AN1392: Detailed Timing Test Results for RAIL

This application note provides information about various timing measurements that may be of interest when using RAIL to develop an application. These timings may vary based on the chip, software release, and other RF/PHY settings, so be sure to reference this document as you update software.

KEY POINTS

- Implementation approach
- About the results
- Results summary
- Detailed results for this release

1 Introduction

Users of Silicon Labs' EFR32 chips may have questions about the time it takes for various radio operations. Not all of these are easy to document with the APIs as they may vary by chip, PHY, or even software release. This document is meant to provide some of those numbers as measured on a particular release in a subset of possible situations. Note that these numbers are informational and may change from release to release or chip to chip.

Note that some users will want to create an application that sends and receives packets at specific times for a synchronized communications channel. While you can use the timings around `RAIL_StartRx()` and `RAIL_StartTx()` to enable that, a better approach is to use the `RAIL_StartScheduledTx()` and `RAIL_ScheduleRx()` APIs, which enable these synchronized operations more reliably from release to release.

2 Implementation Approach

To measure this data, Silicon Labs builds a special version of RAIL and adds some extra application software to capture radio state change events and use hardware timestamping where possible. The goal is to introduce as little overhead as possible and to build an almost stock version of the library and application. This implementation uses an interrupt handler to capture radio state transition events and timestamp them, so some overhead is introduced. Because the application is only testing, the latency from this is minimal and is largely canceled out by measuring the time difference between two state transitions.

In this release, these measurements are taken using the single protocol version of the RAIL library. Different numbers and more variables would be expected if measuring with the multiprotocol version, as it would interact with the radio scheduler for every radio operation.

3 About the Results

Below is a description of each timing measurement and how it is taken. Measurement data for each is provided in the Result section. When a limited set of options impacts the timing, results are provided for every possible set of options, to cover all use cases.

- **Active Radio to Idle Time** – The time to transition into idle mode while in the middle of packet reception. Because the different `RAIL_Idle()` modes and the point in packet reception when `RAIL_Idle()` is called impact this time, the test is run across all idle modes and the abort is triggered at several different points.
- **Channel Change Time (RX to RX)** – The time to transition from receive on one channel to receive on another channel. This involves the radio being idled, reconfiguring the radio for the new channel, and then restarting receive. Measured by checking the time to transition out of the Rx state and into the Rx state on the new channel.
- **ConfigChannel Time** – The time to apply a radio channel configuration with the `RAIL_ConfigChannels()` API. Characterized by implementing the **RAIL Utility, Protocol** component in the test application.
- **EM2 to Active Radio Time** – The time from EM2 sleep wakeup until the radio is ready to receive a packet in an optimal application. This includes the time to restart the HFXO on the radio board and restart the receiver. Measured both with and without resynchronizing the high frequency RAIL time base with the low frequency sleep clock in the `RAIL_ConfigSleepAlt()` API.
- **Image Rejection Calibration (IRCAL) Time** – The time to perform image rejection calibration. Characterized by wrapping a call to `RAIL_CalibrateIrAlt()` and running the test several times to see how long it takes to complete.
- **RAIL_Init() Time With and Without DMA** – The time to initialize the radio via `RAIL_Init()` with and without using a DMA channel to load the sequencer image. Measured by building the application with and without the **RAIL Utility, DMA** component and wrapping the call to `RAIL_Init()`.
- **RX API Call to Actual RX Ready State Time** – The time from the `RAIL_StartRx()` function call until the receiver is active and ready for packet data. Measured from the API call until the radio enters the receive state. The `idleToRx` time is set to 0 µs. Also note that there may be additional receive chain delays that depend on the bitrate of your PHY so it's possible more time would be required here to successfully receive a packet.
- **RX Packet Receive to Event Trigger** – The time from the radio packet receive operation completing until the RAIL event for packet reception is received by the application. Measured by comparing the timer tick at which the packet reception is complete to the time the user callback is triggered. This removed the PHY dependency that influenced the initial results on Series 2. The test application minimizes interrupt latency and other system overhead that can influence this time in a real-world application.
- **TX API Call to Actual Transmit Time** – The time from calling `RAIL_StartTx()` until the first bit of the preamble goes on the air. Measured by computing the time from the API call being issued until the radio enters the transmit state. The idleToTx time is set to 0 µs and the Power Amplifier `rampTime` is configured to the default for that chip in the **RAIL Utility, PA** component. This test is also run over the most common RAIL_TxOptions_t values to show their impact.
- **Temperature Calibration Time** – The time taken to perform temperature calibration. Characterized by calling `RAIL_CalibrateTemp()` and measuring the time between leaving the receive state and completing this calibration.
- **TX to RX** and **RX to TX Auto State Transition Times (Minimal)** – The minimum time required to transition from transmit to receive and vice versa. The `RAIL_SetStateTiming` API is used with the `txToRx` and `rxToTx` transition times set to 0 µs, to eliminate additional delays. Measured by monitoring the radio state transition time from the end of one state until the beginning of the next.

4 Results Summary

This section provides a summary across Gecko SDK Suite (GSDK) releases. The detailed results for this release are included in section 5.

- Version 2024.12.0: Minor updates
- Version 2024.6.0: Series 0/1 support has been removed from sisdk-2024.6.0 and later releases. EFR32FG12 timings will no longer be tracked in this document.
- Version 4.4.0: Moved protocol specific initialization to the initialization functions for that protocol on EFR32xG22 and newer. This resulted in a reduction in the RAIL_Init() time and a corresponding increase in the protocol specific initialization functions.
- Version 4.3.0: Minor updates.
- Version 4.2.0: Results comparisons have been added. **RX Packet Receive to Event Trigger** test method was changed to remove the PHY dependency for Series 2 parts (G23). This explains the variances from the initial results for this test.
- Version 4.1.1: Initial release. Results from RAIL included in GSDK version 4.1.1 for the EFR32FG12 and EFR32xG23 platforms.

5 Results for This Release

The following pages show the measurement results for this release and a comparison with the results from the previous release.

Chip Type: G23			
RAIL Timing	**PHY**	**Average**	**Units**
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_2Mbps_500K	111	us
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	329	us
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_50Kbps_25K	2922	us
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_2Mbps_500K	112	us
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	329	us
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_50Kbps_25K	2921	us
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_2Mbps_500K	100	us
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	101	us
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_50Kbps_25K	100	us
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_2Mbps_500K	112	us
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	184	us
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_50Kbps_25K	184	us
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_2Mbps_500K	120	us
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	121	us
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_50Kbps_25K	121	us
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_2Mbps_500K	112	us
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	205	us
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_50Kbps_25K	203	us
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_2Mbps_500K	123	us
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	123	us
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_50Kbps_25K	123	us
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_2Mbps_500K	111	us
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	206	us
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_50Kbps_25K	207	us
Channel Change Time (RX to RX) 0 To 0	PHY_Studio_915M_2GFSK_2Mbps_500K	162	us
Channel Change Time (RX to RX) 0 To 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	162	us
Channel Change Time (RX to RX) 0 To 0	PHY_Studio_915M_2GFSK_50Kbps_25K	162	us
Channel Change Time (RX to RX) 0 To 1	PHY_Studio_915M_2GFSK_2Mbps_500K	251	us
Channel Change Time (RX to RX) 0 To 1	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	252	us
Channel Change Time (RX to RX) 0 To 1	PHY_Studio_915M_2GFSK_50Kbps_25K	251	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_PROPRIETARY	PHY_Studio_915M_2GFSK_2Mbps_500K	8	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_PROPRIETARY	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	8	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_PROPRIETARY	PHY_Studio_915M_2GFSK_50Kbps_25K	8	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_ANZ	Internal PHY	561	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_CN	Internal PHY	561	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_EU	Internal PHY	561	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_HK	Internal PHY	562	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_IL	Internal PHY	561	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_IN	Internal PHY	562	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_JP	Internal PHY	595	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_KR	Internal PHY	595	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_MY	Internal PHY	562	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_RU	Internal PHY	561	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_US	Internal PHY	562	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_US_LR_END_DEVICE	Internal PHY	580	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_US_LR1	Internal PHY	553	us
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_US_LR2	Internal PHY	553	us
EM2 to Active Radio Time No SYNC	PHY_Studio_915M_2GFSK_2Mbps_500K	499	us
EM2 to Active Radio Time No SYNC	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	499	us
EM2 to Active Radio Time No SYNC	PHY_Studio_915M_2GFSK_50Kbps_25K	499	us
EM2 to Active Radio Time With SYNC	PHY_Studio_915M_2GFSK_2Mbps_500K	565	us
EM2 to Active Radio Time With SYNC	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	568	us
EM2 to Active Radio Time With SYNC	PHY_Studio_915M_2GFSK_50Kbps_25K	565	us
Image Rejection Calibration Time Proprietary	PHY_Studio_915M_2GFSK_2Mbps_500K	200831	us
Image Rejection Calibration Time Proprietary	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	200848	us
Image Rejection Calibration Time Proprietary	PHY_Studio_915M_2GFSK_50Kbps_25K	200847	us
Image Rejection Calibration Time ZWAVE Z-Wave Region: EU-European Union Channel: 0	Internal PHY	101126	us
Image Rejection Calibration Time ZWAVE Z-Wave Region: JP-Japan Channel: 0	Internal PHY	201567	us
Image Rejection Calibration Time ZWAVE Z-Wave Region: KR-Korea Channel: 0	Internal PHY	201569	us
Image Rejection Calibration Time ZWAVE Z-Wave Region: USLR1-United States Long Range 1 Channel: 0	Internal PHY	101122	us
Image Rejection Calibration Time ZWAVE Z-Wave Region: USLRED-United States Long Range End Device Channel: 0	Internal PHY	101023	us
Image Rejection Calibration Time ZWAVE Z-Wave Region: US-United States Channel: 0	Internal PHY	101129	us
RAIL_Init() Time with DMA	Internal PHY	1141	us
RAIL_Init() Time without DMA	Internal PHY	2915	us
RX API call to actual RX ready state time Channel 0 To 0	PHY_Studio_915M_2GFSK_2Mbps_500K	136	us
RX API call to actual RX ready state time Channel 0 To 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	136	us
RX API call to actual RX ready state time Channel 0 To 0	PHY_Studio_915M_2GFSK_50Kbps_25K	136	us
RX API call to actual RX ready state time Channel 0 To 1	PHY_Studio_915M_2GFSK_2Mbps_500K	226	us
RX API call to actual RX ready state time Channel 0 To 1	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	226	us
RX API call to actual RX ready state time Channel 0 To 1	PHY_Studio_915M_2GFSK_50Kbps_25K	226	us
RX pkt receive to event trigger with option RAIL_RX_OPTION_STORE_CRC	PHY_Studio_915M_2GFSK_2Mbps_500K	27	us
RX pkt receive to event trigger with option RAIL_RX_OPTION_STORE_CRC	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	28	us
RX pkt receive to event trigger with option RAIL_RX_OPTION_STORE_CRC	PHY_Studio_915M_2GFSK_50Kbps_25K	27	us
RX pkt receive to event trigger with option RAIL_RX_OPTION_TRACK_ABORTED_FRAMES	PHY_Studio_915M_2GFSK_2Mbps_500K	28	us
RX pkt receive to event trigger with option RAIL_RX_OPTION_TRACK_ABORTED_FRAMES	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	27	us
RX pkt receive to event trigger with option RAIL_RX_OPTION_TRACK_ABORTED_FRAMES	PHY_Studio_915M_2GFSK_50Kbps_25K	28	us
RX to TX Auto state transition times	PHY_Studio_915M_2GFSK_2Mbps_500K	142	us
RX to TX Auto state transition times	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	156	us

Chip Type: G23			
RAIL Timing	**PHY**	**Average**	**Units**
RX to TX Auto state transition times	PHY_Studio_915M_2GFSK_50Kbps_25K	203	us
Temperature Calibration Time	PHY_Studio_915M_2GFSK_2Mbps_500K	122	us
Temperature Calibration Time	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	122	us
Temperature Calibration Time	PHY_Studio_915M_2GFSK_50Kbps_25K	122	us
TX API call to actual transmit time with option ALT PREAMBLE LEN 128	PHY_Studio_915M_2GFSK_2Mbps_500K	155	us
TX API call to actual transmit time with option ALT PREAMBLE LEN 128	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	154	us
TX API call to actual transmit time with option ALT PREAMBLE LEN 128	PHY_Studio_915M_2GFSK_50Kbps_25K	141	us
TX API call to actual transmit time with option ANTENNA 0	PHY_Studio_915M_2GFSK_2Mbps_500K	156	us
TX API call to actual transmit time with option ANTENNA 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	155	us
TX API call to actual transmit time with option ANTENNA 0	PHY_Studio_915M_2GFSK_50Kbps_25K	142	us
TX API call to actual transmit time with option ANTENNA 1	PHY_Studio_915M_2GFSK_2Mbps_500K	156	us
TX API call to actual transmit time with option ANTENNA 1	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	155	us
TX API call to actual transmit time with option ANTENNA 1	PHY_Studio_915M_2GFSK_50Kbps_25K	142	us
TX API call to actual transmit time with option CCA ONLY	PHY_Studio_915M_2GFSK_2Mbps_500K	156	us
TX API call to actual transmit time with option CCA ONLY	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	155	us
TX API call to actual transmit time with option CCA ONLY	PHY_Studio_915M_2GFSK_50Kbps_25K	141	us
TX API call to actual transmit time with option CCA PEAK RSSI	PHY_Studio_915M_2GFSK_2Mbps_500K	156	us
TX API call to actual transmit time with option CCA PEAK RSSI	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	155	us
TX API call to actual transmit time with option CCA PEAK RSSI	PHY_Studio_915M_2GFSK_50Kbps_25K	141	us
TX API call to actual transmit time with option Default	PHY_Studio_915M_2GFSK_2Mbps_500K	148	us
TX API call to actual transmit time with option Default	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	147	us
TX API call to actual transmit time with option Default	PHY_Studio_915M_2GFSK_50Kbps_25K	133	us
TX API call to actual transmit time with option REMOVE CRC	PHY_Studio_915M_2GFSK_2Mbps_500K	157	us
TX API call to actual transmit time with option REMOVE CRC	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	156	us
TX API call to actual transmit time with option REMOVE CRC	PHY_Studio_915M_2GFSK_50Kbps_25K	142	us
TX API call to actual transmit time with option RESEND	PHY_Studio_915M_2GFSK_2Mbps_500K	156	us
TX API call to actual transmit time with option RESEND	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	155	us
TX API call to actual transmit time with option RESEND	PHY_Studio_915M_2GFSK_50Kbps_25K	141	us
TX API call to actual transmit time with option SYNC WORD ID 1	PHY_Studio_915M_2GFSK_2Mbps_500K	156	us
TX API call to actual transmit time with option SYNC WORD ID 1	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	155	us
TX API call to actual transmit time with option SYNC WORD ID 1	PHY_Studio_915M_2GFSK_50Kbps_25K	141	us
TX API call to actual transmit time with option WAIT FOR AUTO ACK	PHY_Studio_915M_2GFSK_2Mbps_500K	157	us
TX API call to actual transmit time with option WAIT FOR AUTO ACK	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	155	us
TX API call to actual transmit time with option WAIT FOR AUTO ACK	PHY_Studio_915M_2GFSK_50Kbps_25K	141	us
Tx To Rx Auto state transition times	PHY_Studio_915M_2GFSK_2Mbps_500K	147	us
Tx To Rx Auto state transition times	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	147	us
Tx To Rx Auto state transition times	PHY_Studio_915M_2GFSK_50Kbps_25K	147	us

Chip Type: G23				
RAIL Timing	**PHY**	**SISDK-2024.6.0**	**SISDK-2024.12.0**	**Diff**
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_2Mbps_500K	110	111	1%
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	329	329	0%
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_50Kbps_25K	2921	2922	0%
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_2Mbps_500K	111	112	1%
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	328	329	0%
Active Radio to Idle Time with Idle Mode: 0 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_50Kbps_25K	2921	2921	0%
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_2Mbps_500K	99	100	1%
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	99	101	2%
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_50Kbps_25K	99	100	1%
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_2Mbps_500K	112	112	0%
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	182	184	1%
Active Radio to Idle Time with Idle Mode: 1 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_50Kbps_25K	183	184	1%
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_2Mbps_500K	119	120	1%
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	119	121	2%
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_50Kbps_25K	119	121	2%
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_2Mbps_500K	112	112	0%
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	202	205	1%
Active Radio to Idle Time with Idle Mode: 2 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_50Kbps_25K	202	203	0%
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_2Mbps_500K	122	123	1%
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	122	123	1%
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 0	PHY_Studio_915M_2GFSK_50Kbps_25K	122	123	1%
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_2Mbps_500K	111	111	0%
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	205	206	0%
Active Radio to Idle Time with Idle Mode: 3 and Idle Delay(Us): 80	PHY_Studio_915M_2GFSK_50Kbps_25K	205	207	1%
Channel Change Time (RX to RX) 0 To 0	PHY_Studio_915M_2GFSK_2Mbps_500K	163	162	-1%
Channel Change Time (RX to RX) 0 To 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	164	162	-1%
Channel Change Time (RX to RX) 0 To 0	PHY_Studio_915M_2GFSK_50Kbps_25K	164	162	-1%
Channel Change Time (RX to RX) 0 To 1	PHY_Studio_915M_2GFSK_2Mbps_500K	250	251	0%
Channel Change Time (RX to RX) 0 To 1	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	250	252	1%
Channel Change Time (RX to RX) 0 To 1	PHY_Studio_915M_2GFSK_50Kbps_25K	250	251	0%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_PROPRIETARY	PHY_Studio_915M_2GFSK_2Mbps_500K	8	8	0%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_PROPRIETARY	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	8	8	0%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_PROPRIETARY	PHY_Studio_915M_2GFSK_50Kbps_25K	8	8	0%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_ANZ	Internal PHY	553	561	1%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_CN	Internal PHY	552	561	2%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_EU	Internal PHY	552	561	2%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_HK	Internal PHY	553	562	2%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_IL	Internal PHY	552	561	2%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_IN	Internal PHY	553	562	2%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_JP	Internal PHY	587	595	1%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_KR	Internal PHY	587	595	1%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_MY	Internal PHY	553	562	2%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_RU	Internal PHY	552	561	2%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_US	Internal PHY	552	562	2%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_US_LR_END_DEVICE	Internal PHY	572	580	1%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_US_LR1	Internal PHY	543	553	2%
ConfigChannel Time SL_RAIL_UTIL_PROTOCOL_ZWAVE_US_LR2	Internal PHY	544	553	2%
EM2 to Active Radio Time No SYNC	PHY_Studio_915M_2GFSK_2Mbps_500K	493	499	1%
EM2 to Active Radio Time No SYNC	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	496	499	1%
EM2 to Active Radio Time No SYNC	PHY_Studio_915M_2GFSK_50Kbps_25K	497	499	0%
EM2 to Active Radio Time With SYNC	PHY_Studio_915M_2GFSK_2Mbps_500K	564	565	0%
EM2 to Active Radio Time With SYNC	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	560	568	1%
EM2 to Active Radio Time With SYNC	PHY_Studio_915M_2GFSK_50Kbps_25K	566	565	0%
Image Rejection Calibration Time Proprietary	PHY_Studio_915M_2GFSK_2Mbps_500K	200861	200831	0%
Image Rejection Calibration Time Proprietary	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	200870	200848	0%
Image Rejection Calibration Time Proprietary	PHY_Studio_915M_2GFSK_50Kbps_25K	200887	200847	0%
Image Rejection Calibration Time ZWAVE Z-Wave Region: EU-European Union Channel: 0	Internal PHY	101120	101126	0%
Image Rejection Calibration Time ZWAVE Z-Wave Region: JP-Japan Channel: 0	Internal PHY	201552	201567	0%
Image Rejection Calibration Time ZWAVE Z-Wave Region: KR-Korea Channel: 0	Internal PHY	201551	201569	0%
Image Rejection Calibration Time ZWAVE Z-Wave Region: USLR1-United States Long Range 1 Channel: 0	Internal PHY	101123	101122	0%
Image Rejection Calibration Time ZWAVE Z-Wave Region: USLRED-United States Long Range End Device Channel: 0	Internal PHY	101007	101023	0%
Image Rejection Calibration Time ZWAVE Z-Wave Region: US-United States Channel: 0	Internal PHY	101122	101129	0%
RAIL_Init() Time with DMA	Internal PHY	1143	1141	0%
RAIL_Init() Time without DMA	Internal PHY	3192	2915	-9%
RX API call to actual RX ready state time Channel 0 To 0	PHY_Studio_915M_2GFSK_2Mbps_500K	138	136	-1%
RX API call to actual RX ready state time Channel 0 To 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	138	136	-1%
RX API call to actual RX ready state time Channel 0 To 0	PHY_Studio_915M_2GFSK_50Kbps_25K	138	136	-1%
RX API call to actual RX ready state time Channel 0 To 1	PHY_Studio_915M_2GFSK_2Mbps_500K	225	226	0%
RX API call to actual RX ready state time Channel 0 To 1	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	225	226	0%
RX API call to actual RX ready state time Channel 0 To 1	PHY_Studio_915M_2GFSK_50Kbps_25K	225	226	0%
RX pkt receive to event trigger with option RAIL_RX_OPTION_STORE_CRC	PHY_Studio_915M_2GFSK_2Mbps_500K	27	27	0%
RX pkt receive to event trigger with option RAIL_RX_OPTION_STORE_CRC	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	27	28	4%
RX pkt receive to event trigger with option RAIL_RX_OPTION_STORE_CRC	PHY_Studio_915M_2GFSK_50Kbps_25K	27	27	0%
RX pkt receive to event trigger with option RAIL_RX_OPTION_TRACK_ABORTED_FRAMES	PHY_Studio_915M_2GFSK_2Mbps_500K	27	28	4%
RX pkt receive to event trigger with option RAIL_RX_OPTION_TRACK_ABORTED_FRAMES	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	27	27	0%
RX pkt receive to event trigger with option RAIL_RX_OPTION_TRACK_ABORTED_FRAMES	PHY_Studio_915M_2GFSK_50Kbps_25K	27	28	4%
RX to TX Auto state transition times	PHY_Studio_915M_2GFSK_2Mbps_500K	142	142	0%
RX to TX Auto state transition times	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	155	156	1%
RX to TX Auto state transition times	PHY_Studio_915M_2GFSK_50Kbps_25K	202	203	0%
Temperature Calibration Time	PHY_Studio_915M_2GFSK_2Mbps_500K	126	122	-3%
Temperature Calibration Time	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	126	122	-3%
Temperature Calibration Time	PHY_Studio_915M_2GFSK_50Kbps_25K	126	122	-3%
TX API call to actual transmit time with option ALT PREAMBLE LEN 128	PHY_Studio_915M_2GFSK_2Mbps_500K	154	155	1%
TX API call to actual transmit time with option ALT PREAMBLE LEN 128	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	153	154	1%
TX API call to actual transmit time with option ALT PREAMBLE LEN 128	PHY_Studio_915M_2GFSK_50Kbps_25K	140	141	1%
TX API call to actual transmit time with option ANTENNA 0	PHY_Studio_915M_2GFSK_2Mbps_500K	154	156	1%

Chip Type: G23				
RAIL Timing	**PHY**	**SISDK-2024.6.0**	**SISDK-2024.12.0**	**Diff**
TX API call to actual transmit time with option ANTENNA 0	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	153	155	1%
TX API call to actual transmit time with option ANTENNA 0	PHY_Studio_915M_2GFSK_50Kbps_25K	141	142	1%
TX API call to actual transmit time with option ANTENNA 1	PHY_Studio_915M_2GFSK_2Mbps_500K	155	156	1%
TX API call to actual transmit time with option ANTENNA 1	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	153	155	1%
TX API call to actual transmit time with option ANTENNA 1	PHY_Studio_915M_2GFSK_50Kbps_25K	141	142	1%
TX API call to actual transmit time with option CCA ONLY	PHY_Studio_915M_2GFSK_2Mbps_500K	155	156	1%
TX API call to actual transmit time with option CCA ONLY	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	153	155	1%
TX API call to actual transmit time with option CCA ONLY	PHY_Studio_915M_2GFSK_50Kbps_25K	139	141	1%
TX API call to actual transmit time with option CCA PEAK RSSI	PHY_Studio_915M_2GFSK_2Mbps_500K	154	156	1%
TX API call to actual transmit time with option CCA PEAK RSSI	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	153	155	1%
TX API call to actual transmit time with option CCA PEAK RSSI	PHY_Studio_915M_2GFSK_50Kbps_25K	140	141	1%
TX API call to actual transmit time with option Default	PHY_Studio_915M_2GFSK_2Mbps_500K	147	148	1%
TX API call to actual transmit time with option Default	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	146	147	1%
TX API call to actual transmit time with option Default	PHY_Studio_915M_2GFSK_50Kbps_25K	132	133	1%
TX API call to actual transmit time with option REMOVE CRC	PHY_Studio_915M_2GFSK_2Mbps_500K	156	157	1%
TX API call to actual transmit time with option REMOVE CRC	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	154	156	1%
TX API call to actual transmit time with option REMOVE CRC	PHY_Studio_915M_2GFSK_50Kbps_25K	141	142	1%
TX API call to actual transmit time with option RESEND	PHY_Studio_915M_2GFSK_2Mbps_500K	154	156	1%
TX API call to actual transmit time with option RESEND	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	153	155	1%
TX API call to actual transmit time with option RESEND	PHY_Studio_915M_2GFSK_50Kbps_25K	140	141	1%
TX API call to actual transmit time with option SYNC WORD ID 1	PHY_Studio_915M_2GFSK_2Mbps_500K	154	156	1%
TX API call to actual transmit time with option SYNC WORD ID 1	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	153	155	1%
TX API call to actual transmit time with option SYNC WORD ID 1	PHY_Studio_915M_2GFSK_50Kbps_25K	140	141	1%
TX API call to actual transmit time with option WAIT FOR AUTO ACK	PHY_Studio_915M_2GFSK_2Mbps_500K	154	157	2%
TX API call to actual transmit time with option WAIT FOR AUTO ACK	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	153	155	1%
TX API call to actual transmit time with option WAIT FOR AUTO ACK	PHY_Studio_915M_2GFSK_50Kbps_25K	140	141	1%
Tx To Rx Auto state transition times	PHY_Studio_915M_2GFSK_2Mbps_500K	147	147	0%
Tx To Rx Auto state transition times	PHY_Studio_915M_2GFSK_500Kbps_175K_mi0p7	146	147	1%
Tx To Rx Auto state transition times	PHY_Studio_915M_2GFSK_50Kbps_25K	147	147	0%

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 & Community
www.silabs.com/community

SILICON LABS

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

www.silabs.com