AN904

PERFORMANCE OF Si4455/Si4460 RFICS AT 434 MHZ WITH JOHANSON 0433BM41A0019 IPD

1. Introduction

Silicon Labs has published several application notes (e.g., AN643: “Si446x/Si4362 RX LNA Matching”, AN627: “Si4060/Si4460/61/67 Low-Power PA Matching”, and AN693: “Si4455 Low-Power PA Matching”) that discuss the design procedures required to match the TX/RX paths on Si4455 and Si4460 chips. The matches discussed within 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 4455-LED-434 RF Toolstick (as an example) is shown in Figure 1. Excluding the dc pull-up inductor (LC) and AC coupling/bypass capacitors (C9, CC1), there are a total of 11 discrete components required in the RF match.

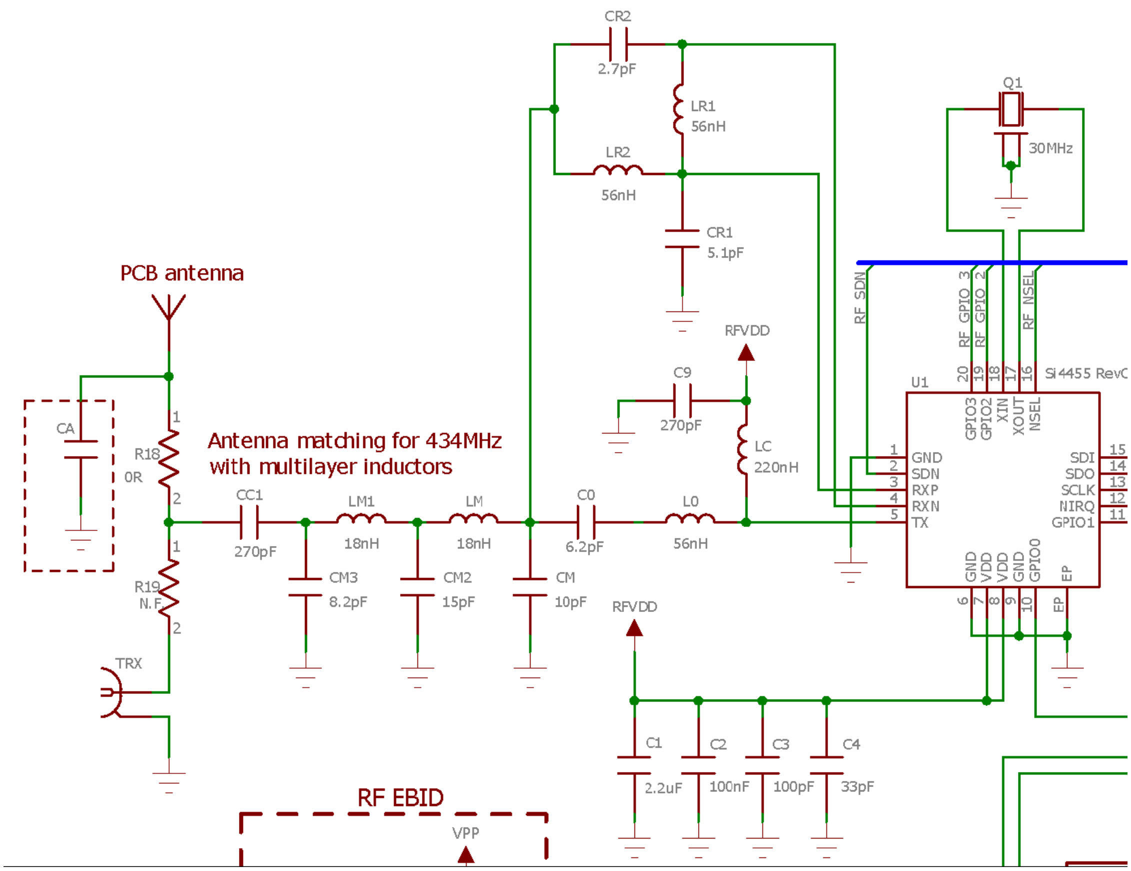

Figure 1. Discrete RF Matching Network for 4455-LED-434 RF Toolstick

A reduction in the number of matching components is desirable, not only from the standpoint of material cost but also when considering the cost of inventory, assembly, and test. Additionally, a smaller number of parts allows a smaller board area, thus also decreasing total cost.

Silicon Labs has partnered with Johanson Technologies, Inc. (JTI) to develop an Integrated Passive Device (IPD) which implements a complete 434 MHz +10 dBm RF matching network within a single small surface mount ceramic package. Using a proprietary Low Temperature Co-Fired Ceramic (LTCC) process, JTI has successfully integrated all of the required discrete matching components, excluding the DC pull-up inductor and AC coupling/ bypass capacitors. In this fashion, the RF matching network may be simplified as shown in Figure 2.

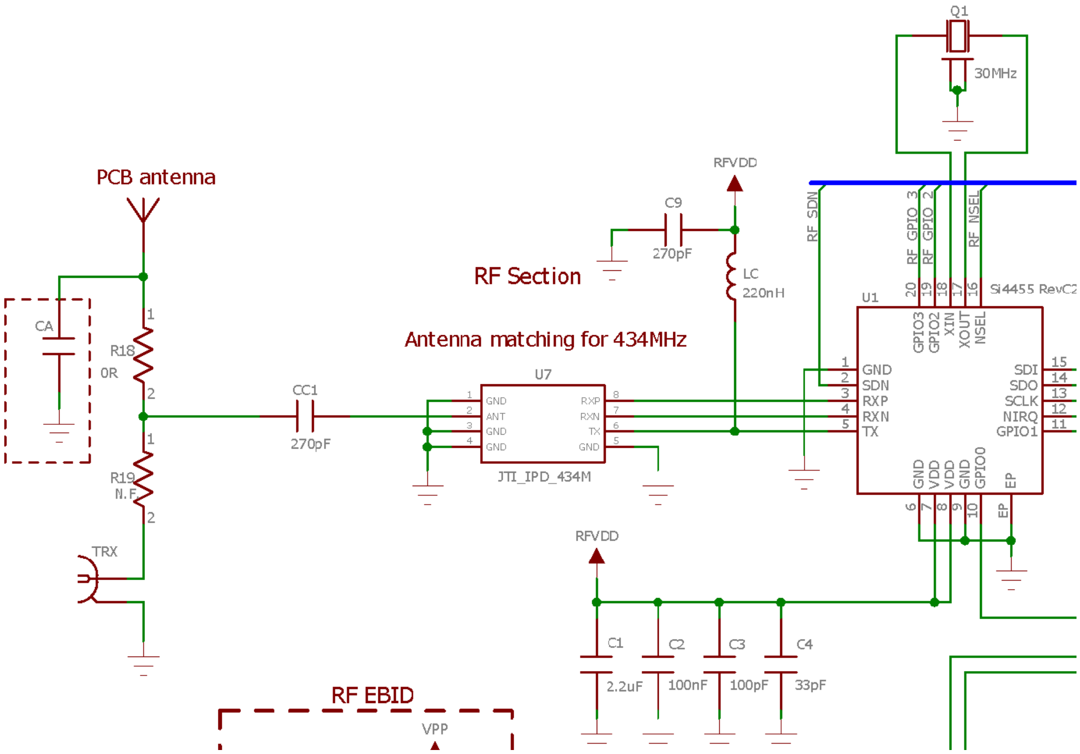

Figure 2. IPD RF Matching Network for 4455-LED-434 RF Toolstick

Furthermore, the board area required for the layout of the matching network may be shrunk as shown in Figure 3.

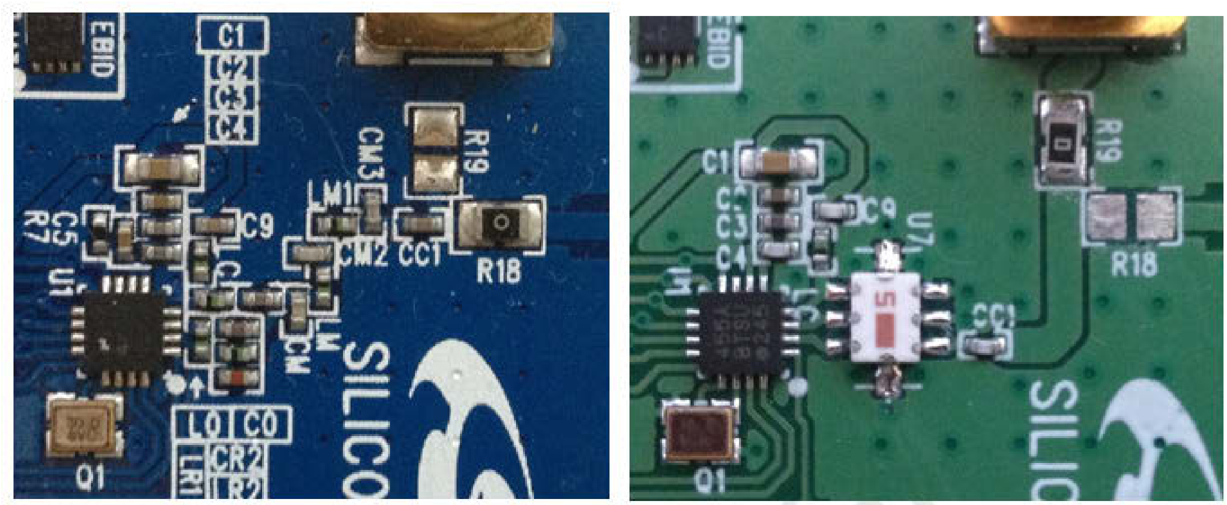

Figure 3. Comparison of Required Board Area (Discrete vs. IPD)

The JTI part number for this IPD device is P/N 0433BM41A0019, and is suitable for use at 434 MHz at ~+10 dBm output power with the following RFICs from Silicon Labs:

- Si4455
- Si4460
- Si1062/63/64/65
- Si1082/83/84/85
- EZR32LG230FxxxR55G/R60G/R67G
- EZR32LG330FxxxR55G/R60G/R67G
- EZR32WG230FxxxR55G/R60G/R67G
- EZR32WG330FxxxR55G/R60G/R67G

Reference design packs (i.e., schematics, board design files, gerbers, and BOM lists) which use the JTI device may be downloaded from the Silicon Labs website. The data sheet for the JTI P/N 0433BM41A0019 device may be downloaded from http://www.johansontechnology.com/integrated-passives.html.

2. Measured Performance

Silicon Labs has performed extensive testing of reference design boards with the JTI device to ensure that its performance is comparable (or better) than a discrete matched board. The reference design platform used for these comparison tests was the 4455-LED-434 RF Toolstick, modified to replace the discrete matching components with the JTI device (see Figure 4). The test results are presented below.

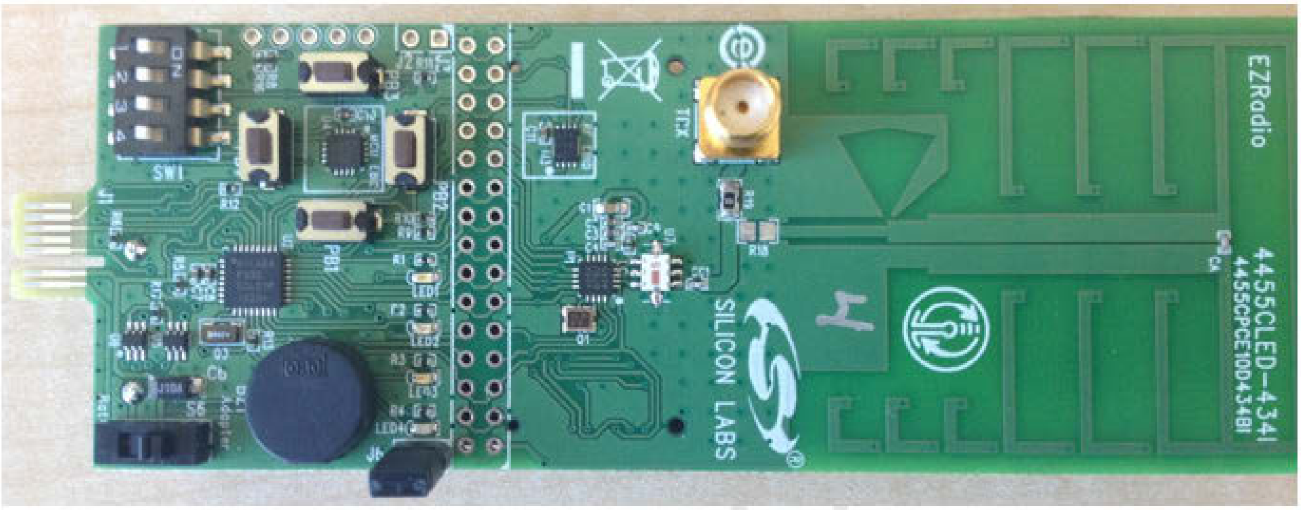

Figure 4. Board Layout for 4455-LED-434I with JTI IPD

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 Figure 5.

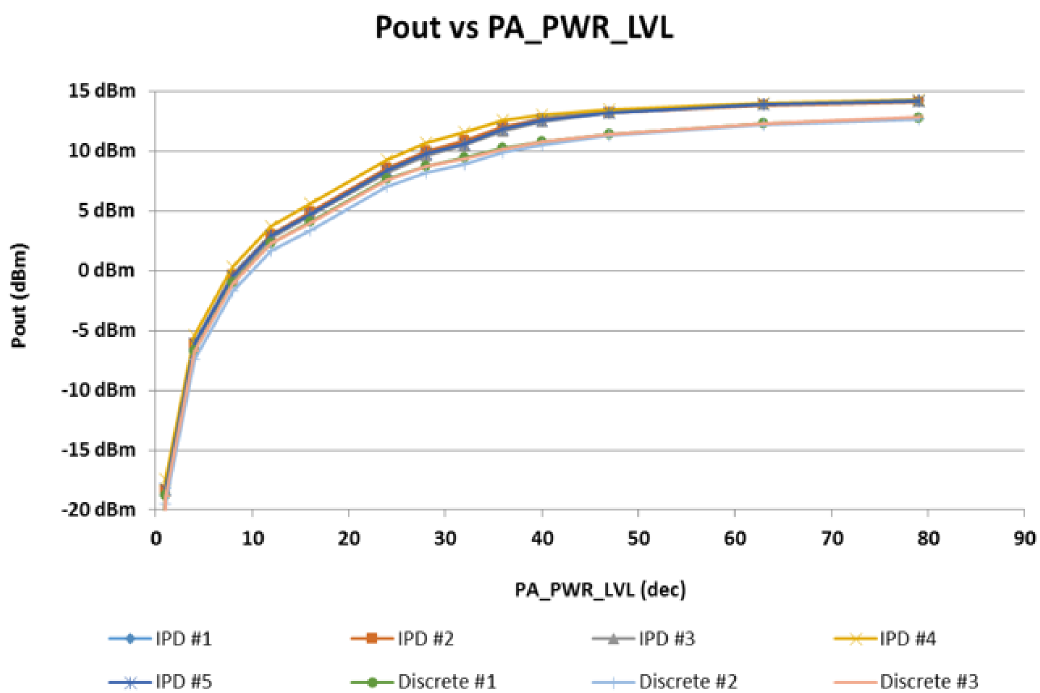

Figure 5. TX Output Power vs. PA_PWR_LVL

The TX output power consistently measured as good (or better) than the output power achievable on the discrete-matched boards.

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 Figure 6.

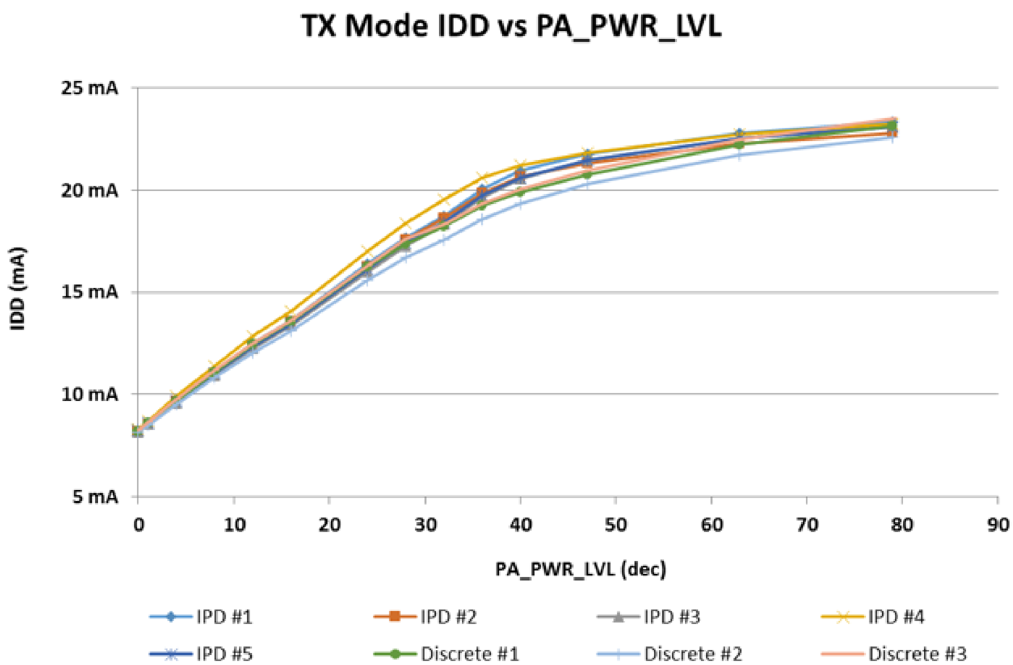

Figure 6. TX Mode Current Consumption

The measured current consumption was quite similar to that of the discrete-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 selected values of PA_PWR_LVL. The results are shown in Figure 7. Annotated balloons are provided on the plot to help distinguish the groups of curves.

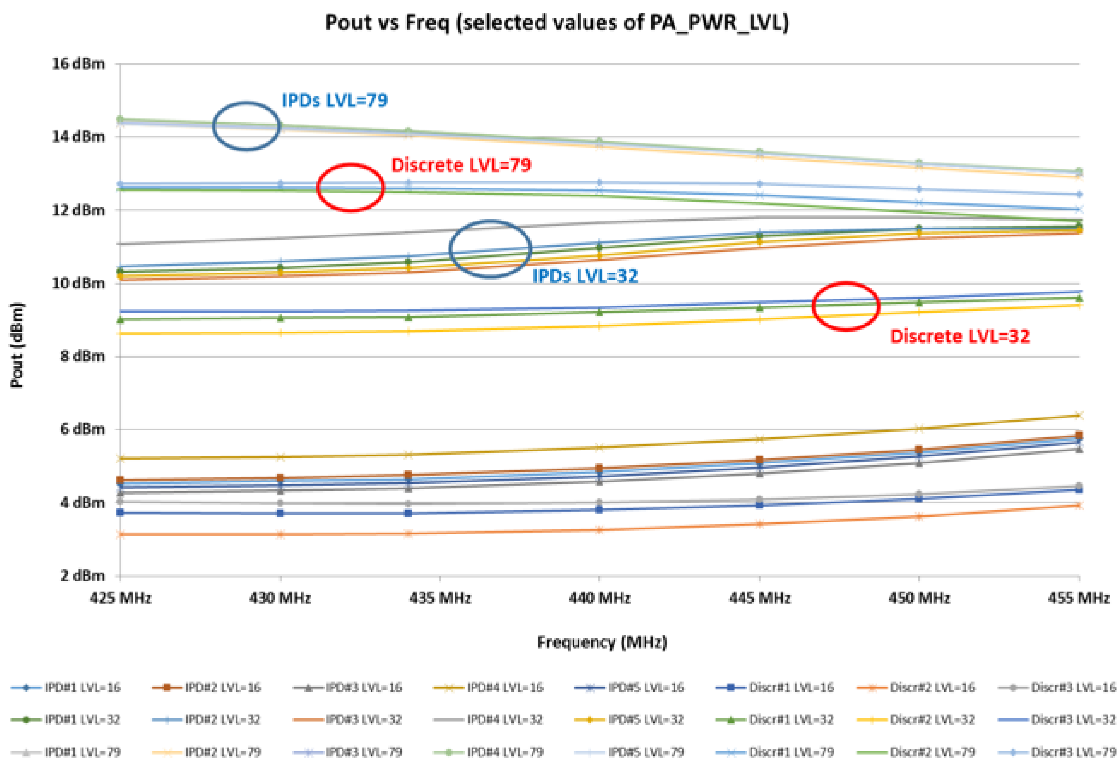

Figure 7. TX Output Power vs. Frequency

The TX output power on the IPD-matched boards consistently measured as good (or better) than the output power achievable 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 434 MHz while the output power was measured as a function of PA_PWR_LVL. The results are shown in Figure 8. Annotated balloons are provided on the plot to help distinguish the groups of curves.

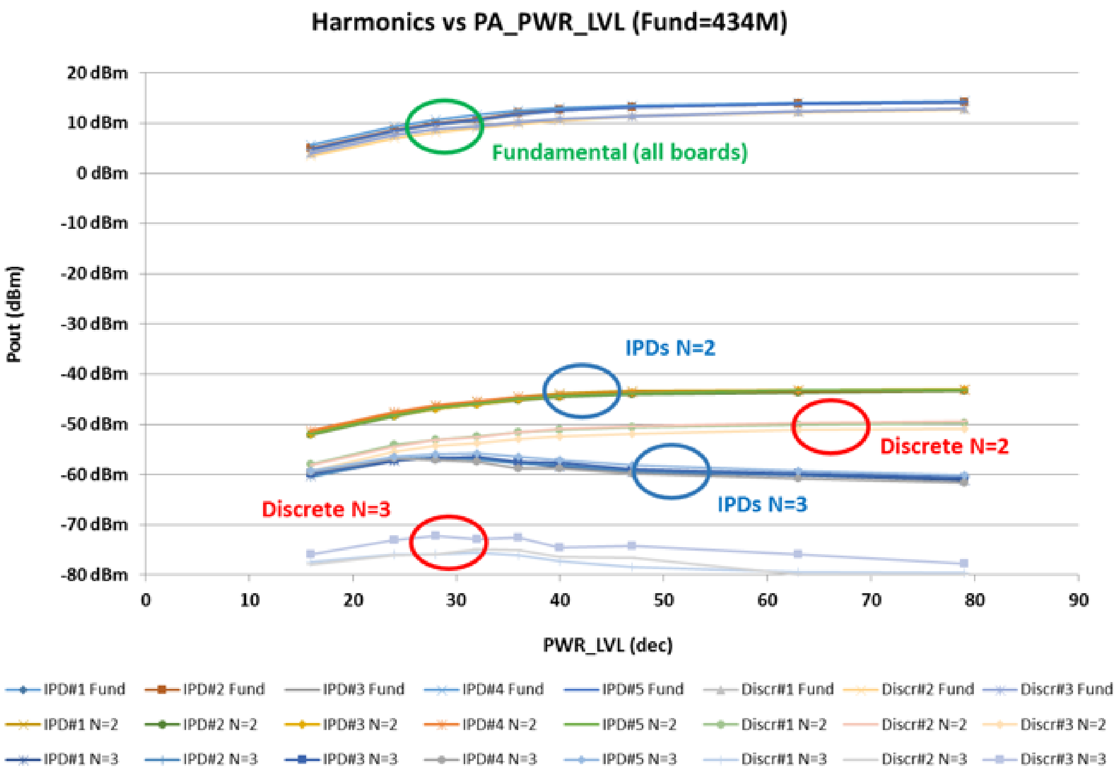

Figure 8. Harmonic Power Level vs. PA_PWR_LVL

The discrete-matched design provides better attenuation of harmonics than the IPD-matched design. However, the harmonic levels of both designs are easily compliant with regulatory standards typically encountered near 434 MHz (e.g., FCC Part 15.231, ETSI EN 300-220, ARIB STD-T67, ARIB RCR-STD30, etc).

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=40kbps, Dev=20kHz, XtalTol=0ppm. The RX sensitivity was measured across a range of frequencies. The results are shown in Figure 9. Annotated balloons are provided on the plot to help distinguish the groups of curves.

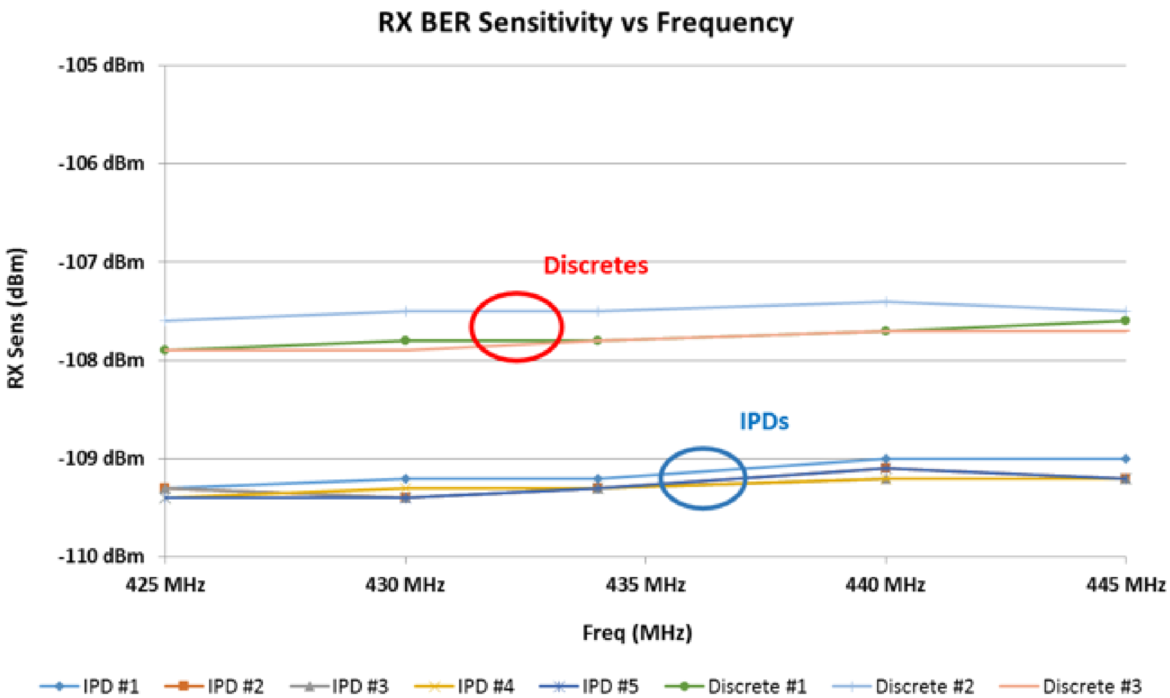

Figure 9. RX Sensitivity vs. Frequency

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

Disclaimer

Silicon Laboratories intends to provide customers with the latest, accurate, and in-depth documentation of all peripherals and modules available for system and software implementers using or intending to use the Silicon Laboratories products. Characterization data, available modules and peripherals, memory sizes and memory addresses refer to each specific device, and "Typical" parameters provided can and do vary in different applications. Application examples described herein are for illustrative purposes only. Silicon Laboratories reserves the right to make changes without further notice and limitation to product information, specifications, and descriptions herein, and does not give warranties as to the accuracy or completeness of the included information. Silicon Laboratories shall have no liability for the consequences of use of the information supplied herein. This document does not imply or express copyright licenses granted hereunder to design or fabricate any integrated circuits. The products must not be used within any Life Support System without the specific written consent of Silicon Laboratories. A "Life Support System" is any product or system intended to support or sustain life and/or health, which, if it fails, can be reasonably expected to result in significant personal injury or death. Silicon Laboratories products are generally not intended for military applications. Silicon Laboratories products shall under no circumstances be used in weapons of mass destruction including (but not limited to) nuclear, biological or chemical weapons, or missiles capable of delivering such weapons.

Trademark Information

Silicon Laboratories Inc., Silicon Laboratories, Silicon Labs, SiLabs and the Silicon Labs logo, CMEMS®, EFM, EFM32, EFR, Energy Micro, Energy Micro logo and combinations thereof, "the world’s most energy friendly microcontrollers", Ember®, EZLink®, EZMac®, EZRadio®, EZRadioPRO®, DSPLL®, ISOmodem ®, Precision32®, ProSLIC®, SiPHY®, USBXpress® and others are trademarks or registered trademarks of Silicon Laboratories Inc. ARM, CORTEX, Cortex-M3 and THUMB are trademarks or registered trademarks of ARM Holdings. Keil is a registered trademark of ARM Limited. All other products or brand names mentioned herein are trademarks of their respective holders.

SILICON LABS

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

http://www.silabs.com