Hello, and welcome to this overview of the radio frequency characteristics of the STM32WB microcontroller. The STM32WB is a new family which combines on the same die an STM32 microcontroller and an RF part for connectivity.
A radio frequency chain consists of a transmitter to send the signal over the air and, on the other hand, a receiver to acquire this signal. At each side (transmitter and receiver), an antenna is needed to convert the electrical signal to electromagnetic waves on the transmitter side and conversely to transform the electromagnetic waves into an electrical signal on the receiver side.
The RF transceiver embedded inside the STM32WB microcontroller comprises a digital interface, a 32 MHz external crystal oscillator for the internal synthesizer used for the modulation, an output-input stage and a dedicated power management circuit.

The output stage consists of a Power Amplifier (PA).
The input stage consists of a Low Noise Amplifier (LNA).
STM32WB microcontrollers support short-range communication technologies such as Bluetooth Low Energy (Bluetooth LE, formerly marketed as Bluetooth Smart) and IEEE 802.15.4 (BLE, Thread, and Zigbee).
The Bluetooth Special Interest Group (SIG) is the standards organization that oversees the development of the Bluetooth standards and the licensing of the Bluetooth technologies and trademarks to manufacturers. The SIG is a not-for-profit, non-stock corporation founded in September 1998. STM32WB is certified Bluetooth 5 with the 2 Mbps RF physical layer (PHY).
Thanks to an internal transformer connected to the RF pins, the circuit provides a direct interface for the antenna (single-ended connection, impedance close to 50 Ω).
The natural band-pass behavior of the internal transformer, simplifies the external circuitry used for harmonic filtering and out-of-band interference rejection. To achieve the best RF performance for both transmission and reception, the use of an external matching network and an integrated low-pass filter (LPF) is recommended.
In Receiver mode, a linearized, smoothed analog control offers a clean power ramp-up. In Receive mode, the circuit can be used in standard high performance or in reduced power consumption (user programmable) mode. The Automatic Gain Control (AGC) is able to reduce the chain gain at both RF and IF locations, for optimized interference rejection. Thanks to the use of complex filtering and highly accurate I/Q architecture, high sensitivity and excellent linearity can be achieved.

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<th>STM32WB RF in details (2/3)</th>
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<td>The STM32WB RF part aims to offer good performance without compromise</td>
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- **STM32WB RF uses state-of-the-art on-chip passive components**
  - These integrated passive are used for both matching/filtering, but also to enhance the RF performance of critical blocks while saving current consumption.
  - In the same way, huge efforts have been made in the frequency synthesizer design to save as much current as possible without compromising the channel selectivity.

- **Maximizing the dynamic**
  - Architecture study focused on offering the maximum signal dynamic by using clever filtering all along the RF chain.
  - Very reactive, smoothed automatic gain control and high resolution Rx ADCs help to withstand huge interference signals at the antenna level.

- **Compatibility with 802.15.4 Thread**
  - The fast, direct modulation internal frequency synthesizer, supports 2 Mbps of GFSK modulation (Bluetooth LE) and also the 250 kbps + 8 time spreading factor of the 802.15.4 Thread Offset QPSK modulation.
  - Programmable bandwidth Rx filtering is well adapted to receive a Thread communication in excellent conditions.
The STM32WB is a dual core device: the microcontroller has a Cortex-M4 core for the application and a Cortex-M0+ core dedicated to the radio. A section of the Flash memory is secured for the RF subsystem CPU (i.e. Cortex-M0+ core), and cannot be accessed by the Cortex-M4 core. Both cores can read/write or erase the embedded Flash memory thanks to a dedicated hardware mechanism. The arbitration is based on time sharing. The STM32WB microcontroller has the same read-out protection as the other STM32 microcontrollers with 3 levels of protection: Level 0 gives full access, while Level 2 ensures full protection by fuse, meaning it cannot be undone.
### STM32WB increases RF performance

The STM32 WB RF offers flexibility

- **Increasing output power**
  - The Tx maximum power is set at +5 dBm over the whole temperature range (-40 to +125°C junction) under a 50 ohm load.
  - At restricting temperature range (-40 to +85°C), the output power should be increased up to +6 dBm under a 50 ohm load.

- **Decreasing output power**
  - The maximum output power can be reduced by some dBs, and the current consumed during the transmission is also decreased.

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Depending on the application, the output power can reach its maximum value of +6 dBm with the maximum LDO voltage or can be reduced to minimize the current consumption.
The 32 MHz crystal oscillator does not need an external trimming capacitor network thanks to a dual network of programmable integrated capacitors. To achieve the best RF performance for both transmission and reception, the use of an external matching network and an integrated low-pass filter (LPF) is recommended.
This slide shows an example of a complete application circuit.