PARTNER WEBINAR

Laird™ CONNECTIVITY

NORDICTECH WEBINARS

BL5340PA - nRF5340 SoC and nRF21540 RF FEM module for extended range

Today's hosts

Jonathan Kaye

VP Product Management
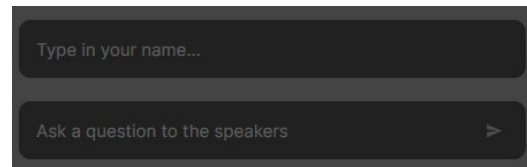
& Marketing

Bjørn Kvaale
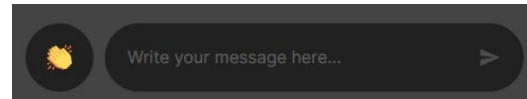

Product Marketing

Engineer

Practicalities

- Duration: 50-60 mins

- Questions are encouraged!

- Please type questions in the top of the right sidebar
  - All questions are anonymous
  - Try to keep them relevant to the topic

- We will answer questions towards the end

- The chat is not anonymous, and should **not** be used for questions

- If you have more questions:
  - Go to DevZone for Nordic related questions
  - https://www.lairdconnect.com/contact

- A recording of the webinar will be available together with the presentation at webinars.nordicsemi.com

Agenda

- Overview of the Nordic nRF5340 advanced dual-core wireless SoC and nRF21540 RF FEM

- Detailed architecture descriptions of nRF5340 SoC and nRF21540 RF FEM

- Overview of how they are integrated into a certified BL5340PA module range from Laird Connectivity

- Review of use cases where this solution maximizes product performance and wireless range

Agenda

nRF5340 overview and highlights

nRF5340 SoC

Application Processor

128 MHz Arm®
Cortex®-M33

1024 KB Flash

512 KB RAM

Network Processor

64 MHz Arm®
Cortex®-M33

256 KB Flash

64 KB RAM

Multiprotocol
2.4 GHz radio

- High-performance application processor
- Fully programmable, ultra-low power network processor
- Redesigned multiprotocol radio
- Advanced security features
- 1.7-5.5 V supply range
- -40 to +105°C

Multi-core flexibility

- High performance and high efficiency – no trade-off

- Distinct optimization
  - Performance
  - Efficiency

- Separation of concerns
  - Real-time requirements
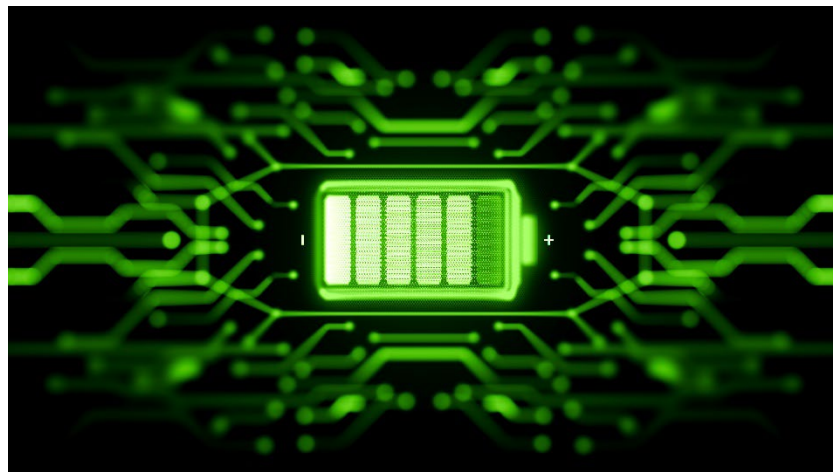 - Software split

Multiprotocol radio

- Bluetooth 5.3 and beyond
  - LE Audio
  - Direction Finding
  - 2 Mbps, Long Range and Advertising Extensions
- Bluetooth mesh, 802.15.4 (Thread, Zigbee)
- Matter
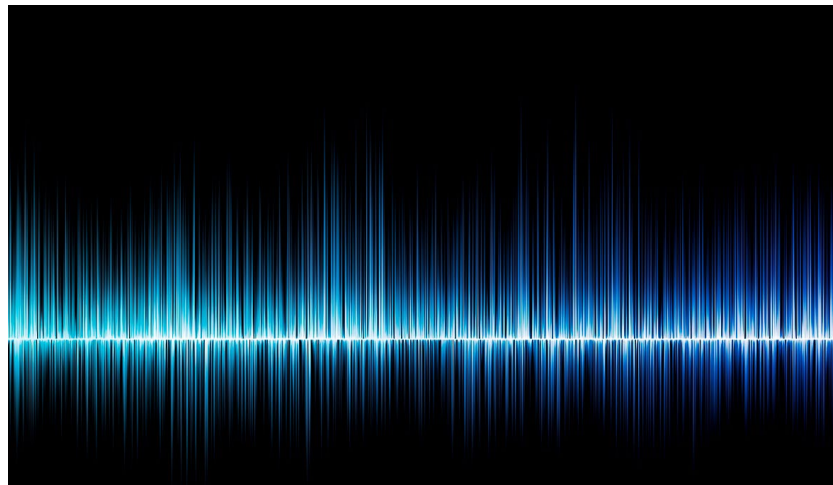
Radio improvements

- TX current reduced by **29 %** down to 3.2 mA

- RX current reduced by **41 %** down to 2.6 mA

- -98 dBm RX sensitivity

- 1 dB resolution of TX power

All-in-one

- nRF52 Series feature superset
  - Bluetooth 5.3, Thread and Zigbee
  - CryptoCell, USB, QSPI, HS-SPI
  - 1.7-5.5 V and up to 105 °C
- More
  - Performance
  - Memory
  - Integration
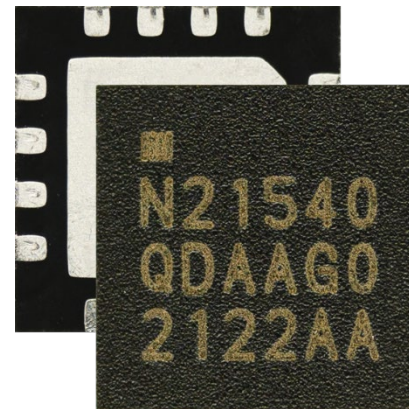- While minimizing power consumption

nRF21540 overview

- RF front-end module (FEM)

- Includes both a power amplifier (PA) and low noise amplifier (LNA)

- Supports

    - Bluetooth LE, Bluetooth mesh

    - Thread/Zigbee

    - 2.4 GHz proprietary

- +13 dB receive gain, 2.7 dB noise figure
    - Up to 5 dB improvement in RX sensitivity

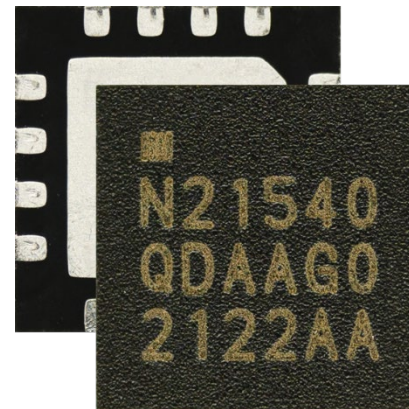- Configurable TX output power up to +21 dBm
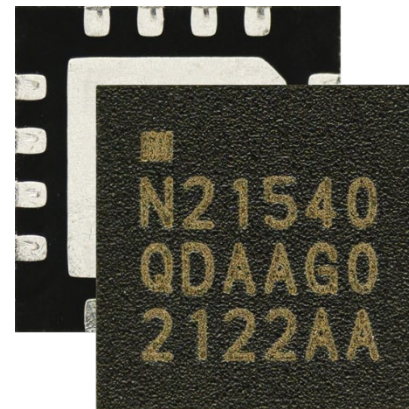
nRF21540 overview

- SoC + nRF21540 configurable to be ARIB, ETSI and/or FCC approved

- Interfaces and TX gain control
  - GPIO control, SPI control or a combination
  - TX gain control, antenna switching and power modes

nRF21540 overview

- Single ended 50 Ω matched input and output

- Antenna diversity support (Thread/Zigbee)

- No bypass mode support

- Operating Conditions
  - 1.7 to 3.6V supply range
  - -40°C to +105°C

- Package Variants
  - 4x4mm QFN16, 0.65mm pitch

Agenda

nRF5340 SoC

Power and clock

Power supply

LDO

Buck DC/DC

| POR | BOR |

Oscillators

32 MHz RC/XO

32 kHz RC/XO

Audio PLL

Debug

Debug

Application Processor

64/128 MHz Arm® Cortex®-M33, DSP, FPU, TrustZone	1024 KB Flash
	512 KB RAM
	8 KB I-Cache	IPC

AHB / APB / EasyDMA / DPPI

System Peripherals

| 3×TIMER | 2×RTC | 2×WDT | 6×EGU |

Security

| Arm CryptoCell-312 | SPU | KMU |

Digital, analog I/F and GPIO

USB	QSPI	HS-SPI	4×UART/SPI/TWI
I2S	PDM	4×PWM	2×QDEC
NFC-A Tag	SAADC	LPCOMP	COMP
GPIOTE	Shared 48-pin crossbar

Network Processor

64 MHz Arm® Cortex®-M33	256 KB Flash
	64 KB RAM
IPC	2 KB I-Cache

AHB / APB / EasyDMA / DPPI

System Peripherals

| 3×TIMER | 2×RTC | WDT | EGU | RNG | TEMP |
| ECB | AAR | CCM |

Digital I/F and GPIO

UART/SPI/TWI

| GPIOTE | Shared 48-pin crossbar |

Multiprotocol
2.4 GHz radio

Application processor

Application Processor

64/128 MHz Arm® Cortex®-M33, DSP, FPU, TrustZone	1024 KB Flash
	512 KB RAM
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AHB / APB / EasyDMA / DPPI

System Peripherals

3×TIMER	2×RTC	2×WDT	6×EGU

Security

Arm CryptoCell-312	SPU	KMU

Digital, analog I/F and GPIO

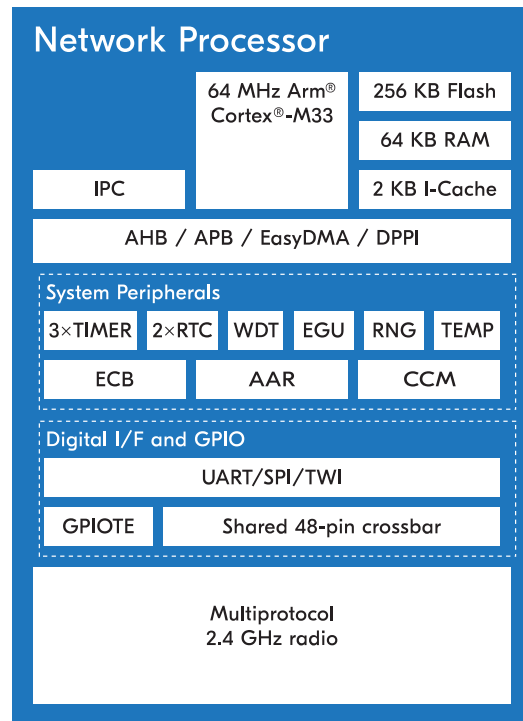| USB	QSPI	HS-SPI	4×UART/SPI/TWI
I2S	PDM	4×PWM	2×QDEC
NFC-A Tag	SAADC	LPCOMP	COMP
GPIOTE	Shared 48-pin crossbar		
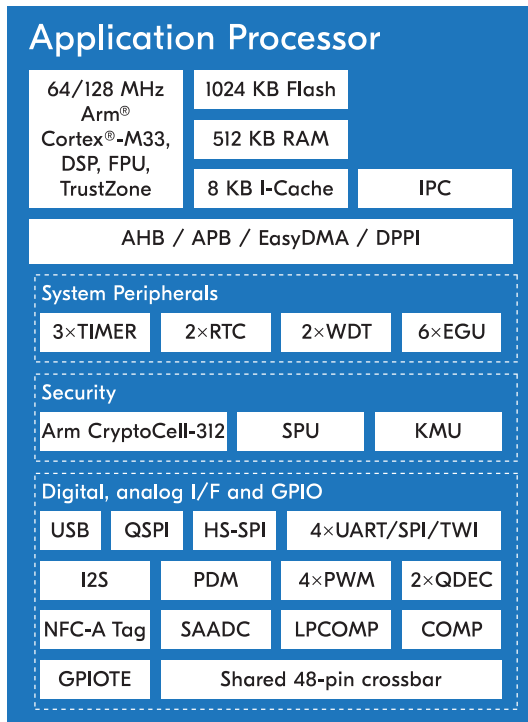
- Arm Cortex-M33 with DSP and floating-point instructions
- 128 MHz and 64 MHz clock speeds
- Voltage-frequency scaling
- Optimized for performance
- Arm TrustZone support
- 8 KB 2-way set associative cache
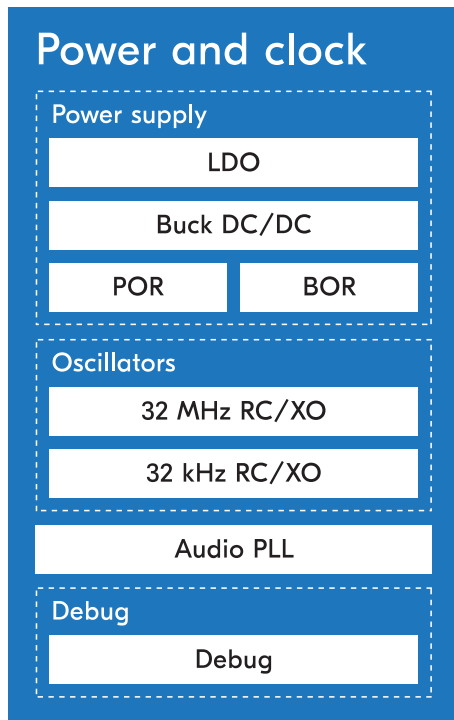- 1024 KB flash
- 512 KB RAM

Network processor

- Arm Cortex-M33

- 64 MHz clock speed

- Optimized for efficiency

- Fully programmable

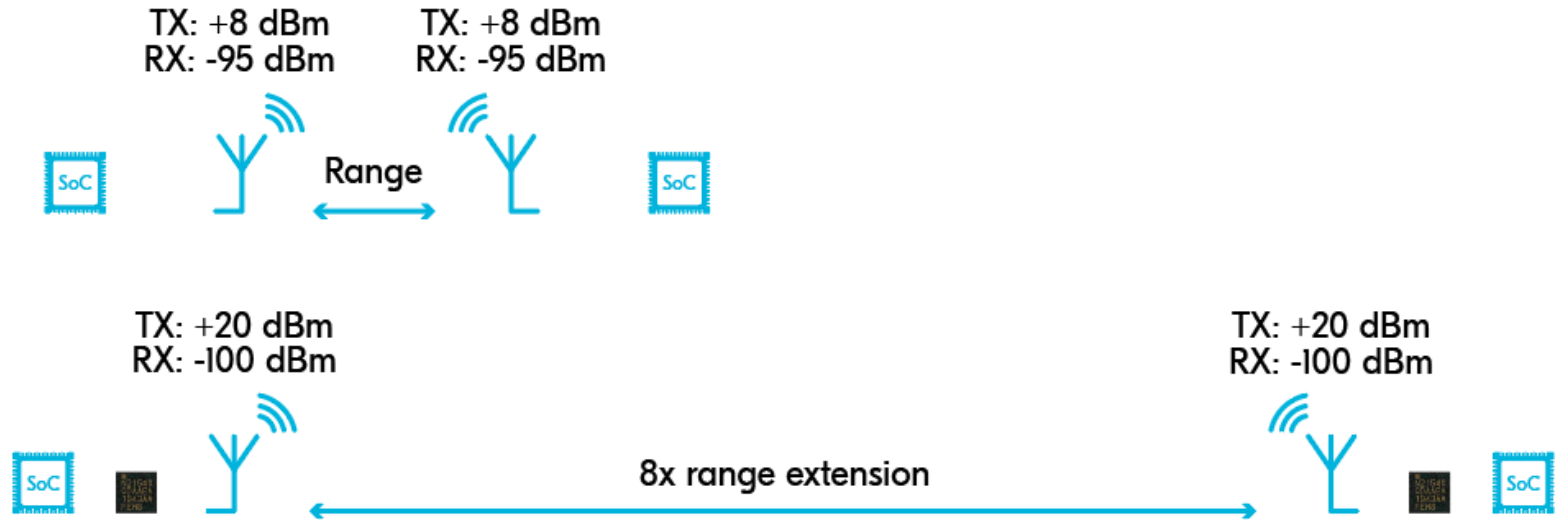- 2 KB instruction cache

- 256 KB Flash

- 64 KB RAM

Network Processor

	64 MHz Arm® Cortex®-M33	256 KB Flash
		64 KB RAM
IPC		2 KB I-Cache

AHB / APB / EasyDMA / DPPI

System Peripherals

3×TIMER	2×RTC	WDT	EGU	RNG	TEMP
ECB		AAR		CCM	

Digital I/F and GPIO

UART/SPI/TWI

GPIOTE	Shared 48-pin crossbar

Multiprotocol
2.4 GHz radio

Multi-core flexibility

App @ 128 MHz

514 CM

66 CM/mA

64 MHz

212 CM

64 CM/mA

App @ 64 MHz

257 CM

73 CM/mA

Net @ 64 MHz

244 CM

101 CM/mA

Performance [CoreMark]

Efficiency [CoreMark/mA]

Power and clock

Power and clock

Power supply
LDO

Buck DC/DC

POR | BOR

Oscillators
32 MHz RC/XO

32 kHz RC/XO

Audio PLL

Debug
Debug

- Power supply
  - 1.7 to 5.5 V
  - LDO and DC/DC options
  - Direct supply from USB

- Oscillators
  - Integrated load capacitors
  - 32 MHz and optional 32 kHz crystals

- Tunable on-chip Audio PLL
  - 11.289 or 12.288 MHz
  - Low jitter, suitable for audio applications
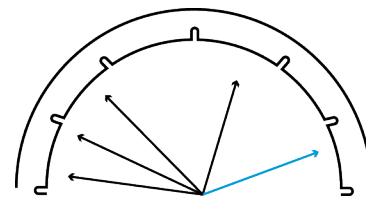
Up to 10x range increase with nRF21540 RF FEM

TX: +8 dBm
RX: -95 dBm

TX: +8 dBm
RX: -95 dBm

Range

TX: +20 dBm
RX: -100 dBm

TX: +20 dBm
RX: -100 dBm

8x range extension

Up to 10x range increase

- Between 6.3-10 x the range in a symmetric link
  - Valid for all nRF52 Series SoCs and the nRF5340 SoC

- Up to ~5 dB improvement in RX sensitivity

- Useful for Bluetooth Low Energy, Bluetooth mesh, Thread and Zigbee and 2.4 GHz proprietary applications

Increased link robustness

- Up to 20 dB increased link budget
  - Up to 17 dB from TX, up to 5 dB from RX (depends on the wireless SoC)

- Minimize packet loss and retransmissions
  - Improved communication latency

- Dynamic output power adjustments
  - Customers can optimize link budget via RSSI measurements to improve link robustness when link environment or link range changes
  - Bluetooth LE Power control experimental support as of nRF Connect SDK 2.2.0

Adjustable output power

- Output power adjustable to +/- 1 dB around 10/20 dBm (ETSI/FCC limits), upper limit 21 dBm

- User programmable modes for TX gain

- Worldwide coverage with one device with different output power settings possible

- Easy adjustments possible via SPI, GPIOs or combination of both

Agenda

Overview of the BL5340PA Series

Industrial Focus
-40°C to + 105°C temp range

Nordic Silicon combination
nRF5340 SoC + nRF21540
Front End Module (FEM)

Unmatched Processing
DUAL CORE Cortex M33

- 128/64 MHz (1MB Flash + 512k RAM)
- 64 MHz (256k Flash + 64k RAM)

Multi-Wireless
Bluetooth 5.x +
802.15.4 + NFC in
one integrated
solution

Sleep
3.1uA System ON Idle
0.9uA System OFF Same
as BL5340, even with FEM
inside BL5340PA

Output Power
Upto 18.5dBm BLE
Upto 21.0dBm IEEE 802.15.4

Broad Certifications
FCC, IC, RCM and
Bluetooth® SIG
Qualification

Multiple Antenna Options
Integrated PCB Antenna or
MHF4 RF connector for
External Antenna options
with 6 pre certified antenna
options

750-03291-R2.1
FCC ID: SQGBL5340PA
IC: 3147A-BL5340PA

M/N:BL5340PA R2
P/N:453-00068 Int

750-03291-R2.1
FCC ID: SQGBL5340PA
IC: 3147A-BL5340PA

M/N:BL5340PA R2
P/N:453-00076 Ext

R-NZ

R-NZ

NORDIC
SEMICONDUCTOR

FC

Industry
Canada

Laird™ CONNECTIVITY

Inside BL5340PA vs BL5340

BL5340PA

BL5340

21mm

10mm

nRF21540 FEM

NORDIC
SEMICONDUCTOR

nRF5340 SoC

15mm

10mm

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Pin out differences BL5340 to BL5340PA

Review of the interconnects between SoC & FEM

BL5340PA – Voltage Modes

- **Designed for performance**
  3.0 – 3.6V, as RF TX power drops with voltage

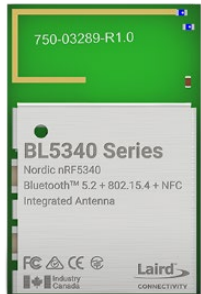- Note this requirement if using USB interface
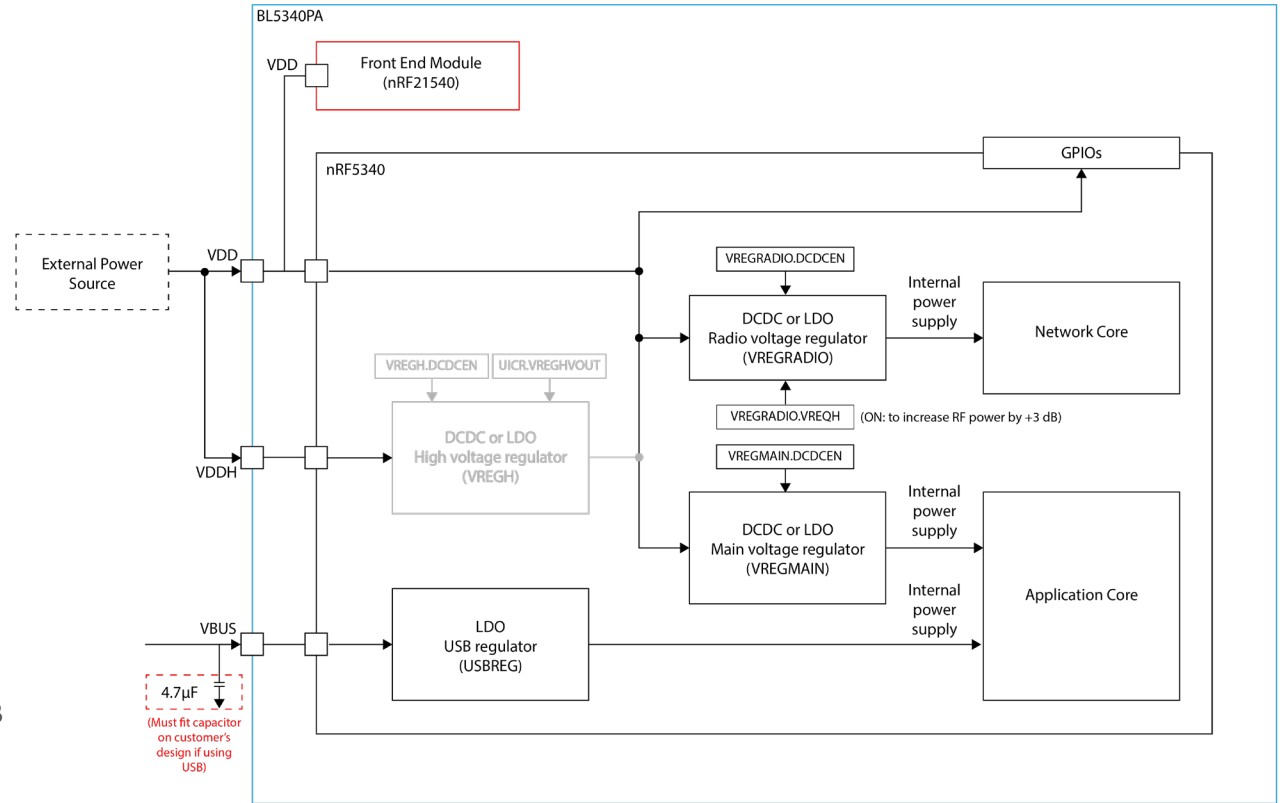
Link Budget – BL5340PA vs BL5340

20.5dB increase in link budget!

TX power BLE	Peak Antenna gain TX and RX side	RX sensitivity BLE 1Mbps	Total Link Budget radiated	LoS Range estimate
+18.5dBm	+1.49dBi	-103dBm	124.48dB	23,000 meters

TX power BLE	Peak Antenna gain TX and RX side	RX sensitivity BLE 1Mbps	Total Link Budget radiated	LoS Range estimate
+3dBm	+1.49dBi	-98dBm	103.98dB	2,180 meters

Antenna Options and Capabilities

BL5340PA has 2 dedicated skus

- 453-00068 has an integrated PCB antenna

- 453-00076 has **BOTH** integrated antenna and MHF4 connector
  - *Enables option for antenna selection or switching!*
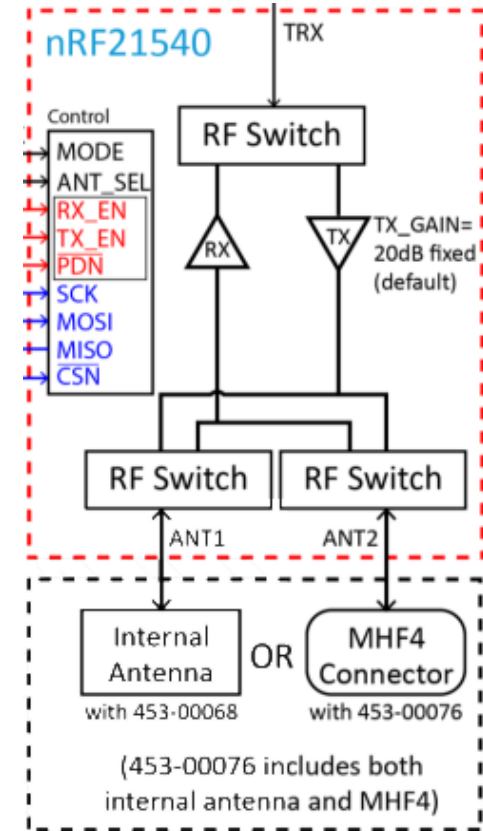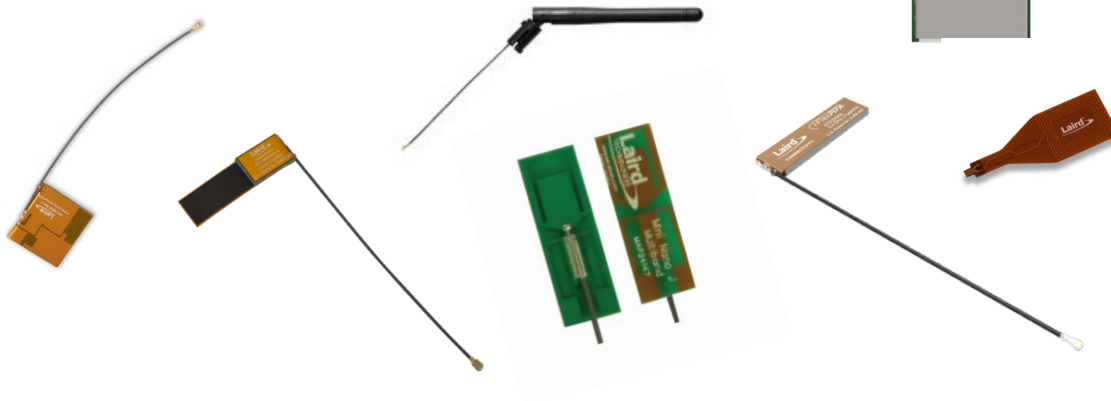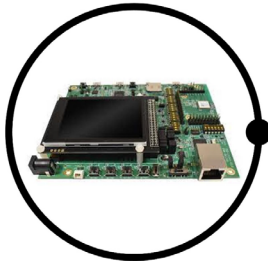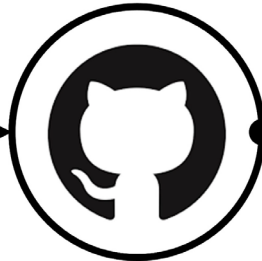
The Kitchen Sink Development Kit!
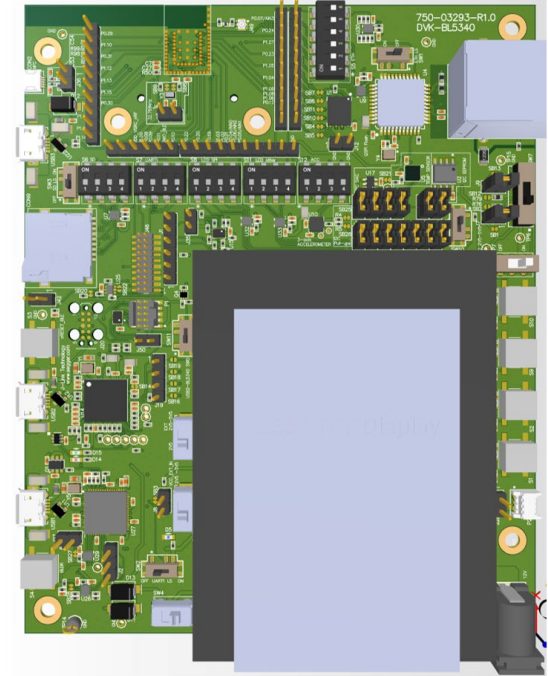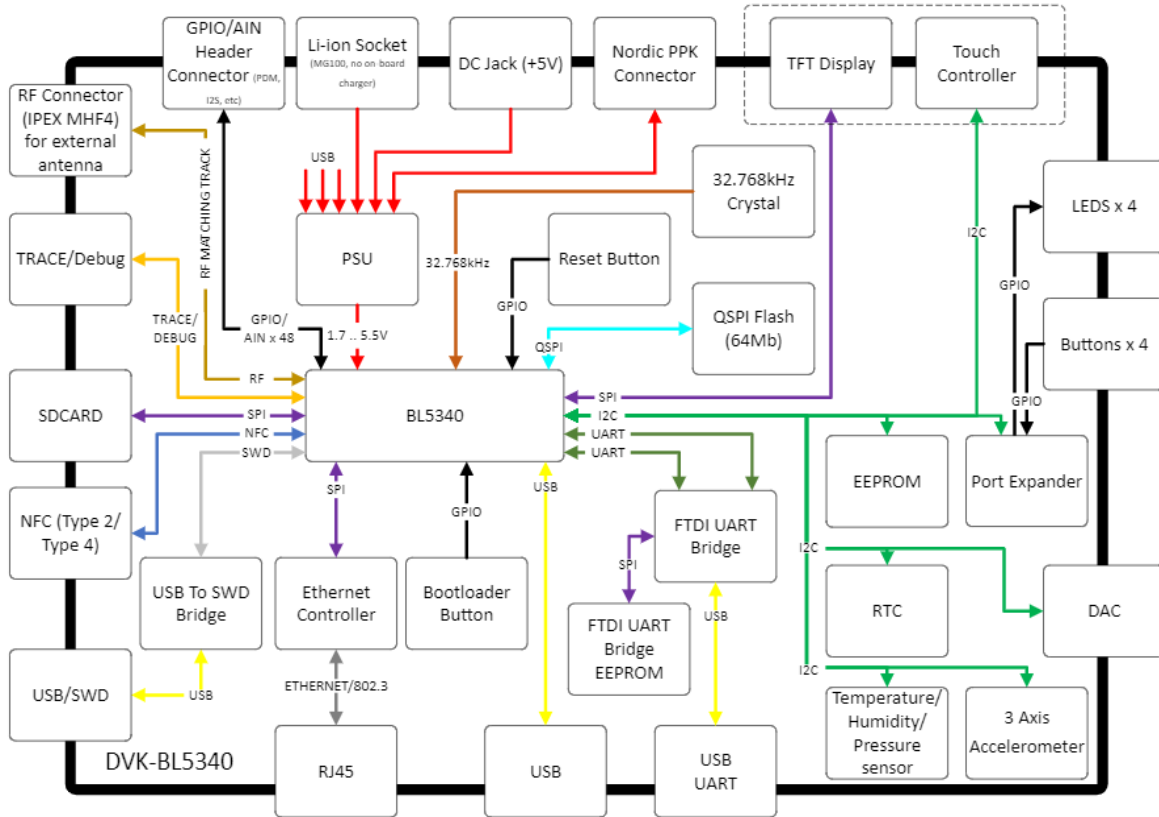
BL5340PA software implementation

- BL5340PA DVK Boards File added to nRFConnect SDK fork of Zephyr

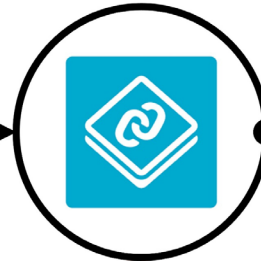- This describes the features of the DVK, but also critically the characteristics of the BL5340PA module
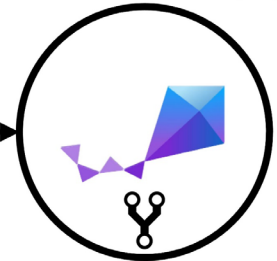
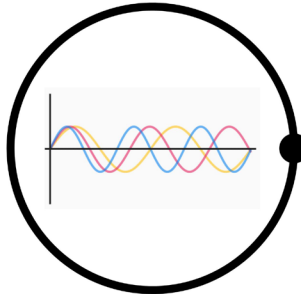BL5340PA DVK Boards File → Github → nRF Connect SDK → nRF Connect SDK Zephyr fork

The critical importance of power tables

- BL5340PA Power Tables added to nRFConnect SDK Drivers section

- These describe the limitations to apply to radio channels to ensure regulatory compliance

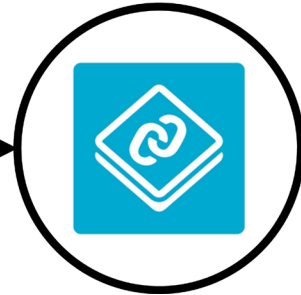- The Power Tables are referenced by the BL5340PA DVK Boards File
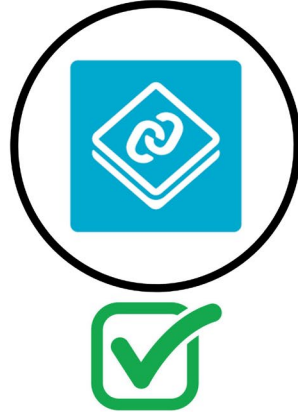
BL5340PA Power Tables   Github   nRF Connect SDK

Multi Protocol Server Layer

- BL5340PA Power Tables work in conjunction with Nordic's Multi Protocol Service Layer (MPSL)

- Only currently available in the nRFConnect SDK

nRF Connect SDK

Zephyr

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Regulatory Certification

- To date the BL5340PA series is certified for
  - FCC (US)
  - ISED (Canada)
  - RCM (Australia & New Zealand)

- Bluetooth LE and 802.15.4 certified for each supported region

- Full range of pre certified antennas per region

What about CE / UKCA?

- ETSI EN300 328 certification for high output radio devices relies on complex control of the radio duty cycle (Time on Air or TOA)

- This needs to be performed at the lower levels of the radio driver

- Currently using the SoftDevice and MPSL, limited to a maximum of +10dBm for Europe, so to date not proceeded with certification due to this limited performance improvement over the BL5340.

CE

UKCA

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Agenda

Predictive Maintenance with Machine Learning

Industrial / Manufacturing

LE Audio

Transport Infrastructure

Asset Tracking

Locationing

Q&A

Further details on BL5340PA –
https://www.lairdconnect.com/bl5340pa-series