APPLICATION NOTE

Using UHF Transceiver Internal RX/TX Switch

ATA542X/ATA581X/ATA582X

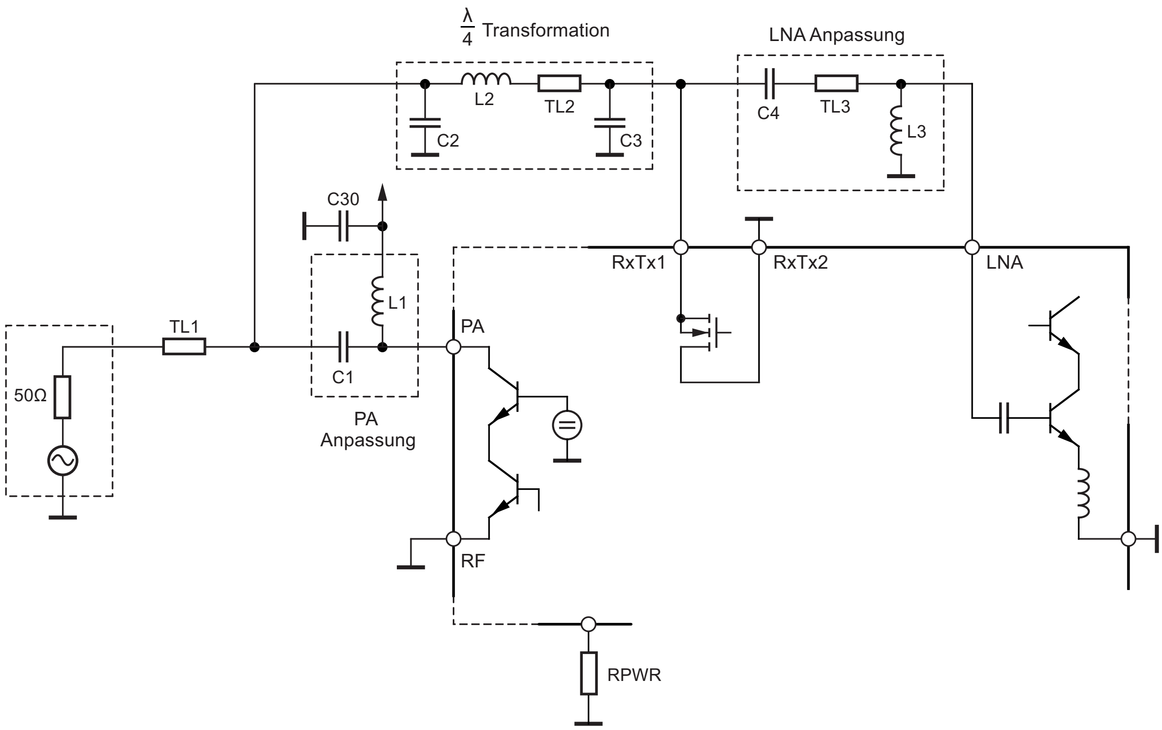
Introduction

Atmel® UHF transceivers family (ATA542x, ATA581x and ATA582x) include an internal RX/TX switch. This application note provides theoretical information, which is required when using the internal RX/TX switch. The use of an external switch with the UHF transceiver family is also briefly mentioned at the end of the document. This document does not provide any details on alternatives to improving the harmonic rejection. To use this theoretical information in practice, a network analyzer, spectrum analyzer, and a simulation tool are necessary.

1. The Application Using the Internal RX/TX Switch

The RX/TX switch can be used in a transceiver application with one single antenna, for example a quarter wave micro strip antenna, to separate the RX path and TX path. For receiving purpose, the antenna is connected to the receiver part of the transceivers. In transmitting mode, the power amplifier must be connected to the antenna. For ideal performance, the switch's attenuation must be very low and the isolation between RX/TX paths must be very high. The following paragraphs provide a step-by-step guide to using the internal RX/TX switch. Note, the explanation in this document focuses on the application with a 50Ω interface to the antenna. Figure 1-1 shows the principle assembly of the transceivers application using the internal switch.

Figure 1-1. The Principle of External Circuitry in the Application using the Internal RX/TX Switch i



1.1 Step 1

The simplest way to start is to match the power amplifier to 50Ω. Figure 1-2a illustrates the principle of matching the PA to 50Ω. The PA is an open-collector output delivering a current pulse nearly independent from the load impedance. Therefore, it can be controlled via the connected load impedance. The maximum output power is delivered to a resistive load if the output parasitic capacitance of the PA (Cpar = 1pF) is compensated by the reactive part of the load impedance and the highest possible RF voltage amplitude at the output is reached without saturating the output transistor.

Figure 1-2. The Principle of Power Amplifier Matching for the Transceiver

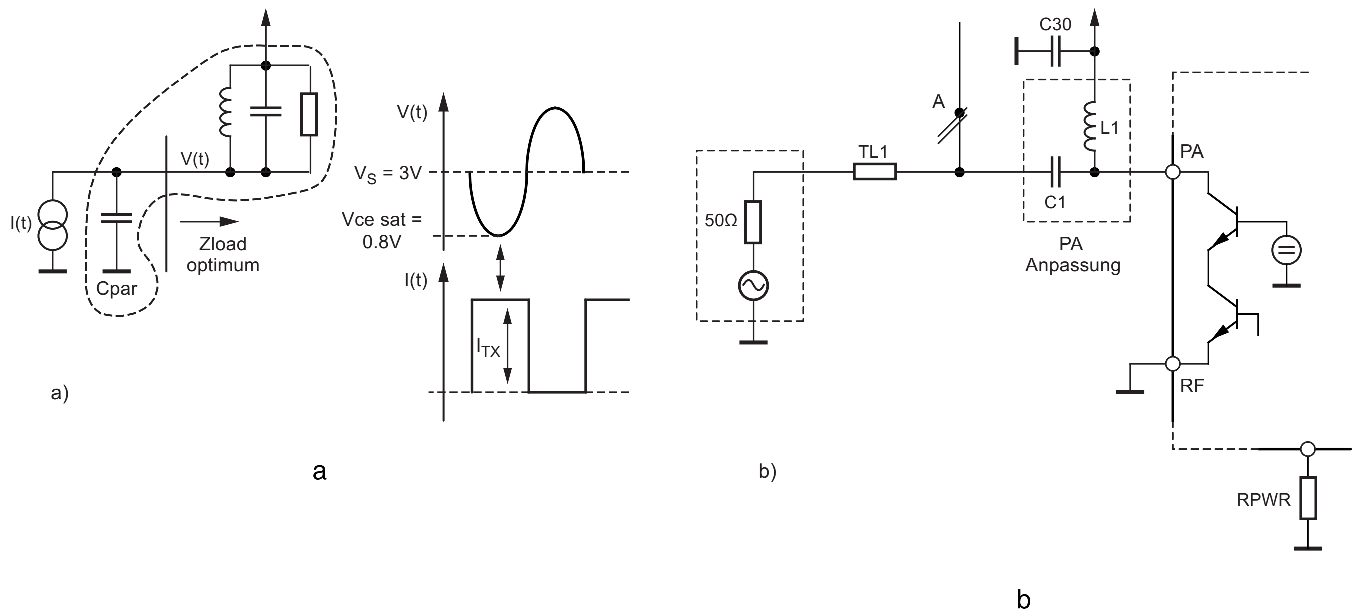
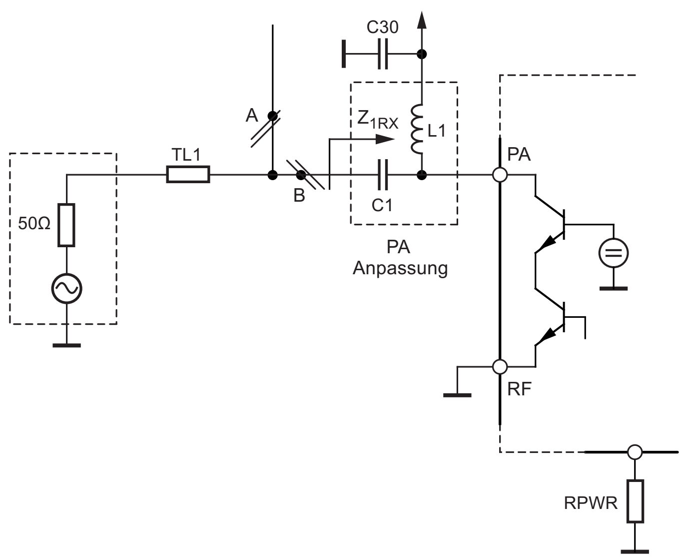


Figure 1-2b shows the principle of the matching for the transceiver. For this step, the connection at point A must be cut off. Optimize the transmit power (P_{out_max}) using L1 and C1. The matching values in the transceiver datasheet can be used as starting values.

1.2 Step 2

After optimizing the output power in step 1, measure the impedance at the PA output in RX mode using a network analyzer (see Figure 1-3). Disconnect point B and measure the impedance (Z_{1RX}) at that point. Note, during this step point A remains open.

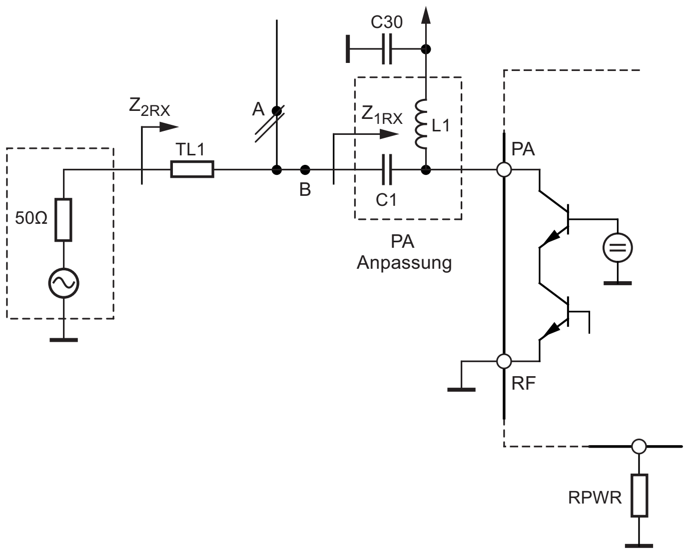
Figure 1-3. First Step of the Impedance Measurement at the Power Amplifier Output



1.3 Step 3

Measure the impedance (Z_{2RX}) in RX mode using a network analyzer. During measurement, point A remains open and point B must be reconnected (see Figure 1-4).

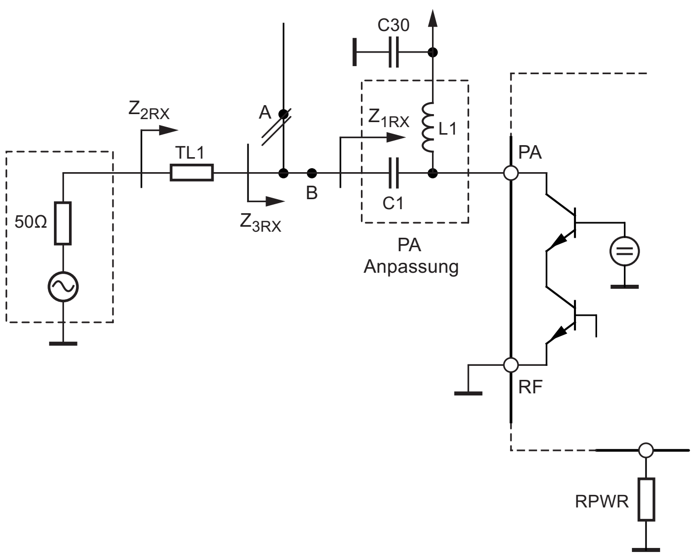
Figure 1-4. Second Step of the Impedance Measurement at the Power Amplifier Output



1.4 Step 4

Based on the measured values Z_{1RX} and Z_{2RX}, determine the impedance of trace TL1 (T_{L1}) on the board using a simulation tool. With the result of T_{L1}, calculate the input impedance (looking from the end of TL1 towards the antenna) Z_{3RX} (see Figure 1-5).

Figure 1-5. Calculated Impedance Z_{3RX}



1.5 Step 5

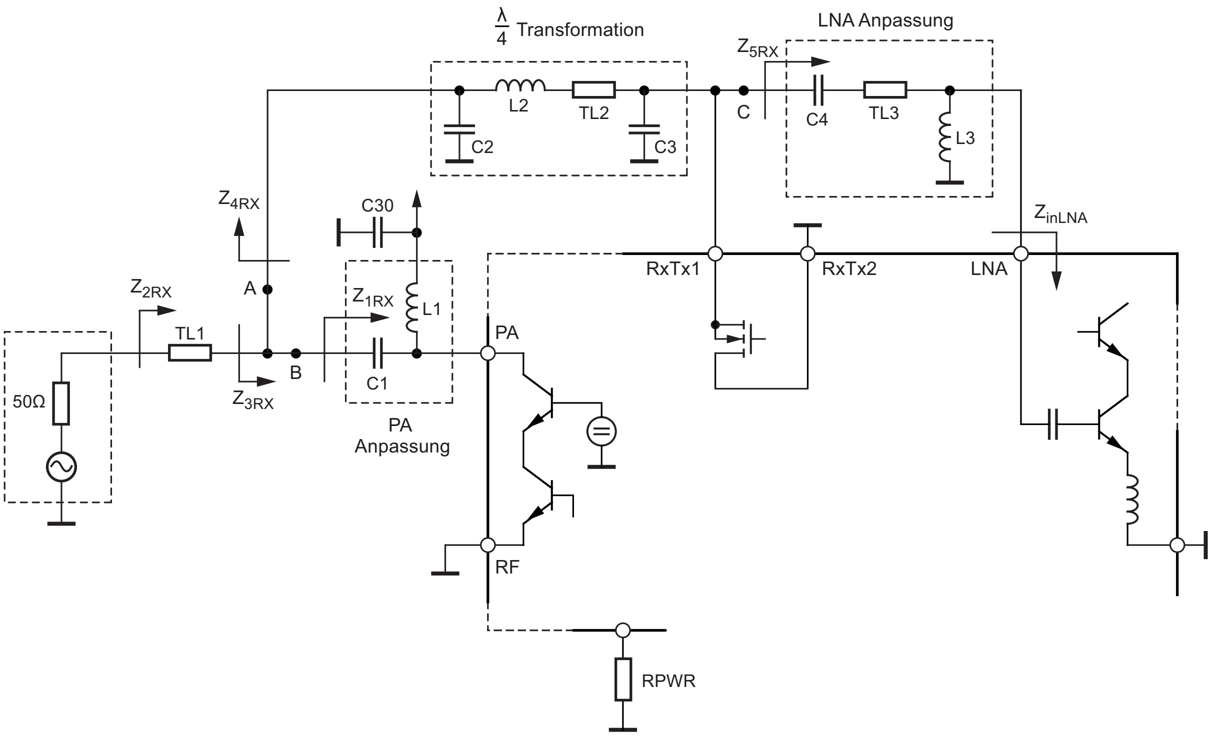
Using the equation 1 below, determine the input impedance Z_{4RX} (looking from at measurement point A back towards the PA). In TX-Mode this impedance must be as high as possible and real (see Figure 1-6).

$$Z_{4RX} = \frac{1}{\left(\frac{1}{Z_{3RX}} - \frac{1}{Z_{1RX}}\right)} \qquad \text{Equation 1}$$

1.6 Step 6

Referring to Figure 1-6, provide a conjugate complex impedance of Z_{4RX}, which is defined as Z_{5RX} at point C. Based on the l/4-transformation, the imaginary part of the Z_{5RX} must be modified, the calculated impedance Z_{4RX} at the point A can be provided. Firstly, determine the input impedance of the LNA and secondly, optimize the impedance Z_{5RX} using matching elements C_4 and L_3. During matching procedure, trace T_{L3} must be taken into account. During this step use a simulation tool and network analyzer measurement at point C. Generally, this step is always an empirical and theoretical approach.

Figure 1-6. Illustration of the Measured and Calculated Impedances for the Application using the Internal RX/TX Switch



1.7 Step 7

Referring to Figure 1-6 on page 5 determine the needed l/4-transformation using the simulation tool. Because the l/4-trace is generally relatively long compared to the geometry of the layout, this transformation must be performed using the additional passive elements (C2, L2, TL2 and if necessary C3). Afterwards the impedance Z_{4RX} in TX- as well as in RX-Mode must be measured by the network analyzer at the point A.

1.8 Step 8

Finally, the complete RX/TX circuit must be built up and the separated measurement points must be connected. The goal is to achieve the following features:

Maximum power difference between the final transmit power and the tuned power P_{out_max} in Step 1 must be ≤ 0.5dB.

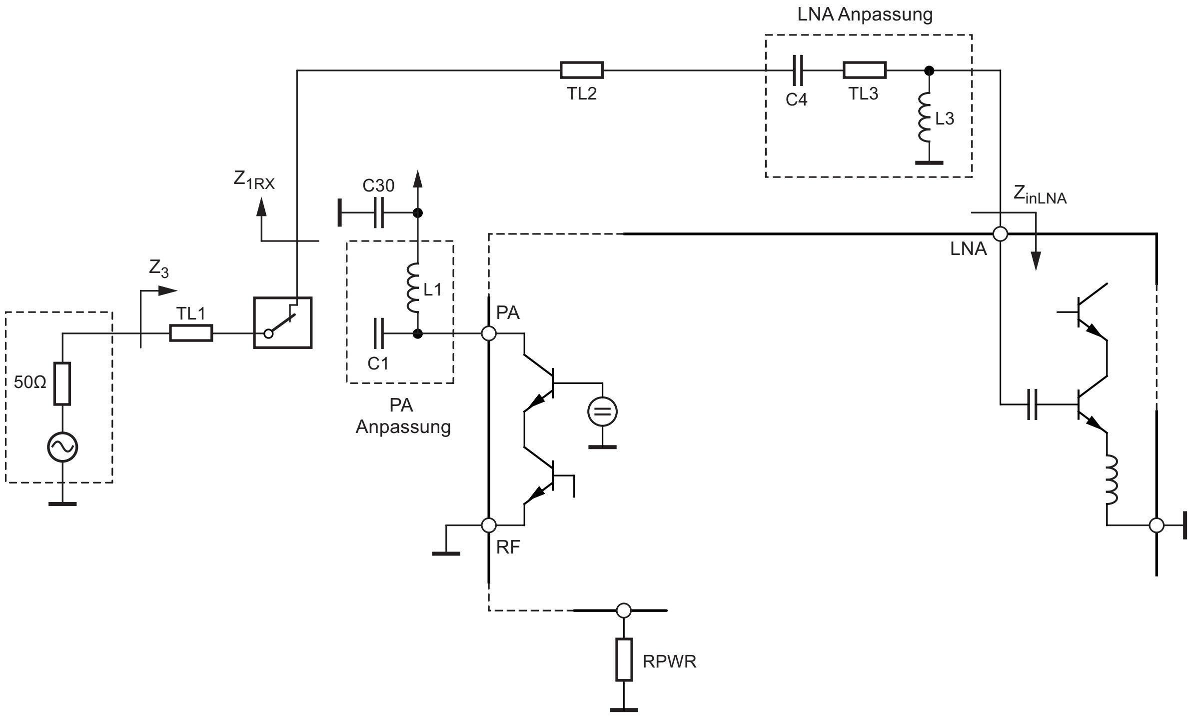
Verification in RX Mode of the input reflection factor, depending on whether the input impedance Z_{2RX} is optimal matched.

If the desired performance has not yet gained, the empirical tuning effort must be performed alternately between TX- and RX-Mode.

2. The Application Using the External RX/TX Switch

Application of the transceivers family using an external RX/TX switch can be easier than using the internal switch. However, this may lead to additional costs for the solution. This section briefly describes the matching principle when using an external switch. Figure 2-1 shows an application circuit using an external RX/TX switch.

Figure 2-1. The Principle of External Circuitry in the Application using the External RX/TX Switch



An external switch generally provides 50Ω interfaces. This enables separate matching for both TX and RX mode. The LNA can be directly matched to 50Ω (Z_{1RX}) using L3 and C4. The inductor L1 and capacitor C1 should optimized the transmit power at 50Ω. Consult the datasheet for details of the elements required for matching the external RX/TX switch to 50Ω (Antenna) The impedance Z_3 must match to 50Ω in RX mode and the optimal output power must be gained in TX mode.

3. Revision History

Please note that the following page numbers referred to in this section refer to the specific revision mentioned, not to this document.

Revision No.	History
9150B-AUTO-04/15	• Put document in the latest template

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