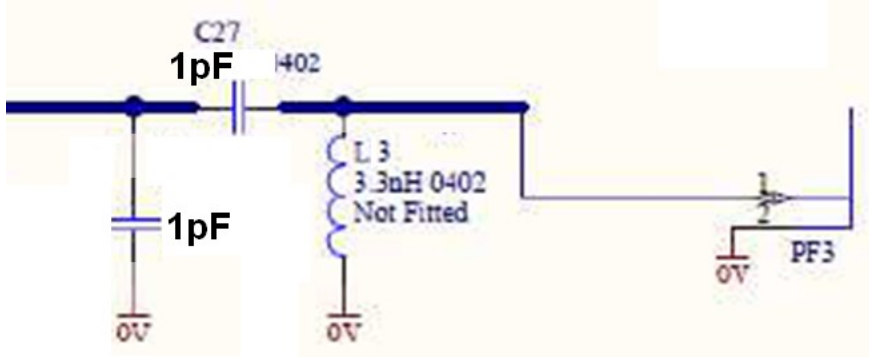


figure 3. antenna matching circuit proposed: "Ant-1pf serie – 1pf shunt"

With this circuit the antenna matching is good. It is the following:

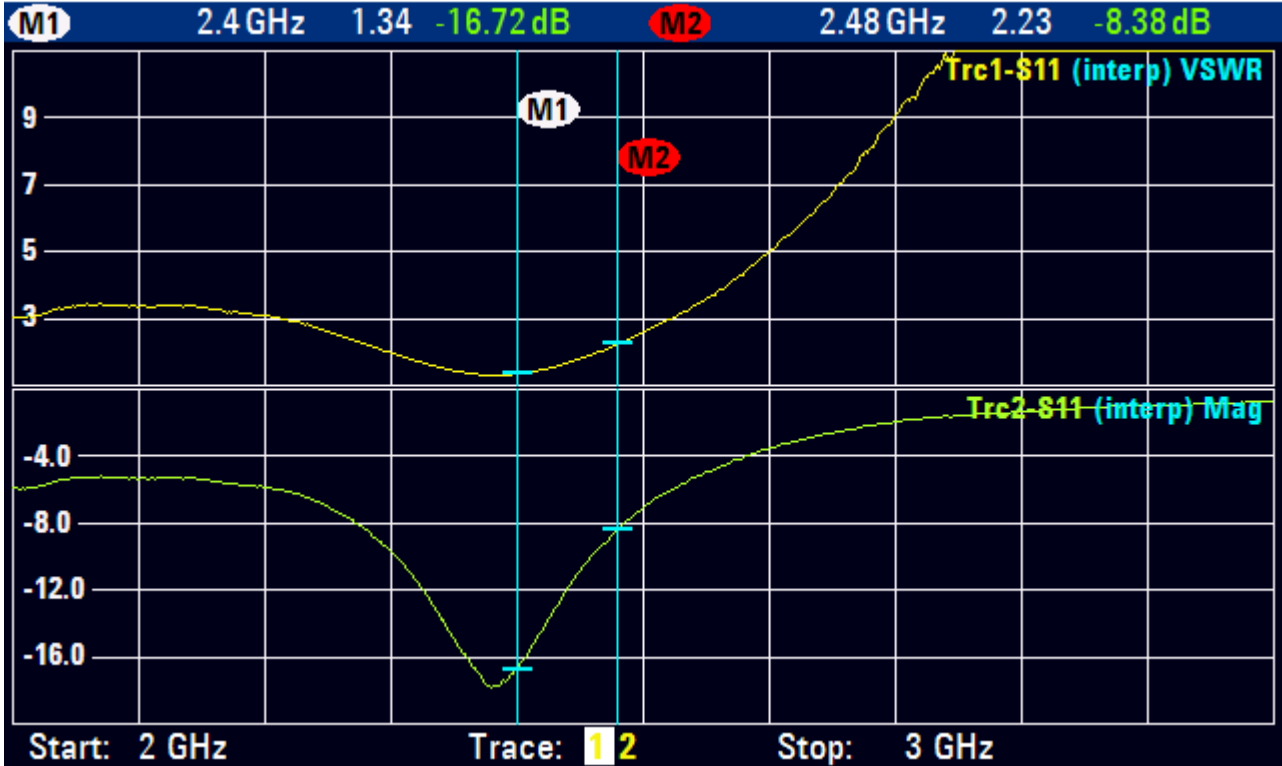


figure 4. Adaptation of the antenna with the matching proposed : "Ant-1pf serie-1pF shunt"

Among the different matching circuit studied, this matching circuit allows the better radiated performances

2.2 Radiated measurements

The measurements were carried out for the E1, E2 and H planes at the 2412, 2442 & 2480MHz frequency in vertical and horizontal polarization with a step of 1°. From these results the total polarization was calculated.

Measurements have been done using the modem of the product tuned at maximum power for two different product configurations: product with Wifi matching circuit used by default – “Ant -1.5pF serie” and Wifi matching circuit proposed – “ant-1pF serie – 1pF shunt”

The E1, E2 and H plane are displayed below :

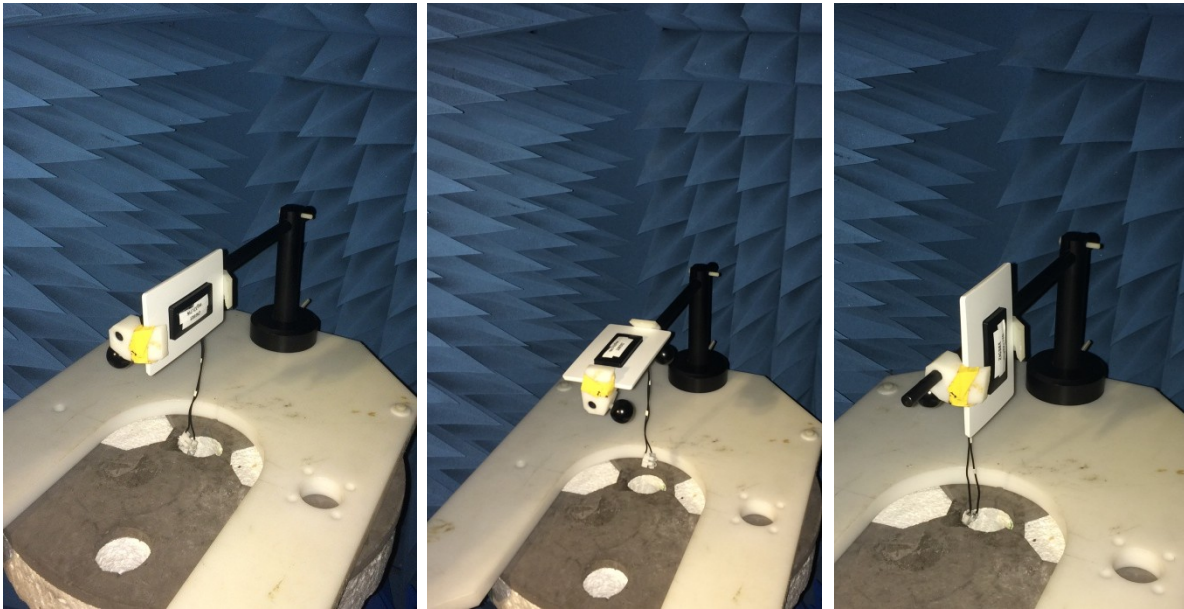


figure 5. Photo of the E1, E2 and H plane

Results are compiled in the table below:

Radiated Power (dBm) / Fréquence / plane	2412MHz		2442MHz			2480MHz			
	H	E1	H	H	E1	E2	H	E1	E2
Default matching network “Ant-1.5pf serie”	17.3	19.6	21.6	16.2	18.5	21.3	14.9	17.3	20.1
Proposed matching network “Ant-1pf serie – 1pF shunt”	20.0	22.7	23.7	19.3	21.6	22.6	18.1	19.8	20.7

tableau 1. Maximum radiated power for the default and proposed matching network

The proposed matching network allow to gain 2.1dB at 2412Mhz, 1.3dB at 2442 and 0.6dB at 2480MHz.

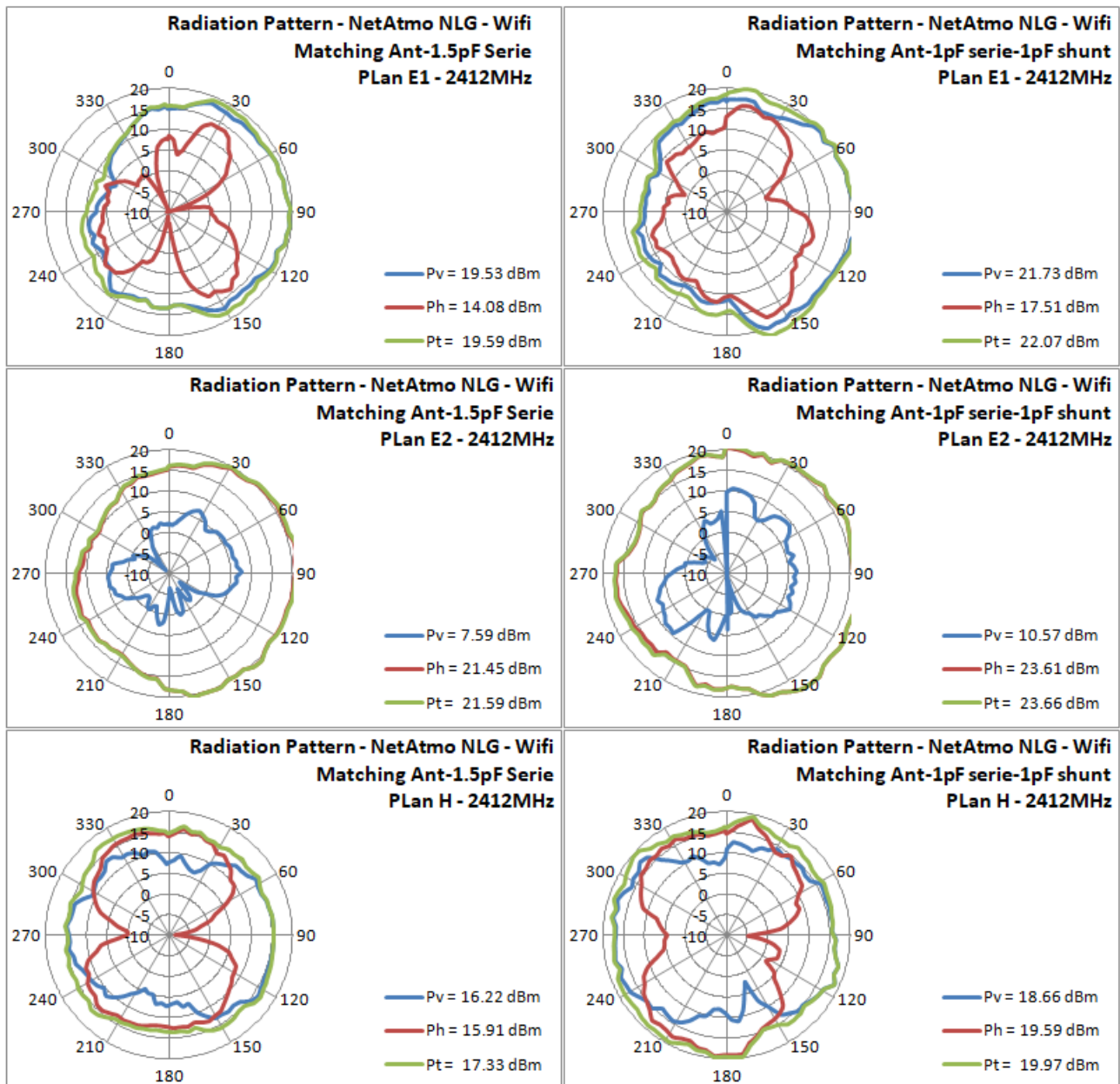


figure 6. From left to right, from top to bottom, Radiation pattern for E1, E2 and H planes for the 2412MHz frequency

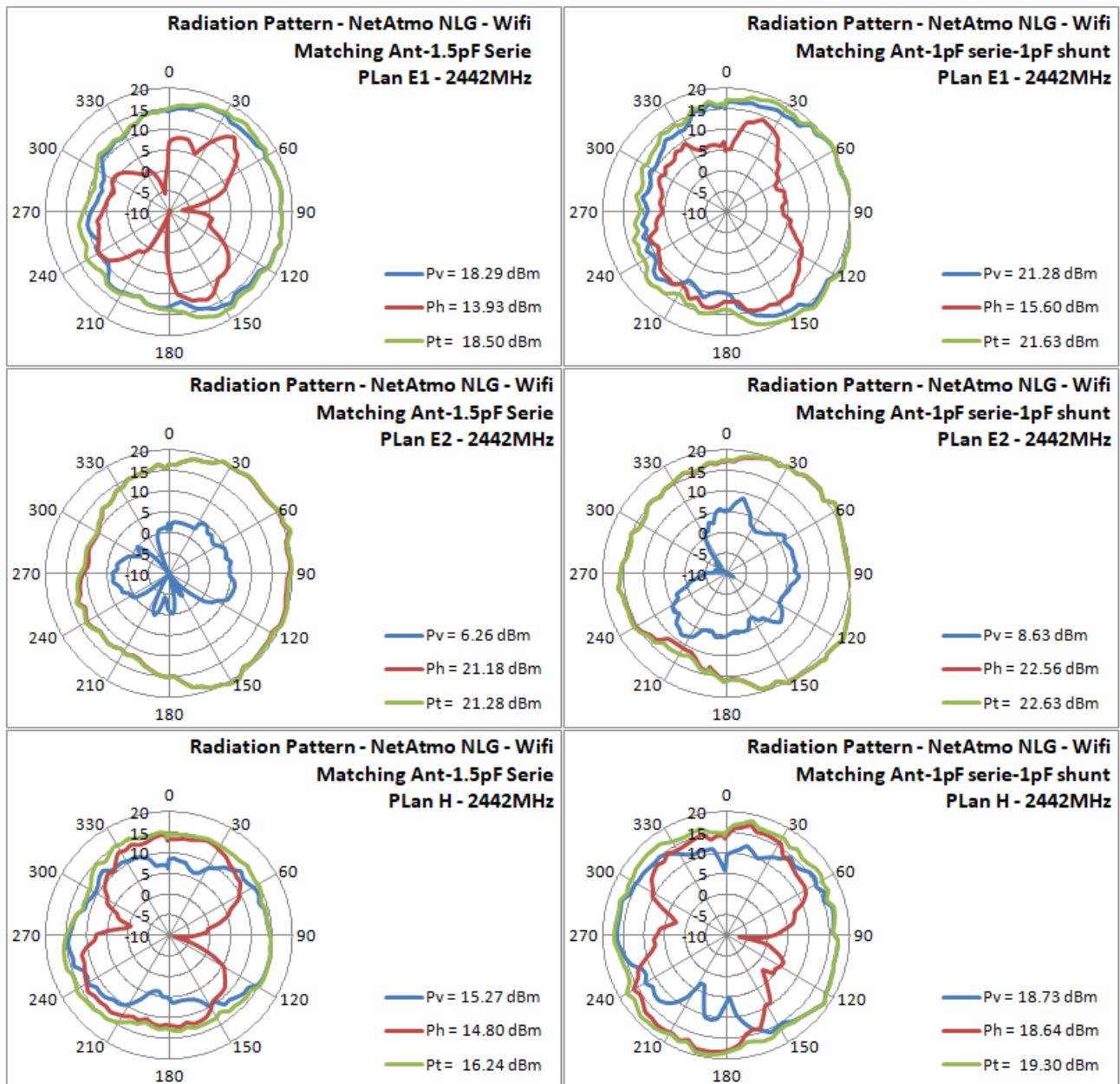


figure 7. From left to right, from top to bottom, Radiation pattern for E1, E2 and H planes for the 2442MHz frequency

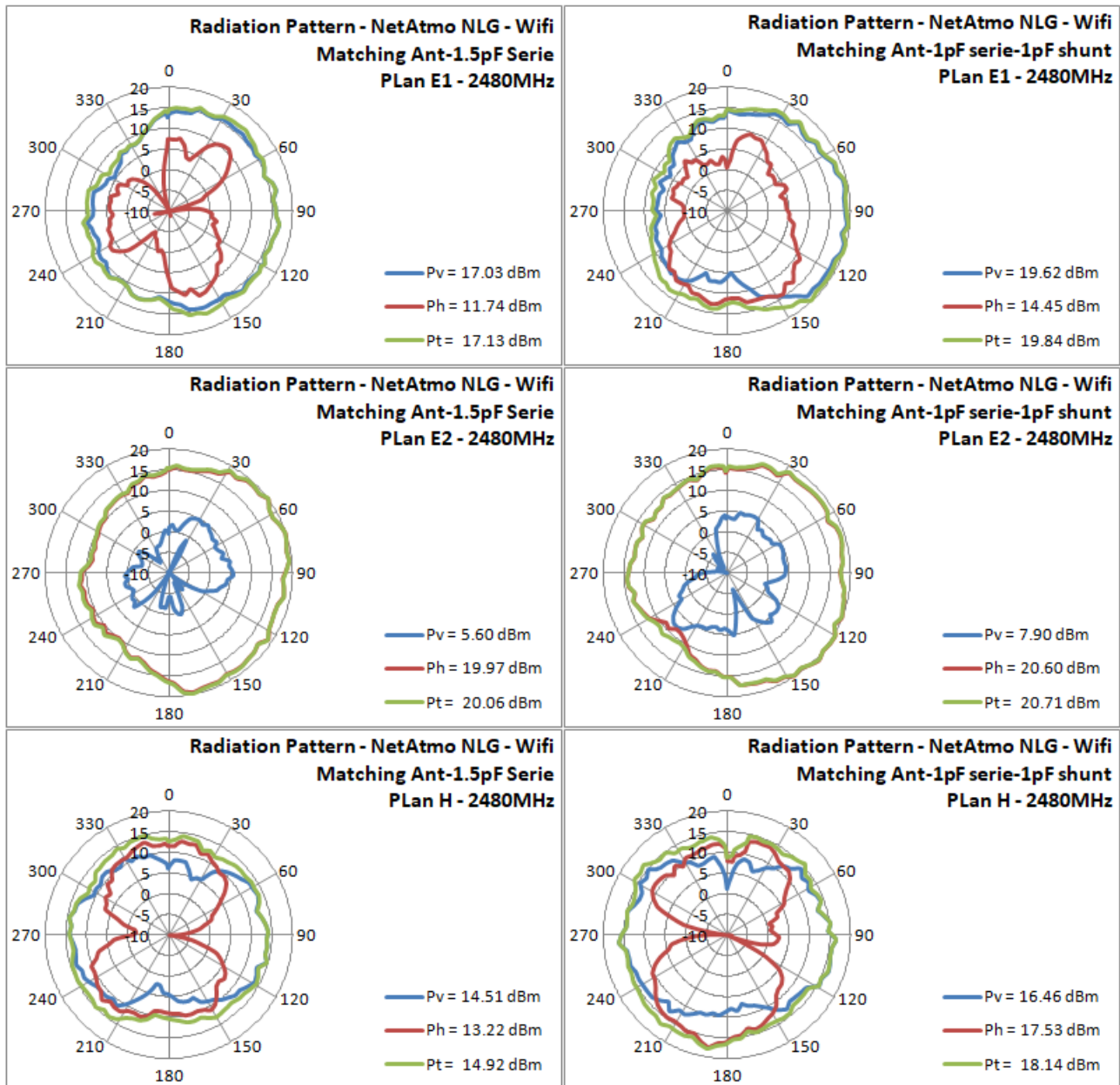


figure 8. From left to right, from top to bottom, Radiation pattern for E1, E2 and H planes for the 2480MHz frequency

3 Zigbee Antenna Performances

3.1 Antenna Matching

With the antenna matching circuit used by default the tuning is not good. The resonance frequency is too low.

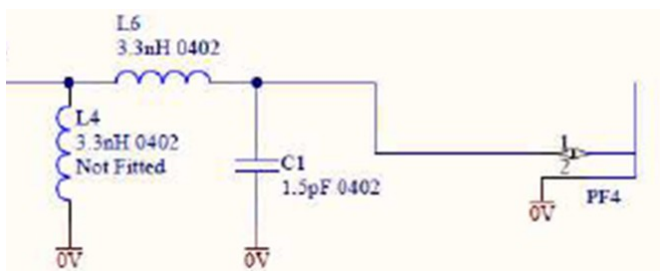


figure 9. antenna matching circuit "Ant-1.5pf shunt – 3.3nHserie" used by default

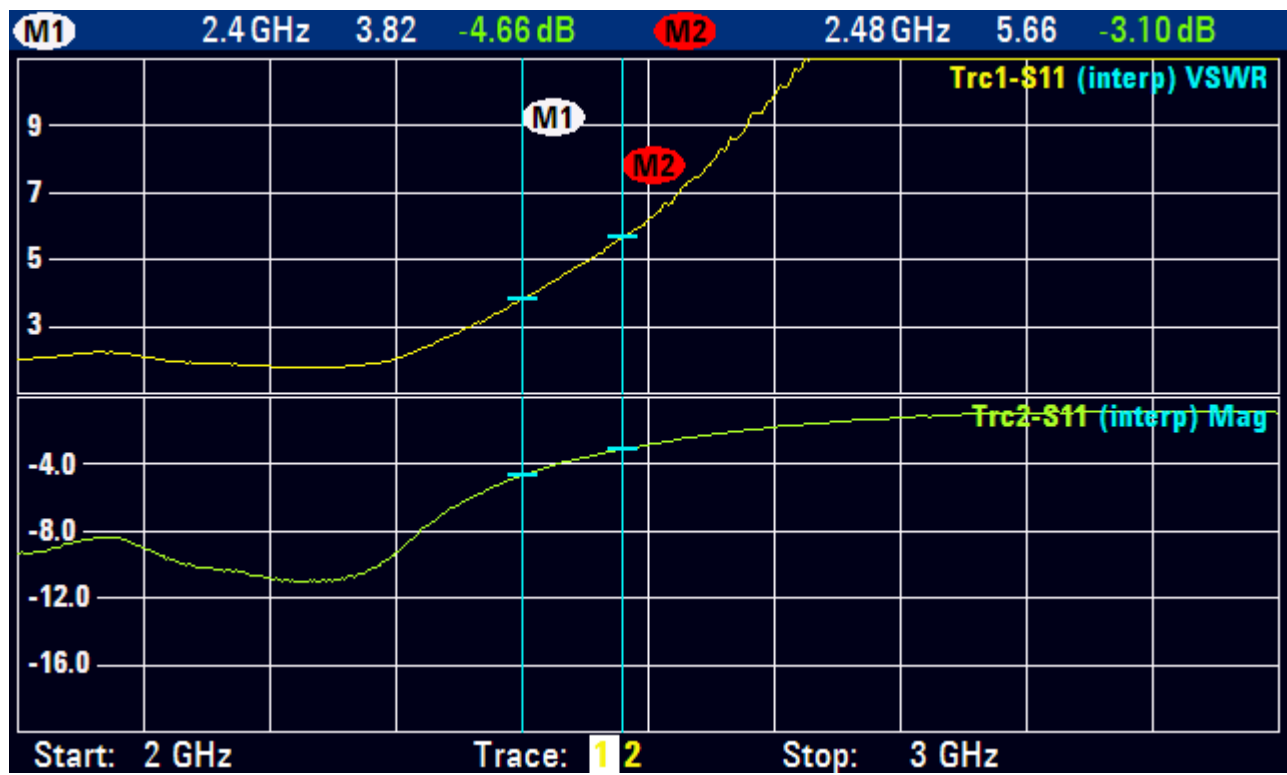


figure 10. Adaptation of the antenna with the matching used as default : "Ant-1.5pf shunt 3.3nHserie"

A new matching circuit has been designed to improve the antenna tuning. This circuit is the following:

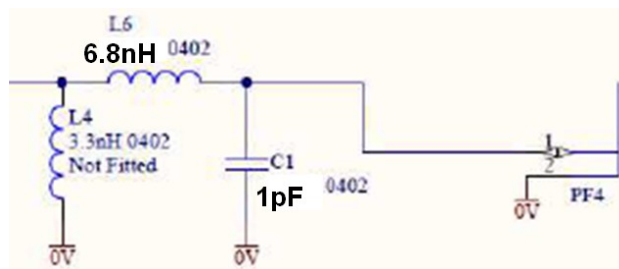


figure 11. antenna matching circuit proposed: "Ant-1pf shunt – 6.8nH serie"

With this circuit the antenna matching is good. It is the following:

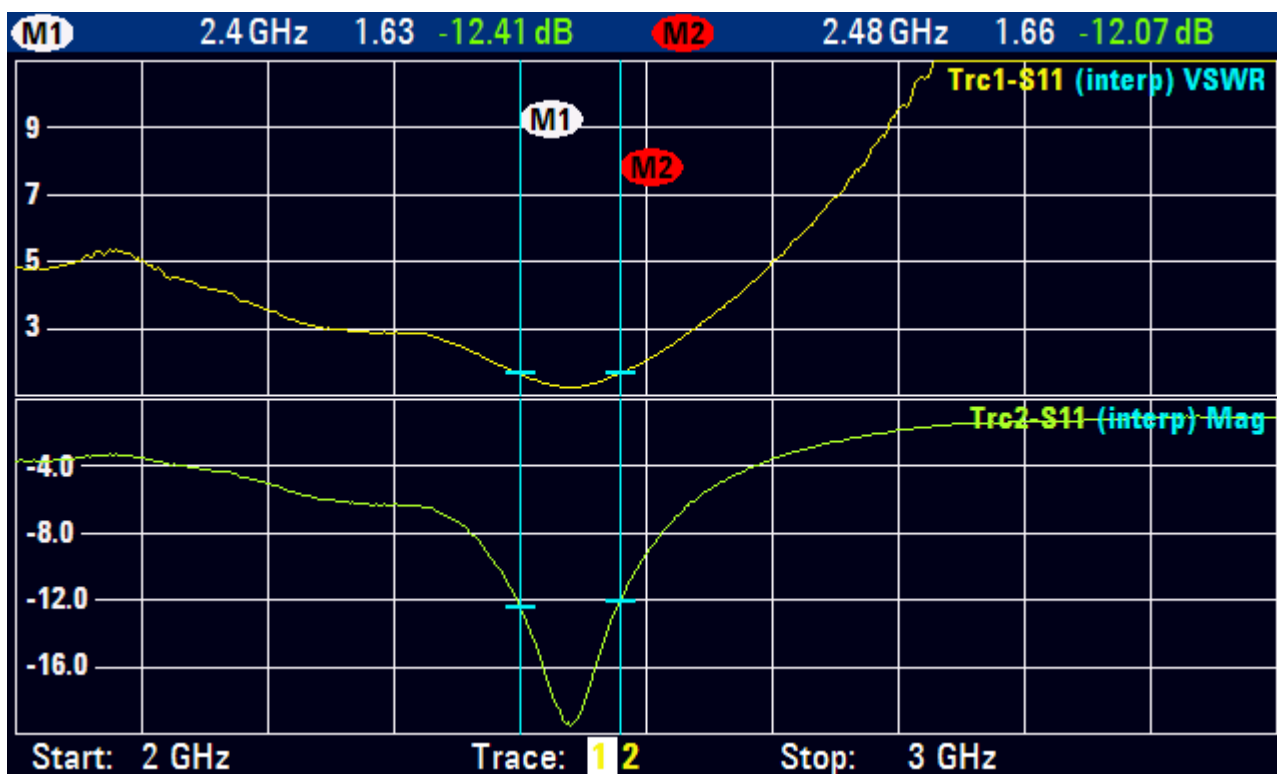


figure 12. Adaptation of the antenna with the matching proposed : "Ant-1pf shunt -6.8nH serie"

Among the different matching circuit studied, this matching circuit allows the better radiated performances

3.2 Radiated measurements

The measurements were carried out for the E1, E2 and H planes at the 2405, 2440 & 2480MHz frequencies in vertical and horizontal polarization with a step of 1°. From these results the total polarization was calculated.

Measurements have been done using the modem of the product tuned at maximum power for two different product configurations: product with Zigbee matching circuit used by default – “Ant-1.5pF shunt – 3.3nH serie” and Zigbee matching circuit proposed – “Ant -1pF shunt – 6.8nH serie”.

The E1, E2 and H plane are those used previously for Wifi.

Results are compiled in the table below:

Radiated Power (dBm) / Fréquence / plane	2405MHz			2440MHz			2480MHz		
	H	E1	H	H	E1	E2	H	E1	E2
Default matching network “Ant-pf serie”	-0.1	+0.0	+1.6	-0.2	-0.2	+1.5	-0.3	-1.1	+0.9
Proposed matching network “Ant-pf serie – pF shunt”	+2.0	+1.7	+3.9	+1.3	+1.7	+4.5	+2.1	+2.5	+4.3

tableau 2. Maximum radiated power for the default and proposed matching network

The proposed matching network allow to gain 2.3dB at 2405Mhz, 3dB at 2440 and 3.4dB at 2480MHz.

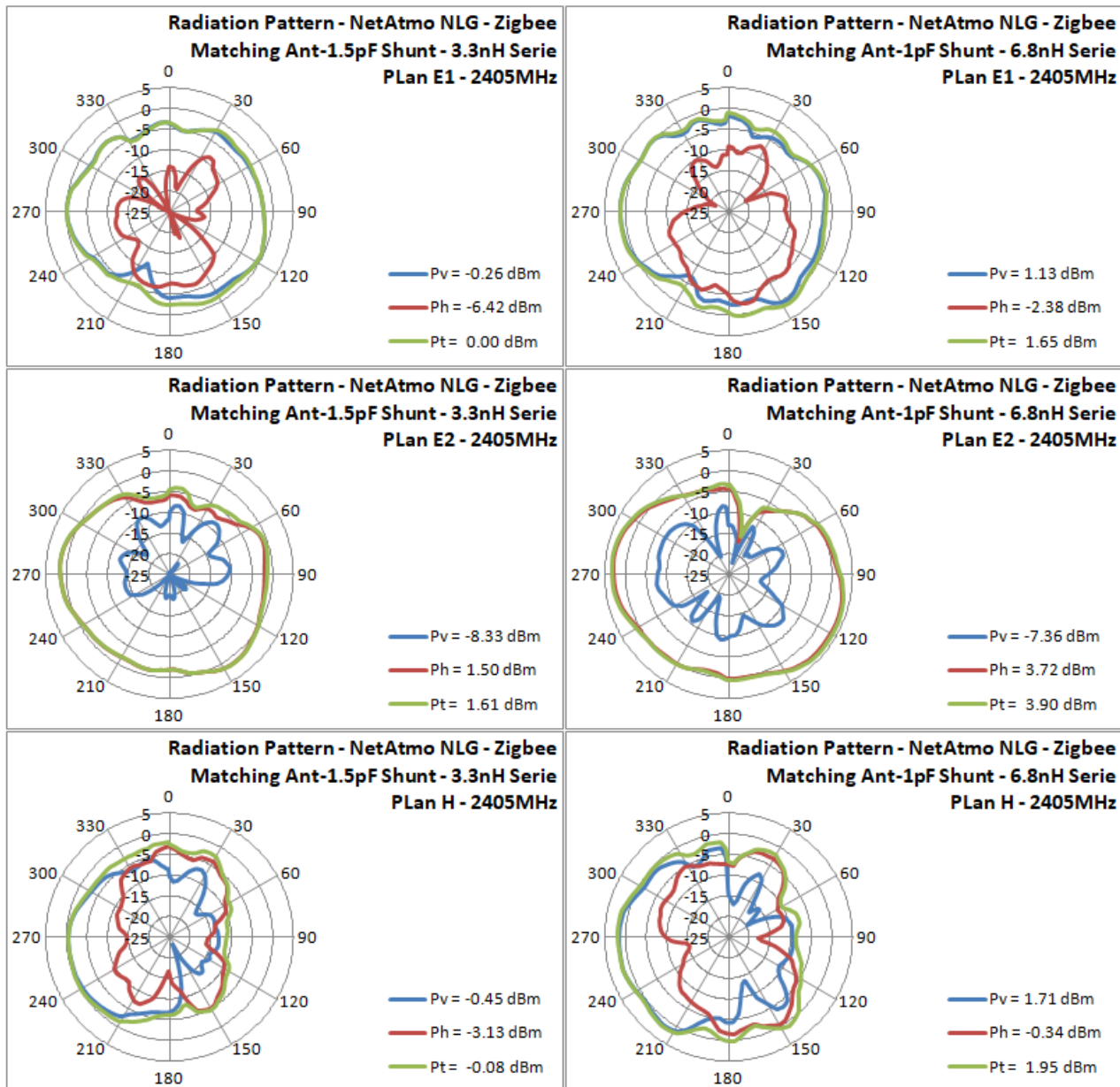


figure 13. From left to right, from top to bottom, Radiation pattern for E1, E2 and H planes for the 2405MHz frequency

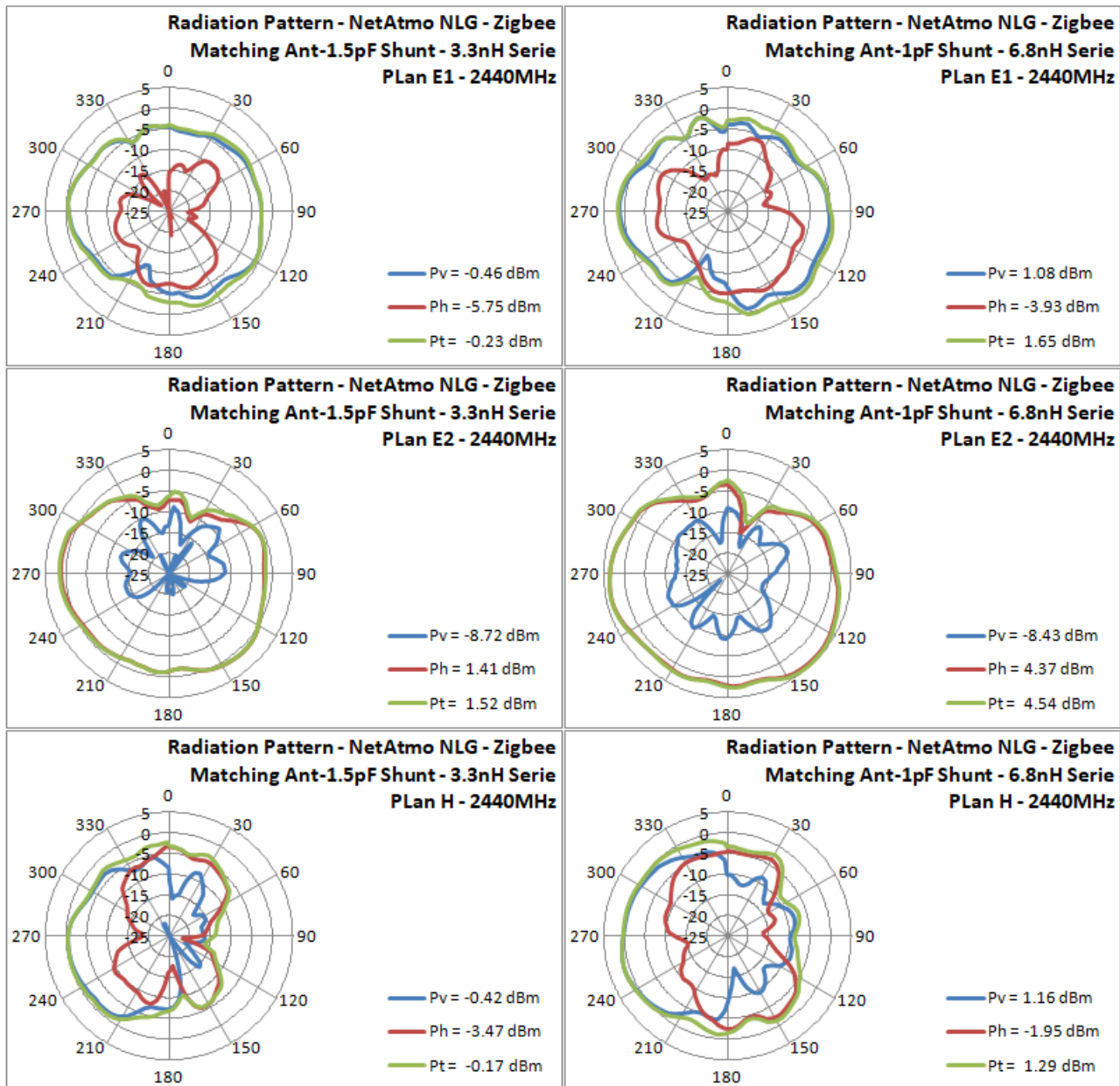


figure 14. From left to right, from top to bottom, Radiation pattern for E1, E2 and H planes for the 2440MHz frequency

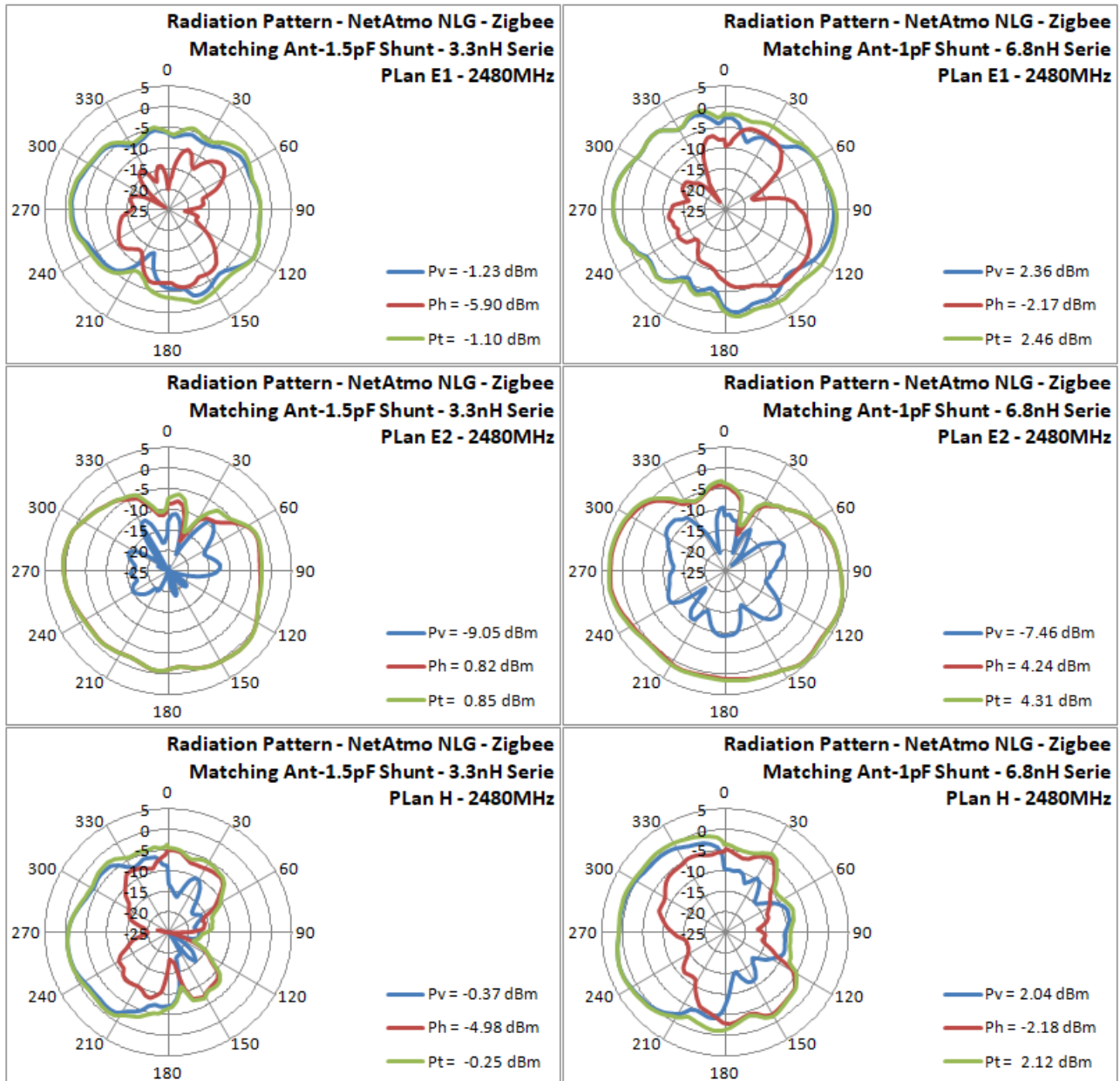


figure 15. From left to right, from top to bottom, Radiation pattern for E1, E2 and H planes for the 2480MHz frequency

4 Conclusion

Zigbee or Wifi antennas are not well matched with matching network used by default. New matching networks are necessary.

Different matching network have been designed and measured. Among those different circuits, the best has been proposed for each antenna. With those matching network radiated power has been improved by

- 2.1dB at 2412Mhz, 1.3dB at 2442 and 0.6dB at 2480MHz for Wifi
- 2.3dB at 2405Mhz, 3dB at 2440 and 3.4dB at 2480MHz for Zigbee