

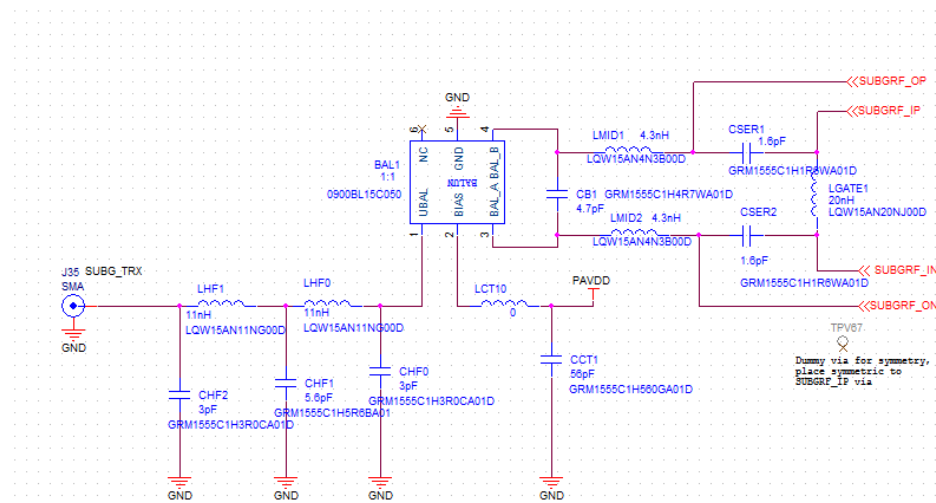
AN1148: Johanson 868 MHz IPDs for EFR32 Series 1 Wireless SOCs

EFR32 Series 1 devices supporting sub-GHz frequency bands utilize an external matching network. This network serves several purposes, including impedance transformation from a 50 Ω antenna to the optimum transmit and receive path impedance for EFR32, single-ended to differential conversion, and low-pass filtering to minimize transmit harmonics and receive out-of-band interference. This network is often implemented by discrete components as shown below.

Some applications, however, benefit in terms of minimized space, bill of materials, and reduced complexity by integrating this external network in a single integrated passive device (IPD).

KEY POINTS

- IPDs simplify the EFR32 Series 1 sub-GHz RF matching network design, reducing complexity and PCB board space by 70%
- IPDs are available from leading RF ceramics providers supporting both the 434 MHz and 868 MHz frequency bands
- Including IPDs in EFR32 Series 1 designs is made straightforward with a few hardware and software design considerations



1. Component Reduction

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 Laboratories has partnered with Johanson to develop an Integrated Passive Device (IPD) that implements a complete 868 MHz +14 dBm RF matching network within a single small surface mount ceramic package. Using a proprietary Low Temperature Co-Fired ceramic (LTCC) process, Johanson has successfully integrated all the required discrete matching components. The RF matching network shown on the front page is now highly simplified, as shown below.

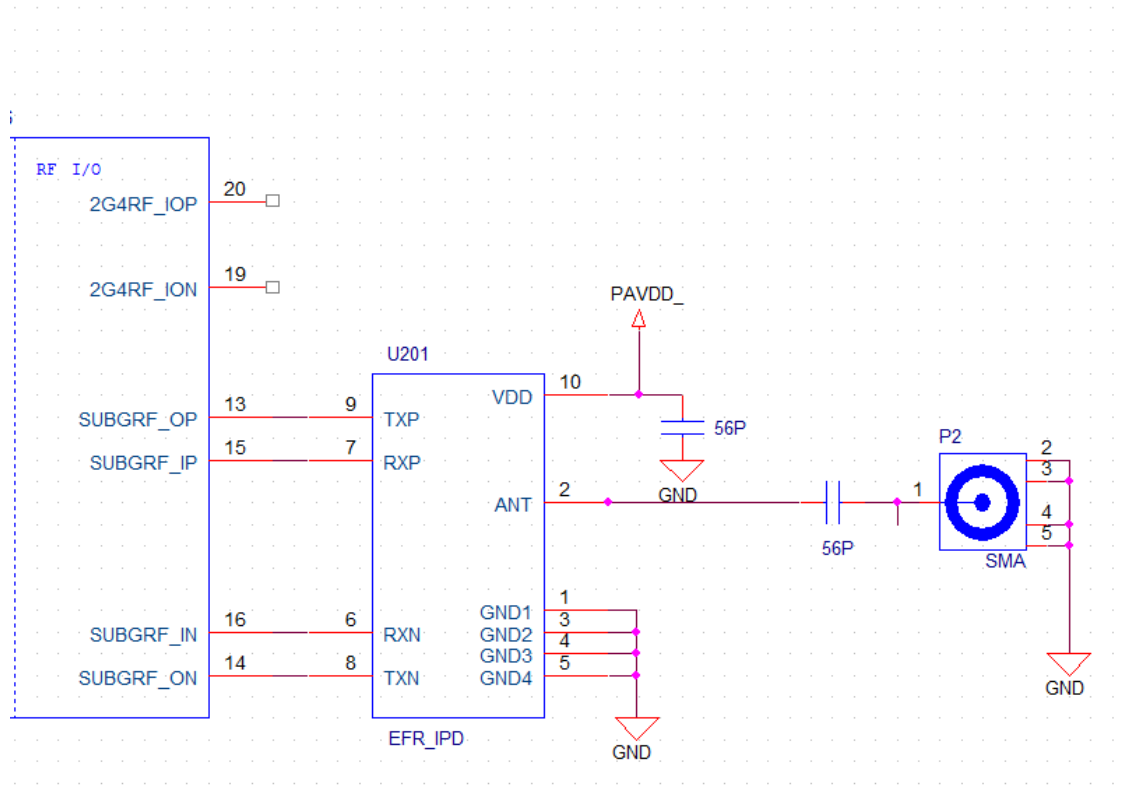


Figure 1.1. IPD RF Matching Network

2. PCB Space Comparison

An IPD solution also significantly reduces the PCB area. A comparison between a layout using discrete components and one using an IPD solution is shown below. The red circles highlight the PCB space savings when using the IPD solution.

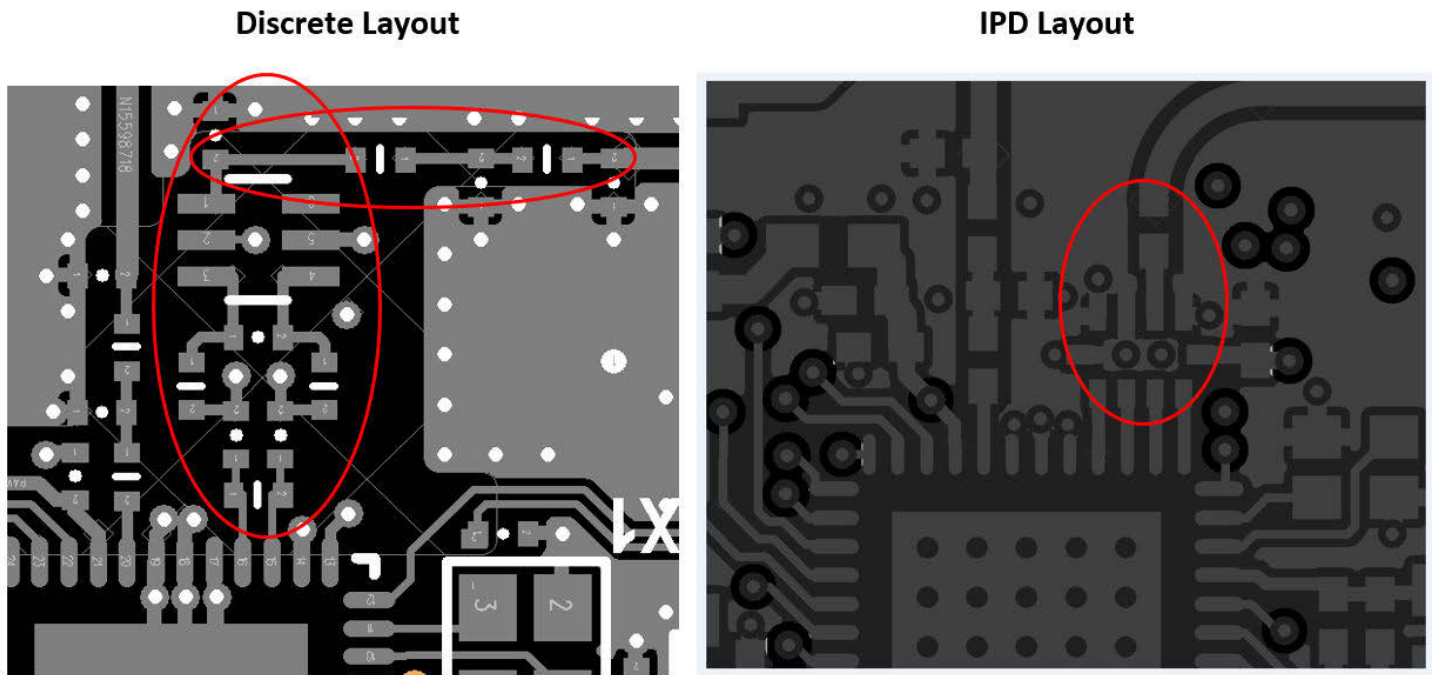


Figure 2.1. Layout Comparison between Discrete Solution (Left) and IPD Solution (Right)

The Johanson part number for the 868 MHz band is 0868BM15G0027 and is suitable for use at 868 MHz at $\sim +14$ dBm output power with the following RFICs from Silicon Laboratories.

- EFR32MG1x
- EFR32BG1x
- EFR32FG1x

Reference design collateral (e.g., schematics, board design files, gerbers and BOM lists) for the Johanson device can be downloaded from the Silicon Laboratories website.

The data sheet for the Johanson 0868BM15G0027 device may be downloaded at <https://www.johansontechnology.com/silabs> or <https://www.johansontechnology.com/datasheets/0868BM15G0027/0868BM15G0027.pdf>.

3. Measured Performance

Silicon Labs has done extensive performance comparisons between Johanson IPDs and discrete matching solutions. The results are shown below.

3.1 Transmit Output Power vs. PA Power Control Level

The conducted Transmit Output Power of one Johanson IPD board is compared against a discrete match solution below.

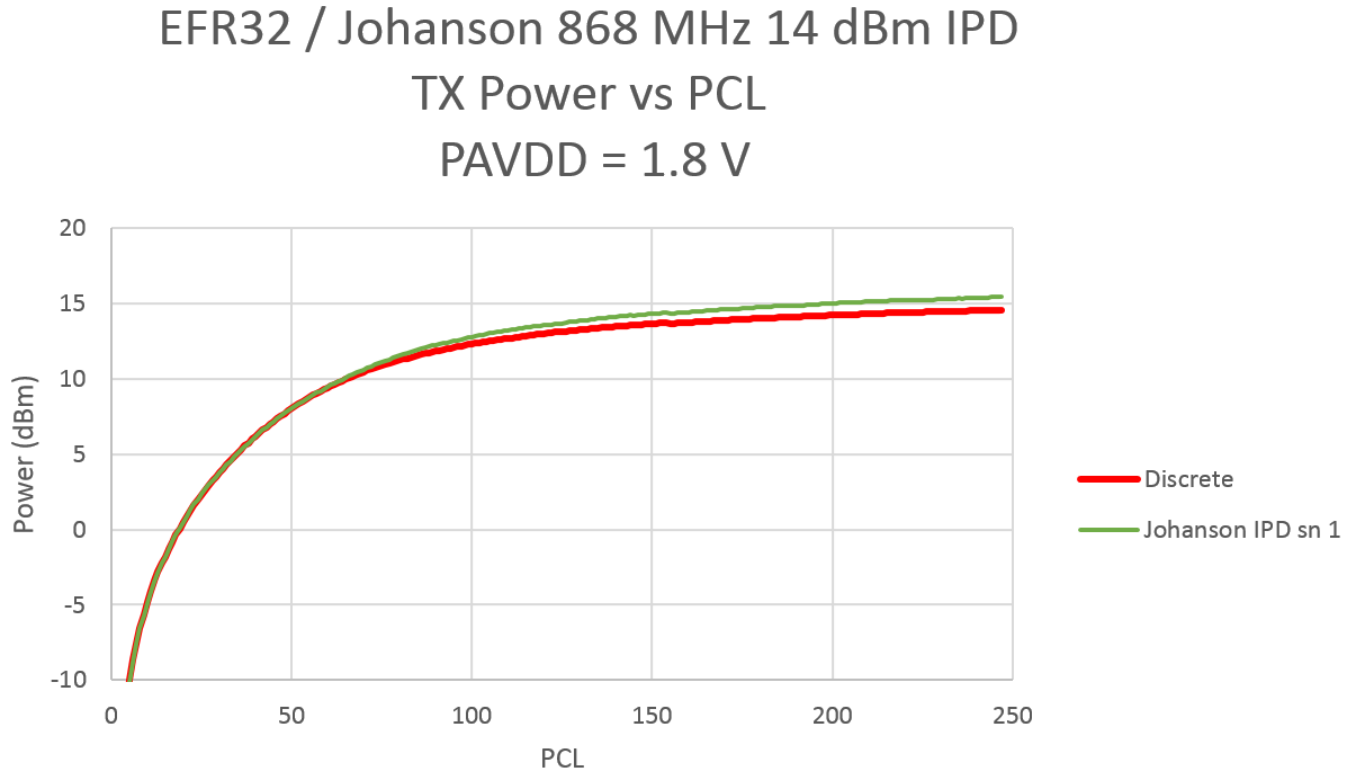


Figure 3.1. Conducted Transmit Output Power (One Johanson IPD Board vs. Discrete Matched Solution)

3.2 Transmit Current Consumption vs. PA Control Level

The conducted Transmit Current of one Johanson IPD (matched board) is shown below compared against a discrete match solution.

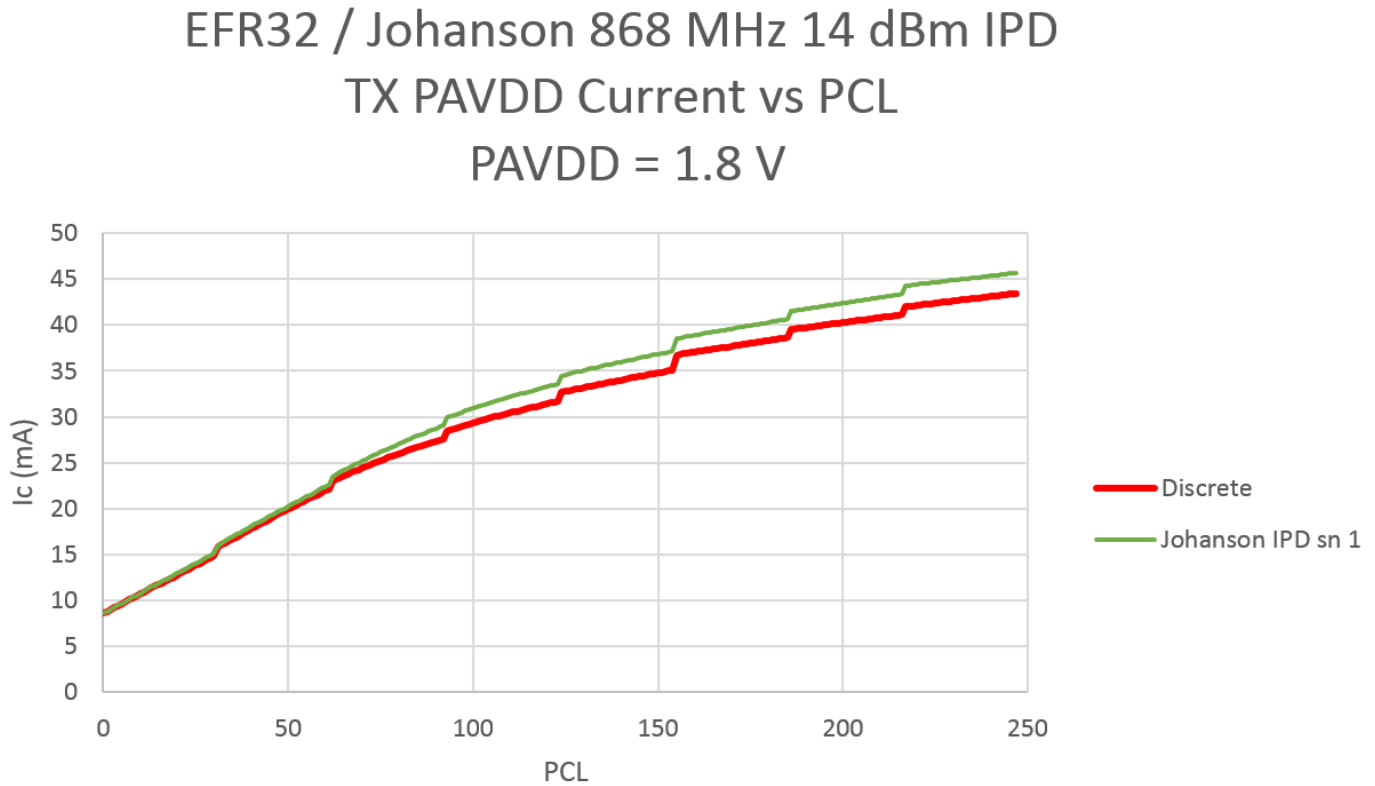


Figure 3.2. Conducted Transmit Current of One Johanson IPD (Matched Board)

3.3 Transmit Power, Second Harmonic Performance vs. PA Control Level

The conducted Transmit second harmonic Performance of one Johanson IPD is shown below. The maximum harmonic levels for the discrete device is shown at the highest PCL levels in red.

EFR32 / Johanson 868 MHz 14 dBm IPD

TX 2nd Harmonic vs PCL

PAVDD = 1.8 V

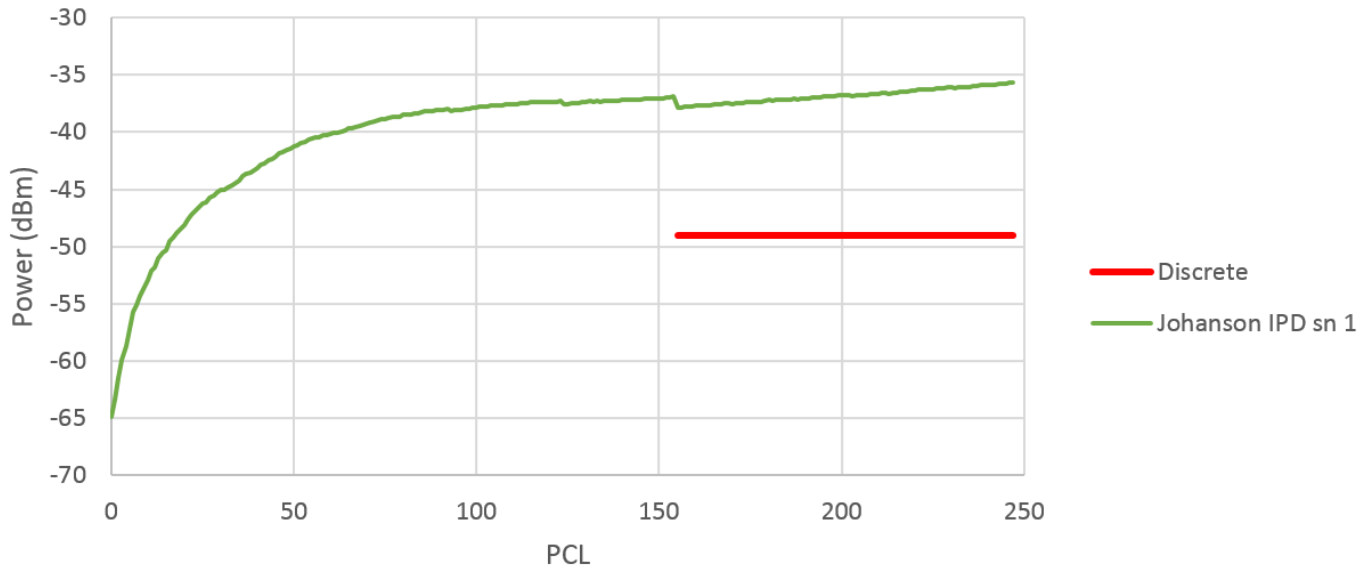


Figure 3.3. Conducted Transmit Second Harmonic Performance of One Johanson IPD

3.4 Transmit Power, Third Harmonic Performance vs. PA Control Level

The Conducted Transmit third harmonic Performance of one Johanson IPD is shown below. The maximum harmonic levels for the discrete device are shown at the highest PCL levels in red.

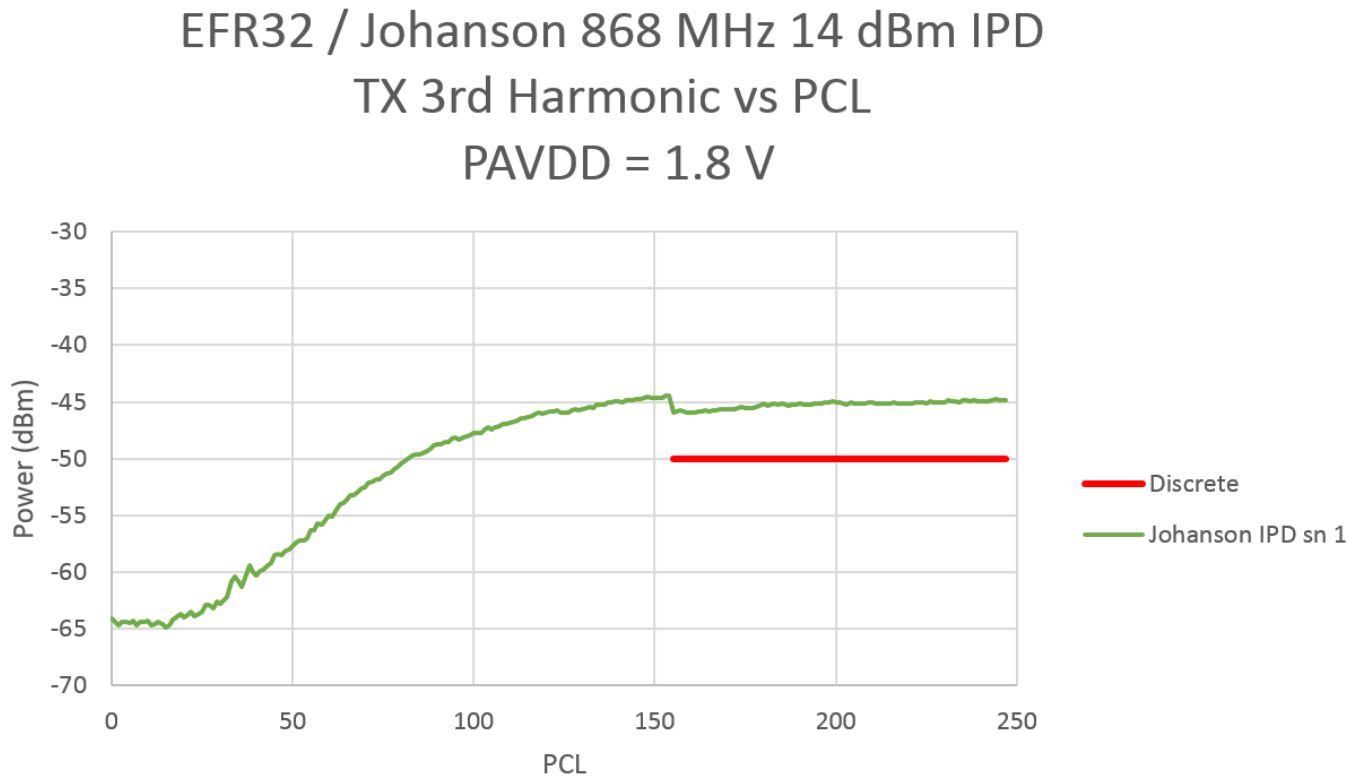


Figure 3.4. Conducted Transmit Third Harmonic Performance of One Johanson IPD

3.5 Transmit Power, Fourth Harmonic Performance vs. PA Control Level

The conducted Transmit fourth harmonic Performance of one Johanson IPD is shown below. The maximum harmonic levels for the discrete device is shown at the highest PCL levels in red.

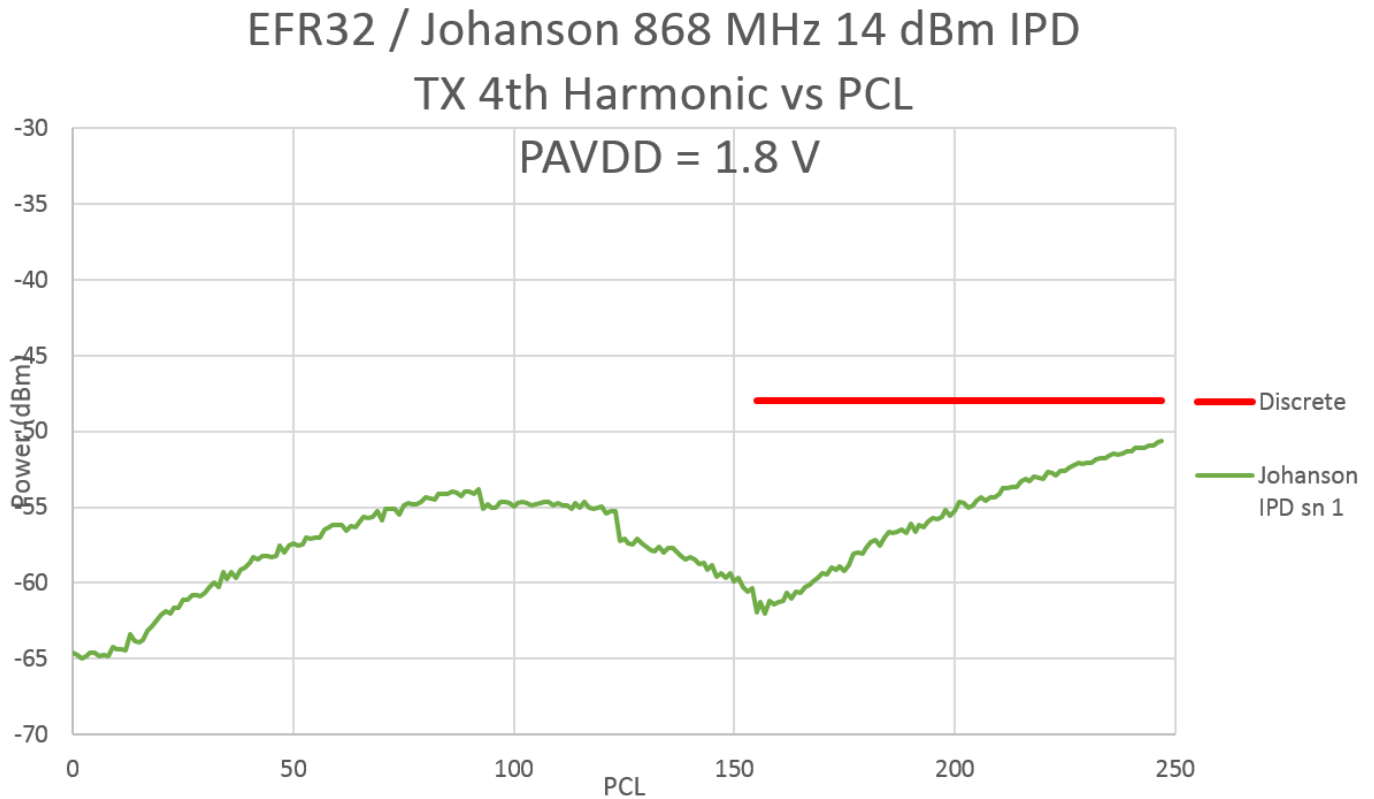


Figure 3.5. Conducted Transmit Fourth Harmonic Performance of One Johanson IPD

3.6 Receiver Packet Error Rate Performance at 868 MHz

The RX Packet Error Rate (PER) for a 62.5 kbps GFSK signal is shown below for one IPD (matched board) are shown below compared to that of the discrete matched solution.

EFR32 / Johanson 868 MHz 14 dBm IPD RX Packet Error Rate 62.5 kbps GFSK Modulation

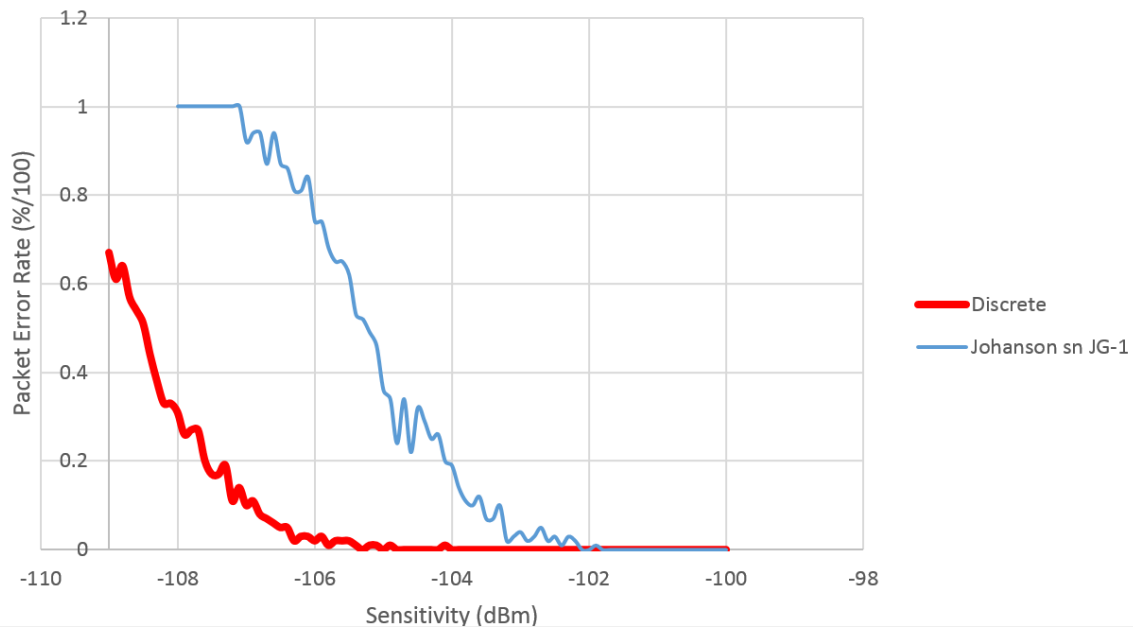


Figure 3.6. Receiver Packet Error Rate

Silicon Labs

Simplicity Studio™4



Simplicity Studio

One-click access to MCU and wireless tools, documentation, software, source code libraries & more. Available for Windows, Mac and Linux!



IoT Portfolio
www.silabs.com/IoT



SW/HW
www.silabs.com/simplicity



Quality
www.silabs.com/quality



Support and Community
community.silabs.com

Disclaimer

Silicon Labs 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 Labs 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 Labs reserves the right to make changes without further notice to the product information, specifications, and descriptions herein, and does not give warranties as to the accuracy or completeness of the included information. Without prior notification, Silicon Labs may update product firmware during the manufacturing process for security or reliability reasons. Such changes will not alter the specifications or the performance of the product. Silicon Labs shall have no liability for the consequences of use of the information supplied in this document. This document does not imply or expressly grant any license to design or fabricate any integrated circuits. The products are not designed or authorized to be used within any FDA Class III devices, applications for which FDA premarket approval is required, or Life Support Systems without the specific written consent of Silicon Labs. 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 Labs products are not designed or authorized for military applications. Silicon Labs 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. Silicon Labs disclaims all express and implied warranties and shall not be responsible or liable for any injuries or damages related to use of a Silicon Labs product in such unauthorized applications.

Trademark Information

Silicon Laboratories Inc.®, Silicon Laboratories®, Silicon Labs®, SiLabs® and the Silicon Labs logo®, Bluegiga®, Bluegiga Logo®, ClockBuilder®, CMEMS®, DSPLL®, EFM®, EFM32®, EFR®, Ember®, Energy Micro, Energy Micro logo and combinations thereof, "the world's most energy friendly microcontrollers", Ember®, EZLink®, EZRadio®, EZRadioPRO®, Gecko®, Gecko OS, Gecko OS Studio, ISOModem®, Precision32®, ProSLIC®, Simplicity Studio®, SiPHY®, Telegesis, the Telegesis Logo®, USBXpress®, Zentri, the Zentri logo and Zentri DMS, Z-Wave®, and others are trademarks or registered trademarks of Silicon Labs. ARM, CORTEX, Cortex-M3 and THUMB are trademarks or registered trademarks of ARM Holdings. Keil is a registered trademark of ARM Limited. Wi-Fi is a registered trademark of the Wi-Fi Alliance. All other products or brand names mentioned herein are trademarks of their respective holders.



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

<http://www.silabs.com>