General description

BTLE40 is a low power connectivity IP compliant with version 5 of the Bluetooth core specification. It supports Bluetooth LE 1 Mb/s and 2 Mb/s and long range 500 kb/s and 125 kb/s. Additionally, BTLE40 supports IEEE802.15.4-2015 ZigBee in the 2.45 GHz ISM band . It is a complete HCI controller designed for manufacturing in the TSMC 40 nm ULP process.

BTLE40 performs the full HCI controller function from antenna to HCI interface. The analog radio part consists of a low-IF receiver with limited selectivity and a directly-modulated AD-PLL with saturated power amplifier for transmission. Full channel selectivity, AGC control, correction of carrier frequency offset, clock and frame synchronization and bit detection are implemented in the digital part of the receiver. Mapping of data bits onto transmit symbols and pulse shaping are performed in the digital part of the transmitter. Firmware executed on an embedded processor implements calibration, receiver and transmitter sequencing, and general low-level radio control.

The receiver's AGC algorithm provides fast gain adaptation, low noise, and high dynamic range. It combines good sensitivity and C/I performance with good blocker performance, in excess of the standard's requirements.

BTLE40 has a single RF interface pin for shared TX output and RX input. It requires a single external capacitor for matching to 50 Ω. The TX/RX switch is integrated.

An all-digital synthesizer generates the local-oscillator signals for the receiver, allowing fast frequency hopping while maintaining good phase noise performance. The synthesizer accepts reference frequencies between 13 MHz and 52 MHz.

An efficient switching regulator allows direct connection of the BTLE40 IP to an unregulated battery voltage. The switching regulator requires a single external inductor and has separate regulated outputs for the analog and for the digital circuits.

The BTLE40 IP is designed to be self-contained. It includes a crystal oscillator circuit with integrated, tunable load capacitors for frequency reference, a one-pin crystal oscillator for timing reference (sleep clock), a general-purpose ADC and a temperature sensor. Thanks to a modular set up, these circuits can be carved out when they are not required, for instance when a reference frequency of sufficient quality is already present in the SoC.

The BTLE40 IP contains the Link Layer of the Bluetooth stack, up to the standard-defined HCI interface. In the SoC, the logical HCI interface must be connected to a physical SoC bus.

Frequency planning, supply structure and interference rejection are chosen to maximize co-existence performance, both as victim and as aggressor. This eases the integration of this IP into the SoC that can contain multiple wireless connectivity IPs.

Features

General
– Compliant to Bluetooth core specification 5
– Supports LE 1 Mb/s and 2 Mb/s and long range 125 kb/s and 500 kb/s
– Supports 802.15.4-2015 in the 2.45 GHz ISM band for ZigBee
– Contains digital modem for all supported modulation formats
– RF-PHY and Link Layer up to HCI
– Low power consumption
– Low-cost BOM
– Optimized frequency plan for on-chip co-existence
– Excellent blocking performance, exceeding standard's requirements
– Single-pin, single-ended RF interface
– Simple matching to 50 Ω using a single capacitor

– Efficient PA delivering up to +5 dBm
– Reference crystal oscillator (13MHz – 52 MHz) with integrated tunable load capacitors
– Efficient buck switching regulator for direct battery connection and low battery drain
– Parallel low-power switched-capacitor DC-DC converter for sleep mode
– LPO crystal oscillator (32.768 kHz) for sleep clock
– General-purpose ADC for user applications
– Temperature sensor
– Simple control through API
– Embedded controller for start-up and shut-down sequencing, calibration routines and general low-level radio control

Specifications in this datasheet are subject to change without notice

Key Specifications

- 2.0 V – 4.8 V supply connection with efficient switching regulator
- Temperature range -40 - +125 °C (junction) (range for ambient dependent on package)
- Sensitivity
  - LE (1 Mb/s)   -97 dBm
  - LE (2 Mb/s)   -94 dBm
  - LE (500 kb/s)   -100 dBm
  - LE (125 kb/s)   -102 dBm
  - 802.15.4 (250 kb/s)   -99 dBm
- P_{out} +5 dBm
- Peak active current consumption (full IP)
  - RX mode:
    - 4.8 mA @ 3.7 V (VBAT)
  - TX mode:
    - 6.0 mA @ 3.7 V (VBAT)
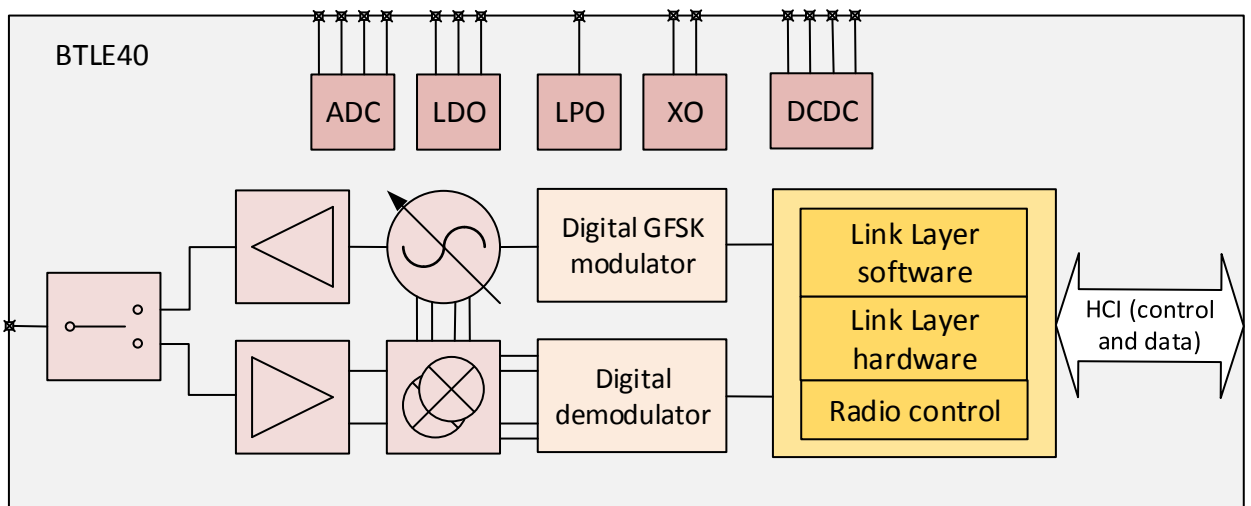
Overall block diagram

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