UG627: SiWG917 Evaluation to Production Guide

Silicon Labs offers a variety of resources to support manufacturers in creating products with the SiWG917 device. To promote efficient production design, Silicon Labs offers reference design materials and application notes for software application development to schematic and PCB layouts.

This document provides a comprehensive overview of the evaluation-to-production process for SiWG917. Rather than detailing every step in full, it serves as a navigational guide, referencing key documentation that developers may need throughout their evaluation-to-production journey. It ensures a smooth transition by pointing to the appropriate resources at each stage

KEY FEATURES

- Evaluation
- Custom Hardware Design
- Application Development and Performance Analysis
- RF Calibration and Certification
- Mass Production

Table of Contents

1. Introduction

The SiWG917 Evaluation to Production Guide is designed to assist engineers and developers in navigating the various stages involved in bringing the SiWG917 to market, ensuring a smooth and efficient process.

The SiWG917 is a highly versatile and powerful Integrated Circuit (IC) designed for a wide range of applications, including IoT devices, industrial automation, and consumer electronics. Its advanced features and capabilities make it an ideal choice for developers looking to create innovative and reliable products.

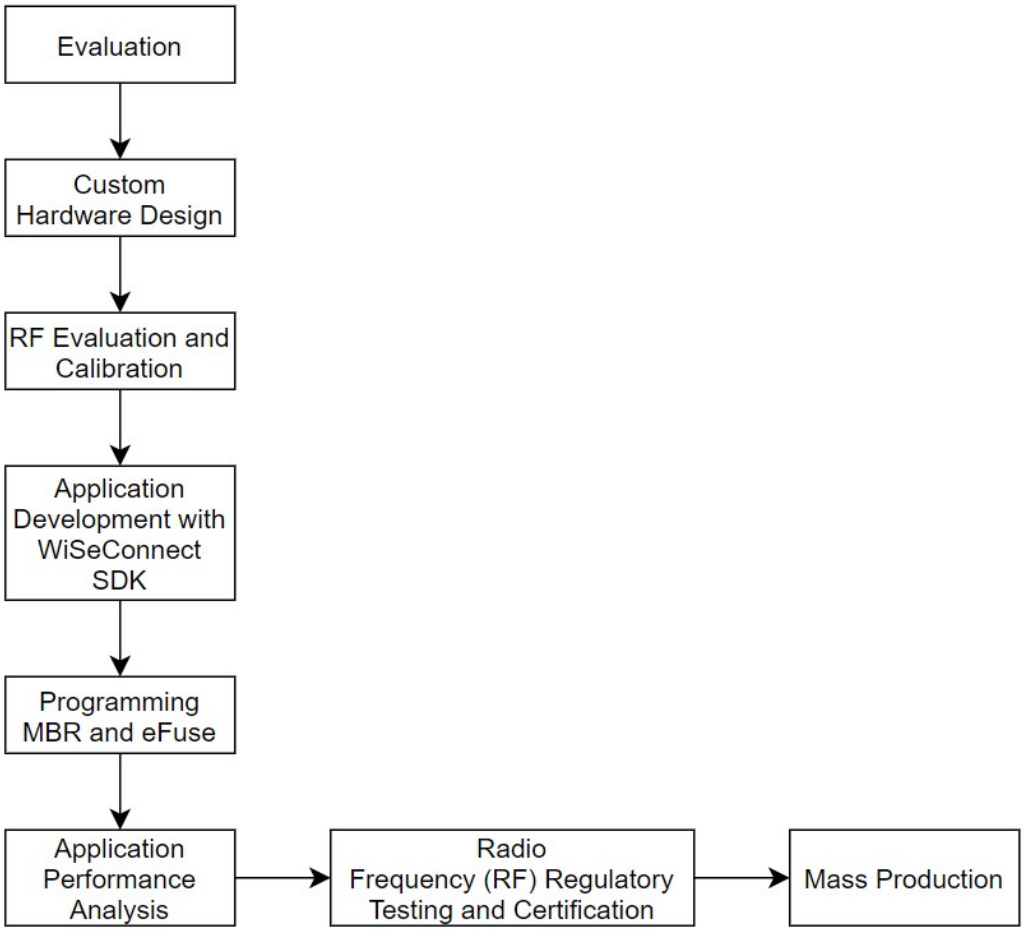


Figure 1.1. Evaluation to Production Flow

This guide covers all the necessary steps to ensure a successful transition from evaluation to production, including:

1. **Evaluation:** Selecting the appropriate evaluation kit and assessing performance metrics such as throughput and sleep current consumption.
2. **Custom Hardware Design:** Creating a custom PCB design tailored to specific application needs.
3. **RF Evaluation and Calibration:** Performing RF (Tx/Rx) performance testing and calibration.
4. **Application Development with WiSeConnect SDK:** Optimizing memory usage, implementing Wi-Fi mode, developing application layer protocols, and managing firmware updates.
5. **Programming MBR and eFuse:** Program the MBR with security levels, eFuse with the boot configurations and add custom Wi-Fi, BLE MAC addresses.
6. **Application Performance Analysis:** Conducting thorough testing of the developed SiWG917 application.
7. **Radio Frequency (RF) Regulatory Testing and Certification:** Ensuring compliance with RF regulations and obtaining necessary certifications.
8. **Mass Production:** Utilizing manufacturing utilities, configuring the Master Boot Record (MBR), loading final firmware, and enabling security features.

By following this guide, developers can ensure that their SiWG917-based products meet the highest standards of performance, reliability, and compliance. The detailed instructions and best practices provided in this guide will help streamline the development process, reduce time-to-market, and ultimately lead to the successful deployment of SiWG917-based solutions.

The **Wi-Fi Developer Journey** by Silicon Labs is an end-to-end guide designed to assist IoT developers in creating low-power Wi-Fi applications. This comprehensive resource outlines each step of the development process, helping developers get their devices to market faster and more efficiently.

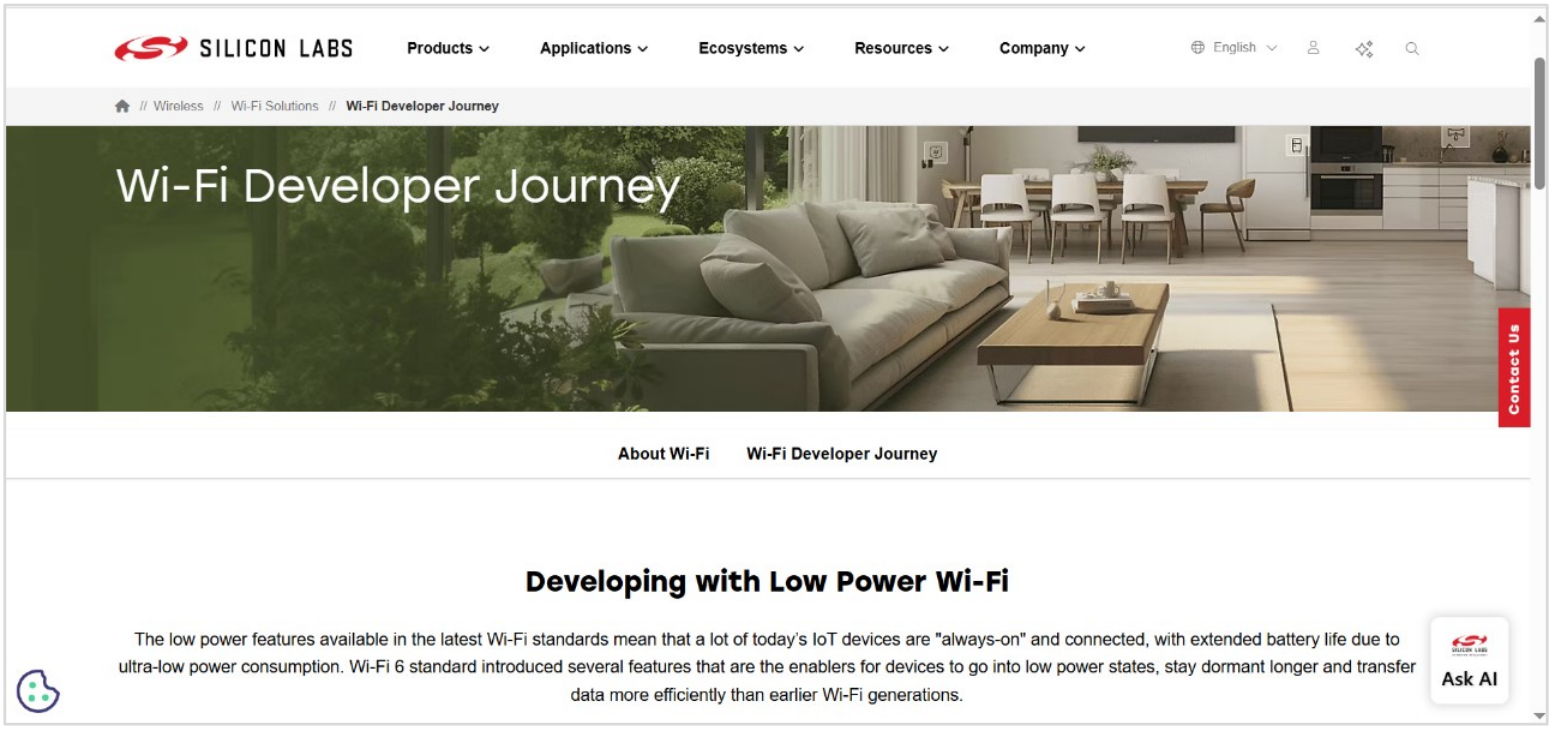


Figure 1.2. Wi-Fi Developer Journey

One of the most important SiWG917 documentation is the datasheet: SiWG917 SoC Single Chip Wi-Fi® and Bluetooth® LE Wireless Secure MCU Solutions datasheet.

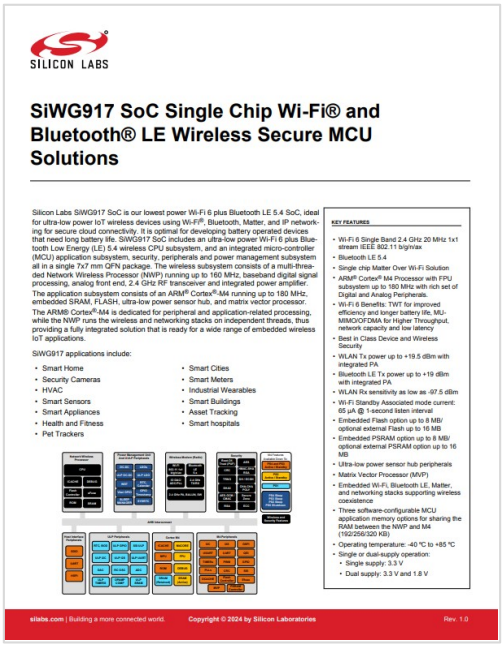


Figure 1.3. SiWG917 Datasheet

Key documentation for the SiWG917 evaluation to production is summarized in the following figures.

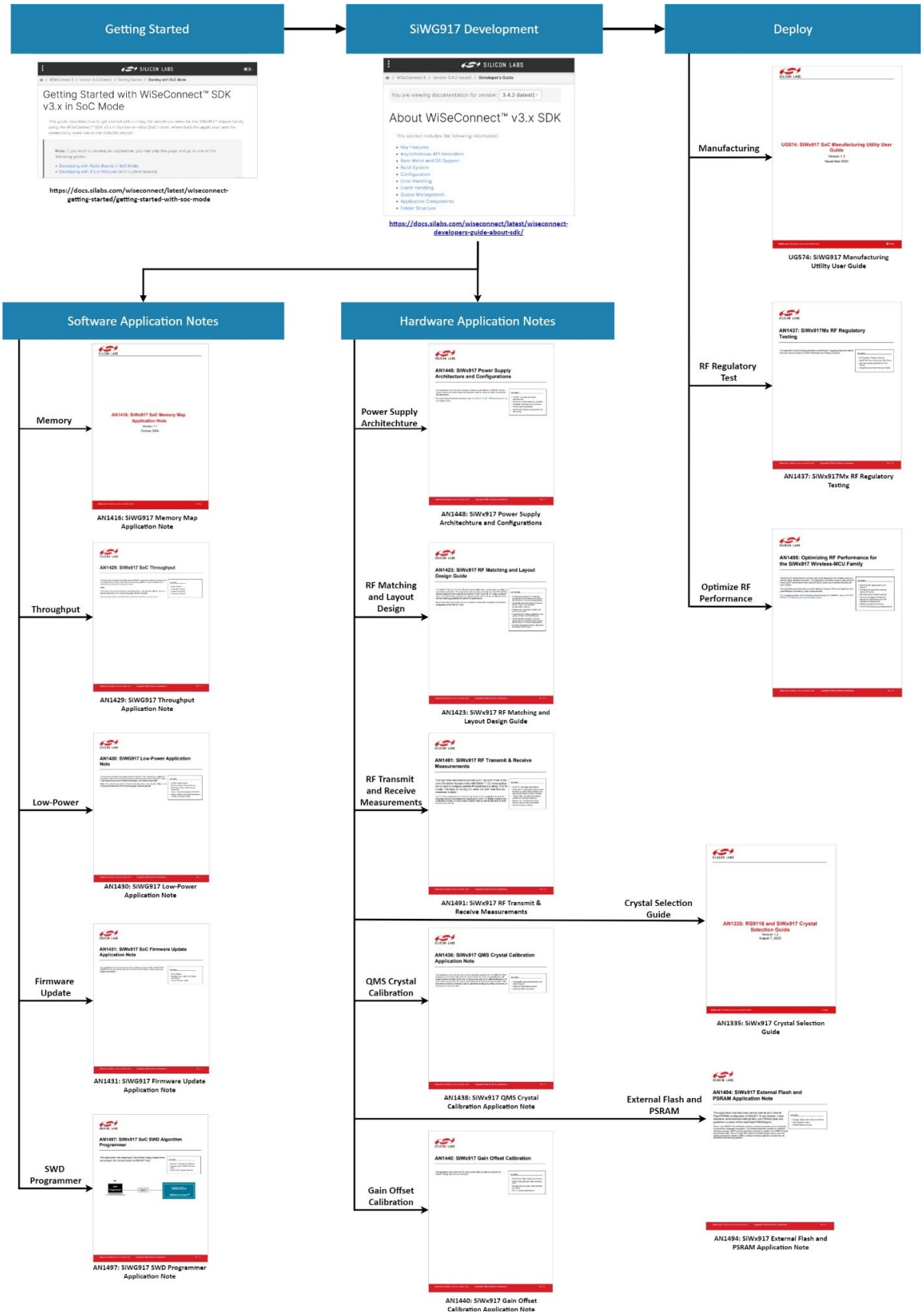


Figure 1.4. SiWG917 Key Documentation

2. Evaluation

The Evaluation Phase is a crucial step in the SiWG917 Evaluation to Production process. This phase involves selecting the appropriate evaluation kit and assessing various performance metrics to ensure that the SiWG917 meets the required specifications for your application.

2.1 Getting Started

The first step in the Evaluation Phase is to select the evaluation kit that best suits your requirements. Silicon Labs provides a comprehensive Getting Started Guide (GSG) that helps you choose the right evaluation kit based on your specific needs. The GSG includes detailed instructions on setting up the hardware and software environment, running and debugging sample applications, and measuring key performance metrics.

You can find the GSG here: Getting Started with SiWG917.

We have an Out of the Box (OOB) demo which is designed to be user-friendly and provides a hands-on experience with the SiWG917's capabilities.

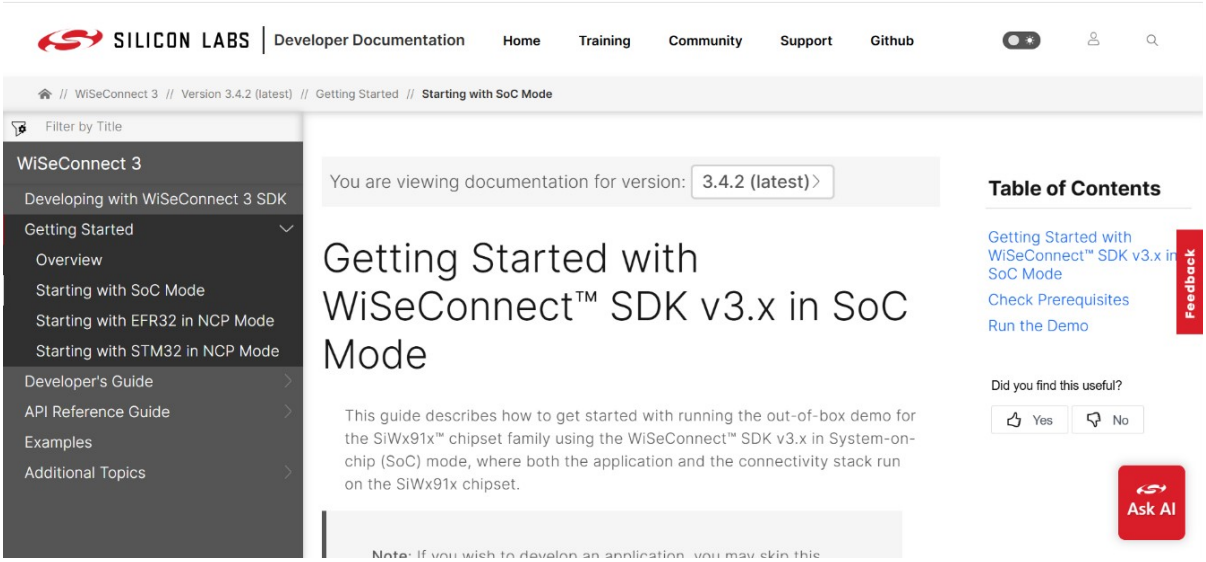


Figure 2.1. Getting Started with SiWG917

2.2 Evaluation Metrics

During the evaluation phase, it is essential to assess various performance metrics to ensure that the SiWG917 meets the desired specifications. The WiSeConnect SDK offers a variety of reference examples to help developers get started with the SiWG917 and other Silicon Labs wireless solutions. These examples are designed to demonstrate the capabilities of the SiWG917 and provide a foundation for developing custom applications. The WiSeConnect SDK is available on GitHub, where developers can find a variety of examples and resources.

Here is a brief overview of the reference examples available in the WiSeConnect SDK:

1. **Featured Examples:**These are full-featured examples that showcase the comprehensive capabilities of the SiWG917. They include applications such as cloud connectivity, power save modes, throughput testing, and RF test applications.
2. **Snippet Examples:** These simpler examples demonstrate specific features of the SiWG917. They are designed to be easy to understand and modify, making them ideal for developers who are new to the WiSeConnect SDK.
3. **Peripheral Examples:** These examples demonstrate how to use various peripherals with the SiWG917, such as USART, I2C, and GPIO. They provide a starting point for integrating peripherals into custom applications.
4. **Wi-Fi and BLE Coexistence Examples:** These examples show how to implement Wi-Fi and BLE coexistence on the SiWG917. They include projects that demonstrate how to manage both wireless technologies simultaneously.

These reference examples provide a solid foundation for developing custom applications with the SiWG917. They demonstrate the capabilities of the SDK and offer practical insights into using the various features and APIs.

Some of the key metrics to evaluate are mentioned in the following sections.

2.2.1 Throughput

Measure the data transfer rate to ensure that the SiWG917 can handle the required data load for your application. You can refer to the AN1429: SiWG917 Throughput Application Note for guidelines and recommendations to achieve optimal performance, along with troubleshooting tips and future scope considerations

Key points covered in AN1429 include:

- **Supported Protocols:** Information on the network protocols supported by the SiWG917, including UDP, TCP, and TLS.
- **Socket Configuration:** Guidelines on configuring sockets to achieve optimal throughput, including considerations for multiple socket scenarios.
- **Performance Results:** Detailed performance metrics and results, including throughput values for different configurations and operating conditions.

2.2.2 Firmware Update Methods

The SiWG917 offers several methods for updating its firmware, ensuring flexibility and convenience for different use cases. The AN1431: SiWG917 Firmware Update Application Note provides a comprehensive guide on the firmware update methods for the SiWG917. It covers various aspects of the firmware load and update process, as well as the importance of secure over-the-air (OTA) updates using combined images (NWP image+M4 image).

Key points covered in AN1431 include:

- **Firmware Load and Update Process:** Detailed instructions on how to load and update the firmware on the SiWG917. This includes different mechanisms for updating the firmware, such as OTA updates via HTTP/S and using the M4 processor as a host.
- **Secure Firmware Update:** Emphasis on the importance of secure firmware updates to ensure the integrity and authenticity of the firmware. This explains how digital code signing and encryption are used to protect the firmware that is transmitted.
- **Combined Image:** Explanation of the combined image approach, which includes both the application and NWP firmware in a single image. This approach simplifies the update process and ensures that both components are updated simultaneously.
- **Guidelines and Recommendations:** Best practices and recommendations for performing firmware updates, including the use of the latest firmware versions, avoiding power fluctuations during the update process, and ensuring that the SiWG917 is not in power save mode during the firmware update.

2.2.3 Low Power Current Consumption

Assess the power consumption of the SiWG917 in low power mode to ensure that it meets the low power requirements for battery-operated devices. The AN1430: SiWG917 Low-Power Application Note

Key points covered in AN1430 include:

- **M4 Power Save:** Detailed descriptions of the M4 power save modes, including active mode power states, standby states, sleep mode power states, and deep sleep/shutdown mode.
- **M4 Power Save Wakeup Sources:** Information on the various wakeup sources available for the M4 processor in different power states.
- **NWP Power Save** Descriptions of the NWP power save modes, including active or high-performance state, transmit mode, receive mode, listen mode, and ultra-low power mode.
- **NWP Power Save Modes:** Detailed explanations of the unconnected and connected power save modes, including standby power save with RAM retention, associated power save mode, and target wake time (TWT) based power save mechanism.
- **Typical Current Consumption:** Typical current consumption values for the SiWG917 in different power modes and power states.
- **Energy Profiling and Use Cases:** Examples of energy profiling and practical use cases of the SiWG917's low-power modes.

3. Custom Hardware Design

The Custom Hardware Design phase is a critical step in the SiWG917 Evaluation to Production process. This phase involves creating a custom PCB design tailored to the specific needs of your application. The goal is to ensure that the hardware design is optimized for performance, reliability, and compliance with industry standards. All the critical aspects of designing products using the SiWx917x chipsets have been documented in the Data sheets, Application Notes and Knowledge Based articles by Silicon Labs. These documents cover aspects like schematic and layout design, RF matching, power supply design etc. This section will provide a short introduction to all these critical hardware design documents.

1. **PCB Design:** The first step in custom hardware design is to create a PCB layout that meets the requirements of your application. This involves selecting the appropriate components, designing the circuit schematic, and laying out the PCB traces. It is essential to follow best practices for PCB design to ensure signal integrity, minimize noise, and optimize power distribution. Refer to the SiWG917 datasheet for reference schematics, recommended BOM and layout guidelines.
2. **RF Design Considerations:** AN1423 covers important information about RF matching and layout design, in addition to the information given in the SiWG917 datasheet. This includes guidelines for routing RF traces, selecting appropriate RF components, and ensuring proper impedance matching. AN1495 covers techniques that can be used to optimize RF performance on your custom PCB using VNA and spectrum analyzer measurements.
3. **Power Supply Architecture:** According to AN1448, the power supply architecture for the SiWG917 should be carefully designed to ensure stable and efficient operation. The document provides detailed guidelines on power supply design, including recommendations for voltage regulators, decoupling capacitors, and power sequencing.
4. **BOM Selection:** The SiWG917 datasheet contains the reference schematics and bill of material (BOM) for optimal design with SiWx917 chipsets. It contains information about decoupling capacitors, RF matching components, crystal oscillators etc.

Additionally you can refer to you can refer to AN1335: SiWx917 Crystal Selection Guide for guidelines on selecting an appropriate 40MHz and 32kHz crystal parts. You can also refer to AN1494: SiWx917 External Flash and PSRAM Application Note to configure and choose an off the shelf Flash or PSRAM.

3.1 Hardware Debugging Guidelines

The document AN1439: SiWx917 Hardware Debugging Guidelines provides comprehensive guidelines for debugging common hardware issues with the SiWG917. This application note is essential for engineers and developers working with the SiWG917, as it offers practical insights and methodologies for identifying and resolving hardware-related problems.

This document outlines procedures to address common issues encountered by SiWx917 users. It begins with a set of general guidelines that apply universally, regardless of the specific issue. These guidelines are then categorized based on issue severity, distinguishing between scenarios where no prototype or product boards are functioning, and those where only a subset are affected.

4. RF Evaluation and Calibration

You need to evaluate the SiWG917 RF while performing crystal calibration and gain offset calibration to ensure accurate frequency and signal strength measurements.

4.1 Crystal Calibration

The AN1436: SiWG917 QMS Crystal Calibration Application Note document provides detailed information on the crystal calibration process for the SiWG917. This application note is essential for ensuring accurate frequency performance and optimal operation of the SiWG917 in various applications. Key points covered in AN1436 include:

- **Frequency Offset Measurement:** The document describes the process of measuring frequency offset using a transmitted Continuous Wave (CW) signal. It provides step-by-step instructions for setting up the measurement and capturing the frequency offset data.
- **Frequency Offset Correction:** Instructions for correcting the frequency offset are provided. This includes updating the optimized values to the flash memory of the SiWG917 chip to ensure accurate frequency performance.
- **Calibration Using Manufacturing Utility:** The document explains how to use the manufacturing utility for crystal calibration. It covers both Continuous Wave (CW) mode and burst mode calibration approaches, providing detailed steps for each method.

By following the guidelines and instructions provided in AN1436, developers can accurately calibrate the crystal frequency of the SiWG917, ensuring optimal performance and reliability in their applications.

4.2 Gain Offset Calibration

The document AN1440: SiWx917 Gain Offset Calibration provides detailed guidelines on calibrating the gain offset for the SiWG917. This application note is essential for ensuring accurate and reliable performance of the SiWG917. The document includes:

- **Calibration Procedures:** Detailed steps on how to perform gain offset calibration.
- **Technical Specifications:** Information on the technical requirements and specifications for the calibration process.
- **Best Practices:** Recommendations for achieving optimal calibration results.

Note: AN1491: SiWx917 RF Transmit & Receive Measurements has information about using Command-Line-Interface (CLI) demo to test RF performance.

5. Application Development with WiSeConnect SDK

The WiSeConnect™ v3.x SDK is a comprehensive software development kit provided by Silicon Labs for use with the SiWx91x™ chip-set family, which supports Wi-Fi and Bluetooth Low Energy (BLE) connectivity.

The SDK offers asynchronous API invocation, bare metal and OS support, build system configuration, error handling, event handling, and queue management. It includes various components such as the folder structure, version history, and support documentation.

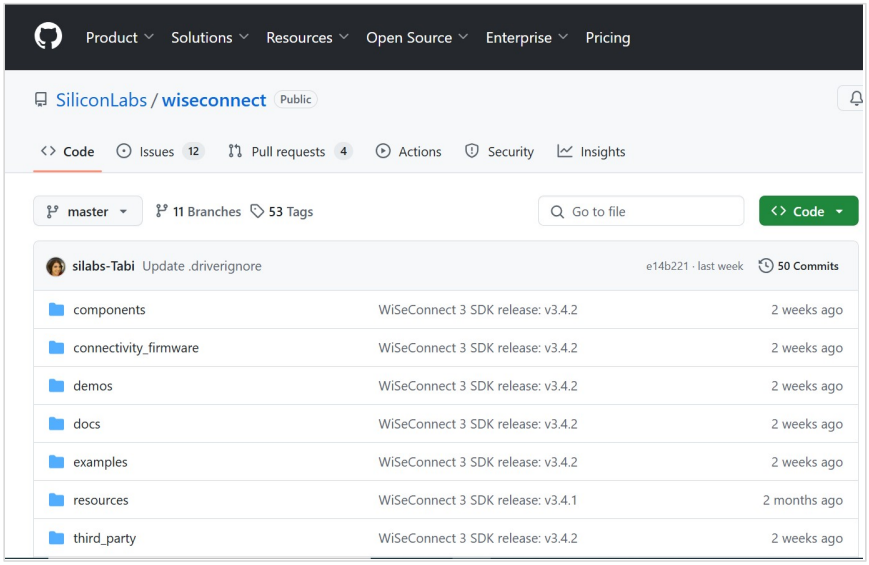


Figure 5.1. WiSeConnect SDK on GitHub

Throughout the application development process, you can refer to various resources such as the **WiSeConnect™ v3.x SDK**, Developer's Guide, API Reference Guide, and Application Notes to get detailed information and examples. TheAPI Reference Guide provides a comprehensive overview of the application programming interface (API) for the WiSeConnect SDK v3.x. This has sections explaining about the wireless, network management, sockets, network, application protocol and peripheral APIs. If you require any support during the development process, you can go through the community forum or reach out to Silicon Labs.

- To migrate from the previous SDK version to the next one, refer to the Migration Guide.

You can find the detailed information about the updates, bug fixes, and new features included in the specific release of the SDK in the Release Notes.

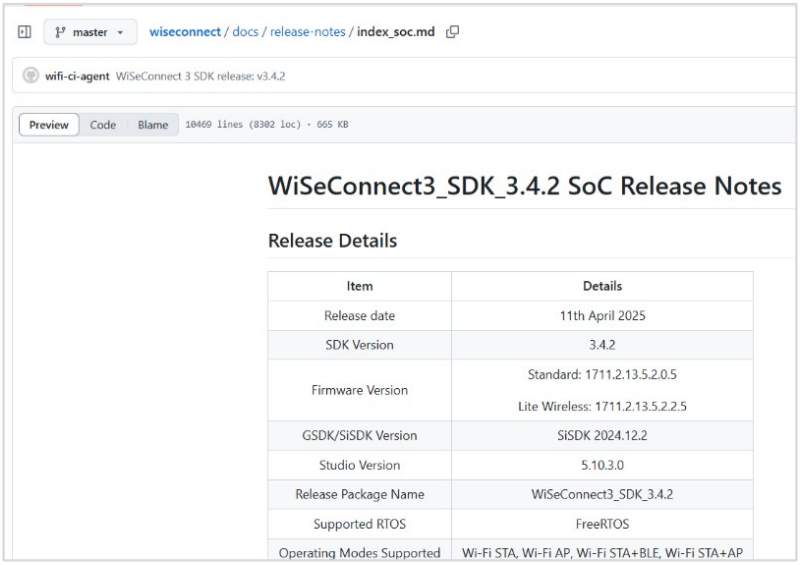


Figure 5.2. SiWG917 Release Notes in WiSeConnect SDK release

Application development for SiWG917 involves several key steps to ensure that the application is optimized and fully functional. Here are the main aspects of the process.

Table 5.1. SiWG917 Main Development Aspects

S.N.	Development Aspect	Details	Reference Document
1	Memory Management	Optimize memory usage for your application to ensure efficient memory utilization. • This involves managing the allocation and deallocation of memory resources to avoid memory leaks and ensure smooth operation.	AN1416: SiWG917 Memory Map Application Note is a comprehensive document that provides an overview of the different memory regions of the SiWG917 for optimized application design.
2	Wi-Fi Mode Implementation	Implement Wi-Fi mode using the provided API documentation. • The SiWG917 supports various Wi-Fi modes such as Station (STA), Access Point (AP), and concurrent STA + AP mode. You can refer to the examples provided in the WiSeConnect 3 SDK to understand the working of these features	Wi-Fi examples in WiSeConnect SDK release
3	Transport Layer Protocols	Develop applications using TCP/UDP/TLS protocols. • This involves creating communication protocol sockets that enable data exchange between devices over the network. The WiSeConnect 3 SDK provides examples and documentation to help you implement these protocols	AN1429: SiWG917 Throughput Application Note provides guidelines and troubleshooting steps for measuring and optimizing throughput on the SiWG917.
4	Application Protocols	Develop applications using HTTP/MQTT/MDNS protocols. • The WiSeConnect 3 SDK provides examples and documentation to help you implement these protocols	Refer to SDK documentation to understand the available APIs for implementing the protocols.
5	Peripheral Requirements	This includes configuring and using various peripherals such as GPIOs, UART, SPI, I2C, and more	Refer to datasheets, reference manuals, and SDK documentation to understand the peripheral requirements for your application.
6	Low Power Requirements	Implement low power modes as per your requirement. • The SiWG917 supports various low power modes to reduce power consumption and extend battery life.	AN1430: SiWG917 Low-Power Application provides detailed information about the low-power modes and current consumption values of the SiWG917.
7	Firmware Updates	Manage firmware updates securely. • This involves implementing mechanisms for over-the-air (OTA) updates and ensuring that the firmware update process is secure and reliable.	AN1431: SiWG917 Firmware Update outlines the firmware update procedures for the SiWG917.

6. Programming MBR and eFuse

You can program the MBR and eFuse of SiWG917 to enable or disable a feature. The MBR is stored in flash memory and contains critical information such as clock frequencies, offsets of structures like eFuse copy, SPI configurations, and external flash details. There are separate MBRs for the NWP and M4 cores at the beginning of their respective flash regions. Any SiWG917 IC (with in-package flash) that is shipped out of the factory will have a default MBR. When enabling security configurations, several fields in the MBR need to be programmed, including the PUF Activation code, Key descriptors, and the Keys. You can refer to **section 5.4** in the UG574: SiWG917 Manufacturing Utility User Guide.

eFuse is a One-Time Programmable (OTP) memory that stores important configuration data for SiWG917. Since eFuse is a type of programmable read-only memory that allows for permanent configuration changes to the device, it is crucial to ensure that all necessary fields are accurately configured before writing to it, as changes cannot be made to a field once enabled.

Programming the Master Boot Record (MBR) and eFuse for the SiWG917 involves several steps to ensure the device is properly configured and secure, the steps involved are mentioned in the **section 7** of UG574: SiWG917 Manufacturing Utility User Guide.

7. Application Performance Analysis

Application performance analysis for the SiWG917 involves several key steps to ensure that the developed application is fully functional, reliable, and meets performance standards. After developing the application, you must conduct thorough testing to ensure that all features are working as expected. This includes testing the application on custom hardware and verifying that it meets the performance and reliability requirements. You can make modifications to your application to meet your requirements during this phase.

Application performance analysis for the SiWG917 involves several key steps to ensure that the developed application is fully functional, reliable, and meets performance standards. Here are the main aspects of the process:

- Wi-Fi Connectivity
- BLE Performance (if you are using BLE)
- Low power Consumption
- Peripheral Performance

The WiSeConnect Developer's Guide on Application Debugging is a comprehensive resource designed to help developers identify and resolve issues in applications using the SiWG917. This serves as a practical toolkit for debugging and fine-tuning applications.

It covers several key areas:

- **Enabling Debug Logs:** Instructions on how to activate runtime debug output to trace application behavior effectively.
- **Monitoring Tx/Rx Frames:**Guidance on tracking data being sent and received between the host and the network processor.
- **Filtering Commands:**Techniques to focus debugging efforts on specific commands based on their type.
- **Error Logging:** Steps to enable logs specifically for error detection within the SDK.
- **Socket Monitoring:** Methods for viewing active sockets and their states through the debugger.
- **Command Queues:** Insights into the internal queues used for handling various command types, including Wi-Fi and BLE.
- **NWP RAM Dump:** Procedures for extracting and analyzing RAM content from the Network Processor to diagnose low-level issues.

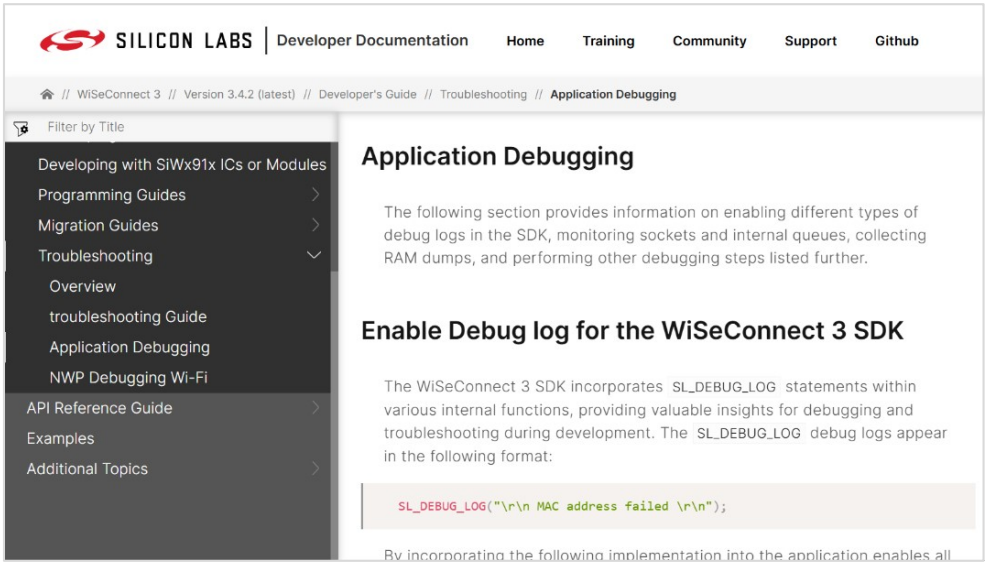


Figure 7.1. Application Debugging

The NWP Debugging – Wi-Fi offers strategies to diagnose and resolve issues related to the Network Processor (NWP) in Wi-Fi applications using the SiWG917.

- **Enabling NWP Debug Logs:** To capture detailed logs from the Network Processor (NWP), configure the device to output debug information over UART. This setup is crucial for monitoring NWP operations and identifying potential issues.
- **Capturing NWP RAM Dumps:** In the event of a crash or unexpected behavior, obtaining a RAM dump from the NWP can provide valuable insights into its state. This process involves using specific APIs to extract and analyze the NWP's memory contents.

- **Handling NWP Errors:** Be aware of common error codes that the NWP may return, such as association failures, authentication issues, or memory allocation errors. Understanding these codes can significantly expedite troubleshooting efforts.

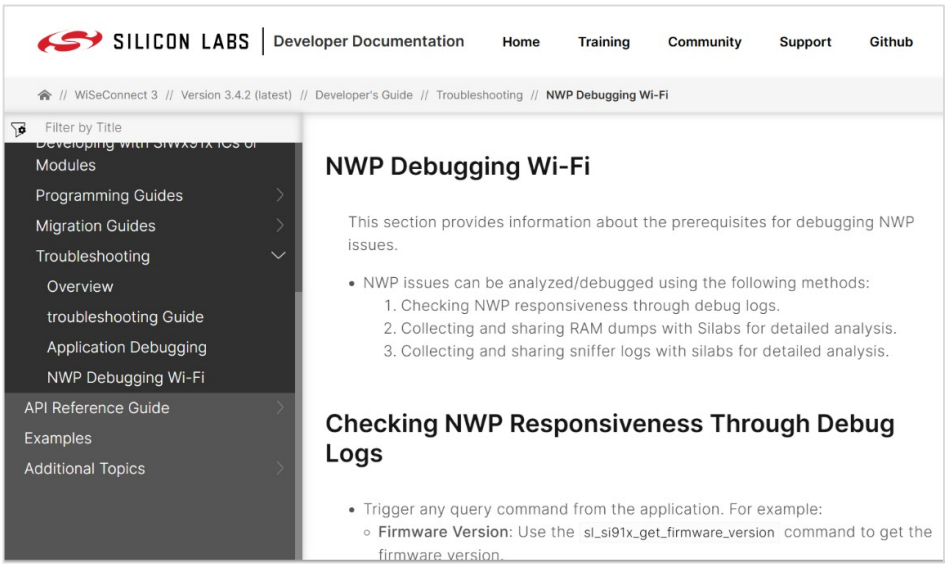


Figure 7.2. NWP Debugging Wi-Fi

8. Radio Frequency (RF) Regulatory Test or Certification

The Radio Frequency (RF) Regulatory Test or Certification process for the SiWG917 involves steps to ensure that the device complies with RF regulations and obtains the necessary certifications for various regions. The SiWG917 modules are designed to meet worldwide RF regulatory certifications. This includes modular radio type approvals for countries such as the USA (FCC), Canada (IC/ISED), Japan (MIC), and compliance with the relevant EN standards for the EU (CE) and UK (UKCA).

Evaluate the receiver sensitivity to ensure that the SiWG917 can reliably receive signals in various operating conditions. Measure the transmitter output power to ensure that the SiWG917 can transmit signals at the required power levels. The AN1491: SiWG917 RF Transmit & Receive Measurementsprovides detailed information on the RF transmit and receive measurements for the SiWG917. It is designed to guide developers through the process of configuring and setting up the SiWG917 for RF performance testing.

Key points covered in AN1491 include:

- **CLI Commands**: The document includes a comprehensive list of commands that can be used to configure SiWG917 for RF testing. These commands allow users to perform tasks such as enabling transmit (Tx) and receive (Rx) modes, configuring RF parameters, and capturing measurement data.
- **Transmit Test**: Instructions for performing transmit tests are provided, including the setup of a serial terminal, configuration of transmit modes, and capturing spectral measurements. The document also covers EVM measurements and provides guidelines for interpreting the results.
- **Receive Test**: The document outlines the steps for performing receive tests, including the configuration of receive modes and capturing sensitivity measurements. It also includes commands for initializing and configuring the receive tests.
- **Measurement Data**: The document provides example measurement data for both transmit and receive tests. This includes spectral measurements, EVM data, and receive sensitivity measurements.

By following the guidelines and instructions provided in AN1491, developers can accurately measure the RF performance of the SiWG917 and ensure that it meets the required specifications for their applications.

Note: You can also use the simplicity commander CLI interface to perform the calibration and do RF measurements. Refer to **Section 8: RF Calibration** in the UG574: SiWx917 SoC Manufacturing Utility User Guide.

9. Mass Production

Mass production for the SiWG917 involves several key steps to ensure that the devices are manufactured efficiently and meet quality standards.

The manufacturing utility (simplicity commander CLI) is used to streamline the mass production process. This includes functionalities such as flash programming, security key management, and certificate handling.

The detailed steps to be followed based on the SiWG917 flash mode are mentioned in the UG574: SiWx917 SoC Manufacturing Utility User Guide:

- **Master Boot Record (MBR) Configuration:** The MBR is configured based on the Ordering Part Number (OPN) of the SiWG917. This involves programming production-specific information into the SiWG917, including device security features.
- **RF Calibration:** RF calibration is performed to ensure that the SiWG917 operates within the specified RF parameters. This includes gain and frequency offset calibrations.
- **Security Features:** Security features are enabled during the manufacturing process to protect the devices against unauthorized access and ensure secure operation.
- **Firmware Loading:** The final firmware is loaded onto the devices during the mass production process. This ensures that the devices are ready for deployment and meet the required performance standards.

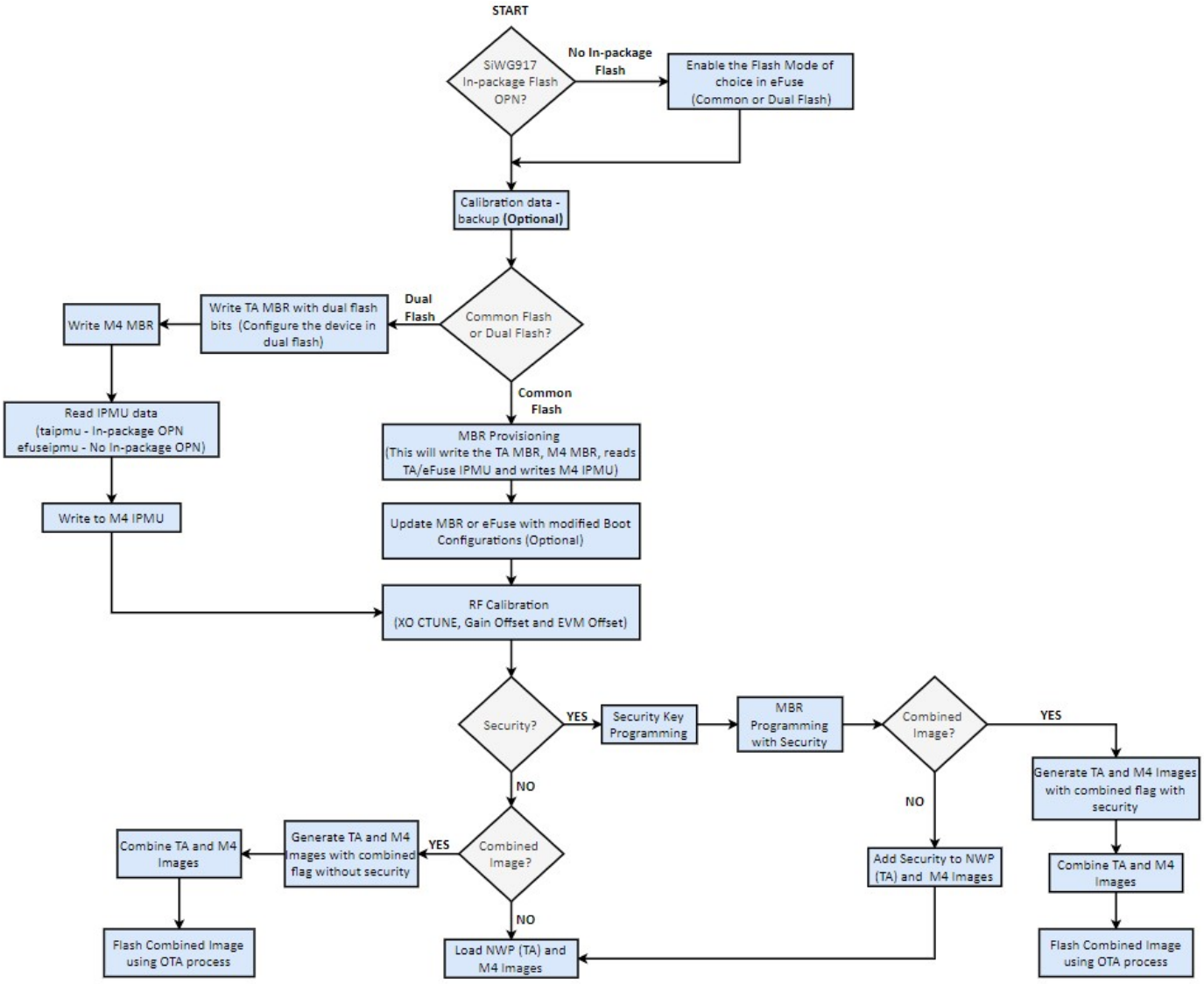


Figure 9.1. Manufacturing Procedure Flow

10. Appendix

Following is the list of abbreviations used in the document.

Table 10.1. Acronym and Abbreviation

Acronym/Abbreviation	Definition
AP	Access Point
API	Application Programming Interface
BLE	Bluetooth Low Energy
CLI	Command Line Interface
CW	Continuous Wave
eFuse	Electronic Fuse
EVM	Error Vector Magnitude
GPIO	General Purpose Input/Output
GSG	Getting Started Guide
HTTP/S	HyperText Transfer Protocol Secure
I2C	Inter-Integrated Circuit
IC	Integrated Circuit
IoT	Internet of Things
MAC	Media Access Control
MBR	Master Boot Record
NWP	Network Wireless Processor
OPN	Ordering Part Number
OTA	Over the Air
PCB	Printed Circuit Board
RF	Radio Frequency
Rx	Receive
SDK	Software Development Kit
SoC	System on Chip
SPI	Serial Peripheral Interface
STA	Station
TCP	Transmission Control Protocol
TLS	Transport Layer Security
TWT	Target Wake Time
Tx	Transmit
UART	Universal Asynchronous Receiver Transmitter
UDP	User Datagram Protocol
USART	Universal Synchronous/Asynchronous Receiver/Transmitter

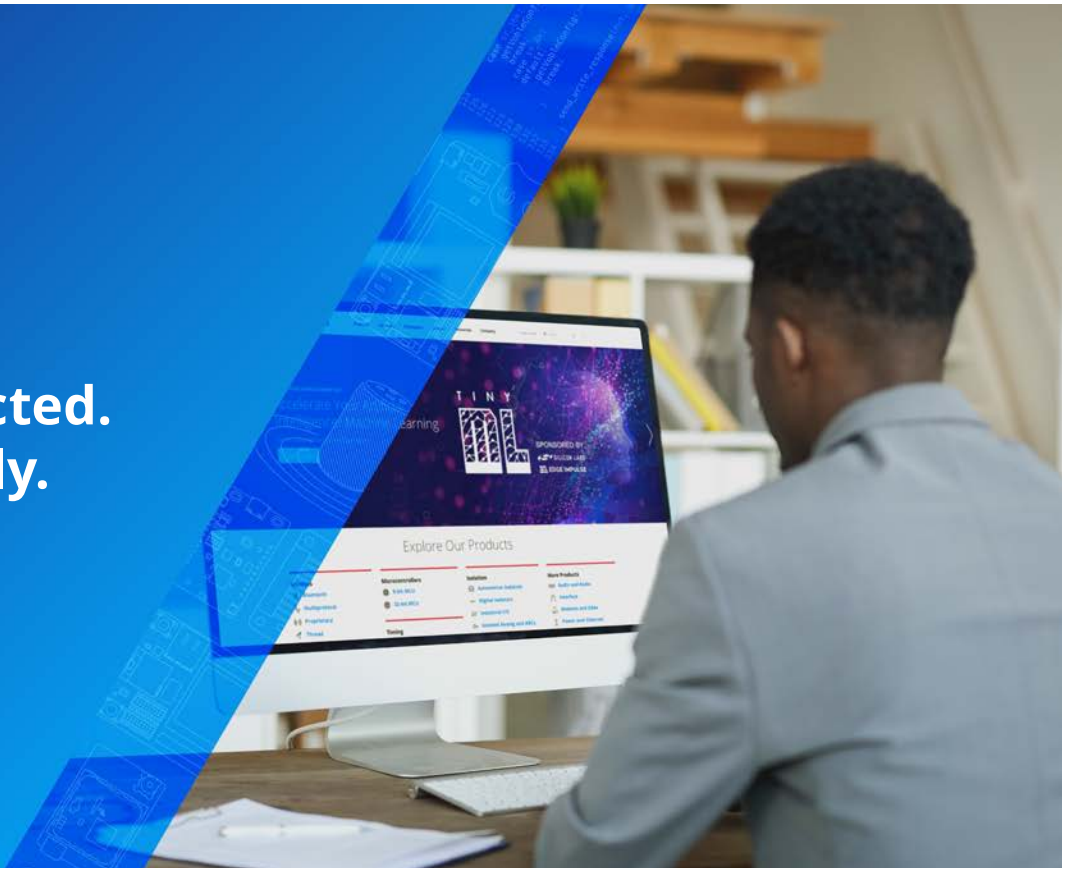
11. Revision History

Revision 0.1

August, 2025

- Initial Release.

Smart. Connected. Energy-Friendly.



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