

Radio

nRF52 Global Tech Tour

Radio

- ▶ Highlights
- ▶ New features and improvements
- ▶ Radio block diagram
- ▶ Specifications; nRF52 vs nRF51
- ▶ Encryption and packet assembly
- ▶ Hardware
 - ▶ External components
 - ▶ Simplified matching network

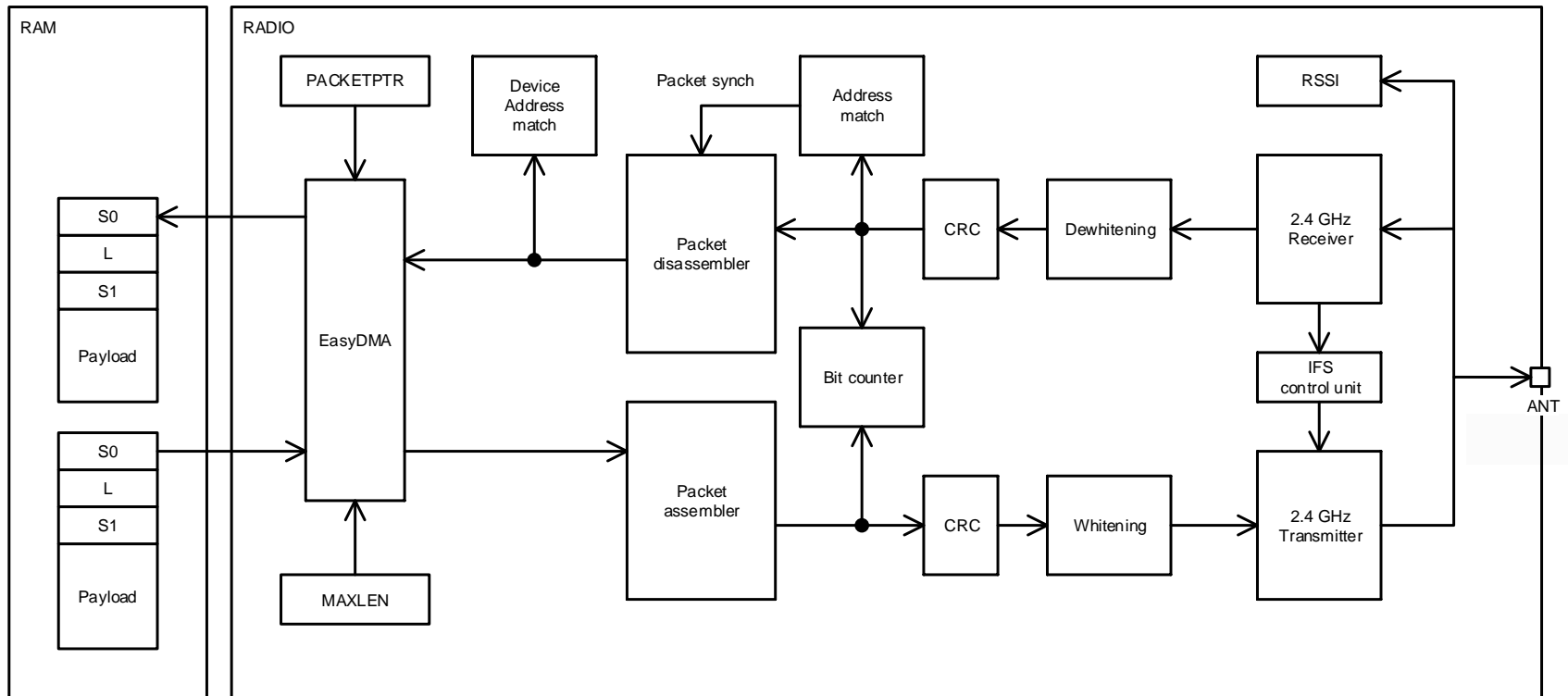
nRF52 radio highlights

- ▶ Multi-protocol 2.4GHz Transceiver
 - ▶ Bluetooth 4.2 compliant (LE only)
 - ▶ nRF24L series 1Mbps, 2Mbps compatible
 - ▶ ANT compatible (1Mbps)
- ▶ Baseband logic
 - ▶ “On the fly” packet assembly/dis-assembly, similar to Shockburst
 - ▶ Dynamic payload length – up to 256 bytes
 - ▶ Data whitening using 7-bit LFSR
 - ▶ PPI support for protocol hardware acceleration
- ▶ Processor interface
 - ▶ RAM mapped FIFOs, flexible size and placement
 - ▶ EasyDMA for payload data
 - ▶ SFR for configuration

New features and improvements

- ▶ Digital RX IF filters
 - ▶ Better performance and selectivity
- ▶ Unlimited transmit time
- ▶ Fast RX and TX startup: 40 us.
- ▶ Increased frequency range
 - ▶ 2360 MHz to 2500 MHz
- ▶ Wide range RSSI: -90 dBm to -20 dBm
 - ▶ Always on, no current penalty
- ▶ 1.3 V radio operation -> more efficient use of the DCDC converter.
- ▶ On-chip balun: simpler layout and less RF components

Radio block diagram



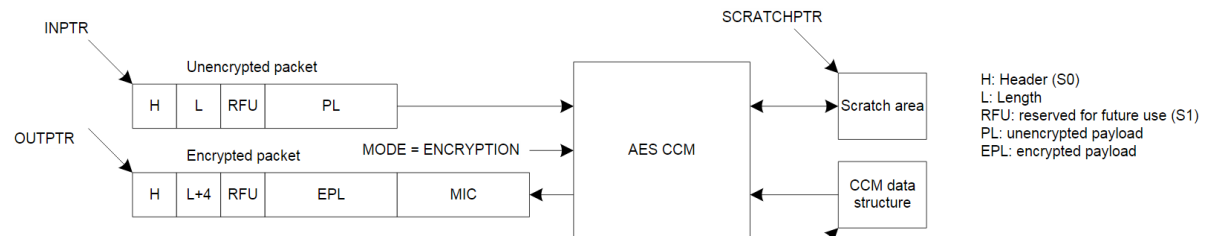
Identical to the nRF51

Specifications; nRF52 vs nRF51

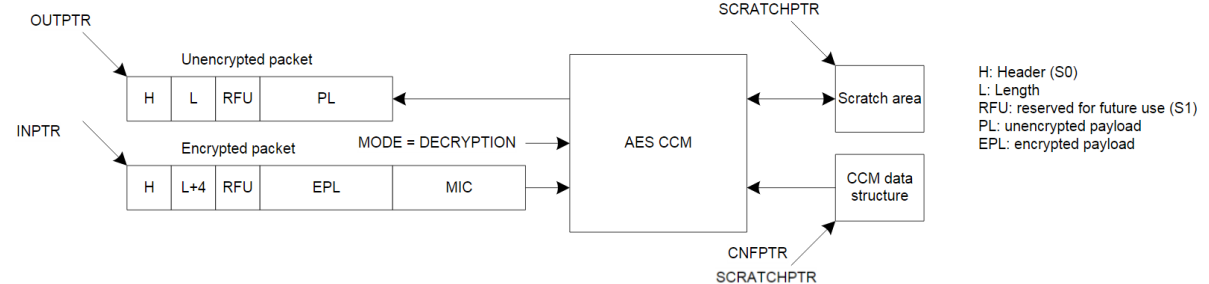
	nRF52832	nRF51	Δ
Protocol support	Bluetooth Smart, ANT, 2.4GHz RF	Bluetooth Smart, ANT, 2.4GHz RF	
RF interface	Single-ended, on-chip balun	Differential, off-chip balun	eBOM, PCB size
RX Sensitivity (1 Mbps BLE) TX Output power	-96 dBm Up to +4 dBm	-93 dBm Up to +4 (3) dBm	+ 4 dB link budget
RX Current	5.4 mA at 3 V with DC/DC 11.7 mA at 1.7 V with LDO	9.9 mA at 3 V with DC/DC 13 mA at 1.8 V with LDO	× ½ RX Current
TX Current (at 0dBm)	5.3 mA at 3 V with DC/DC 11.6 mA at 1.7 V with LDO	8 mA at 3 V with DC/DC 10.5 mA at 1.8 V with LDO	× 0.7 TX Power
Start-up (RX and TX) Switching (RX and TX)	40 μs 20 μs	130 μs 130 μs	> 3x faster
On-the-air data rate	1 and 2 Mbps	1 and 2 Mbps, 250 kbps	- 250 kbps
Total time in TX mode	Unlimited	4 or 16 ms (crystal dependent)	
Crystal frequency	32 MHz	16/32 MHz	

On the fly encryption and packet assembly

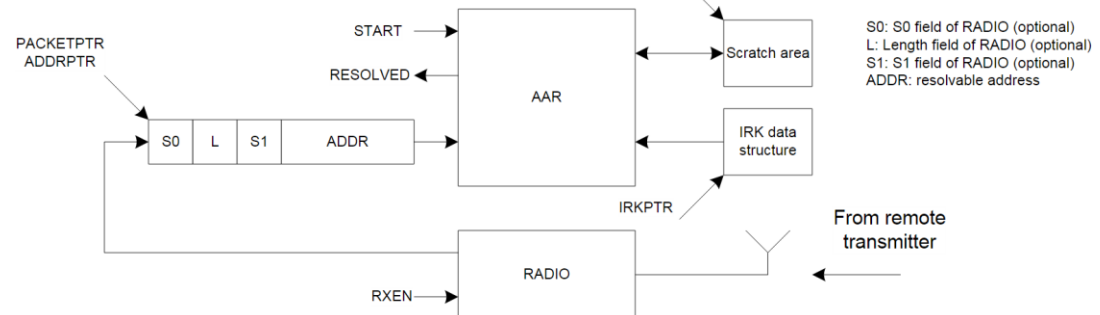
► Encrypt



► Decrypt



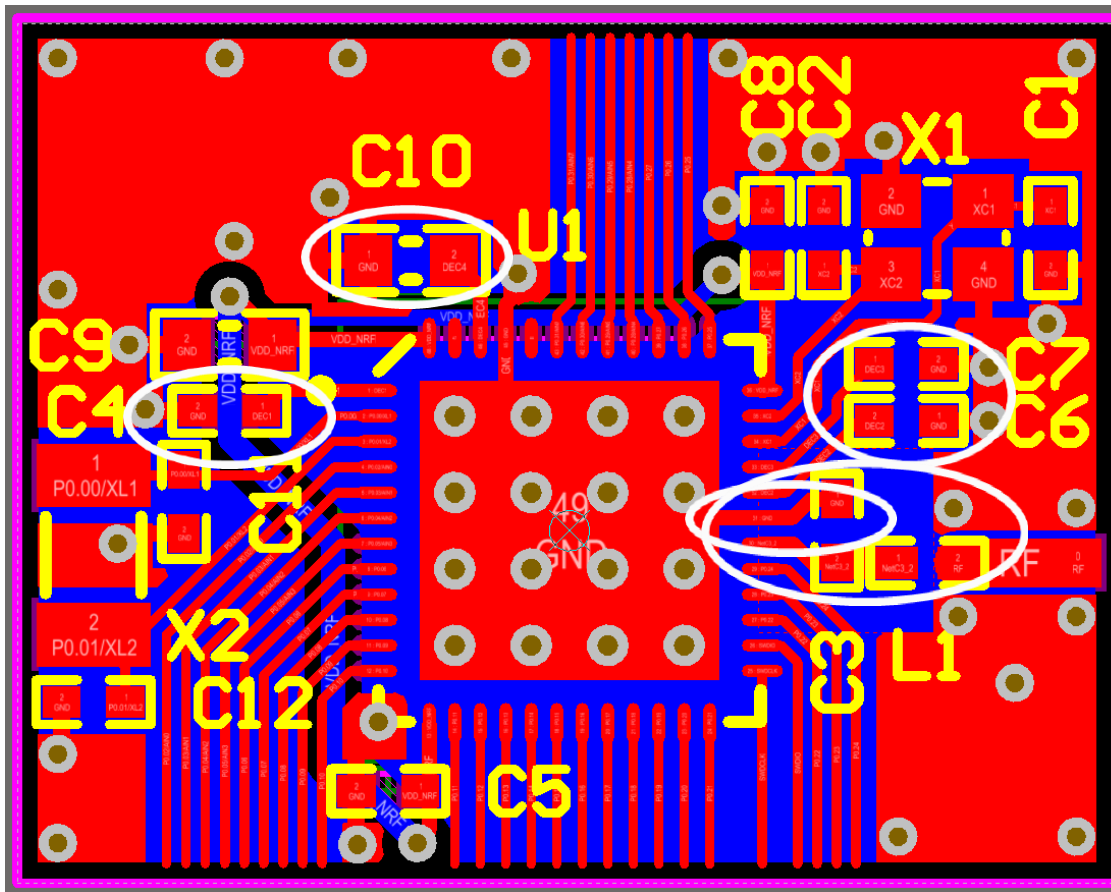
► Automatic address resolution



The schematic diagram illustrates the nRF52832-QFAA module with the following components and connections:

- Optional Crystal Circuit:** A dashed box labeled "Optional" contains a crystal (X2, 32.768kHz) and two 12pF capacitors (C11, C12) connected to pins P0.00/XL1 and P0.01/XL2.
- Power and Decoupling:**
 - VDD pins (13, 48, 47, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13) are connected to a common VDD line with a 100nF capacitor (C5).
 - DEC1 (1) is connected to a 100nF capacitor (C4).
 - VDD nRF (2) is connected to a 4.7μF capacitor (C9).
 - C10 (1.0μF) is connected to pin 48.
- RF and Antenna:**
 - ANT (30) is connected to an antenna (L1, 3.9nH) and a 0.8pF capacitor (C3).
 - RF is connected to the antenna.
- Crystal and Timing:**
 - X1 (32MHz) is connected to pins 35 (XC2) and 34 (XC1).
 - C1 (12pF) and C2 (12pF) are connected to pins 35 and 34.
 - C7 (12pF) is connected to pin 33 (DEC3).
 - C6 (100pF) is connected to pin 32 (DEC2).
- SWDIO and SWDCLK:**
 - SWDIO (26) and SWDCLK (25) are connected to the SWDIO and SWDCLK pins.
- Other Pins:**
 - P0.02/AIN0 (4) is connected to pin 4.
 - P0.03/AIN1 (5) is connected to pin 5.
 - P0.04/AIN2 (6) is connected to pin 6.
 - P0.05/AIN3 (7) is connected to pin 7.
 - P0.06 (8) is connected to pin 8.
 - P0.07 (9) is connected to pin 9.
 - P0.08 (10) is connected to pin 10.
 - P0.09 (11) is connected to pin 11.
 - P0.10 (12) is connected to pin 12.
 - P0.21/RESET (21) is connected to pin 21.

Layout



- ▶ Decoupling capacitors
- ▶ Matching network
- ▶ Track

Matching network

- ▶ On-chip balun
- ▶ Impedance transformation
- ▶ Harmonic filterering
- ▶ No need for a 3rd party filter balun!

- Resonant frequency between 2nd and 3rd harmonic

$$f = \frac{1}{2\pi\sqrt{LC}} \approx 6 \text{ GHz}$$

$$C = 0.8 \text{ pF}$$

$$L = 0.9 \text{ nH} \approx 0.9 \text{ mm length}$$

Equivalent circuit

