

NXP TPMS RECOMMENDED IMPEDANCE TO BE PRESENTED AT THE RF PIN MATCHING NETWORK DESIGN

APRIL 2019



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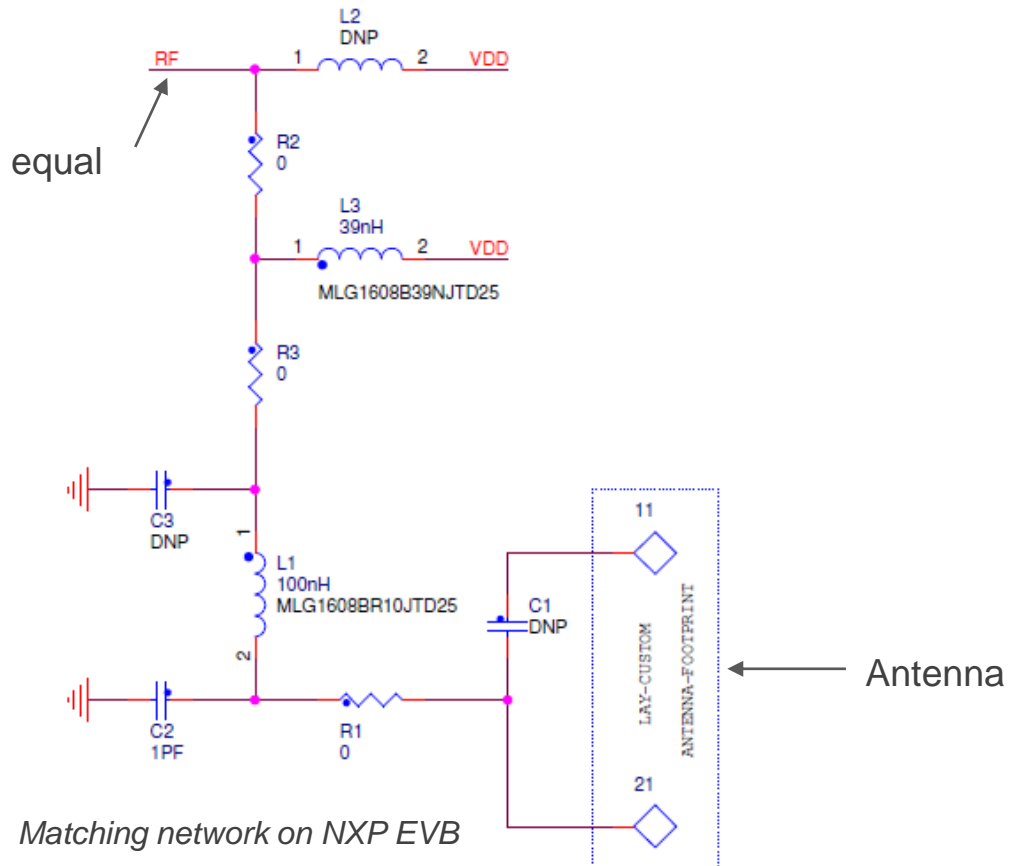
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Introduction

- The matching network must be designed to maximize the transfer of power between the RF pin and the antenna.
- To optimize this transfer of power, the matching network must be designed so that a specific impedance is presented at the RF pin. In other words, NXP provides information of the impedance that must be present at the RF pin, and customers must design their matching network taking into account this requirement.
- The impedance value is related to the PA efficiency and is different for 315MHz and 434MHz.

RF pin
At this point the impedance must be equal to the impedance indicated by NXP

Note that customers cannot directly reuse the matching network on NXP EVB but must design their own based on the RF frequency and their PCB and antenna characteristics, targeting the impedance at the RF pin recommended by NXP.



Access to the RF pin

- Each customer has its own methodology to measure the impedance at the RF pin i.e. its own path to the RF pin (SMA, probe etc...), and the key point is to have a reliable RF model of the path in order to de-embed this access.

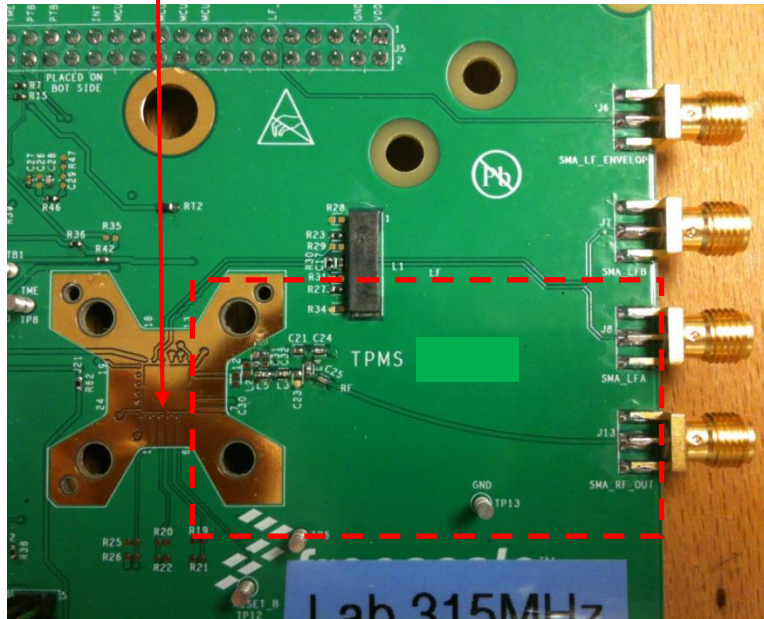
For example, if the impedance at the RF pin is measured with an RF probe, then the actual impedance measured is the impedance of the RF pin + the probe. In that case it is necessary to remove the influence of the probe to deduce the impedance of the RF pin only (this is the de-embedding process). Removing the influence of the probe is done by computing an RF model of the probe. The reliability of the result directly depends on the reliability of the model.

- To measure the impedance at the RF pin, NXP is using a simple SMA connector between the RF pin plane and the plane of measurement. NXP directly measured the impedance at the SMA connector plane giving the optimized output power. Customers using the same setup as NXP can target the recommended impedance at the SMA plane, and thus do not need to go through the de-embedding process. Proceeding this way gives the most precise result as de-embedding is not performed, so there is no imprecision coming from the RF model of the SMA connector.
- Customers not using the same setup as NXP have to go through the de-embedding process and target the recommended impedance at the RF pin plane. In other words, the impedance recommended at the RF pin is the impedance that needs to be targeted in case customers use any other access to the RF pin than a simple SMA connector. In that case customers must have a reliable model of that access to do a reliable de-embedding.



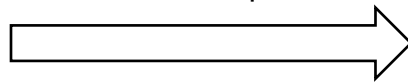
Impedance at the SMA connector plane

TPMS chip (FXTH87, FXTH87E, NTM88)



SMA connector plane
(measurement plane)

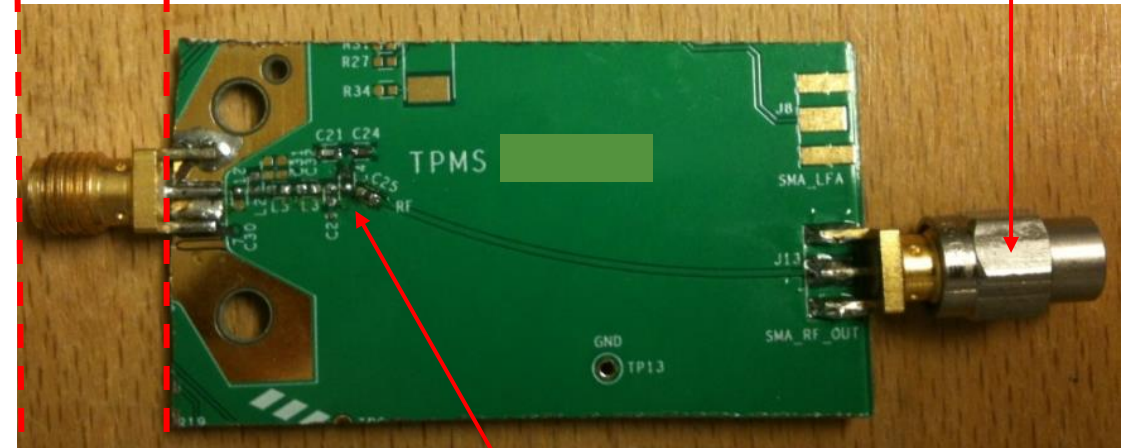
By sawing a bare board, we add a SMA connector in order to measure the impedance seen at the SMA connector plane



RF Pin plane

We cannot directly measure the impedance at the RF pin plane, this would require going through a de-embedding process

Antenna load
(can be replaced by the actual antenna)



Matching network

The impedance at the **SMA connector plane** giving the optimized output power was measured and is:

✓ **For 315MHz: $253 + j*224$**

✓ **For 434MHz: $201 + j*238$**

These values are the exact values as they were measured with a VNA and not calculated. Customers can use the same setup to measure the impedance of their circuit and target the impedance given above. No de-embedding process is needed as the impedance value communicated by NXP is the recommended impedance at the SMA connector plane, and customer using this setup will measure the impedance at the SMA connector plane.

References of 50 ohm SMA connectors:

<https://fr.rs-online.com/web/p/connecteurs-sma/8857532/>

<https://fr.farnell.com/amphenol-rf/132255-11/rf-connector-sma-straight-jack/dp/2611797>



Impedance at the RF pin

Customers not using the setup presented on the previous slide have to use the information of the impedance to be presented directly at the RF pin. In that case customers must use a reliable model of the RF path and go through de-embedding process to calculate the impedance actually seen at the RF pin plane, and try to match the impedance we recommend.

The impedance to be presented at the RF pin is summarized in the tables below. These impedances have been calculated by NXP with loadpull measurements followed by a deembedding process.

Impedance to be presented at the RF pin:

- “Matching CZ” ensures a minimum output power of 3dBm over the whole range of specified temperature and voltage, and over the device lifetime.
- “Matching 3V” ensures the maximum output power at 3V.

| 315 MHz | | Matching "CZ" | Matching "3V" |
|---------------------------------|------------------|---|---|
| Power step 5dBm (trim value) | Impedance | 144 + j*221 Ohm series (484 Ohm / 159 nH parallel) | 149 + j*288 Ohm series (706 Ohm / 184 nH parallel) |
| | Pout (I_RFM) @3V | 5.7 dBm (5.9 mA) | 6.8 dBm (5.85 mA) |
| Power step 20 (maximum) | Impedance | | 194 + j*222 Ohm series (449 Ohm / 198 nH parallel) |
| | Pout (I_RFM) @3V | | 8.9 dBm (7.9 mA) |

| 434 MHz | | Matching "CZ" | Matching "3V" |
|---------------------------------|------------------|---|---|
| Power step 5dBm (trim value) | Impedance | 114 + j*214 Ohm series (517 Ohm / 101 nH parallel) | 101 + j*265 Ohm series (796 Ohm / 112 nH parallel) |
| | Pout (I_RFM) @3V | 6.4 dBm (6.6 mA) | 7.25 dBm (6.5 mA) |
| Power step 20 (maximum) | Impedance | | 154 + j*241 Ohm series (532 Ohm / 124 nH parallel) |
| | Pout (I_RFM) @3V | | 8.6 dBm (8.1 mA) |



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