

Integrated Passive Device for Semtech SX1261 / SX1262 / LLCC68

For 902 - 928MHz Operation

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Abstract

This application note serves as a guide on the usage and performance of Johanson Technology's impedance-matched filter 0900FM15D0039, designed specifically for the Semtech SX1261, SX1262, and LLCC68 RF transceivers at 915MHz ISM band − part of their Long Range Low Power LoRA® and LoRa Smart Home™ product lines.

Introduction

Using Johanson's integrated passive device (IPD) 0900FM15D0039, overall PCB space and component count can be significantly reduced as illustrated in Figure 3. This IPD's performance has shown to meet (and in some cases exceed) the original discrete reference design in terms of fundamental and harmonic power.

With this device, the entire front end RF matching network is reduced to a single EIA 0805 (2.0mm x 1.25mm) component. It is recommended for applications where PCB space is a priority along with consistency of RF performance over production.

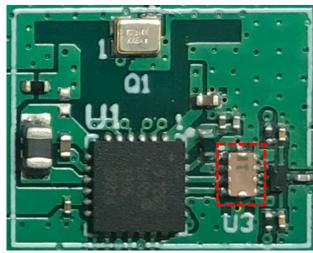


Figure 1. Johanson 0900FM15D0039

For more detailed information regarding this IPD, please see the 0900FM15D0039 datasheet.



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Semtech Discrete Reference Design (SX1262)

The current L/C discrete reference design consists of 12 capacitors and inductors which make up the impedance matching and filtering portion of the RF front end. This discrete system accounts for both the transmit and receive networks. C9, L5, and C10 represent an additional pi filter which should be present in all designs.

For consistency, the SX1262 pi filter is used in our IPD qualification.

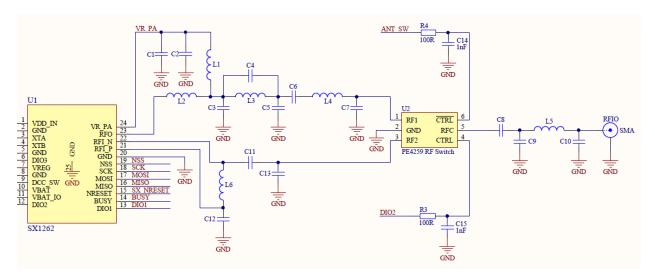


Figure 2. Semtech SX1262 mbed shield PCB Discrete Reference Design

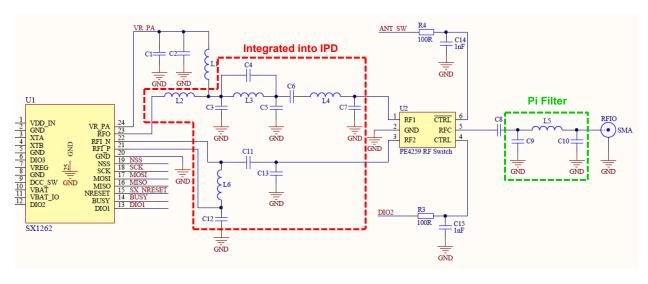


Figure 3. Components replaced by JTI IPD and Pi filter



Semtech Reference Design with Johanson Technology IPD (Applicable for Semtech SX1261, SX1262, LLCC68)

Figure 4 shows the RF front end schematic using the Johanson IPD 0900FM15D0039. The RFO and both RFI pins from the chipset feed directly into the integrated device which then feed directly into the SPDT switch of choice. The SPDT single-pole can be fed toward a single-band antenna or dual-band 868/915MHz antenna.

You can find more information regarding Johanson's single and dual-band chip antennas here.

The below RF front end reference design is applicable for Semtech chipsets SX1261, SX1262, and LLCC68.

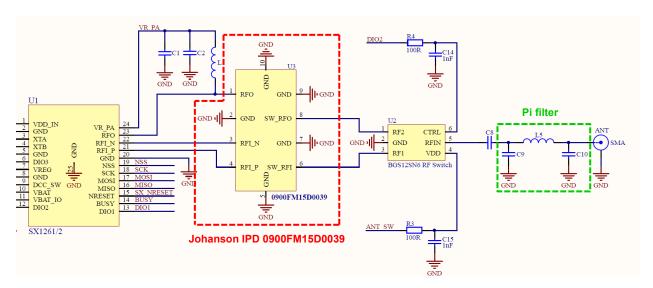


Figure 4. Simplified RF Front End with Johanson IPD and Pi filter



Semtech SX1261/2 mbed shield PCB Layout with Johanson 0900FM15D0039

The dimensions for this IPC are 2.00mm x 1.25mm which is equivalent to an EIA 0805 package device. The miniature size of this makes it ideal for compact designs as well as simplicity of layout.

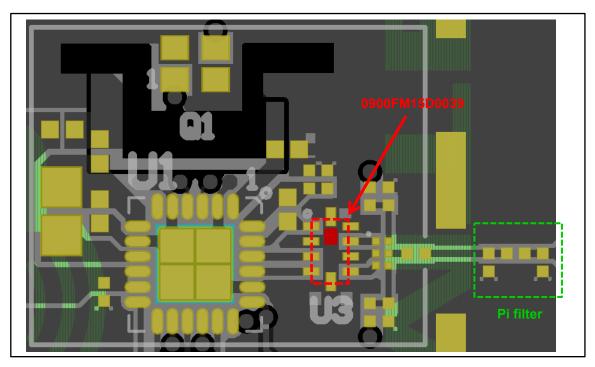


Figure 5. SX1261/2 PCB Layout with Johanson 0900FM15D0039

If you would like to connect with a Johanson Technology RF engineer to go over the layout or suggest an antenna to go with your design, see our Ask-a-question page.

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Semtech SX1261/2 mbed shield PCB Stack-up Information

Top

SX126xMB2xAS_e588v01a.GTO – Silkscreen Top	
SX126xMB2xAS_e588v01a.GTS - Solder_mask Top	
SX126xMB2xAS_e588v01a.GTL - Signal_top (35um Copper)	
Isolation – FR4 (0.15mm)	
SX126xMB2xAS_e588v01a.G1 – Internal signal layer (35um Copper)	
Isolation − FR4 (approximately ~0.58mm)	
SX126xMB2xAS_e588v01a.G2 – Internal signal layer (35um Copper)	
Isolation – FR4 (0.15mm)	
SX126xMB2xAS_e588v01a.GBL - Signal Bottom (35um Copper)	
SX126xMB2xAS_e588v01a.GBS - Solder_mask Bottom	
SX126xMB2xAS_e588v01a.GBO - Silkscreen Bottom	

Bottom

Complete gerber files can be requested from us <u>directly</u>.



Johanson 0900FM15D0039 Reference PCB Layout

Figure 6 depicts some of the more important characteristics to follow to ensure optimal performance when implementing this IPD. Some key points are:

- Ensure that all RF transmission lines are designed to maintain 50Ω impedance.
- Distance between the IPD and transceiver RF pins is important for proper impedance matching.
- GND via placement plays a significant role in the harmonic filtering of this integrated device.

We recommend that designers download the below reference design layout package to find all the necessary information.

Full reference design layout package can be found here.

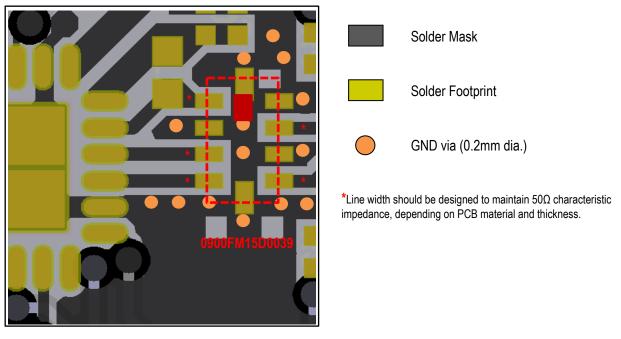


Figure 6. Johanson 0900FM15D0039 Reference Layout



SX1261/2 and 0900FM15D0039 IPD Active Power Measurements (Conducted)

The following figures and tables are active measured results of Johanson's 0900FM15D0039 IPD when paired with the Semtech SX1262. These measurements are taken on Semtech's SX126xMB2xAS mbed shield PCB as seen below.

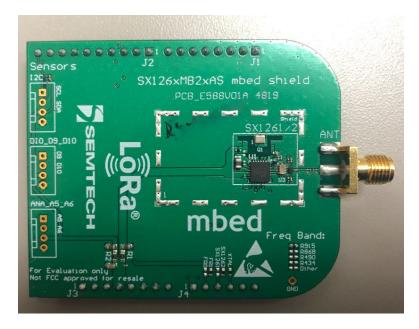


Figure 7. Semtech SX6xMB2AS mbed shield PCB

Please note that all measurements include Semtech's on-board pi filter for direct comparison to the discrete L/C reference design.



902MHz Measurement (SX1261 + 0900FM15D0039)

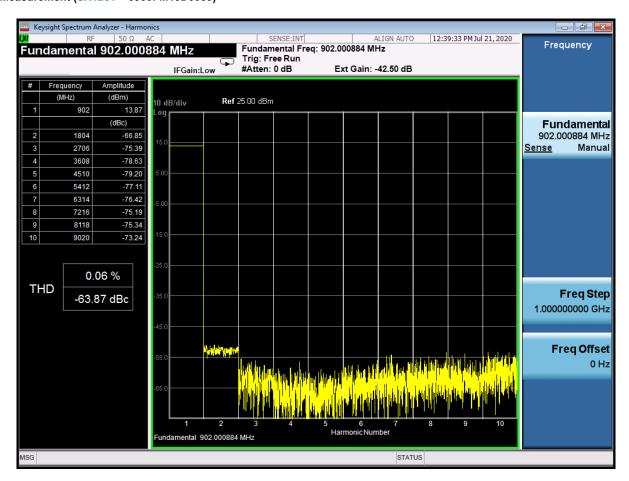


Figure 8. SX1261 IPD Measurement 902MHz, +15dBm TX Power

Frequency : 902 MHz Power Setting: +15 dBm (CW)		SX1262 Discrete Reference Design	0900FM15D0039 Reference Design	
	Fundamental	13.89	13.87	
	2 nd	-58.96	-52.98	
	3 rd	-48.53	-61.52	
	4 th	< -62	< -62	
Harmonic	5 th	< -62	< -62	
(dBm)	6 th	< -62	< -62	
	7 th	< -62	< -62	
	8 th	<-62	-61.32	
	9 th	< -62	-61.47	
	10 th	-57.49	-59.37	

Table 1. SX1261 Measurement Summary 902MHz, +15dBm TX Power



915MHz Measurement (SX1261 + 0900FM15D0039)

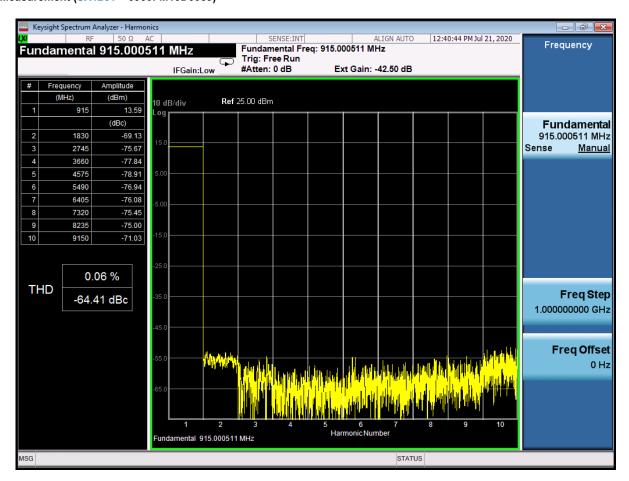


Figure 9. SX1261 IPD Measurement 915MHz, +15dBm TX Power

Frequency : 915 MHz Power Setting: +15 dBm (CW)		SX1261 Discrete Reference Design	0900FM15D0039 Reference Design
	Fundamental	13.50	13.59
	2 nd	-60.2	-55.54
	3 rd	-45.68	<-62
	4 th	< -62	< -64
Harmonic (dBm)	5 th	< -62	< -65
	6 th	< -62	< -63
	7 th	< -62	< -62
	8 th	<-62	-61.86
	9 th	<-62	-61.41
	10 th	-60.13	-57.44

Table 2. SX1261 Measurement Summary 915MHz, +15dBm TX Power



928MHz Measurement (SX1261 + 0900FM15D0039)

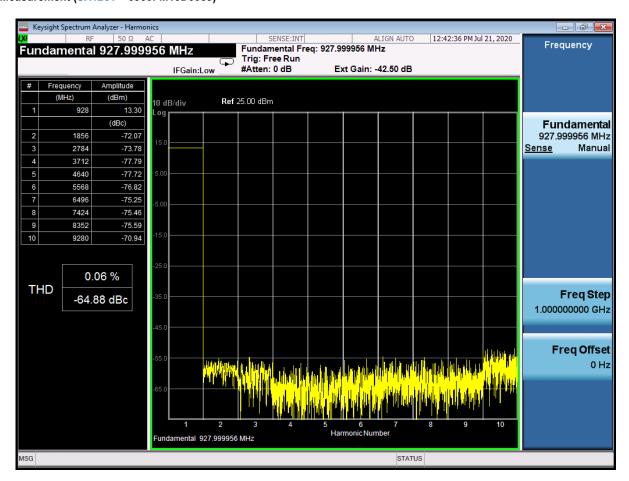


Figure 10. SX1261 IPD Measurement 928MHz, +15dBm TX Power

Frequency : 928 MHz Power Setting: +15 dBm (CW)		SX1262 Discrete Reference Design	0900FM15D0039 Reference Design
	Fundamental	13.07	13.30
	2 nd	-60.42	-58.77
	3rd	-44.76	-60.48
Harmonic (dBm)	4 th	< -62	< -62
	5 th	< -62	<-62
	6 th	< -62	< -62
	7 th	< -62	-61.95
	8 th	< -62	<-62
	9 th	-59.01	<-62
	10 th	<-62	-57.64

Table 3. SX1261 Measurement Summary 928MHz, +15dBm TX Power



902MHz Measurement (SX1262 + 0900FM15D0039)

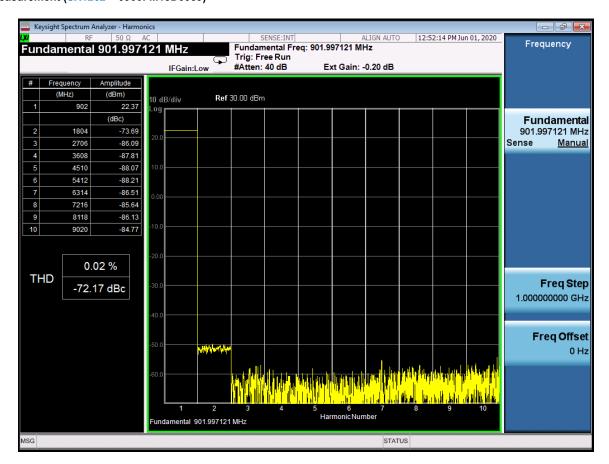


Figure 11. SX1262 IPD Measurement 902MHz, +22dBm TX Power

Frequency : 902 MHz Power Setting: +22 dBn	n (CW)	SX1262 Discrete Reference Design	0900FM15D0039 Reference Design
	Fundamental	22.17	22.37
	2 nd	-46.20	-51.32
	3 rd	-48.84	-63.82
	4 th	<-62	-65.44
Harmonic	5 th	<-62	-65.7
(dBm)	6 th	<-62	-65.84
	7 th	<-62	-64.14
	8 th	<-62	-63.27
	9 th	<-62	-63.76
	10 th	<-62	-62.40

Table 4. SX1262 Measurement Summary 902MHz, +22dBm TX Power



915MHz Measurement (SX1262 + 0900FM15D0039)

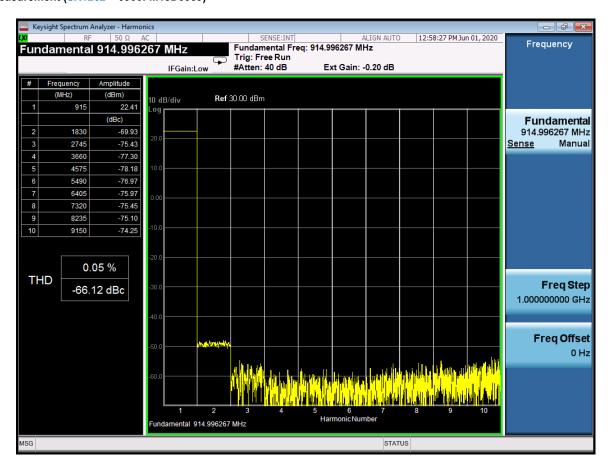


Figure 12. SX1262 IPD Measurement 915MHz, +22dBm TX Power

Frequency : 915 MHz Power Setting: +22 dBm (CW)		SX1262 Discrete Reference Design	0900FM15D0039 Reference Design
	Fundamental	22.01	22.41
	2 nd	-41.67	-47.52
	3 rd	-50.61	-53.02
	4 th	<-62	-54.89
Harmonic	5 th	<-62	-55.77
(dBm)	6 th	<-62	-54.56
	7 th	<-62	-53.56
	8 th	<-62	-53.04
	9th	<-62	-52.69
	10 th	<-62	-51.84

Table 5. SX1262 Measurement Summary 915MHz, +22dBm TX Power



928MHz Measurement (SX1262 + 0900FM15D0039)

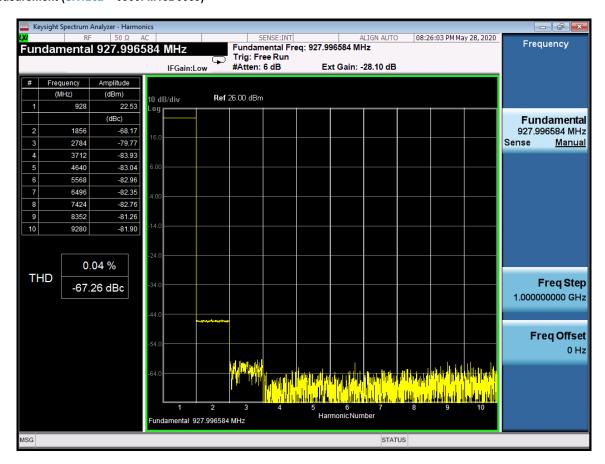


Figure 13. SX1262 IPD Measurement 928MHz, +22dBm TX Power

Frequency : 928 MHz Power Setting: +22 dBm	ı (CW)	SX1262 Discrete Reference Design	0900FM15D0039 Reference Design
	Fundamental	21.74	22.53
	2 nd	-39.36	-45.64
	3 rd	-52.60	-57.24
	4 th	<-62	-61.40
Harmonic	5 th	<-62	-60.51
(dBm)	6 th	<-62	-60.43
	7 th	<-62	-59.82
	8 th	<-62	-60.23
	9 th	<-62	-58.73
	10 th	<-62	-59.37

Table 6. SX1262 Measurement Summary 928MHz, +22dBm TX Power



Note Regarding 868MHz Operation

During our tests, we have verified the TX power at 868MHz to be excellent when pairing the 0900FM15D0039 with the Semtech SX126x series for 868MHz operation. Please be aware, however, that we experience an average of 3dB decrease in RX sensitivity. This is where we look to improve in our world-wide version.

For designers looking toward using the new part, we will ensure that it is drop-in compatible with the current 0900FM15D0039. It will share the same PCB footprint and over-all layout guidelines.

Current estimate of availability is late Q2 to early Q3 of 2021.

If you have any questions or would like more up-to-date information, feel free to contact us.



Important Links

0900FM15D0039 Datasheet

0900FM15D0039 Reference Design Layout Package

Johanson Technology Ask-a-question

Semtech LoRa® Transceivers

Semtech LoRa® Developer Portal

A worldwide (868MHz / 915MHz) version with more harmonic attenuation is in development!

	Changelog
1.0	Initial Release
1.1	Added note regarding 868MHz operation