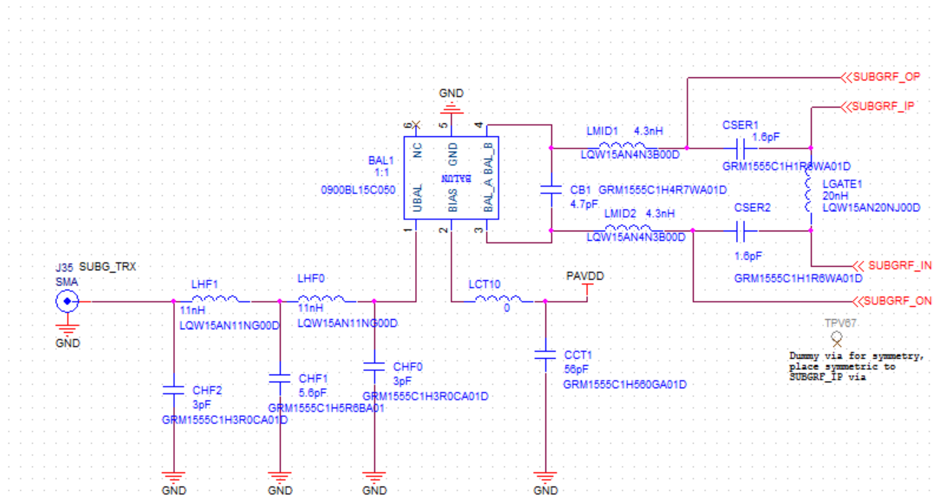
AN1148: Johanson 868 MHz IPDs for EFR32 Series 1 Wireless SOCs

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.

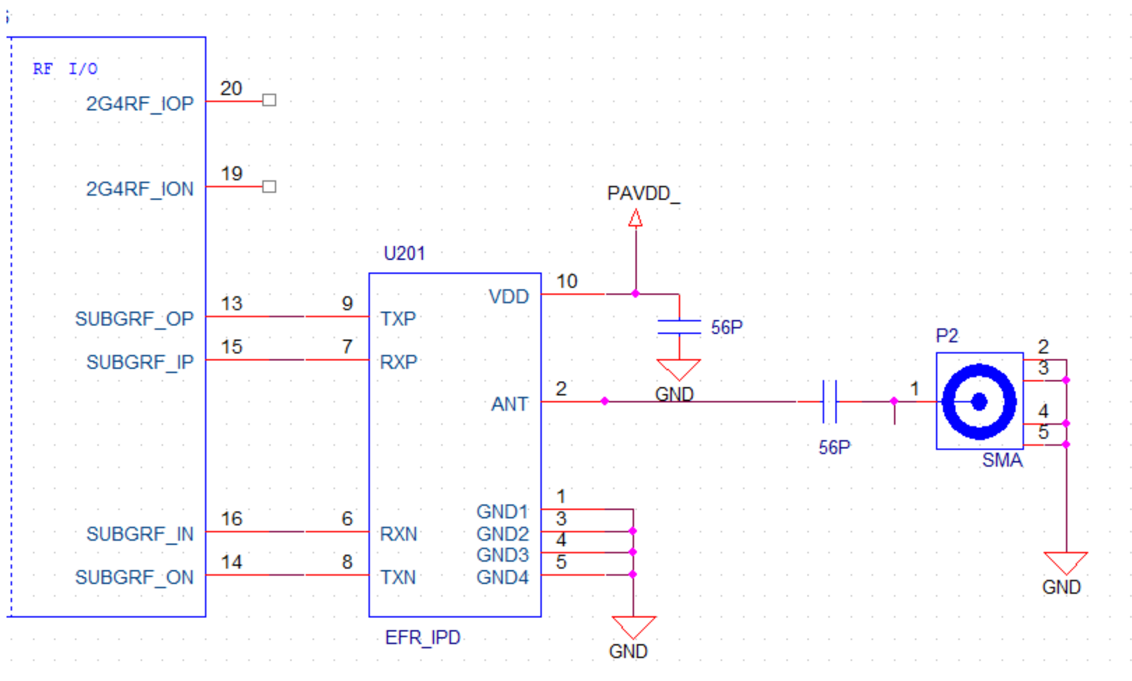


Figure 1.1. IPD RF Matching Network

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.

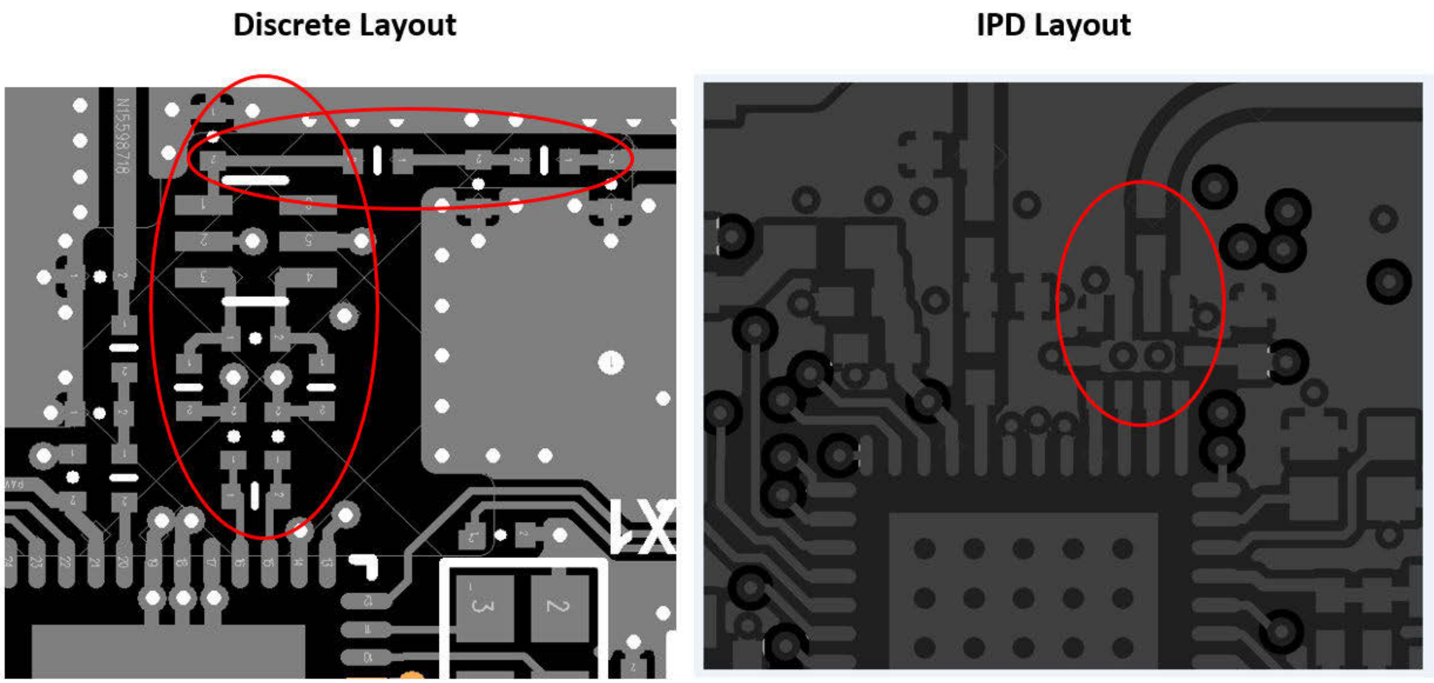


Figure 2.1. Layout Comparison between Discrete Solution (Left) and IPD Solution (Right)

The Johanson part number for the 868 MHz band is 0868BM15G0027 and is suitable for use at 868 MHz at ~ +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.

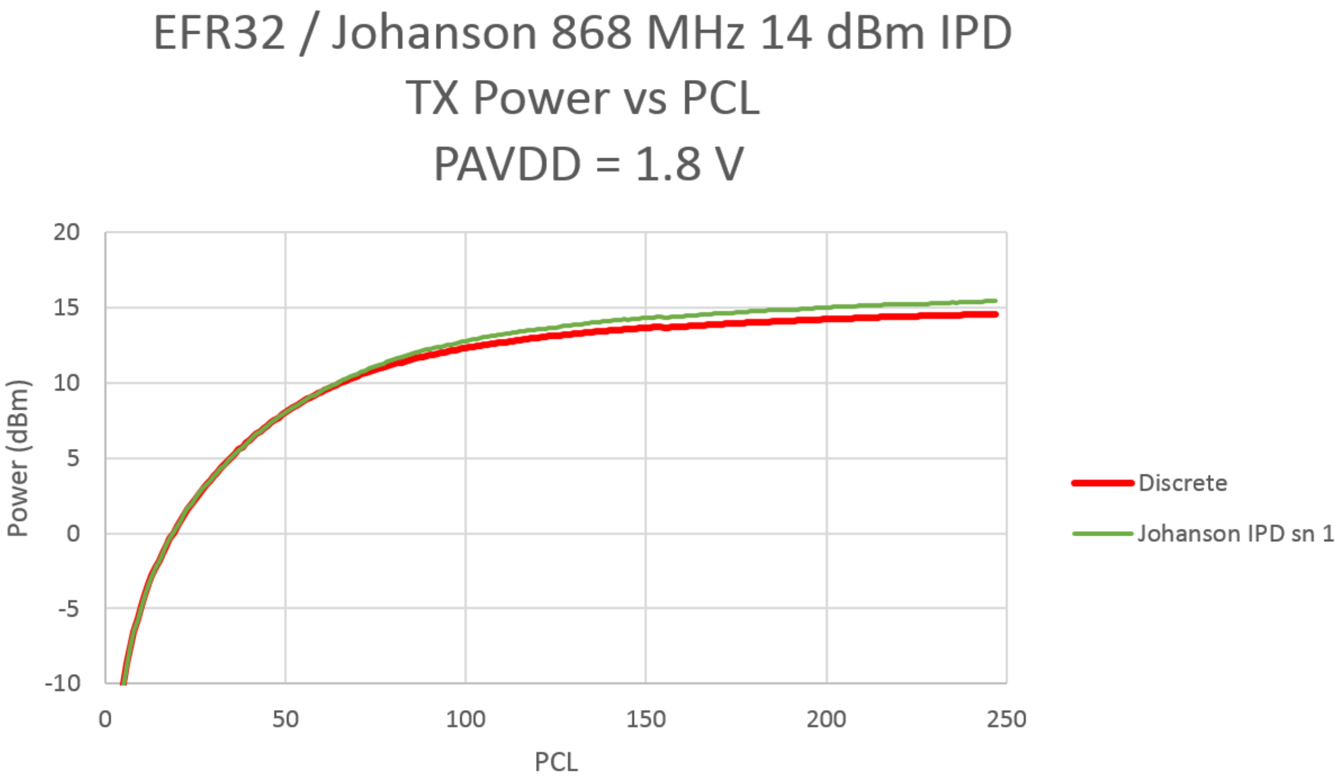


Figure 3.1. Conducted Transmit Output Power (One Johanson IPD Board vs. Discrete Matched Solution)

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.

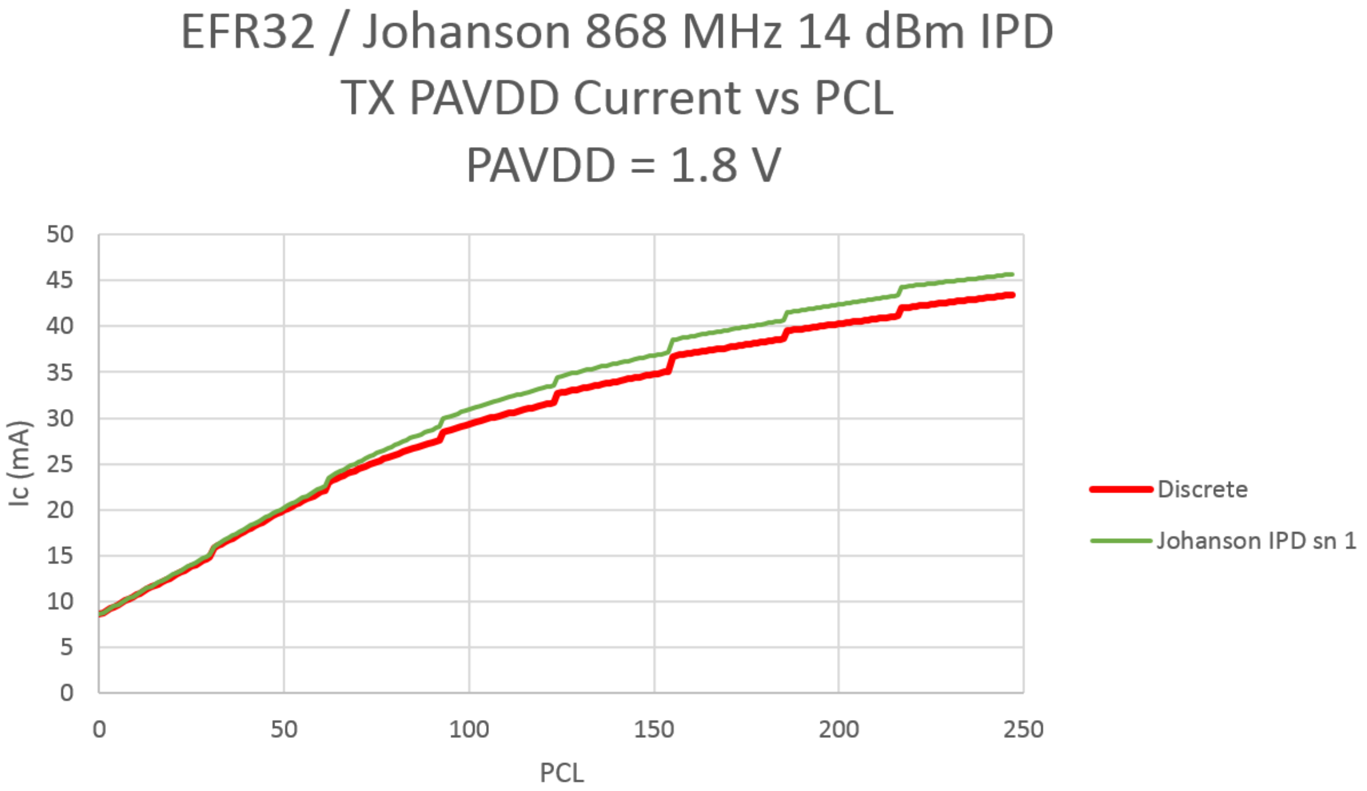


Figure 3.2. Conducted Transmit Current of One Johanson IPD (Matched Board)

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.

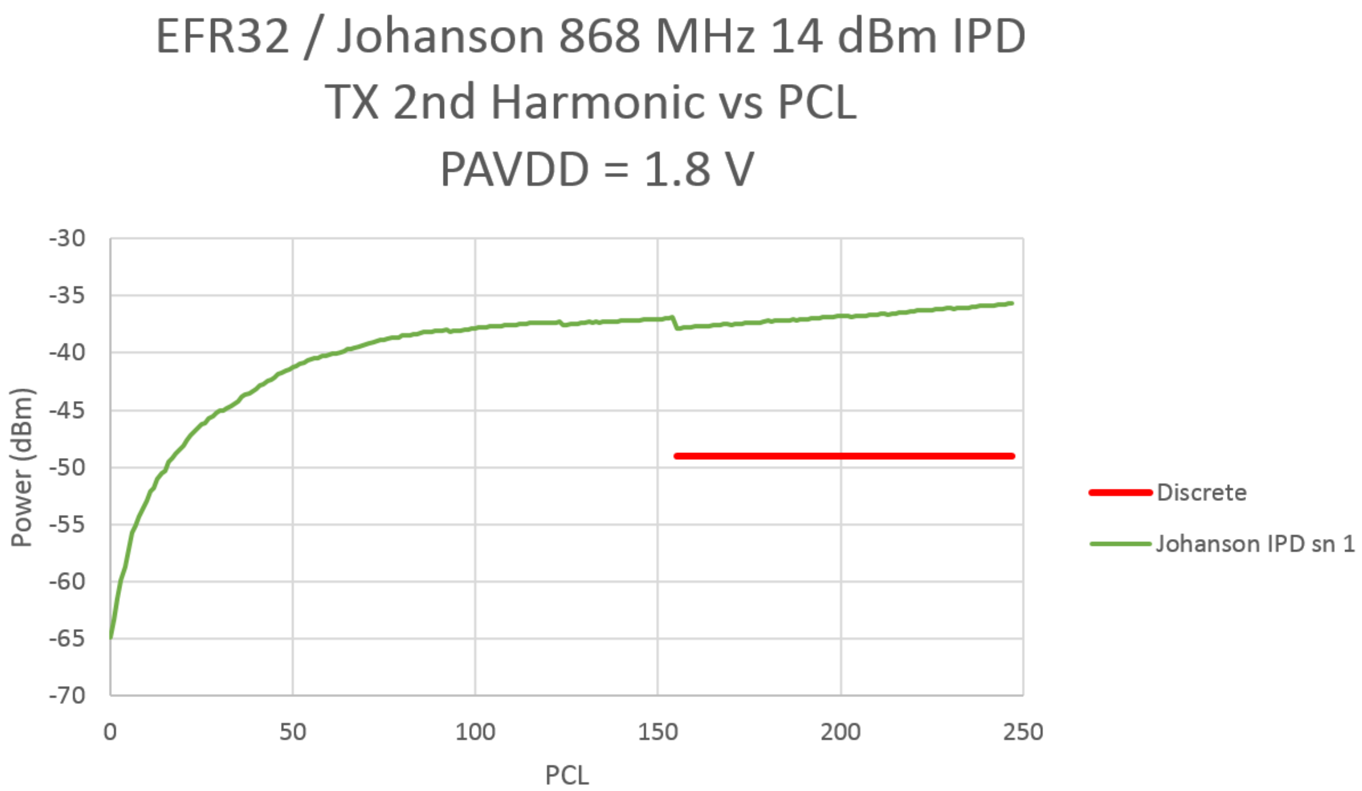


Figure 3.3. Conducted Transmit Second Harmonic Performance of One Johanson IPD

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.

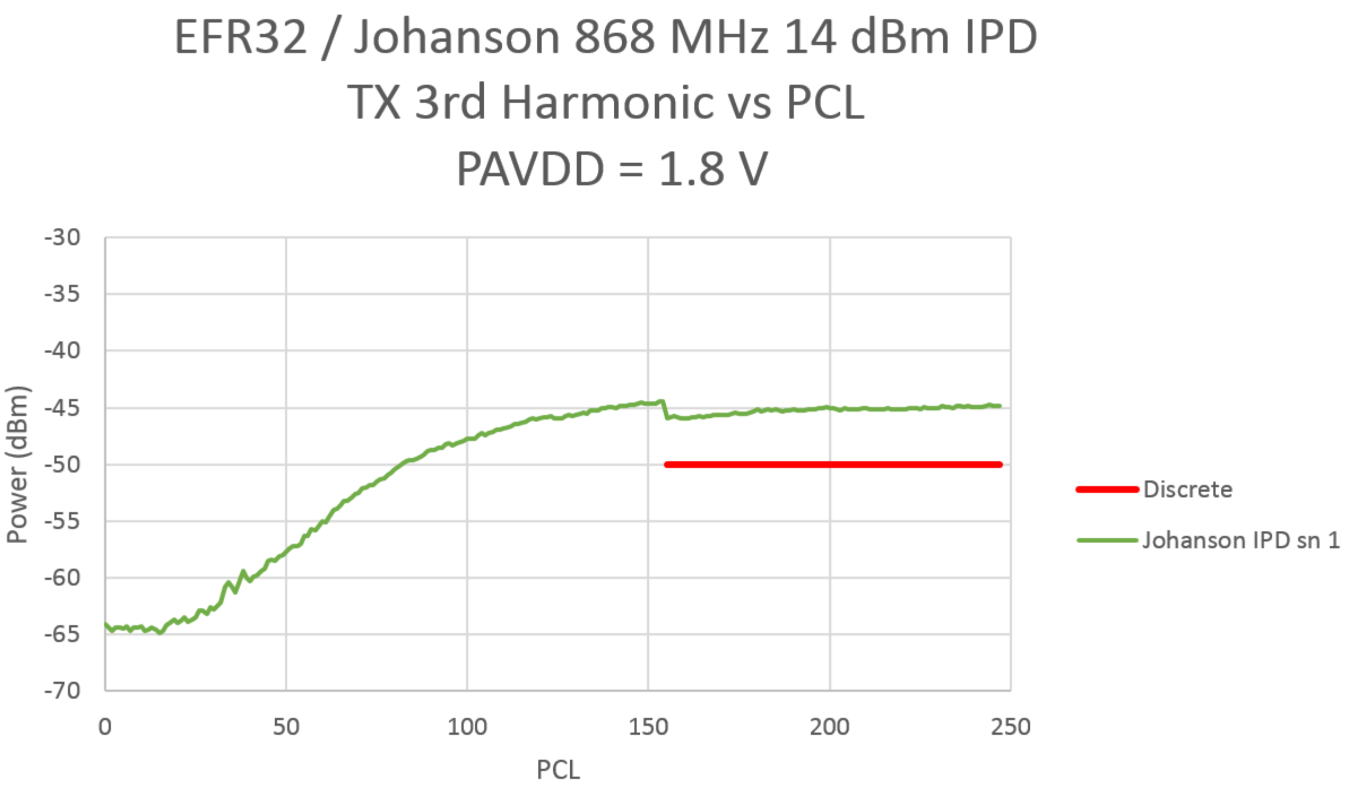


Figure 3.4. Conducted Transmit Third Harmonic Performance of One Johanson IPD

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.

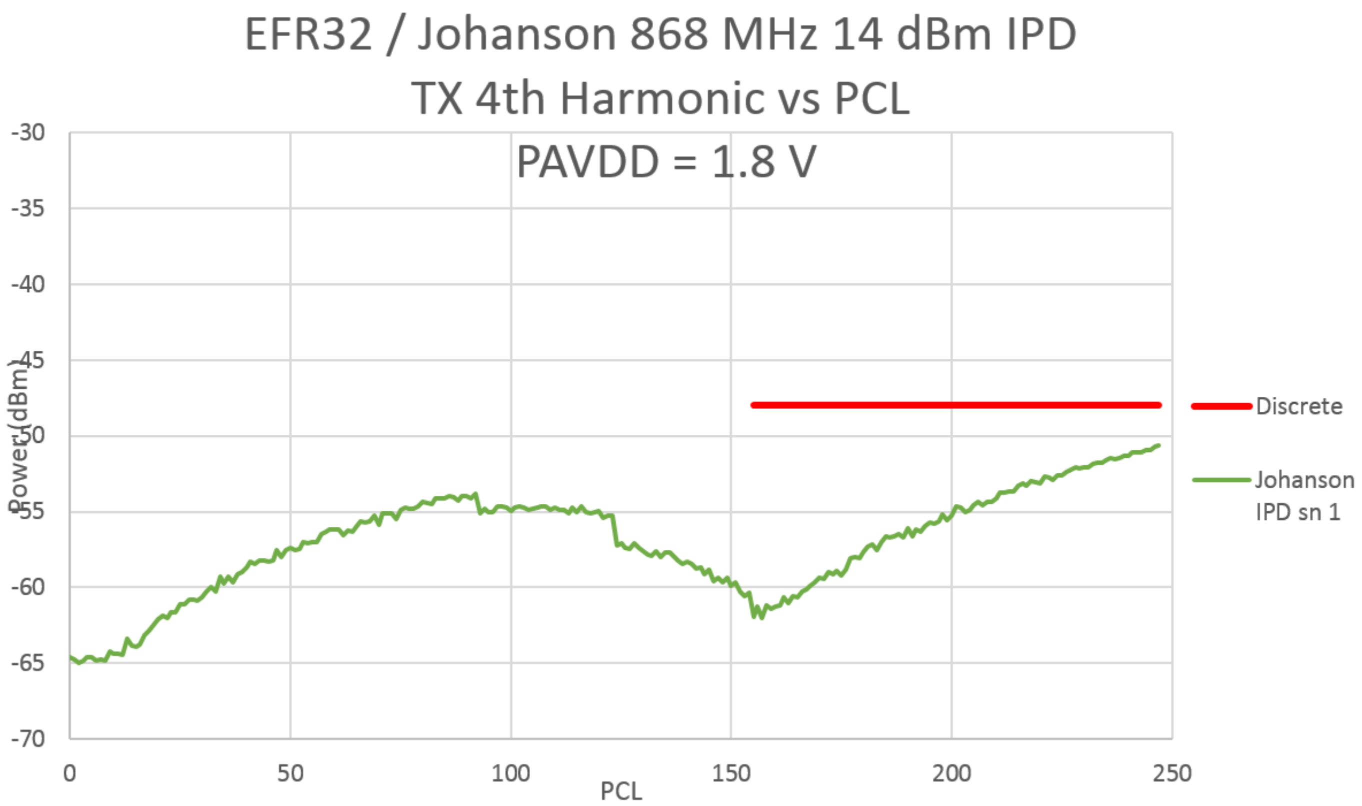


Figure 3.5. Conducted Transmit Fourth Harmonic Performance of One Johanson IPD

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.

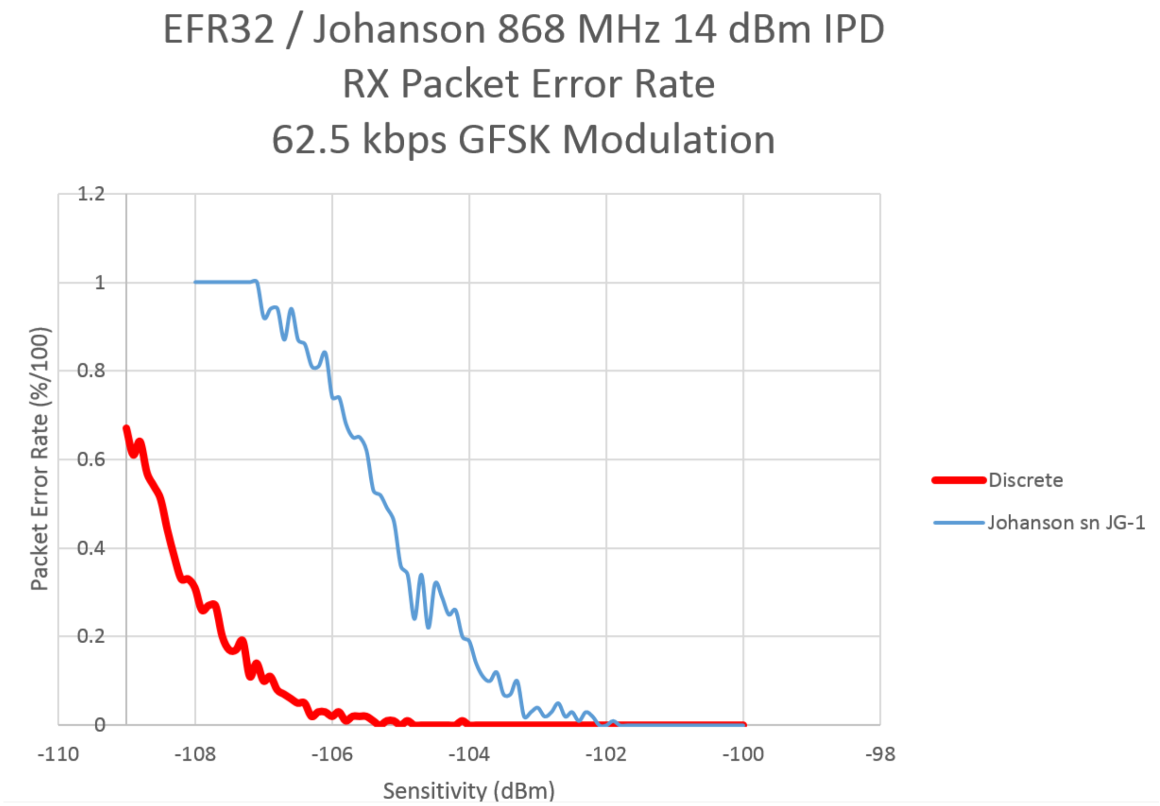
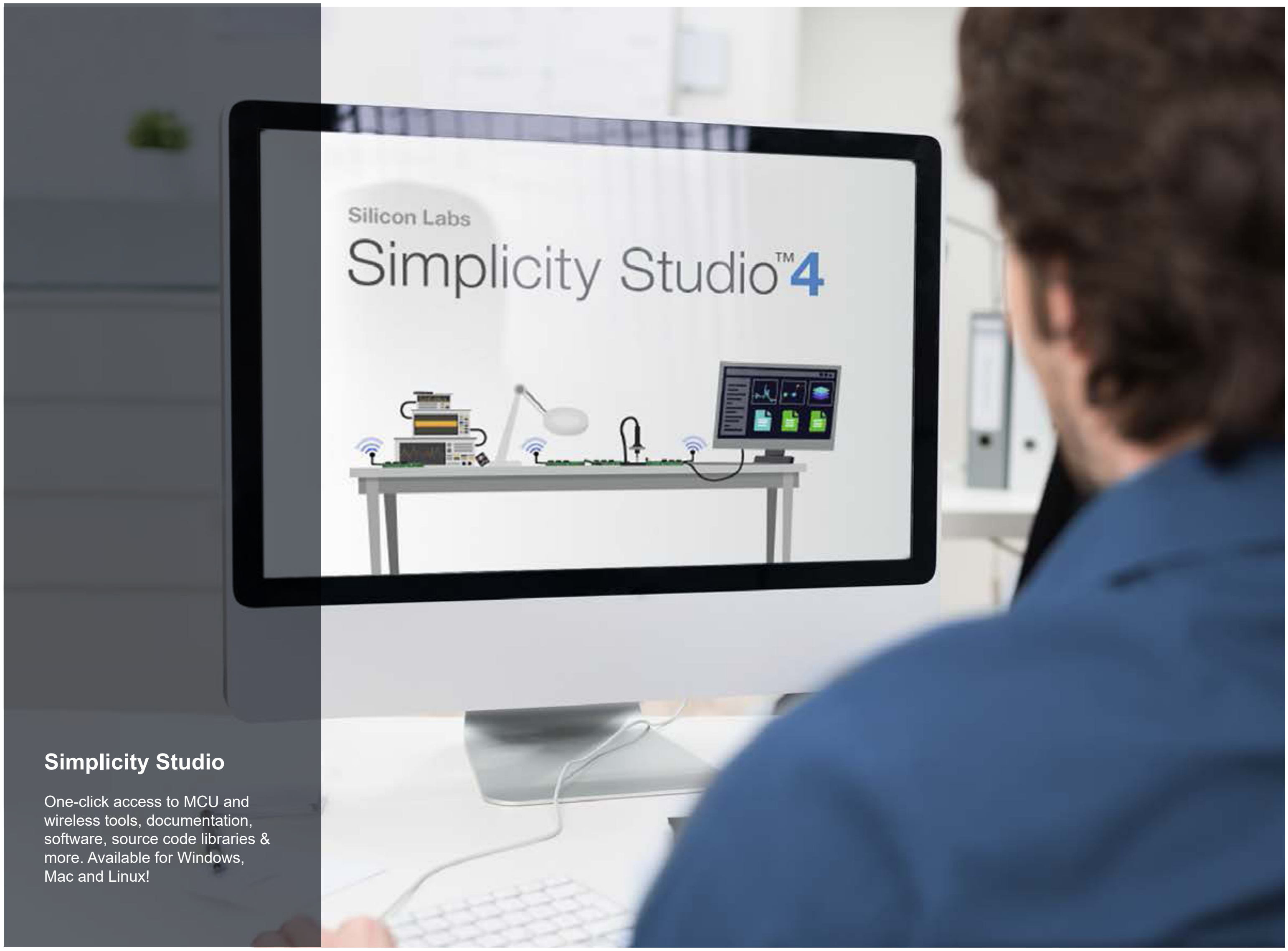


Figure 3.6. Receiver Packet Error Rate



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