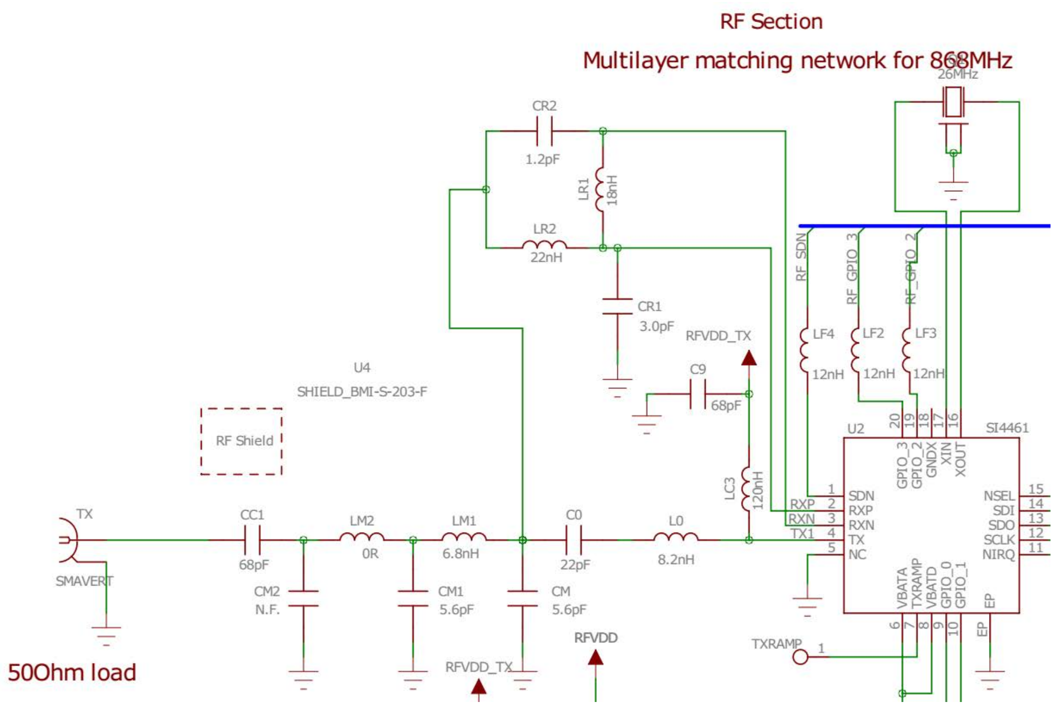
AN924: Performance of Si4461 RFIC at 868 MHz with Murata LFD21891MMF3D931 IPD

Several application notes, such as AN643: “Si446x/Si4362 RX LNA Matching” and AN627: “Si4x6x and EZR32 Low-Power PA Matching” discuss the design procedures required to match the TX/RX paths on Si4461 chips.

The matches discussed in these application notes (and additionally published as reference designs on the Silicon Labs website) are effective and provide good performance. However, these designs require a moderate number of discrete matching components (i.e., inductors and capacitors). The schematic for the RF match of the 4461-PCE14D868M RF Pico Board (as an example) is shown in the figure below. Excluding the DC pull-up inductor (LC3) and AC coupling/bypass capacitors (C9, CC1), there are potentially a total of 9 to 11 discrete components required in the RF match (depending upon required level of harmonic suppression).

KEY POINTS

- Provides schematic comparison of discrete and IPD solution
- Compares output power, harmonic performance, TX current consumption and RX sensitivity



1. Introduction

A reduction in the number of matching components is desirable not only to reduce material cost but also the cost of inventory, assembly, and testing. Additionally, a smaller number of parts allows a smaller board area, which also decreases total cost.

Silicon Labs has partnered with Murata to develop an Integrated Passive Device (IPD), which implements a complete 868MHz +14dBm RF matching network within a single small surface mount ceramic package. Using a proprietary Low Temperature Co-Fired Ceramic (LTCC) process, Murata has successfully integrated all of the required discrete matching components, excluding the DC pull-up inductor and AC coupling/bypass capacitors. This way, the RF matching network may be simplified as shown in the figure below.

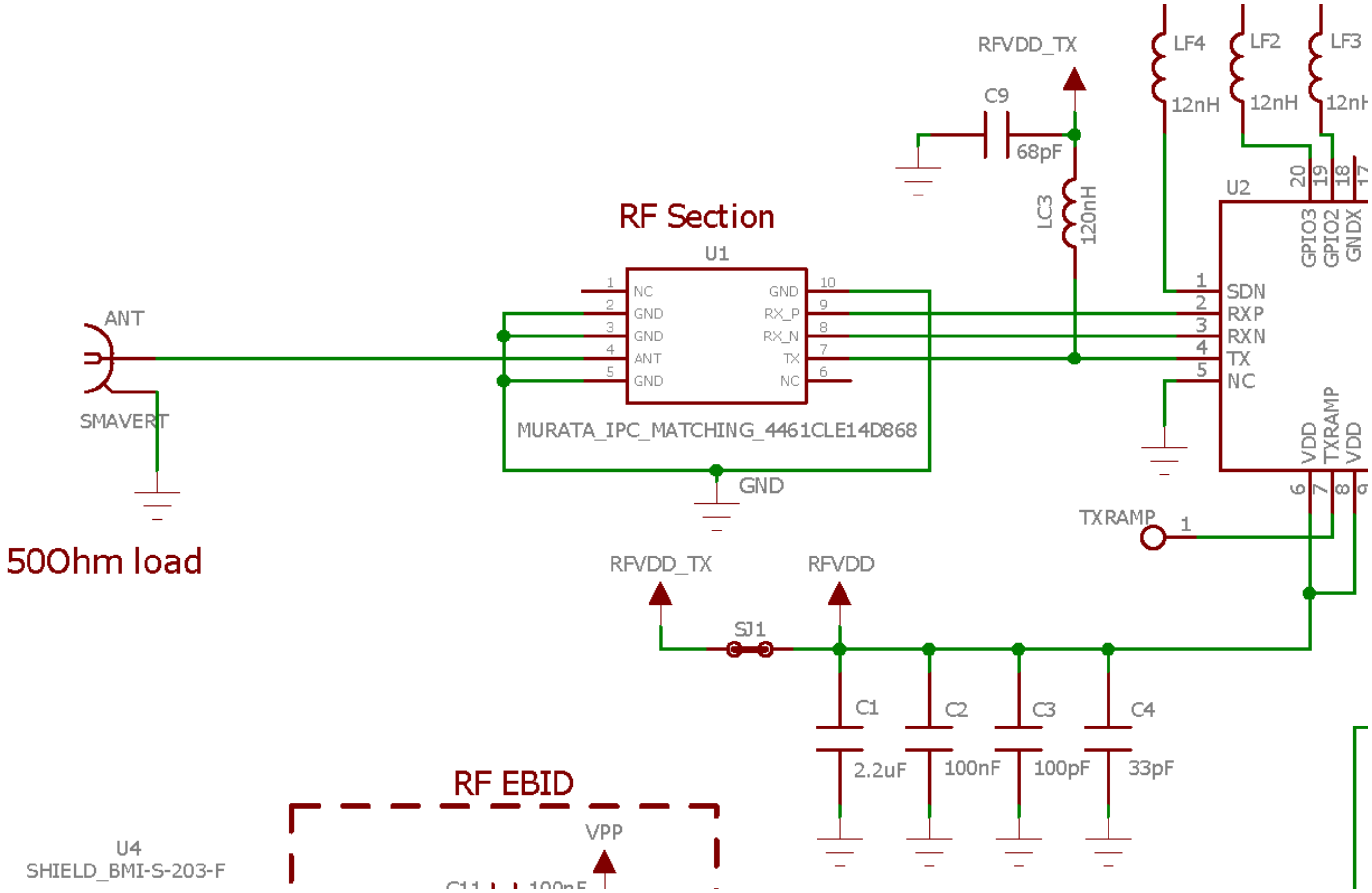


Figure 1.1. IPD RF Matching Network for 4461CPCE14D868I RF Pico Board

Furthermore, the board area required for the layout of the matching network may be shrunk as shown in the figure below.

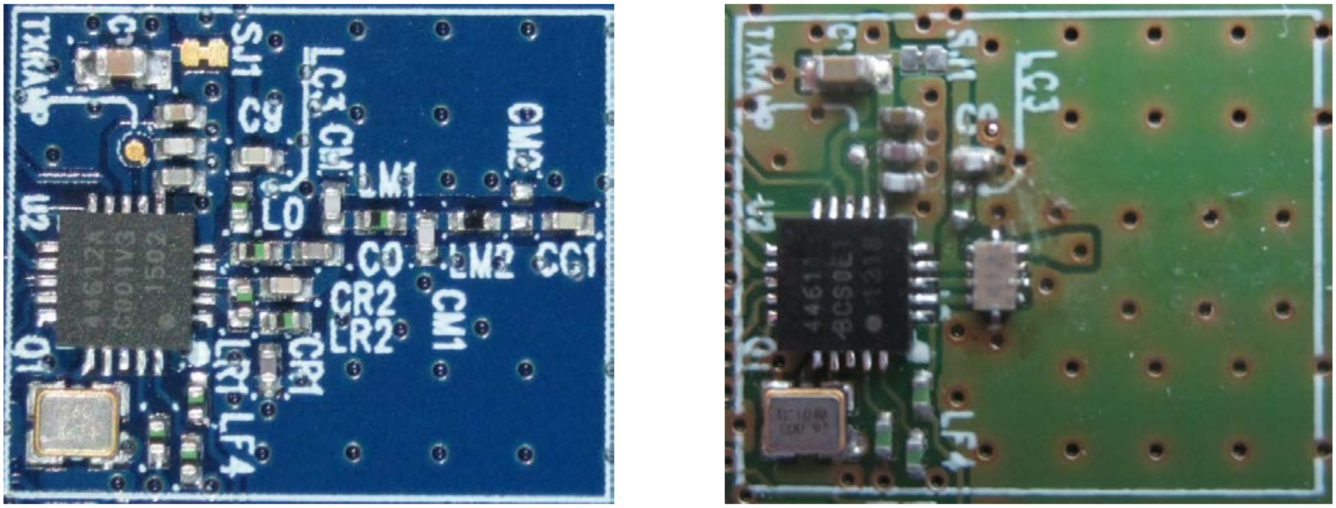


Figure 1.2. Comparison of Required Board Area (Discrete vs. IPD)

The Murata part number for this IPD device is P/N LFD21891MMF3D931 and is suitable for use at 868 MHz at ~+14 dBm output power with the following RFICs from Silicon Labs.

- Si4461
- EZR32LG230FxxxR61G
- EZR32LG330FxxxR61G
- EZR32WG230FxxxR61G
- EZR32WG330FxxxR61G
- EZR32HG220FxxxR61G
- EZR32HG320FxxxR61G

Reference design packs (i.e., schematics, board design files, gerbers, and BOM lists) which use the Murata device may be downloaded from the Silicon Labs website. The data sheet for the Murata P/N LFD21891MMF3D931 device may be downloaded from http://www.murata.com/~/media/webrenewal/products/balun/balun/forconnectivity/lfd21891mmf3d931.ashx?la=en.

2. Measured Performance

Silicon Labs has performed extensive testing of reference design boards with the Murata device to ensure that its performance is comparable to (or better than) a discrete matched board. The reference design platform used for these comparison tests was the 4461-CPCE14D868I RF Pico Board, modified to replace the discrete matching components with the Murata device (see figure below). The test results are presented below. In general, the IPD-matched boards achieve slightly better RX performance than discrete-matched boards but at a slight reduction of TX performance.

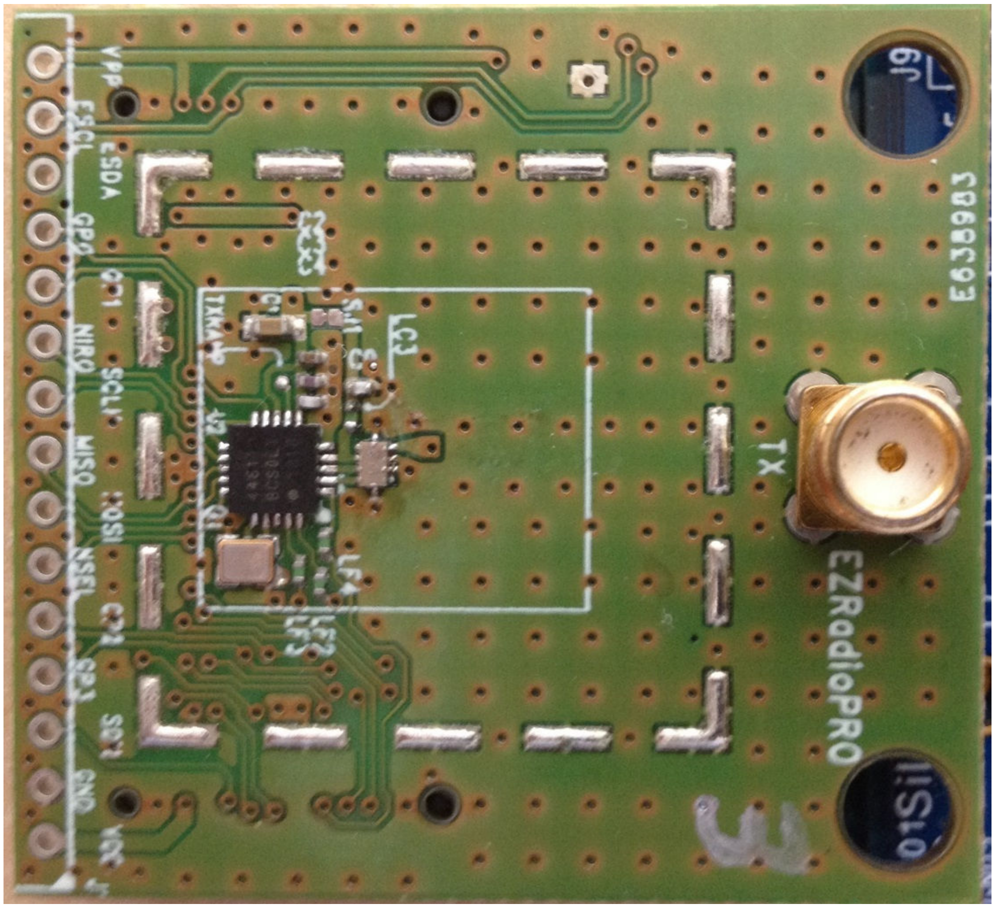


Figure 2.1. Board Layout for 4461-CPCE14D868I with Murata IPD

2.1 TX Output Power vs. PA_PWR_LVL

The TX output powers of five IPD-matched boards were compared to the output powers of three discrete-matched boards. The conducted output power was measured as a function of the commanded PA_PWR_LVL property setting. The results are shown in the figure below. Annotated balloons are provided on the plot to help distinguish the groups of curves.

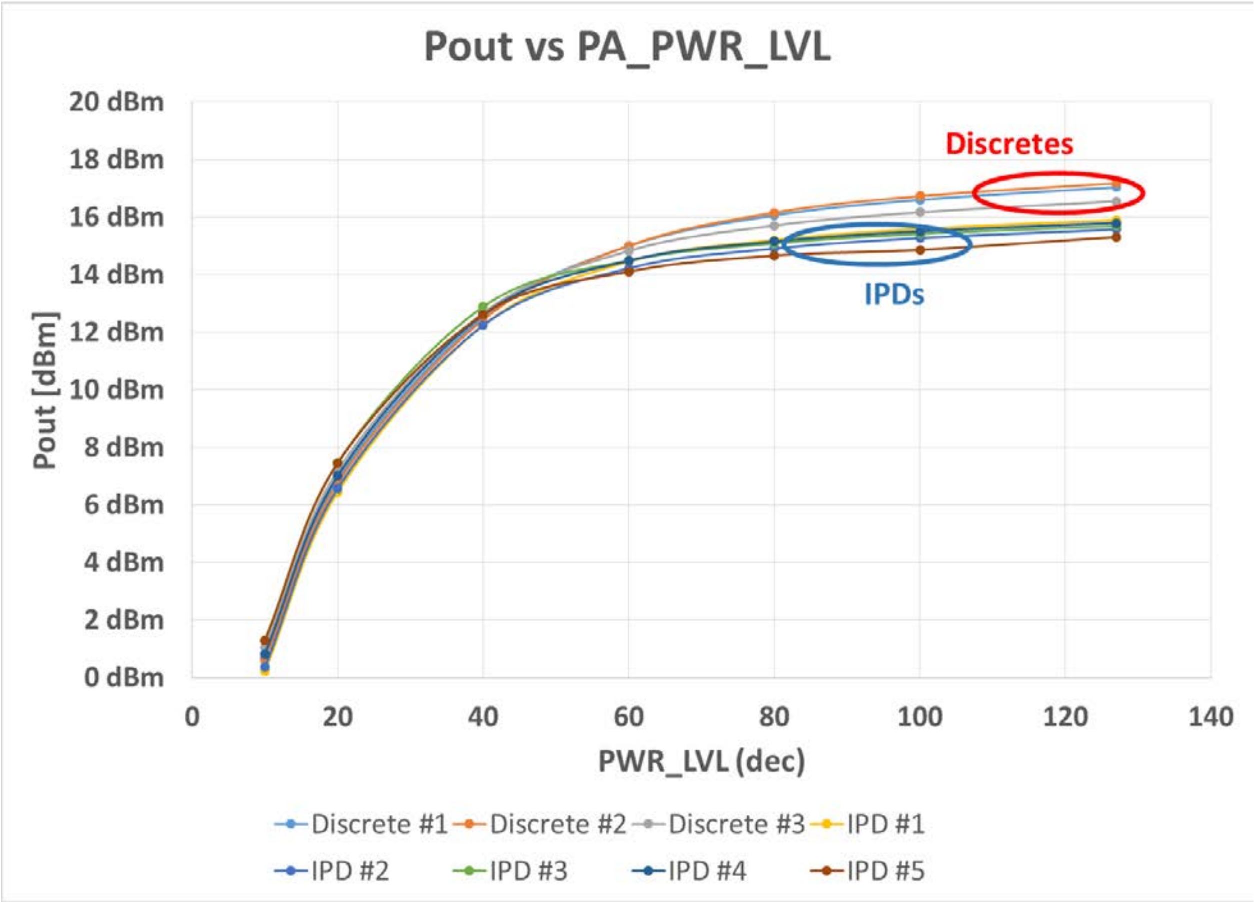


Figure 2.2. TX Output Power vs. PA_PWR_LVL

The TX output power is slightly less than the output power achievable on the discrete-matched boards, but can easily achieve the target output power level of +14dBm.

2.2 Current Consumption in TX Mode

The TX mode currents of five IPD-matched boards were compared to the current consumption of three discrete-matched boards. The current consumption was measured as a function of the commanded PA_PWR_LVL property setting. The results are shown in the figure below. Annotated balloons are provided on the plot to help distinguish the groups of curves.

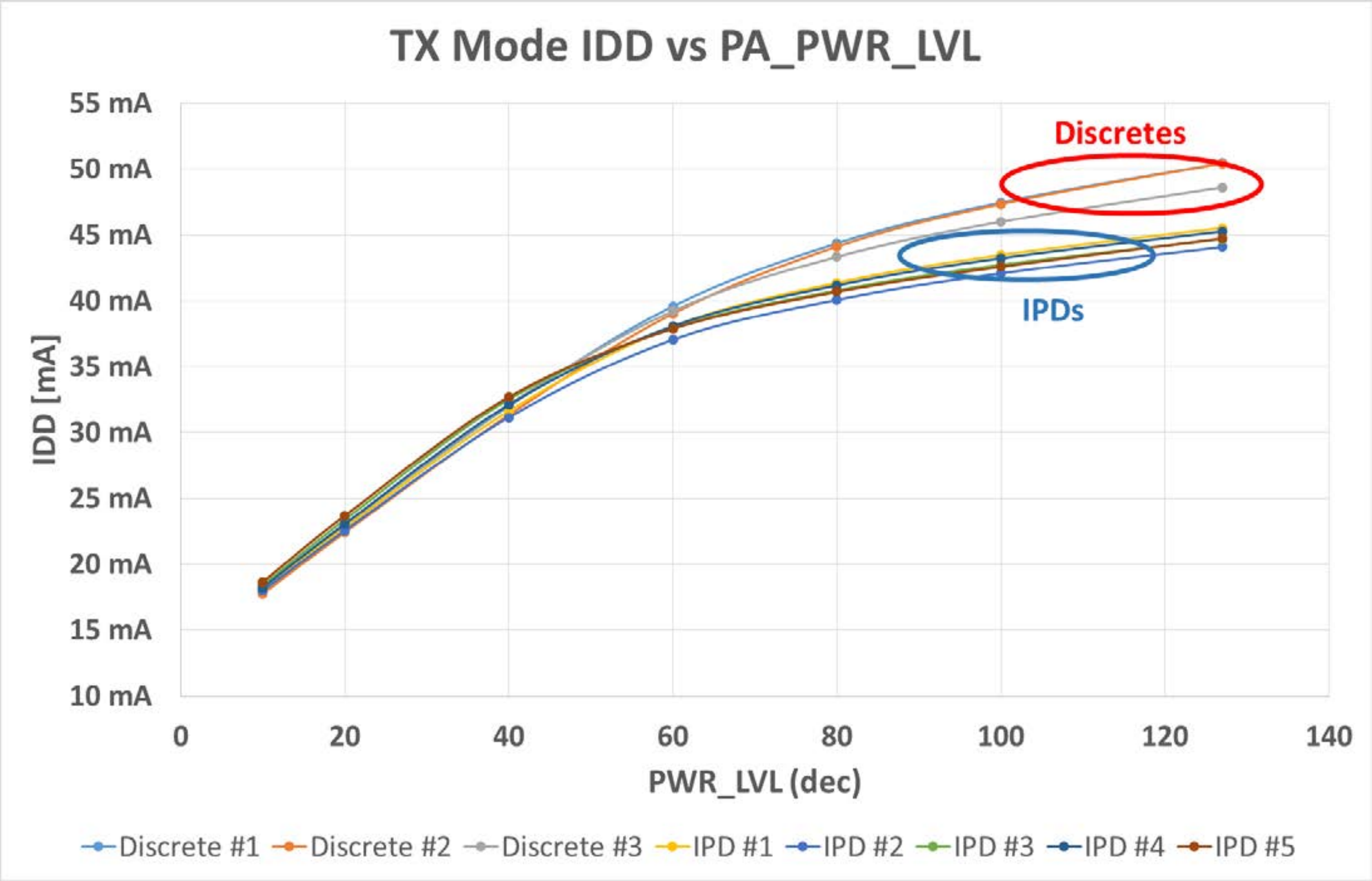


Figure 2.3. TX Mode Current Consumption

The measured current consumption of the IPD-matched boards was slightly less than the discrete-matched boards; this corresponds to the slightly lower output power obtained on the IPD-matched boards.

2.3 TX Output Power vs. Frequency

The TX output powers of five IPD-matched boards were compared to the output powers of three discrete-matched boards. The conducted output power was measured as a function of frequency for a selected value of PA_PWR_LVL that provided an output near the target value of +14dBm. The results are shown in the figure below. Annotated balloons are provided on the plot to help distinguish the groups of curves.

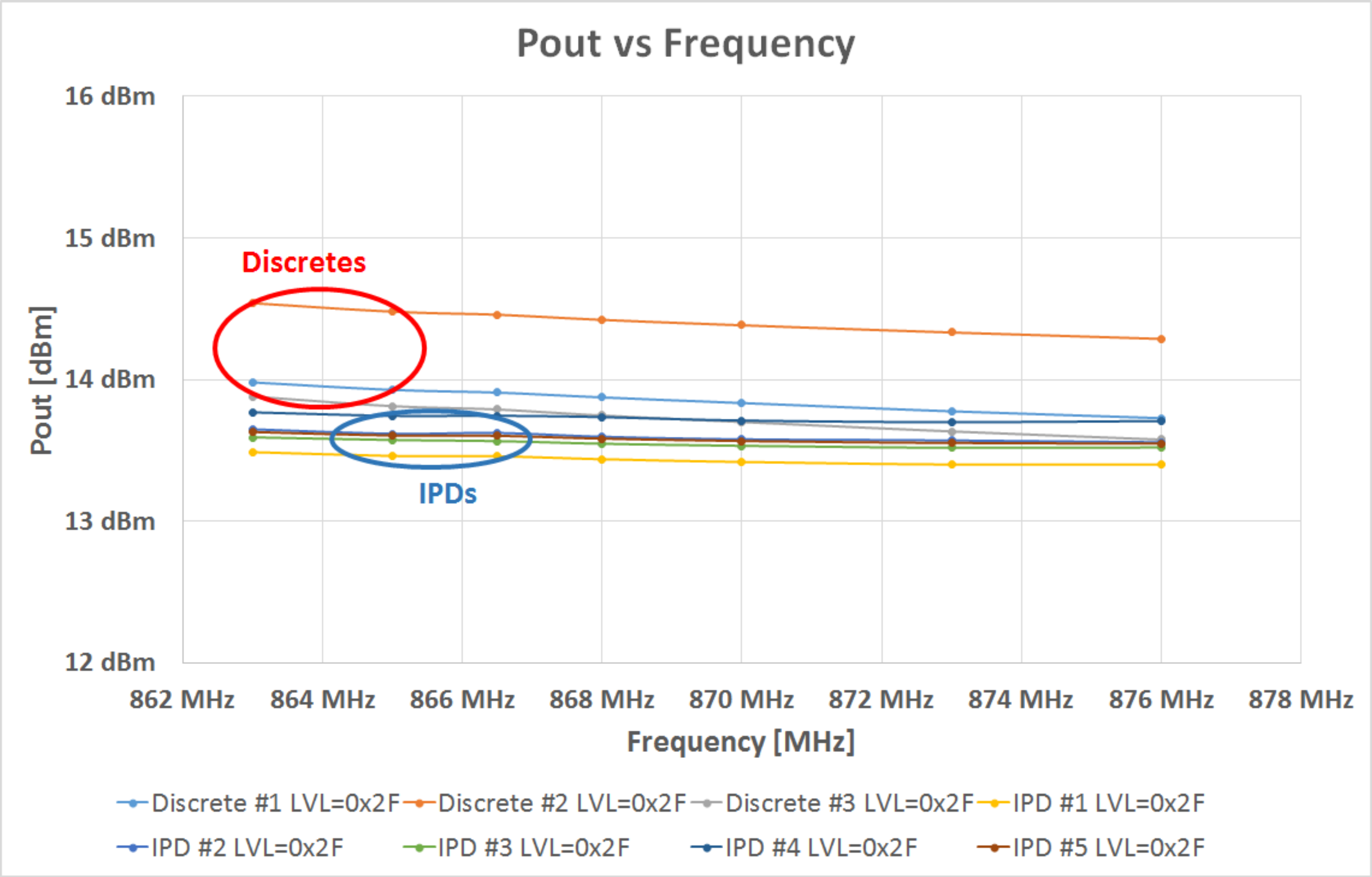


Figure 2.4. TX Output Power vs. Frequency

The TX output power on the IPD-matched boards is just slightly less than the output power obtained on the discrete-matched boards.

2.4 Conducted Harmonics vs PA_PWR_LVL

The conducted harmonic output power levels of five IPD-matched boards were compared to the harmonic levels of three discrete-matched boards. The fundamental frequency was fixed at 868 MHz while the output power was measured as a function of PA_PWR_LVL. The results are shown in the figures below. Annotated balloons are provided on the plot to help distinguish the groups of curves.

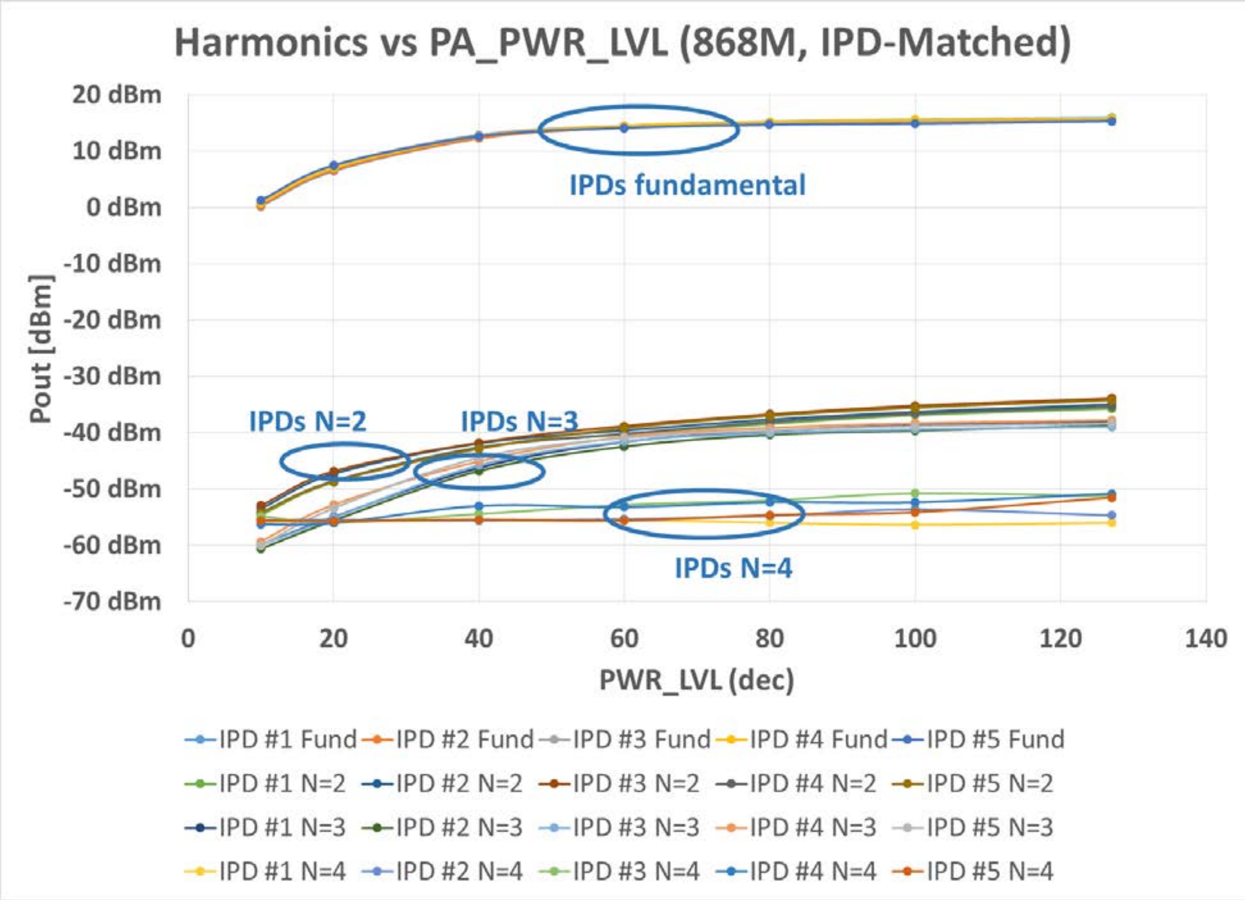


Figure 2.5. Harmonic Power Level vs. PA_PWR_LVL, IPD-matched Boards

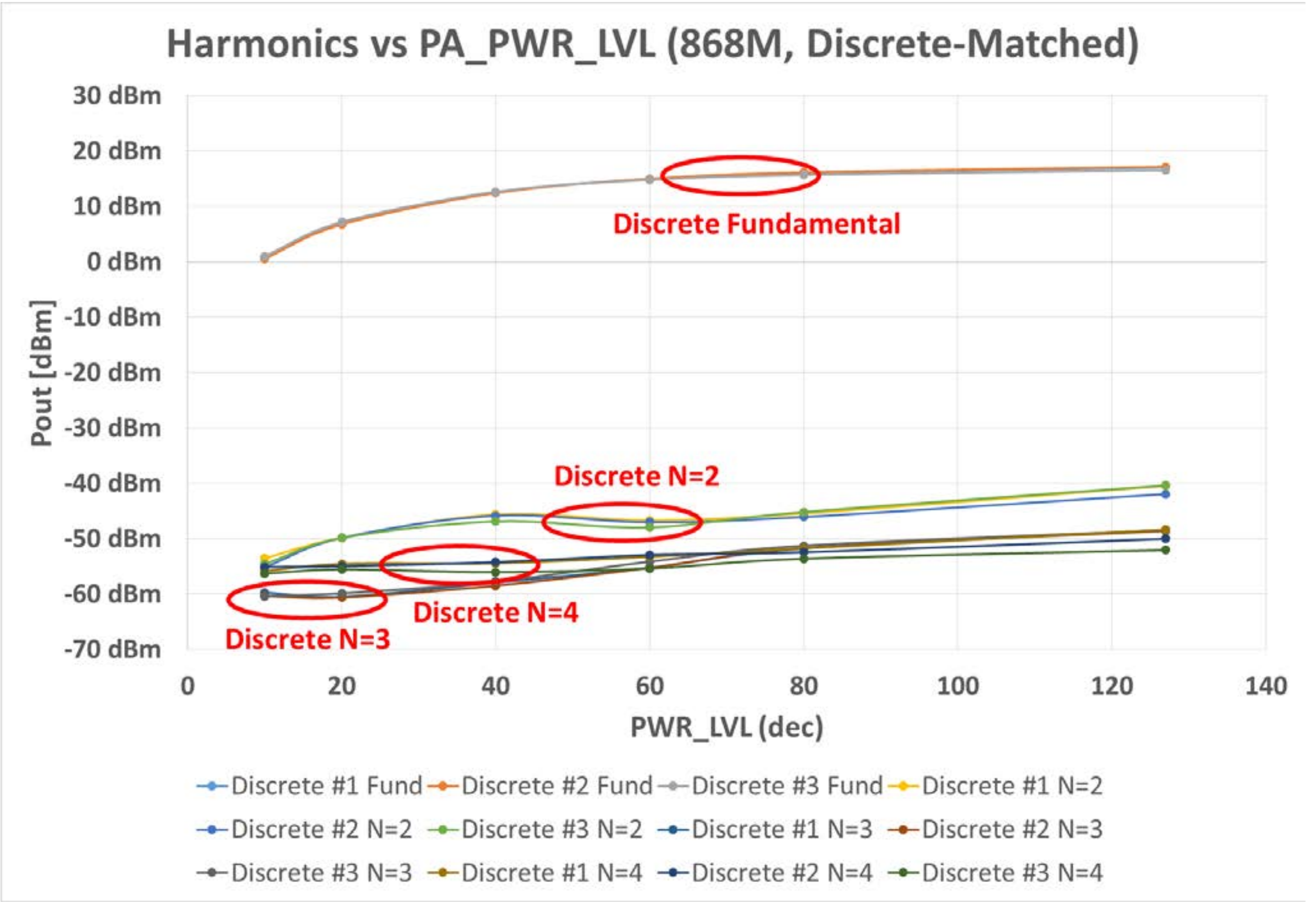


Figure 2.6. Harmonic Power Level vs. PA_PWR_LVL, Discrete-matched Boards

The IPD-matched design provides slightly worse attenuation of 2nd and 3rd harmonics, while it provides similar attenuation of the 4th harmonic. However, the harmonic levels of ***both*** designs are compliant with the ETSI EN 300-220 regulatory standard at 868 MHz at an output power level of +14 dBm.

2.5 RX Sensitivity vs. Frequency

The RX sensitivities of five IPD-matched boards were compared to the RX sensitivities of three discrete-matched boards. The selected modulation protocol was 2GFSK, DR=40 kbps, Dev=20 kHz, XtalTol=0 ppm. The RX sensitivity was measured across a range of frequencies. The results are shown in the figure below. Annotated balloons are provided on the plot to help distinguish the groups of curves

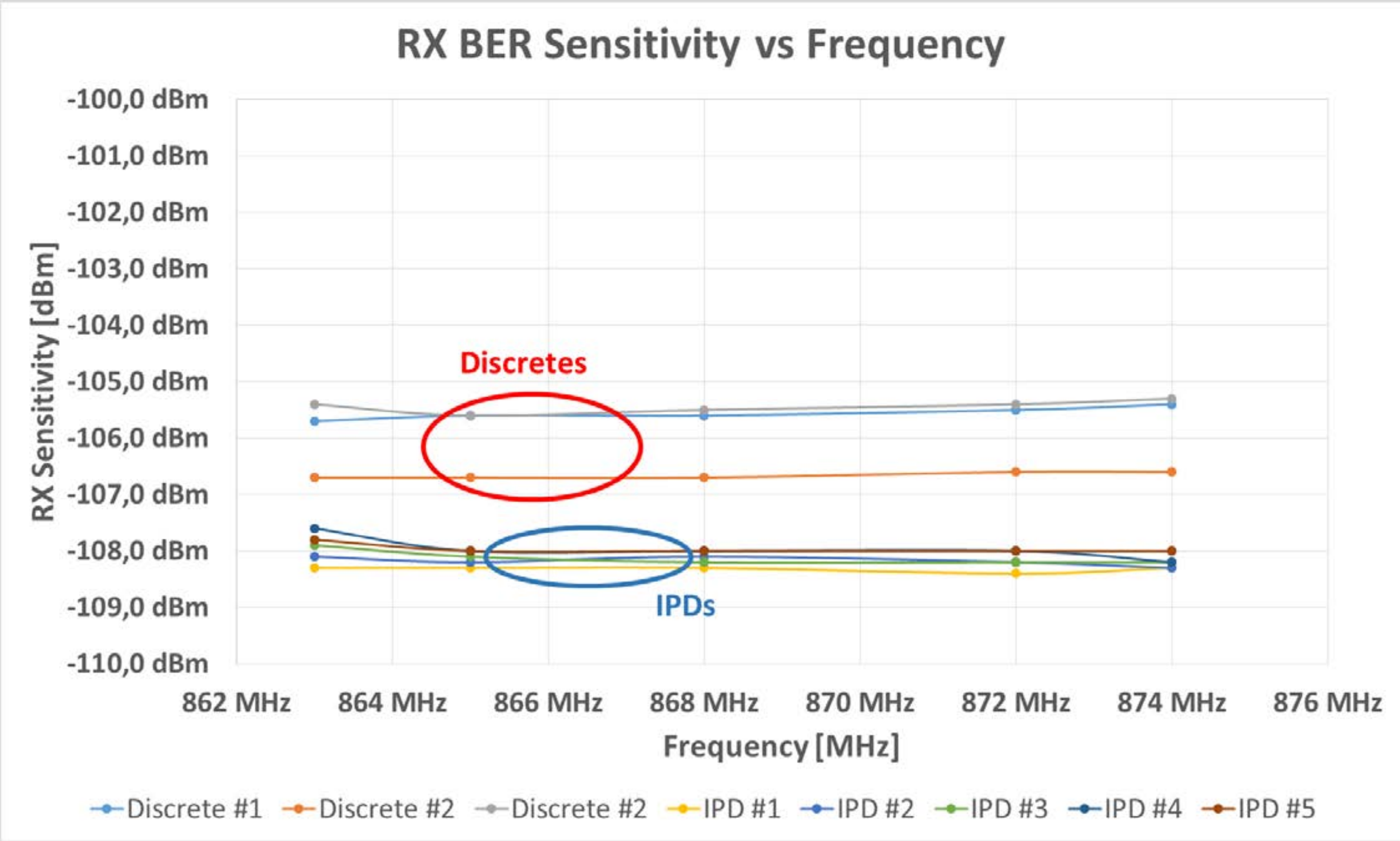
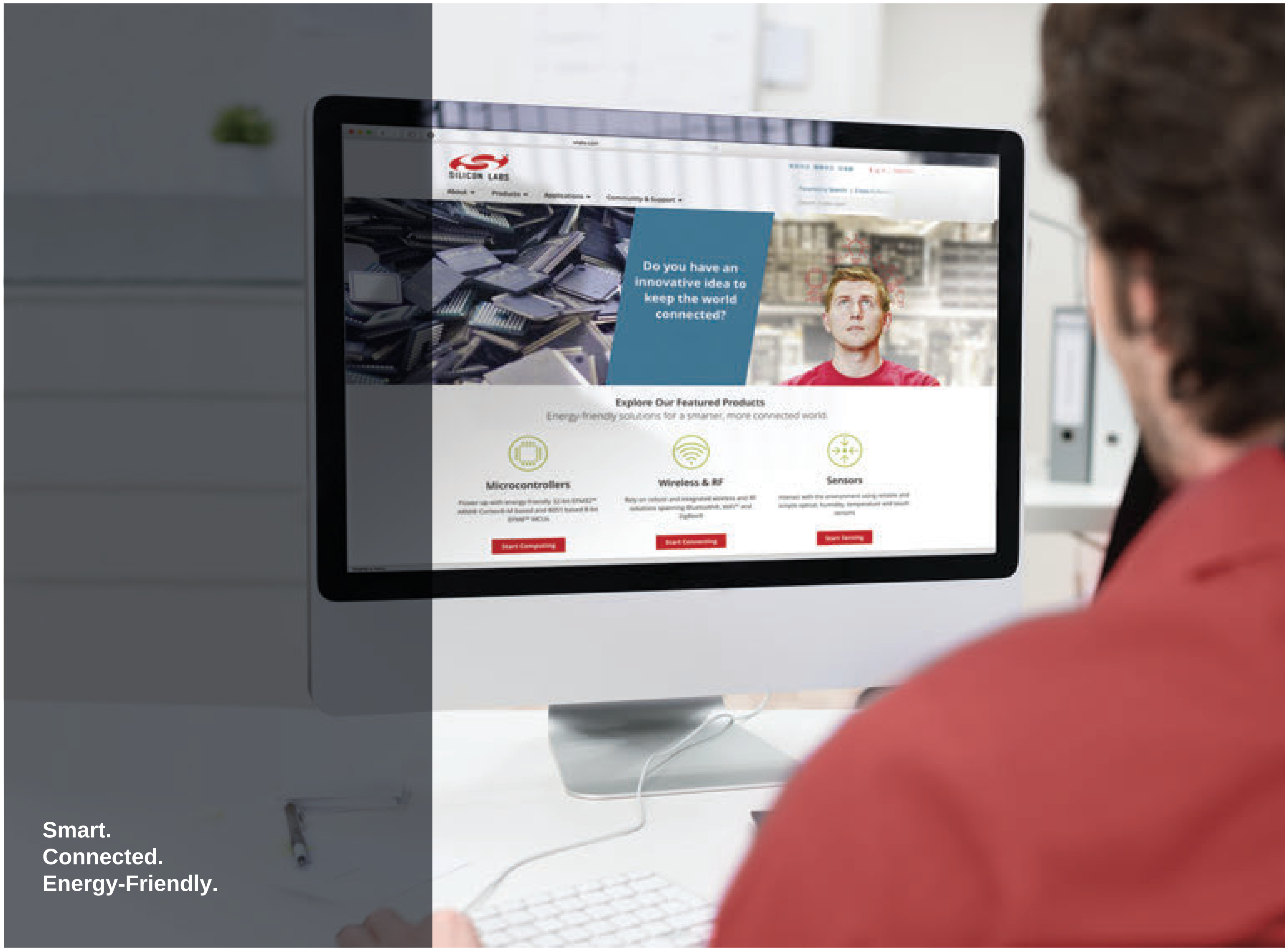


Figure 2.7. RX Sensitivity vs. Frequency

The RX sensitivity on the IPD-matched boards consistently measured as good (or better) than the RX sensitivity achievable on the discrete-matched boards.



Products
www.silabs.com/products

Quality
www.silabs.com/quality

Support and Community
community.silabs.com

Silicon Laboratories Inc.
400 West Cesar Chavez
Austin, TX 78701
USA

http://www.silabs.com