

# Datasheet

## BL54H20 Series

*Version 1.0*

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## Revision History

| Version | Date        | Notes                                                                                                  | Contributor(s) | Approver      |
|---------|-------------|--------------------------------------------------------------------------------------------------------|----------------|---------------|
| 0.1     | 02 Oct 2024 | Initial PRELIMINARY release.                                                                           | Raj Khatri     | Jonathan Kaye |
| 0.2     | 16 Oct 2024 | Added External Antenna Integration with BL54H20 MHF4 variant (453-00198)                               | Raj Khatri     | Jonathan Kaye |
| 0.3     | 25 Oct 2024 | Added Ignion NN02-101 chip antenna part number into section PCB Layout on Host PCB for the 453-0019x   | Raj Khatri     | Jonathan Kaye |
| 0.4     | 22 Nov 2024 | Add Chip Antenna Performance<br>Modify Maximum Transmit Power Setting in Specification Summary to 7dBm | Louis Chang    | Jonathan Kaye |
| 0.5     | 5 Dec 2024  | Modify some incorrect comment in 3.2 Pin Definition<br>Add partial sensitivity value                   | Louis Chang    |               |
| 1.0     | 5 Dec 2024  | Initial release.                                                                                       | Dave Drogowski | Jonathan Kaye |
|         |             |                                                                                                        |                |               |
|         |             |                                                                                                        |                |               |

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# 1 Overview and Key Features



The newest entry in our Nordic Semiconductor based Bluetooth LE portfolio is by far the most advanced, most secure, and highest performing multi core MCU architecture wireless solution available anywhere.

The BL54H20 series of robust, tiny modules feature the **Nordic nRF54H20 SoC**. It directly targets the highest-performance processing capabilities with double the application processing (vs. prior BL5340). **2x Cortex-M33** AND **2x RISC-V coprocessors** each are optimized for particular workloads. We've also scaled up memory to 2MB non-volatile and 1MB RAM.

Featuring BT 5.4, capabilities include support for Bluetooth LE, LE Audio, Bluetooth Mesh, and 802.15.4 protocols including Thread and Matter.

It's further enhanced with state-of-the-art security, designed for PSA Certified level 3, and supports Secure Boot, Secure Firmware Update, Secure Storage, and integrated tamper sensors for physical security.

The BL54H20 series brings out all nRF54H20 hardware features and capabilities including high speed **USB access**, **CAN FD** controller, 2 x **I3C** and **14bit ADC**, up to +10 dBm transmit power, from **1.9V to 5.5V** supply considerations, and a true industrial operating range of **-40 to 105°C**.

Complete regulatory certifications enable faster time to market and reduced development risk, simplifying your next wireless design.

**Note:** BL54H20 hardware provides all functionality of the nRF54H20 chipset used in the module design. This is a hardware datasheet only – it does not cover the software aspects of the BL54H20. This is to acknowledge that information in this datasheet is referenced from the nRF54H20 datasheet.

## 1.1 Features and Benefits

- **Nordic nRF54H20** – 4.7xmm4.3 WSCLP with 64 GPIOs available.
- **Multi-protocol support:** Bluetooth 5.4 LE, 802.15.4 (Thread/Matter)
- Bluetooth LE: Peripheral/Central, 2 Mbps (high throughput), LE Coded (long range), AoA/AoD, LE Audio/Isochronous Channels, Mesh
- **Dual Cortex M33 processor cores:** Application processor (up to 320MHz Cortex M33), Radio processor (256MHz Cortex M33)
- Dual RISC-V co-processor cores: 320 MHz VPR, 16 MHz VPR
- **Memory:** 2MB non-volatile memory, 768 KB RAM, and External interfaces – XIP, QSPI, xSPI, HyperBus
- Extended Industrial Temperature Rating (-40° to +105°C)
- **Small form factor:** 13.5 x 10 x 1.8 mm
- **Most configurable interfaces:** - NFC A-Tag, USB, CAN FD, I3C, UART, QSPI, SPI, High Speed SPI, SMIF, I2S, I2C, PDM, PWM, ADC, GPIO, QDEC, Comparator, Low Power Comparator
- **Additional SoC Hardware Features** like RNG, WDT, temperature sensor, floating point unit, inter-processor communication, debug trace, NFC
- **Antenna choice** –external antenna support via MHF4 connector OR integrated pre-certified Chip antenna - **Ignion NANO NN02**
- **Development choice:** Zephyr RTOS, Nordic nRF Connect SDK, Canvas Software Suite
- Firmware Over the Air (FOTA) via MCUboot and Zephyr
- Hostless operation – Multi Core MCU reduces BOM
- Fully featured development kits to jump start Bluetooth LE development

## 1.2 Application Areas

- Smart Building
- Asset Tracking
- Secure Medical Peripherals
- Industrial Automation

## 2 Specification

### 2.1 Specification Summary

| Categories/Feature                                                                          | Implementation                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                   |
|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| Wireless Specification                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                   |
| Bluetooth®                                                                                  | Bluetooth 5.4 – Single mode <ul style="list-style-type: none"><li>GATT client/server – Any adopted/custom services</li><li>Central/Peripheral roles</li><li>Bluetooth LE mesh</li><li>2M PHY</li><li>LE Coded PHY</li><li>LE Audio w/ Isochronous streams</li><li>AoA / AoD</li><li>LE Advertising Extensions</li><li>LE secure connections</li><li>Data packet length extensions</li><li>LE privacy v1.2</li><li>DTM Firmware (Test Modes)</li></ul> |                                                                   |
| IEEE 802.15.4-2006 PHY                                                                      | 2405–2480 MHz IEEE 802.15.5-2006 radio transceiver, implementing IEEE 802.15.5-2006 compliant <ul style="list-style-type: none"><li>250kbps,2450MHz, O-QPSK PHY</li><li>Channels 11-26. Channel 11 2405MHz and CH26 2480MHz.</li><li>Clear channel assessment (CCA)</li><li>Energy detection (ED) scan</li><li>CRC generation</li></ul>                                                                                                               |                                                                   |
| Nordic proprietary 1Mbps and 2Mbps modes radio ( <i>not currently certified by Ezurio</i> ) | 2402–2480 MHz Nordic proprietary 1Mbps and 2Mbps modes radio transceiver <ul style="list-style-type: none"><li>1Mbps nRF proprietary mode (ideal transmitter)</li><li>2Mbps nRF proprietary mode (ideal transmitter)</li><li>4Mbps nRF proprietary mode (ideal transmitter)</li></ul>                                                                                                                                                                 |                                                                   |
| Frequency                                                                                   | 2.402 - 2.480 GHz for BLE (CH0 to CH39)<br>2.405 - 2.480 GHz for IEEE 802.15.4-2006 PHY (CH11 to CH26)                                                                                                                                                                                                                                                                                                                                                |                                                                   |
| Raw Data Rates                                                                              | 1 Mbps BLE (over-the-air)<br>2 Mbps BLE (over-the-air)<br>125 kbps BLE (over-the-air)<br>500 kbps BLE (over-the-air)<br>250 kbps IEEE 802.15.4 802.15.4-2006 (over-the-air)<br>Nordic proprietary 1Mbps, 2Mbps and 4Mbps modes (over-the-air)                                                                                                                                                                                                         |                                                                   |
| Maximum Transmit Power Setting                                                              | +7 dBm                                                                                                                                                                                                                                                                                                                                                                                                                                                | Conducted 453-000197 (Integrated antenna), (Exclude antenna gain) |
|                                                                                             | +7 dBm                                                                                                                                                                                                                                                                                                                                                                                                                                                | Conducted 453-000198 (External antenna), (Test at MHF4 connector) |
| Minimum Transmit Power Setting                                                              | TBD                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                   |
| Receive Sensitivity (≤37byte packet for BLE) <sup>1</sup>                                   | BLE 1 Mbps (BER=1E-3)                                                                                                                                                                                                                                                                                                                                                                                                                                 | -97 dBm typical                                                   |
|                                                                                             | BLE 2 Mbps                                                                                                                                                                                                                                                                                                                                                                                                                                            | -94 dBm typical                                                   |
|                                                                                             | BLE 125 kbps                                                                                                                                                                                                                                                                                                                                                                                                                                          | -105 dBm typical                                                  |
|                                                                                             | BLE 500 kbps                                                                                                                                                                                                                                                                                                                                                                                                                                          | -100 dBm typical                                                  |
|                                                                                             | IEEE 802.15.4-2006 250kbps                                                                                                                                                                                                                                                                                                                                                                                                                            | -TBD dBm typical                                                  |
| Link Budget (conducted)                                                                     | TBD dB                                                                                                                                                                                                                                                                                                                                                                                                                                                | @ BLE 1 Mbps                                                      |
|                                                                                             | TBD dB                                                                                                                                                                                                                                                                                                                                                                                                                                                | @ BLE 125 kbps                                                    |

Note<sup>1</sup> Known Noise on channels 2432MHz and 2464MHz degrades receiver sensitivity, in which sensitivity are not within the typical value

**NFC**

NFC-Tag A Listen mode compliant

**Based on NFC forum specification:** 13.56 MHz, Date rate 106 kbps, NFC Type2 and Type 4 emulation

**Modes of Operation:** Disable, Sense, Activated

**Use Cases:** Touch-to-Pair with NFC, NFC enabled Out-of-Band Pairing

System Wake-On-Field function: Proximity Detection

| Peripherals Domain                | Co-processor High Speed Core                                                                              | Co-processor Low Leakage Core                           | Application Core                                                                                         | Radio Core                                                                                                          | Security Core                                                                                |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| Global Domain                     |                                                                                                           |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| Two co-processors                 | FLPR “Flipper”<br>Viper Risc-V<br>320MHz<br>64KB RAM<br>2048KB MRAM                                       | PPR “Pepper”<br>Viper Risc-V<br>16MHz<br>64KB RAM       | Arm Cortex M33<br>320MHz Max<br>32KB RAM,<br>DVFS<br>L1 I-cache<br>L1 D-cache<br>TrustZone, FPU,<br>DSP. | Arm Cortex M33<br>256MHz Max<br>Fast Start-Stop.<br>192KB RAM<br>L1 I-cache<br>L1 D-cache<br>TrustZone, FPU,<br>DSP | Arm Cortex M33 DVFS.<br>32kB RAM.<br><br>Designed for PSA Level 3.<br>Secure boot, secure FW |
| Total                             | 64 x multifunction I/O lines                                                                              |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| GPIO                              | 14x 1.8V 200MHz GPIO’s.<br>8x 1.8V 100MHz GPIO’s.                                                         | 6x 1.8-3.6V 16MHz GPIO’s.<br>36x 1.2-1.8V 16MHz GPIO’s. |                                                                                                          |                                                                                                                     |                                                                                              |
| EXMIF (External Memory Interface) | 1x EXMIF interface XiP capable, supports SPI, QPSI, xSPI, Hyperbus upto 400MB/s.<br>Max clock 200MHz      |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| HS-USB 2.0                        | 1x<br>480Mbps                                                                                             |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| I3C                               | 2x I3C (33.4Mbps)<br>Master, slave or Multimaster                                                         |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| CAN                               | 1x                                                                                                        |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| Global RTC                        | 1x<br>System Timer 1us resolution<br>52bits wide                                                          |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| HS-SPIM                           | 1x (64MHz)                                                                                                |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| HS-SPIS                           | 1x (64MHz)                                                                                                |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| HS-SPIM-UART                      | 1x                                                                                                        |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| HS-PWM                            | 1x 8 channel PWM (160MHz)                                                                                 |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| PWM                               | 2x<br>runs 320MHz                                                                                         | 4x 4 channel PWM (16MHz).<br>8channel                   |                                                                                                          |                                                                                                                     |                                                                                              |
| Timer                             | 2x<br>runs 320MHz                                                                                         | 6x<br>runs 16MHz                                        |                                                                                                          |                                                                                                                     |                                                                                              |
| SMIF                              | 1x<br>works with external ISO7816 standard                                                                |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| I2S, TDM                          | 1x                                                                                                        |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| PDM                               | 1x                                                                                                        |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| Audio PLL                         | 1x<br>Optional clock source for PDM, I2S, TDM audio interfaces. Incoming BLE audio.                       |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| QDEC (Quadrature decoder)         | 2x                                                                                                        |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| SPI, I2C, UART                    | 8x                                                                                                        |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |
| ADC (200kbps)                     | 1xSAADC on GPIO port P1 or P9. P9 can use voltage division.<br>3 modes:<br>10-bit 4MS/s<br>12-bit 125kS/s |                                                         |                                                                                                          |                                                                                                                     |                                                                                              |

| Peripherals Domain                                                    | Co-processor High Speed Core                                                                                                                                                                                                                                                                                                                                                                                                                                     | Co-processor Low Leakage Core                                                                                                                                                                                                                                                                | Application Core | Radio Core | Security Core                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Global Domain                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
|                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 14-bit 31.25kS/s<br>Upto 8channels AIN0-AIN7                                                                                                                                                                                                                                                 |                  |            |                                                                                                                                                                                                                                      |
| COMP                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 x COMP (comparator)                                                                                                                                                                                                                                                                        |                  |            |                                                                                                                                                                                                                                      |
| LPCOMP                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 x LPCOMP (low power comparator) can wake from System OFF                                                                                                                                                                                                                                   |                  |            |                                                                                                                                                                                                                                      |
| NFC A-Tag                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1x NFC A-Tag                                                                                                                                                                                                                                                                                 |                  |            |                                                                                                                                                                                                                                      |
| External optional 32.768 kHz crystal                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Not needed for normal radio operation.<br><br>Optionally, connect +/-20ppm accuracy crystal for more accurate protocol timing. Fit associated load capacitor for crystal or use nRF54L15 internal load capacitor, which is configurable as TBD pF to TBD pF in TBDpF steps on pins XL1, XL2. |                  |            |                                                                                                                                                                                                                                      |
| Security                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                              |                  |            | Designed for PSA Certified Level 3 with Secure Boot, Secure Firmware Update, and Secure Storage. Integrated tamper sensors detect attacks and take action, and cryptographic accelerators are hardened against side-channel attacks. |
| Programmability                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Programming Options                                                   | Nordic nRF Connect SDK: Software/Support available from Nordic directly: <a href="https://devzone.nordicsemi.com/">https://devzone.nordicsemi.com/</a><br>Zephyr RTOS: Software/Support available from Nordic directly: <a href="https://www.zephyrproject.org/">https://www.zephyrproject.org/</a><br>Canvas SW Suite: Software/ Support available from <a href="https://www.ezurio.com/canvas/software-suite">https://www.ezurio.com/canvas/software-suite</a> |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| FW upgrade                                                            | Via UART, SWD, or Bluetooth LE – via nRF Connect SDK or Zephyr                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Supply Voltage                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Supply Voltage                                                        | High Voltage Mode (VDD_HV): 1.9 - 5.5V (Internal DCDC convertor or LDO)<br>Normal Voltage Mode (VDD_VDD_HV): 1.8V                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Power Consumption                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Active Modes Peak Current (for maximum Tx power +10 dBm) – Radio only | TBD mA peak Tx (with DCDC)                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Active Modes Peak Current (for Tx power -TBD dBm) – Radio only        | TBD mA peak Tx (with DCDC)                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Active Modes Average Current                                          | Depends on many factors (e.g. BLE Advertising interval BLE connection interval etc..)                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Ultra-low Power Modes                                                 | System ON Idle                                                                                                                                                                                                                                                                                                                                                                                                                                                   | TBD uA (wake on any event)                                                                                                                                                                                                                                                                   |                  |            |                                                                                                                                                                                                                                      |
|                                                                       | System OFF                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.6 uA (with GPIO wake up on 12pins)                                                                                                                                                                                                                                                         |                  |            |                                                                                                                                                                                                                                      |
| Antenna Options                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Internal                                                              | Chip antenna – on-board (453-00197 variant)                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| External                                                              | Connection via on module IPEX MHF4 – 453-00198 variant                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Physical                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Dimensions                                                            | 13.5mm x 10mm x 1.8mm<br><br>Pad Pitch – 0.65 mm<br><br>Pad Type – Three rows of pads (LGA - Land Grid Array).                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Weight                                                                | <1 gram                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Environmental                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |
| Operating                                                             | -40 °C to +105 °C                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                              |                  |            |                                                                                                                                                                                                                                      |

|                          |                                                                             |
|--------------------------|-----------------------------------------------------------------------------|
| Storage                  | -40 °C to +105 °C                                                           |
| <b>Miscellaneous</b>     |                                                                             |
| Lead Free                | Lead-free and RoHS compliant                                                |
| Warranty                 | One-Year Warranty                                                           |
| <b>Development Tools</b> |                                                                             |
| Development Kit          | Development kit per module SKU (453-00197-K1 and 453-00198-K1 respectively) |
| Development Tools        | Nordic nRF Connect - Android and iOS applications<br>XBit Tools & Utilities |
| Bluetooth®               | Full Bluetooth SIG Declaration ID                                           |
| FCC/ISED/CE/MIC/RCM/UKCA | All BL54H20 Series                                                          |

### 3.1 Block Diagram and Pin-out

**Figure 1: BL54H20 HW block diagram**



## Table 1: Pin definitions

<https://www.ezurio.com/>

| Pin # | Pin Name     | nRF54H20<br>WLCSP Pin | nRF54H20 WLCSP Name | Comment                                                                                                           | If Not<br>Used |
|-------|--------------|-----------------------|---------------------|-------------------------------------------------------------------------------------------------------------------|----------------|
|       |              |                       |                     | 1.8V typical (1.62V-1.98V).                                                                                       |                |
| 22    | P9.04        | C11                   | P9.04               | -                                                                                                                 |                |
| 23    | P9.00        | A11                   | P9.00               | Ezurio Devkit: LED2                                                                                               |                |
| 24    | P0.11        | G9                    | P0.11               | Ezurio Devkit: BUTTON4                                                                                            |                |
| 25    | D+           | B7                    | D+                  |                                                                                                                   |                |
| 26    | P0.10        | F9                    | P0.10               | Ezurio Devkit: BUTTON3                                                                                            |                |
| 27    | P0.07        | E9                    | P0.07               | -                                                                                                                 |                |
| 28    | D-           | B8                    | D-                  |                                                                                                                   |                |
| 29    | P0.04        | D8                    | P0.04               | -                                                                                                                 |                |
| 30    | P0.00        | C9                    | P0.00               | -                                                                                                                 |                |
| 31    | GND          |                       | VSS                 |                                                                                                                   |                |
| 32    | P0.03        | D9                    | P0.03               | -                                                                                                                 |                |
| 33    | GND          |                       | VSS                 |                                                                                                                   |                |
| 34    | P0.06        | E10                   | P0.06               | -                                                                                                                 |                |
| 35    | P0.09        | F10                   | P0.09               | Ezurio Devkit: BUTTON2                                                                                            |                |
| 36    | VDDIO_P9     | A12                   | VDDIO_P9            | External supply for 3V GPIO port P9.<br>3.3V typical (1.62-3.6V).                                                 |                |
| 37    | P0.01        | D11                   | P0.01               | -                                                                                                                 |                |
| 38    | P0.02        | D10                   | P0.02               | -                                                                                                                 |                |
| 39    | XL1          | B12                   | XL1                 | Ezurio Devkit: Optional 32.768kHz crystal pad XL2<br>and associated 9pF load capacitor inside<br>nRF54H20 chipset |                |
| 40    | GND          |                       | VSS                 |                                                                                                                   |                |
| 41    | XL2          | C12                   | XL2                 | Ezurio Devkit: Optional 32.768kHz crystal pad XL2<br>and associated 9pF load capacitor inside<br>nRF54H20 chipset |                |
| 42    | VDD_EXT      | D12                   | VDD_EXT             | Power output                                                                                                      |                |
| 43    | P0.05        | E11                   | P0.05               | -                                                                                                                 |                |
| 44    | P0.08        | F11                   | P0.08               | Ezurio Devkit: BUTTON1                                                                                            |                |
| 45    | SWDCLK       | F12                   | SWDCLK              | Serial Wire Debug clock input for debug and<br>programming                                                        |                |
| 46    | VDDIO_P7     | J12                   | VDDIO_P7            | External supply for GPIO port P7.<br>1.8V typical (1.62V-1.98V).                                                  |                |
| 47    | SWDIO        | G12                   | SWDIO               | Serial Wire Debug IO for debug and programming                                                                    |                |
| 48    | GND          |                       | VSS                 | -                                                                                                                 |                |
| 49    | NRESET       | H12                   | NRESET              | Pin RESET with internal pull-up resistor (13k<br>Ohms). System Reset (Active Low).                                |                |
| 50    | VDDIO_P6     | K8, K9, K19,<br>K11   | VDDIO_P6            | External supply for GPIO port P6.<br>1.8V typical (1.62V-1.98V).                                                  |                |
| 51    | P6.03/CS0    | K12                   | P6.03/CS0           | Recommended usage EXMIF CS0.                                                                                      |                |
| 52    | P6.04/DQ7    | L11                   | P6.04/DQ7           | Recommended usage EXMIF DQ7.                                                                                      |                |
| 53    | P6.01/CKN    | L12                   | P6.01/CKN           |                                                                                                                   |                |
| 54    | P6.00/CK     | M12                   | P6.00/CK            | Recommended usage EXMIF CK.                                                                                       |                |
| 55    | P6.02/RWDS   | M11                   | P6.02/RWDS          | Recommended usage EXMIF DQS.                                                                                      |                |
| 56    | P6.05/DQ1    | M10                   | P6.05/DQ1           | Recommended usage EXMIF DQ1.                                                                                      |                |
| 57    | GND          |                       | VSS                 |                                                                                                                   |                |
| 58    | P6.06/DQ6    | L10                   | P6.06/DQ6           | Recommended usage EXMIF DQ6.                                                                                      |                |
| 59    | P6.08/DQ5    | L9                    | P6.08/DQ5           | Recommended usage EXMIF DQ5.                                                                                      |                |
| 60    | P6.07/DQ0    | M9                    | P6.07/DQ0           | Recommended usage EXMIF DQ0.                                                                                      |                |
| 61    | P6.11/DQ4    | M7                    | P6.11/DQ4           | Recommended usage EXMIF DQ4.                                                                                      |                |
| 62    | P6.09/DQ3    | M8                    | P6.09/DQ3           | Recommended usage EXMIF DQ3.                                                                                      |                |
| 63    | P6.12/RESETN | L7                    | P6.12/RESETN        | Recommended usage EXMIF RESETN.                                                                                   |                |

| Pin # | Pin Name    | nRF54H20<br>WLCSP Pin | nRF54H20 WLCSP Name | Comment                                                                                                                                                                 | If Not<br>Used |
|-------|-------------|-----------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| 64    | P6.10/DQ2   | L8                    | P6.10/DQ2           | Recommended usage EXMIF DQ2.                                                                                                                                            |                |
| 65    | P6.13/CS1   | K7                    | P6.13/CS1           | .                                                                                                                                                                       |                |
| 66    | P7.06       | J10                   | P7.06               | Ezurio Devkit: MikroE SPI PWM (default no connection) and TRACE DATA2                                                                                                   |                |
| 67    | P7.05       | J11                   | P7.05               | Ezurio Devkit: MikroE SPI PWM (default connection) and TRACE DATA1                                                                                                      |                |
| 68    | P7.02       | H11                   | P7.02               | Ezurio Devkit: MikroE SPI CLK                                                                                                                                           |                |
| 69    | P7.03       | H10                   | P7.03               | Ezurio Devkit: TRACE CLK                                                                                                                                                |                |
| 70    | P7.01       | G10                   | P7.01               | Ezurio Devkit: MikroE SPI MOSI                                                                                                                                          |                |
| 71    | P7.00       | G11                   | P7.00               | Ezurio Devkit: MikroE SPI MISO                                                                                                                                          |                |
| 72    | P7.04       | H9                    | P7.04               | Ezurio Devkit: TRACE DATA0 and MikroE SPI CS                                                                                                                            |                |
| 73    | P7.07       | J9                    | P7.07               | Ezurio Devkit: TRACE DATA3                                                                                                                                              |                |
| 74    | P2.03       | H3                    | P2.03               | Ezurio Devkit: MikroE INT                                                                                                                                               |                |
| 75    | P2.05       | J3                    | P2.05               | Ezurio Devkit: UART0_CTS (input)                                                                                                                                        |                |
| 76    | P2.07       | K3                    | P2.07               | Ezurio Devkit: UART0_RTS (output)                                                                                                                                       |                |
| 77    | VDD_HV      | L1                    | VDD_HV              | Main Supply input 1.9V-5.5V for High Voltage Mode where connect external supply to VDD_HV and pin104(VDD_1V8) becomes an output supply (1.8V).<br>MUST fit 10uF to GND. |                |
| 78    | P2.08       | K2                    | P2.08               | Ezurio Devkit: MikroE UART RX                                                                                                                                           |                |
| 79    | P2.06       | J2                    | P2.06               | Ezurio Devkit: UART0_TXD                                                                                                                                                |                |
| 80    | GND         |                       | VSS                 |                                                                                                                                                                         |                |
| 81    | P2.04       | H2                    | P2.04               | Ezurio Devkit: UART0_RXD                                                                                                                                                |                |
| 82    | P2.09       | K1                    | P2.09               | Ezurio Devkit: MikroE UART TX                                                                                                                                           |                |
| 83    | VDDIO_P2    | G1                    | VDDIO_P2            | External supply for GPIO port P2.<br>1.8V typical (1.62V-1.98V).                                                                                                        |                |
| 84    | P2.11/NFC_P | J1                    | P2.11/NFC_P         | For NFC or GPIO                                                                                                                                                         |                |
| 85    | P2.02       | G2                    | P2.02               |                                                                                                                                                                         |                |
| 86    | P2.00       | F3                    | P2.00               |                                                                                                                                                                         |                |
| 87    | P2.10/NFC_N | H1                    | P2.10/NFC_N         | For NFC or GPIO                                                                                                                                                         |                |
| 88    | P2.01       | G3                    | P2.01               |                                                                                                                                                                         |                |
| 89    | GND         |                       | VSS                 | -                                                                                                                                                                       |                |
| 90    | GND         |                       | VSS                 |                                                                                                                                                                         |                |
| 91    | GND         |                       | VSS                 | -                                                                                                                                                                       |                |
| 92    | GND         |                       | VSS                 | -                                                                                                                                                                       |                |
| 93    | GND         |                       | VSS                 | -                                                                                                                                                                       |                |
| 94    | GND         |                       | VSS                 | -                                                                                                                                                                       |                |
| 95    | GND         |                       | VSS                 | -                                                                                                                                                                       |                |
| 96    | GND         |                       | VSS                 | -                                                                                                                                                                       |                |
| 97    | GND         |                       |                     | Extra GND for chip antenna                                                                                                                                              |                |
| 98    | GND         |                       |                     | Extra GND for chip antenna                                                                                                                                              |                |
| 99    | GND         |                       |                     | Extra GND for chip antenna                                                                                                                                              |                |
| 100   | GND         |                       |                     | Extra GND for chip antenna                                                                                                                                              |                |
| 101   | GND         |                       |                     | Extra GND for chip antenna                                                                                                                                              |                |
| 102   | GND         |                       |                     | Extra GND for chip antenna                                                                                                                                              |                |
| 103   | GND         |                       |                     | Extra GND for chip antenna                                                                                                                                              |                |
| 104   | VDD_1V8     |                       |                     | For Normal voltage mode connect external supply of 1.8V only to BOTH pin104(VDD_1V8) and pin77(VDD_HV).                                                                 |                |

| Pin # | Pin Name | nRF54H20<br>WLCSP Pin | nRF54H20 WLCSP Name | Comment                         | If Not<br>Used |
|-------|----------|-----------------------|---------------------|---------------------------------|----------------|
| G1    | GND      |                       |                     | GND for the nRF54H20 GND paddle |                |
| G2    | GND      |                       |                     | GND for the nRF54H20 GND paddle |                |
| G3    | GND      |                       |                     | GND for the nRF54H20 GND paddle |                |
| G4    | GND      |                       |                     | GND for the nRF54H20 GND paddle |                |

**Pin Definition Notes:**

|                                                                |                                                                                                                                                                                                                                                                                         |
|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Note 1</b><br><b>GPIO</b>                                   | <b>GPIO = General Input or Output (GPIO level voltage tracks VDD pin). AIN =Analog input.</b>                                                                                                                                                                                           |
|                                                                | If GPIO is selected as an input, ensure the input is not floating (which can cause current consumption to drive with time in low power modes (such as System ON Idle), by selecting the internal pull up or pull down.<br><b>Must connect all GND pads to host board PCB GND plane.</b> |
| <b>Note 2</b><br><b>SPI/TWI/Trace</b>                          | TBD                                                                                                                                                                                                                                                                                     |
| <b>Note 3</b><br><b>USB</b>                                    | <b>If using the USB interface</b> , then the BL54H20 VBUS pin (pin15) must be connected to external supply within the range 4.4V to 5.5V and <b>MUST</b> externally fit a 10uF to ground.                                                                                               |
| <b>Note 4</b><br><b>SWDIO / SWCLK / nRESET /<br/>VDD / GND</b> | <b>Customer MUST bring out SWDIO, SWCLK, nRESET, VDD, GND for programming purposes.</b>                                                                                                                                                                                                 |

|                               |                                                                |                       |                 |                            |
|-------------------------------|----------------------------------------------------------------|-----------------------|-----------------|----------------------------|
| <b>GPIO ports information</b> | GPIO ports per port number GOIO pins, pad type and description |                       |                 |                            |
|                               | <b>Port number</b>                                             | <b>Available pins</b> | <b>Pad type</b> | <b>Description</b>         |
|                               | P0                                                             | 11:0                  | 1V8 - Slow      | Always-on port             |
|                               | P1                                                             | 11:0                  | 1V8 - Slow      | Analog peripherals         |
|                               | P2                                                             | 11:0                  | 1V8 - Slow      | Slow peripherals           |
|                               | P6                                                             | 13:0                  | 1V8 - Fast      | EXMIF and Fast peripherals |
|                               | P7                                                             | 7:0                   | 1V8 - Fast      | Fast peripherals           |
|                               | P9                                                             | 5:0                   | 3V3 - Slow      | Analog peripherals         |

## 3.3 Electrical Specifications

### 3.3.1 Absolute Maximum Ratings

Absolute maximum ratings are the extreme limits for supply voltage and voltages on digital and analogue pins of the module are listed below; exceeding these values causes permanent damage.

**Table 2: Absolute maximum ratings**

| Parameter                         | Min  | Max      | Unit |
|-----------------------------------|------|----------|------|
| <b>Supply Voltages</b>            |      |          |      |
| VDD_HV pin                        | -0.3 | +5.8     | V    |
| VDD pin                           | -0.3 | +2       | V    |
| VBUS                              | -0.3 | +5.8     | V    |
| VDDIO_P1                          | -0.3 | +2       | V    |
| VDDIO_P2                          | -0.3 | +2       | V    |
| VDDIO_P6                          | -0.3 | +2       | V    |
| VDDIO_P7                          | -0.3 | +2       | V    |
| VDDIO_P9                          | -0.3 | +3.9     | V    |
| Voltage at GND pin                | -0.3 | 0        | V    |
| <b>I/O pin voltage</b>            |      |          |      |
| Voltage at GPIO pin (at VDD≤3.6V) | -0.3 | VDD +0.3 | V    |
| Voltage at GPIO pin (at VDD≥3.6V) | -0.3 | +3.9     | V    |
| NFC antenna pin current (NFC1/2)  | -    | TBD      | mA   |
| Radio RF input level              | -    | TBD      | dBm  |
| <b>Environmental</b>              |      |          |      |

| Parameter                        | Min | Max  | Unit               |
|----------------------------------|-----|------|--------------------|
| Storage temperature              | -40 | +105 | °C                 |
| MSL (Moisture Sensitivity Level) | -   | 4    | -                  |
| ESD (as per EN301-489)           |     |      |                    |
| Conductive                       |     | 4    | kV                 |
| Air Coupling                     |     | 8    | kV                 |
| Flash Memory (Endurance)         | -   | TBD  | Write/erase cycles |
| Flash Memory (Retention)         | -   | TBD  | -                  |

**Note 1**   Wear levelling can be implemented by customer.

### 3.3.2 Recommended Operating Parameters

Table 3: Power supply operating parameters

| Parameter                                                                                          | Min  | Typ | Max  | Unit |
|----------------------------------------------------------------------------------------------------|------|-----|------|------|
| VDD_HV (independent of DCDC) supply range                                                          | 1.9  | 3.0 | 5.5  | V    |
| VDD supply voltage                                                                                 |      | 1.8 |      | V    |
| VBUS USB supply range                                                                              | 4.4  | 5   | 5.5  | V    |
| VDDIO_P1 External supply for GPIO port P1                                                          | 1.62 | 1.8 | 1.98 | V    |
| VDDIO_P2 External supply for GPIO port P2                                                          | 1.62 | 1.8 | 1.98 | V    |
| VDDIO_P6 External supply for GPIO port P6                                                          | 1.62 | 1.8 | 1.98 | V    |
| VDDIO_P7 External supply for GPIO port P7                                                          | 1.62 | 1.8 | 1.98 | V    |
| VDDIO_P9 External supply for 3V GPIO port P9                                                       | 1.62 | 3.3 | 3.6  | V    |
| VDD Maximum ripple or noise (See Note 1)                                                           | -    | -   | 10   | mV   |
| Time in Power-on reset after supply reaches minimum operating voltage, depend on supply rise time. |      |     |      |      |
| VDD supply rise time (0V to 1.7V) <sup>2</sup> 10uS                                                | -    | TBD | TBD  | mS   |
| VDD supply rise time (0V to 1.7V) <sup>2</sup> >10mS                                               | -    | TBD | TBD  | mS   |
| Operating Temperature Range                                                                        | -40  | +25 | +105 | °C   |

**Note 1** This is the maximum VDD or VDD\_HV ripple or noise (at any frequency) that does not disturb the radio.

**Note 2** The on-board power-on reset circuitry may not function properly for rise times longer than the specified maximum.

**Note 3** BL54H20 power supply options:

- **Option 1 High Voltage Mode** - Connect external supply voltage (within range 1.9V-5.5V) to VDDH pin. Customer MUST externally fit a 10uF (0603 body size) to ground. Ensure capacitor value reduction due to DC bias, AC bias, temperature is minimized so the Effective Specification for this 10uF capacitor is 3uF to 12uF over all conditions (DCbias=5.5V, ACbias=0.01V and temperature range -40°C to +105°C).
- **Option 2 Normal Voltage Mode** - Connect external supply voltage (within range 1.8V) to both VDDH and VDD pin.

If using USB interface then the BL54H20 VBUS pin must be connected to external supply within the range 4.4V to 5.5V.

When using the BL54H20 VBUS pin, customer MUST externally fit a 10uF (0603 body size) to ground. Ensure capacitor value reduction due to DC bias, AC bias, temperature is minimized so the Effective Specification for this 10uF capacitor is 3uF to 12uF over all conditions (DCbias=5.5V, ACbias=0.01V and temperature range -40°C to +105°C).

**Note 4** VDDH/VDD (either High voltage mode or Normal voltage mode) must be powered before VDDIO\_Px.

## 3.4 Clocks

### 3.4.1 HFXO - 32MHz crystal oscillator and nRF54H20 internal load capacitor TBDpF mandatory setting

The BL54H20 module contains the 32 MHz crystal, but the load capacitors to create 32MHz crystal oscillator circuit are inside the nRF54H20 chipset. Customer MUST set the internal nRF54H20 capacitors to TBDpF (for proper operation of the 32 MHz crystal circuit).

The 32 MHz crystal inside the BL54H20 module is a high accuracy crystal ( $\pm 15$  ppm at room temperature) that helps with radio operation and reducing power consumption in the active modes.

### 3.4.2 LFCLK – Low Frequency clock source

There are four possibilities (see figure 5) for the low frequency clock (LFCLK) and options are:

**LFRC (32.768kHz RC oscillator):** The Internal 32.768 kHz RC oscillator (LFRC) is fully embedded in nRF54H20 (and does not require additional external components) with an accuracy  $\pm 250$  ppm (after calibration of LFRC at least every eight seconds using the HFXO as a reference oscillator). See section 錯誤! 找不到參照來源。 .

**LF XO (32.768kHz crystal oscillator):** For higher LFCLK accuracy (greater than  $\pm 250$ ppm accuracy is required), the low frequency crystal oscillator (LF XO) must be used. To use LF XO, a 32.768kHz crystal must be connected between the XL1 and XL2 pins and the load capacitance between each crystal terminal and ground. Optionally internal (to nRF54H20) capacitor of maximum TBDpF in TBDpF steps are provided on pins XL1 and XL2.

**Low frequency (32.768 kHz) external source:** The 32.768 kHz oscillator (LF XO) is designed to work with external sources. Following external sources are supported:

**LFSYNTH (32.768kHz Synthesised clock) from HFCLK (LFSYNTH):** The LFCLK can be synthesised from the HFCLK source. LFSYNTH depends on the HFCLK to run. The accuracy of the LFCLK clock with LFSYNTH as a source assumes the accuracy of the HFCLK. If high accuracy is required, the HFCLK must generated from the HFXO.

Using the LFSYNT clock removes the requirement for an external 32.768kHz crystal but the increases the average power consumption as the HFCLK will be turned on in the system.

### 3.4.3 Other Internal Clocks

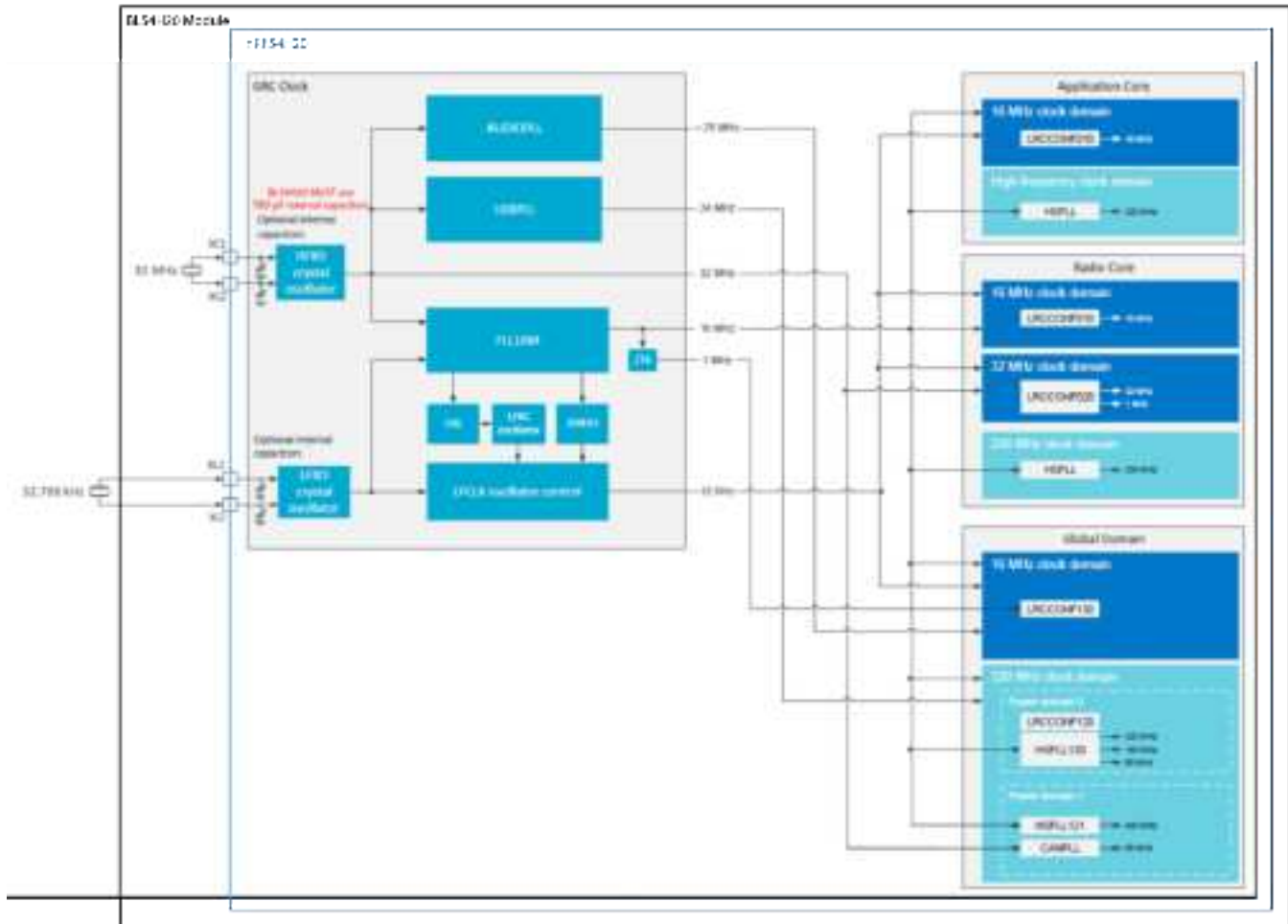


Figure 3: nRF54H20 Clock System Overview (adapted from Nordic)

### 3.5 BL54H20 Power Supply Options

The BL54H20 module power supply internally contains the following two main supply regulator stages (Figure 4):

- VDD\_HV pin
- VDD pin

The USB peripheral is powered separately (connected to the VBUS pin).

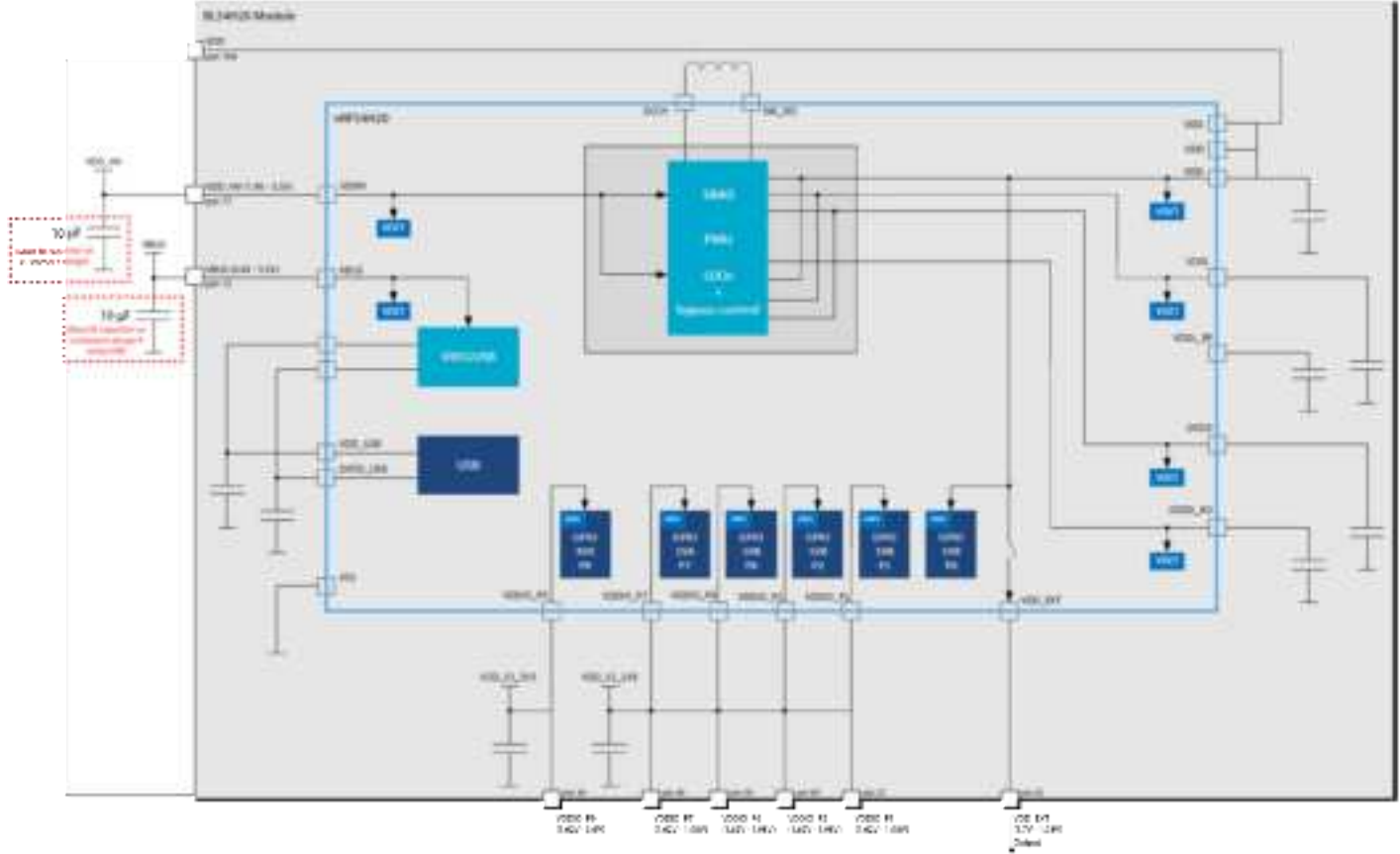


Figure 4: BL54H20 power supply block diagram (adapted from Nordic)

#### 3.5.1 High Voltage mode (option1) or Normal Voltage mode (option2)

The BL54H20 power supply system enters one of two supply voltage modes, High voltage mode or Normal voltage mode, depending on how the external supply voltage is connected to these pins.

BL54H20 power supply options:

- **Option 1 High Voltage Mode** - Connect external supply voltage (within range 1.9V-5.5V) to VDDH pin. Customer MUST externally fit a 10µF (0603 body size) to ground. Ensure capacitor value reduction due to DC bias, AC bias, temperature is minimized so the Effective Specification for this 10µF capacitor is 3µF to 12µF over all conditions (DCbias=5.5V, ACbias=0.01V and temperature range -40°C to +105°C).

OR

- **Option 2 Normal Voltage Mode** - Connect external supply voltage (1.8V) to both VDDH and VDD pin.

For either option, If using USB interface then the BL54H20 VBUS pin must be connected to external supply within the range 4.4V to 5.5V.

When using the BL54H20 VBUS pin, customer MUST externally fit a 10µF (0603 body size) to ground. Ensure capacitor value reduction due to DC bias, AC bias, temperature is minimized so the Effective Specification for this 10µF capacitor is 3µF to 12µF over all conditions (DCbias=5.5V, ACbias=0.01V and temperature range -40°C to +105°C).

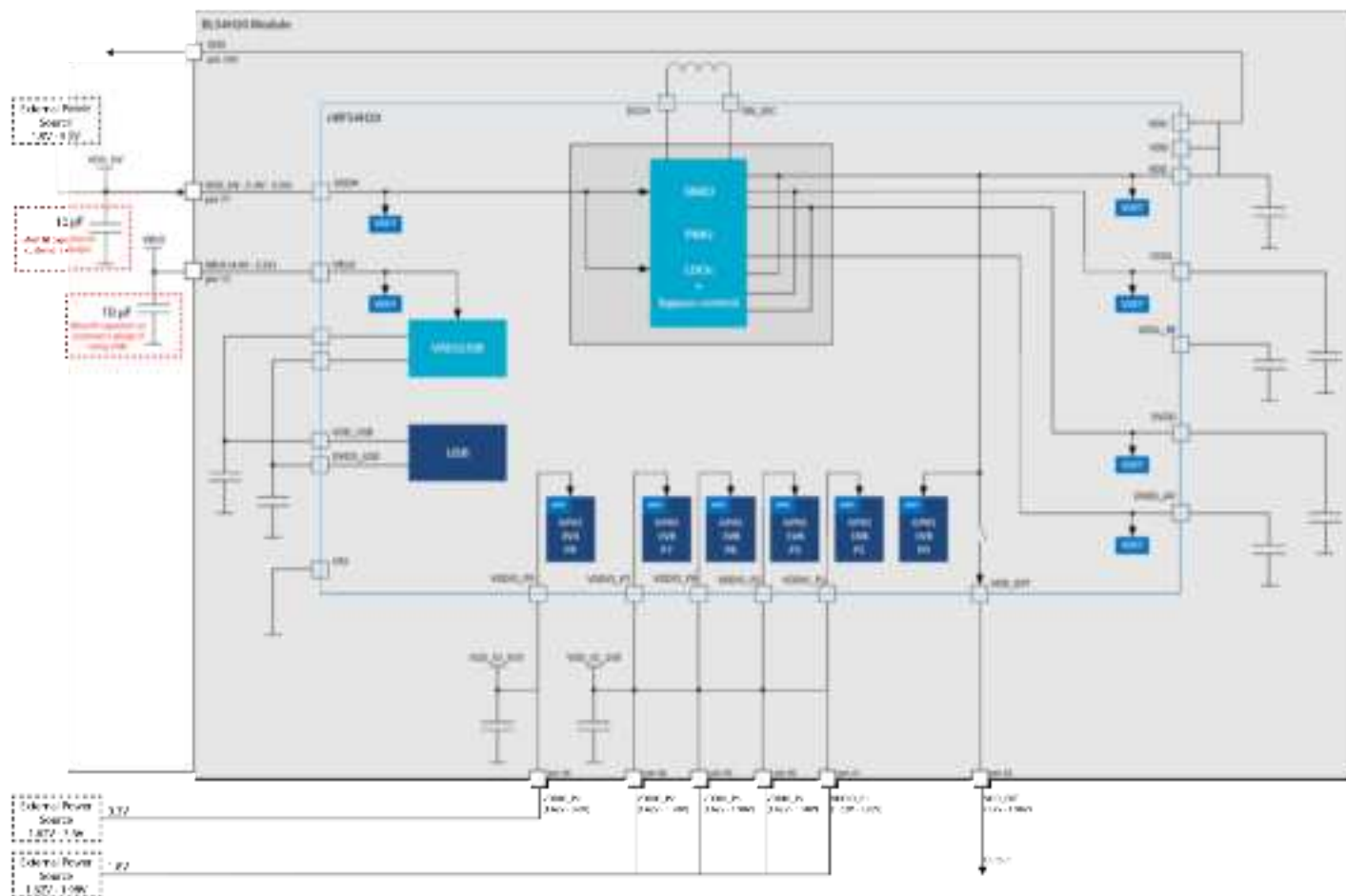


Figure 5: High Voltage mode (option1)

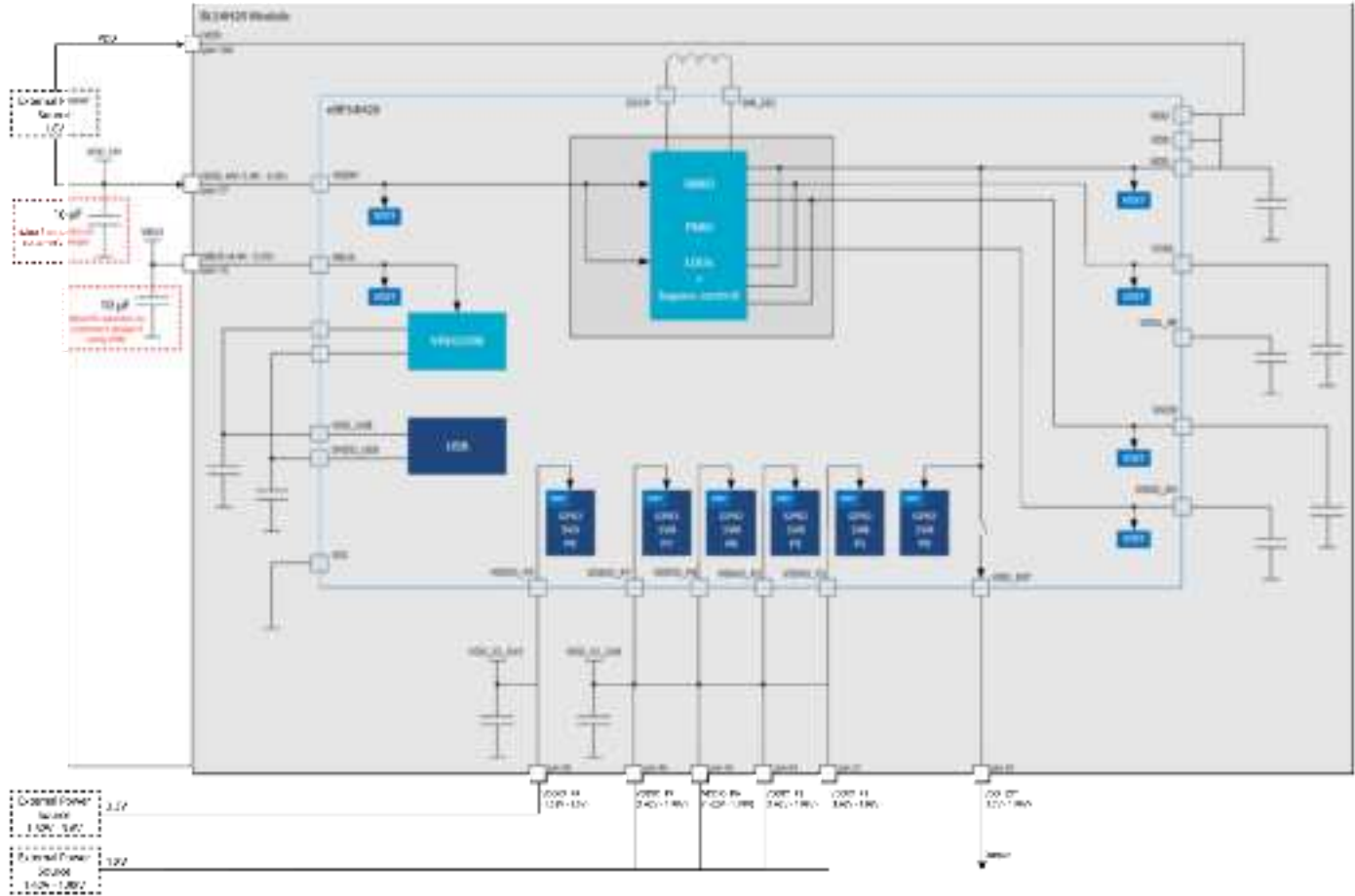


Figure 6: Normal Voltage Mode (option2)

### 3.5.2 VBUS pin and 10uF Mandatory Capacitor

To use the BL54H20 USB peripheral:

1. Connect the BL54H20 VBUS pin to the external supply within the range 4.4V to 5.5V. When using the BL54H20 VBUS pin, you **MUST** externally fit a 10uF (0603 body size) to ground. Ensure capacitor value reduction due to DC bias, AC bias, temperature is minimized (the Effective Specification for this 10uF capacitor is 3uF to 12uF over all conditions DCbias=5.5V, ACbias=0.01V and temperature range -40°C to +105°C).
2. When using the BL54H20 USB peripheral, the VBUS pin can be supplied from same source as VDD\_HV (within the operating voltage range of the VBUS pin and VDD\_HV pin).
3. An optional series 2.2Ohms resistor on the USB supply (VBUS) can be fitted for improved immunity to transient over-voltage VBUS connection.

If not using USB peripheral, the VBUS pin can be left unconnected.

## 4 Programmability

### 4.1 BL54H20 Default Firmware

The BL54H20 module is shipped from Ezurio manufacturing facilities with no firmware programmed.

### 4.2 BL54H20 Firmware Options

Firmware for use with the BL54H20 can be divided into the following types.

- **Bootloader** – This is the application that resides on the Application core used for perform firmware updates on the Application, Radio, FLPR and PPR cores. The MCU Boot or Trusted Firmware M Bootloaders are recommended to be used as the basis for the BL54H20 Bootloader functionality.
- **Application** – This is the main application code that resides on the Application core. It interfaces with the Radio core and PPR/FLPR cores and provides supplementary functionality to that of the time critical activities being performed on the Radio, PPR and FLPR cores.
- **Radio Stack** – This is the protocol stack(s) that reside on the Radio Core. These control the radio and perform time critical radio operations, the results of which are provided to the Application core for high level processing.
- **Software Defined Peripheral** – These are the applications running on the FLPR and PPR RISC-V cores intended to offload activities from the Application core.

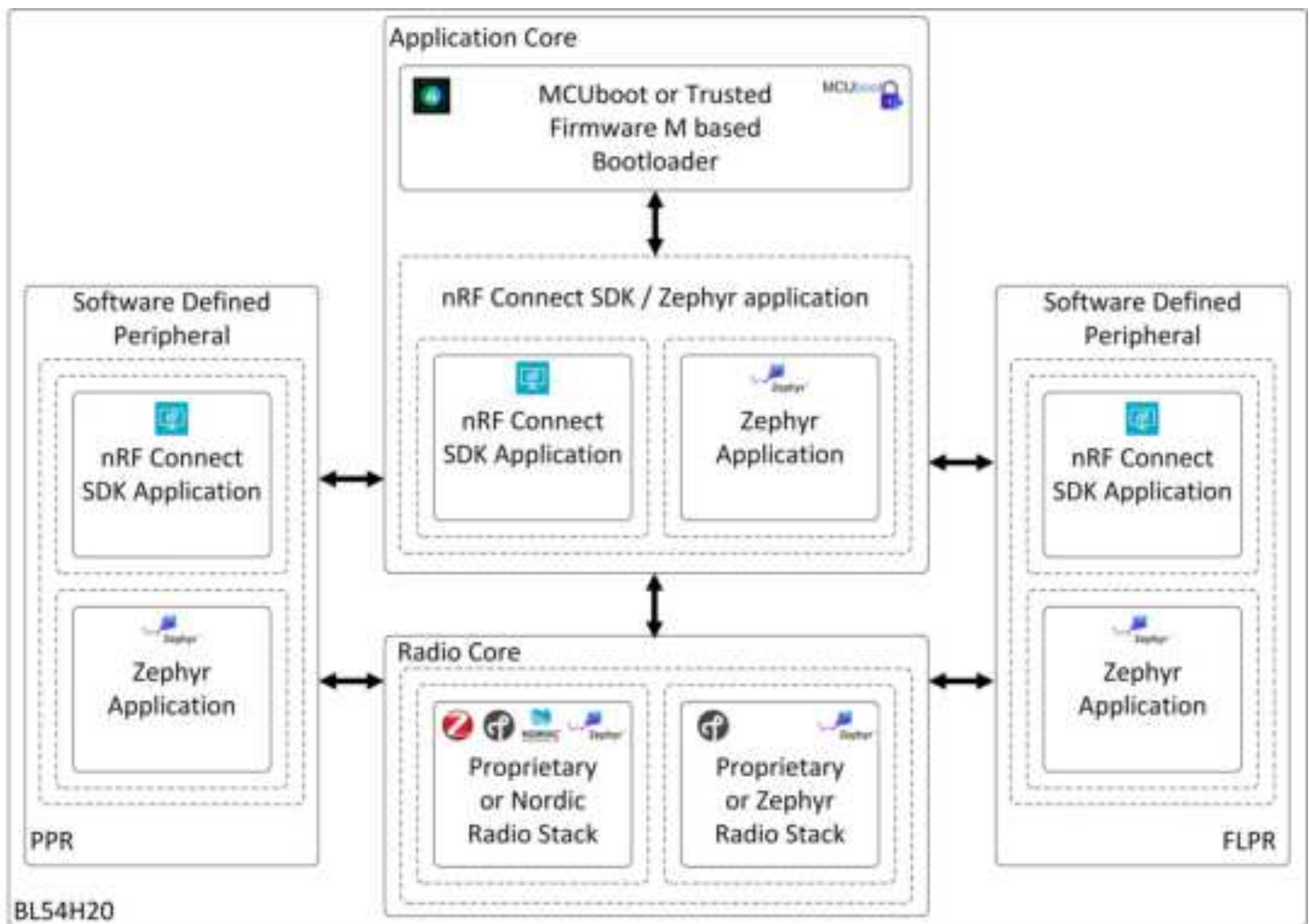


Figure 7: Functional SW block diagram for BL54H20 series module

## 5 Mandatory SW requirements related to hardware

### 5.1 32MHz crystal internal load capacitor setting of TBD pF

MANDATORY. BL54H20 module contains the 32 MHz crystal but the load capacitors to create 32 MHz crystal oscillator circuit are inside the nRF54H20 chipset. Customer MUST set the internal nRF54H20 capacitors to TBD pF (for proper operation of the 32 MHz crystal circuit in the BL54H20 module).

## 6 Hardware Integration Suggestions

### 6.1 Circuit

The BL54H20 is easy to integrate, requiring no external components on your board apart from those which you require for development and in your end application.

The following are suggestions for your design for the best performance and functionality.

#### Checklist (for Schematic):

- **BL54H20 power supply options:**

**Option1 High Voltage Mode** – Main voltage input (using BL54H20 VDD\_HV pin) the external supply voltage (within range 1.9V-5.5V) is ONLY connected to the VDD\_HV pin.

**Option 2 Normal Voltage Mode** - Connect external supply voltage (within range 1.8V) to both VDD\_HV and VDD pin.

- **BL54H20 GPIO ports power:**

**VDDIO\_P1, VDDIO\_P2, VDDIO\_P6, VDDIO\_7** GPIO power supply pins: Connect external supply (within range 1.62V to 1.98V range) to power BL54H20 GPIO these GPIO ports P1, P2, P6, P7 ports power pins

**VDDIO\_P9** GPIO power supply pins: Connect external supply (within range 1.62V to 3.6V range) to power BL54H20 GPIO 3V port power pin VDDIO\_P9.

External power source should be within the operating range, rise time and noise/ripple specification of the BL54H20. Add decoupling capacitors for filtering the external source. Power-on reset circuitry within BL54H20 series module incorporates brown-out detector, thus simplifying your power supply design. Upon application of power, the internal power-on reset ensures that the module starts correctly.

- **BL54H20 USB peripheral:**

To use the BL54H20 USB peripheral:

1. Connect the BL54H20 VBUS pin to the external supply within the range 4.4V to 5.5V. When using the BL54H20 VBUS pin, you **MUST** externally fit a 10uF to ground. Ensure capacitor value reduction due to DC bias, AC bias, temperature is minimized so the Effective Specification for this 10uF capacitor is 3uF to 12uF over all conditions (DCbias=5.5V, ACbias=0.01V and temperature range -40°C to +105°C).
2. Connect the external supply to VDD\_HV pin to operate the rest of BL54H20 module.
3. When using the BL54H20 USB peripheral, the VBUS pin can be supplied from same source as VDD\_HV (within the operating voltage range of the VBUS pin and VDD\_HV pin).
4. An optional series 2.2Ohms resistor on the USB supply (VBUS) can be fitted for improved immunity to transient over-voltage VBUS connection.

If not using USB peripheral, the VBUS pin can be left unconnected.

- **AIN (ADC) and GPIO pin IO voltage levels**

BL54H20 GPIO voltage levels are at VDD. Ensure input voltage levels into GPIO pins are at VDD also (if VDD source is a battery whose voltage drops). Ensure ADC pin maximum input voltage for damage is not violated.

- **AIN (ADC) impedance and external voltage divider setup**

If you need to measure with ADC a voltage higher than 3.6V, you can connect a high impedance voltage divider to lower the voltage to the ADC input pin.

- **SWD**

This is REQUIRED for loading firmware. MUST wire out the SWD two wire interface on host design. Five lines should be wired out, namely SWDIO, SWDCLK, nRESET, GND and VDD.

- **UART and flow control (CTS, RTS)**

Required if customer requires UART.

- **TWI (I2C)**

It is essential to remember that pull-up resistors on both SCL and SDA lines are required, the value as per I2C standard. nRF54H20 can provide 13K Ohms typical pull up values internally. For other values, fit external pull-up resistor on both SCL and SDA as per I2C specification to set speed. The I2C specification allows a line capacitance of 400pF.

- **EXMIF, QSPI, High Speed SPI (32Mbps), High speed TWI (I2C, 1Mbps), QSPI and Trace**

EXMIF, QSPI, High-Speed SPI (32Mbps), TWI 1Mbps and Trace come on dedicated GPIO pins only. Other lower speed SPI and TWI can come out on any GPIO pins.

For all high-speed signal, the printed circuit board (PCB) layout must ensure that connections are made using short PCB traces.

- **GPIO pins**

If GPIO is selected as an input, ensure the input is not floating (which can cause current consumption to drive with time in low power modes (such as System ON Idle), by selecting the internal pull up or pull down.

- **NFC antenna connector**

To make use of the Ezurio flexi-PCB NFC antenna (part # 0600-00061), fit connector:

- Description – FFC/FPC Connector, Right Angle, SMD/90d, Dual Contact, 1.2 mm Mated Height
- Manufacturer – Molex
- Manufacturers Part number – 512810594

Add tuning capacitors of 300 pF on NFC1 pin to GND and 300 pF on NFC2 pins to GND if the PCB track length is similar as development board.

- **nRESET pin (active low)**  
Hardware reset. Wire out to push button or drive by host.  
By default module is out of reset when power applied to VDD pins (13K pull-up inside nRF54H20).
- **Optional External 32.768kHz crystal**  
If the optional external 32.768kHz crystal is needed, then use a crystal that meets specification and add load capacitors (either inside nRF54H20 or discrete capacitors outside nRF55) whose values should be tuned to meet all specification for frequency and oscillation margin.

## 6.2 PCB Layout on Host PCB - General

### Checklist (for PCB):

- MUST locate BL54H20 module close to the edge of PCB (mandatory for the 453-00197 for on-board chip antenna to radiate properly).
- Use solid GND plane on inner layer (for best EMC and RF performance).
- All module GND pins MUST be connected to host PCB GND.
- Place GND vias close to module GND pads as possible.
- Unused PCB area on surface layer can flooded with copper but place GND vias regularly to connect the copper flood to the inner GND plane. If GND flood copper is on the bottom of the module, then connect it with GND vias to the inner GND plane.
- Route traces to avoid noise being picked up on VDD, VDD\_HV, VBUS supply and AIN (analogue), GPIO (digital) traces and high-speed traces.
- Ensure no exposed copper is on the underside of the module (refer to land pattern of BL54H20 development board).

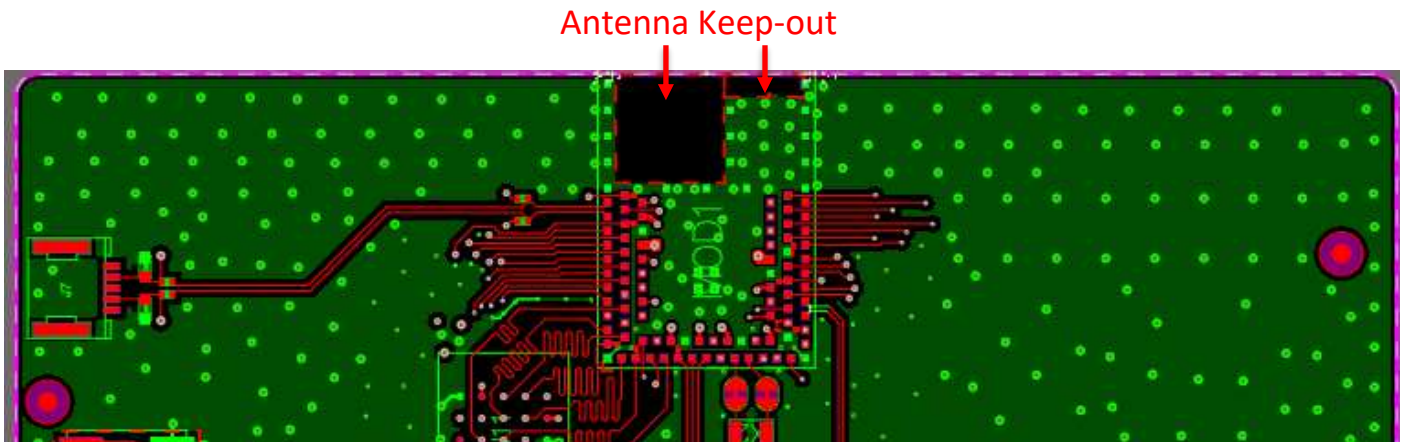
## 6.3 PCB Layout on Host PCB for the 453-0019x

### 6.3.1 Antenna Keep-out on Host PCB

The 453-00197 has an integrated chip antenna (Ignion NN02-101) and its performance is sensitive to host PCB. It is critical to locate the 453-00197 on the edge of the host PCB (or corner) to allow the antenna to radiate properly. Refer to guidelines in section **PCB land pattern and antenna keep-out area for the 453-00197**. Some of those guidelines repeated below.

- Ensure there is no copper in the antenna keep-out area on any layers of the host PCB. Keep all mounting hardware and metal clear of the area to allow proper antenna radiation.
- For best antenna performance, place the 453-00197 module on the edge of the host PCB, preferably in the edge center.
- The BL54H20 development board (453-00197-K1) has the 453-00197 module on the edge of the board (not in the corner). The antenna keep-out area is defined by the BL54H20 development board which was used for module development and antenna performance evaluation is shown in **Figure 8**, where the antenna keep-out area is 5mm wide, 5mm long; with PCB dielectric (no copper) height 1.6mm sitting under the 453-00197 chip antenna. There is an extra copper cutout of 3.631mm x 1.046mm under 453-00197 chip antenna RF matching circuit.
- The 453-00197 chip antenna is tuned when the 453-00197 is sitting on development board (host PCB) with size of 141.6mm x 63.5mm x 1.6mm.
- A different host PCB thickness dielectric will have small effect on antenna.
- The antenna-keep-out defined in the **7.2 Host PCB Land Pattern and Antenna Keep-out for the 453-00197** section.
- Host PCB land pattern and antenna keep-out for the BL54H20 applies when the 453-00197 is placed in the edge of the host PCB preferably in the edge center.

**Figure 8** shows an example.



**Figure 8:** Chip Antenna keep-out area (shown in red), corner of the BL54H20 development board for the 453-00197 module.

#### Antenna Keep-out Notes:

- Note 1** The BL54H20 module is placed on the edge, preferably edge centre of the host PCB.
- Note 2** Copper cut-away on all layers in the *Antenna Keep-out* area under the 453-00197 on host PCB.

### 6.3.2 Antenna Keep-out and Proximity to Metal or Plastic

#### Checklist (for metal /plastic enclosure):

- Minimum safe distance for metals without seriously compromising the antenna (tuning) is 40 mm top/bottom and 30 mm left or right.
- Metal close to the 453-00197 chip antenna (bottom, top, left, right, any direction) will have degradation on the antenna performance. The amount of that degradation is entirely system dependent, meaning you will need to perform some testing with your host application.
- Any metal closer than 20 mm will begin to significantly degrade performance (S11, gain, radiation efficiency).
- It is best that you test the range with a mock-up (or actual prototype) of the product to assess effects of enclosure height (and materials, whether metal or plastic) and host PCB ground (GND plane size).

## 6.4 External Antenna Integration with BL54H20 MHF4 variant (453-00198)

Please refer to the regulatory sections for FCC, ISSED, CE, MIC, UKCA and RCM details of use of BL54H20 with external antennas in each regulatory region.

The BL54H20 family has been designed to operate with the below external antennas (with a maximum gain of 2.32 dBi). The required antenna impedance is 50 ohms. See Table 4. External antennas improve radiation efficiency.

Table 4: External antennas for the BL54H20 MHF4 variant module (453-00198)

| Manufacturer | Model                 | Ezurio Part Number | Type            | Connector         | Peak Gain     |               |
|--------------|-----------------------|--------------------|-----------------|-------------------|---------------|---------------|
|              |                       |                    |                 |                   | 2400-2500 MHz | 2400-2480 MHz |
| Ezurio       | NanoBlue              | EBL2400A1-10MH4L   | PCB Dipole      | IPEX MHF4         | 2 dBi         | -             |
| Ezurio       | FlexPIFA              | 001-0022           | FlexPIFA        | IPEX MHF4L        | -             | 2 dBi         |
| Mag.Layers   | EDA-8709-2G4C1-B27-CY | 0600-00057         | Dipole          | IPEX MHF4         | 2.32 dBi      | -             |
| Ezurio       | mFlexPIFA             | EFA2400A3S-10MH4L  | FlexPIFA        | IPEX MHF4L        | -             | 2 dBi         |
| Ezurio       | iFlexPIFA Mini        | EFG2401A3S-10MH4L  | i-FlexPIFA      | IPEX MHF4L        | -             | 2 dBi         |
| Ezurio       | Ezurio NFC            | 0600-00061         | Coiled Inductor | FFC/FPC Connector | -             | -             |

## 7 Mechanical Details

### 7.1 BL54H20 Mechanical Details

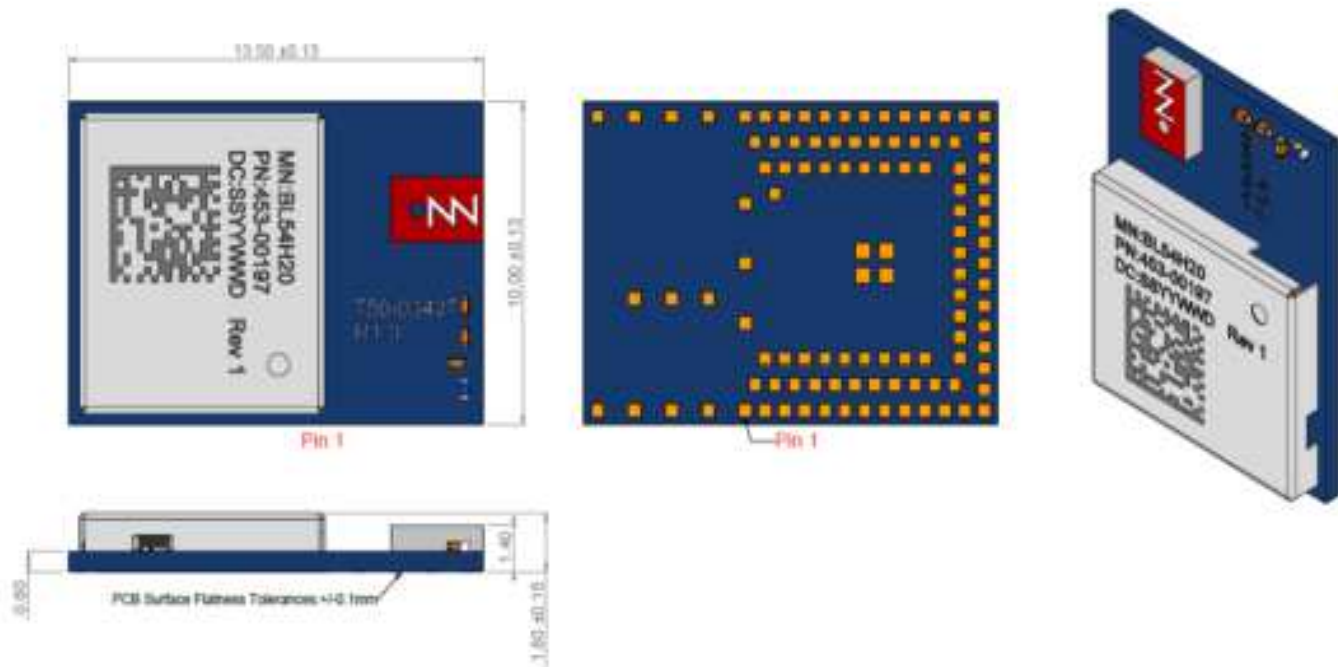


Figure 9: Mechanical Details – Internal Antenna variant

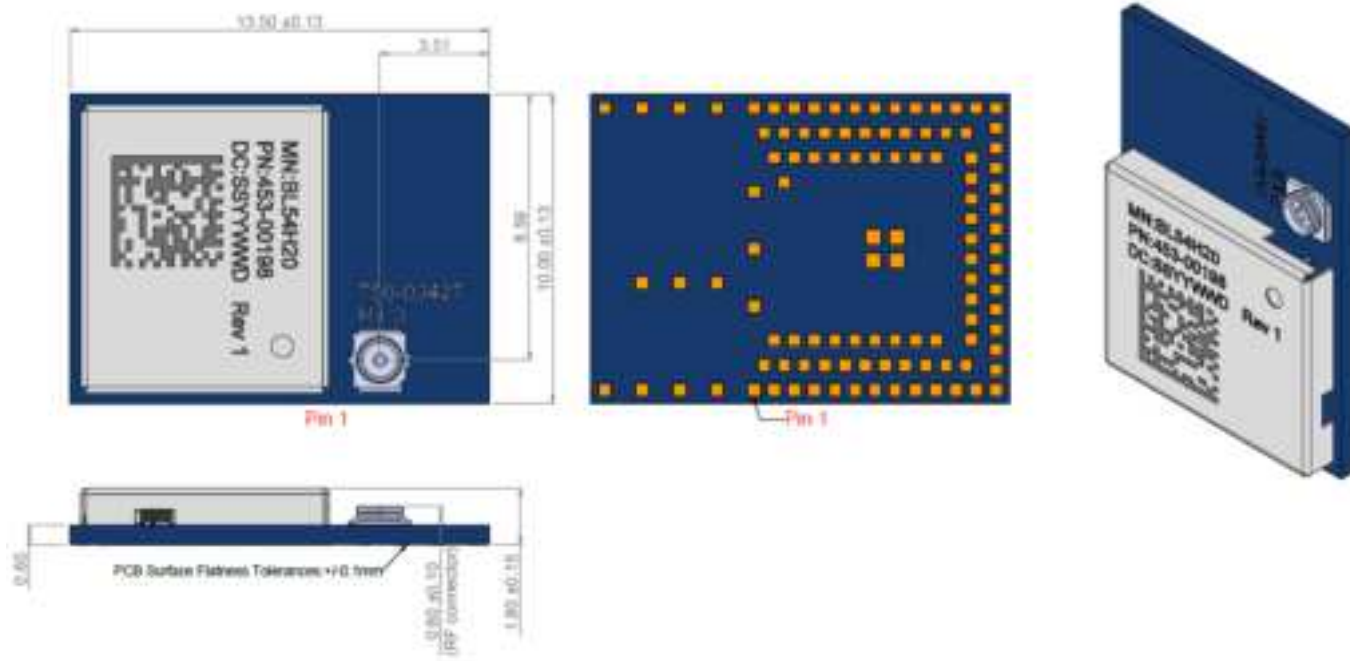


Figure 10: Mechanical Details – MHF4 RF connector variant

3D models for BL54H20 Module, Chip Antenna (453-00197) and BL54H20 Module, MHF4 (453-00198) can be found on the BL54H20 product page <https://www.ezurio.com/product/bl54h20-series-multi-core-bluetooth-le-80215-4-nfc>



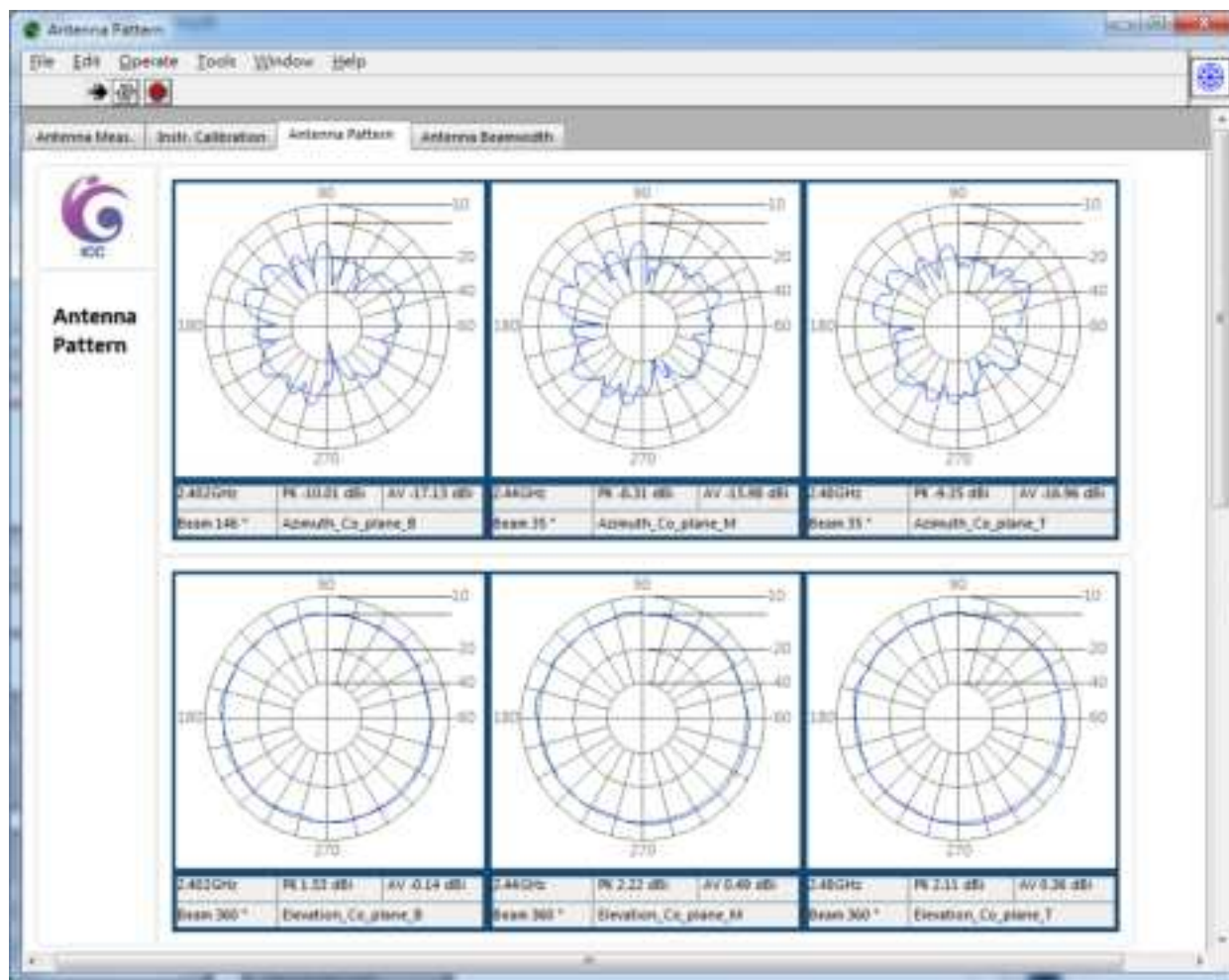
## 8 Chip Antenna Performance

### 8.1 Summary of Antenna Performance

**Note :** The result is measured with 453-00197-K1

|                          | 2402MHz  | 2440MHz | 2480MHz |
|--------------------------|----------|---------|---------|
| Peak Antenna Gain dBi    | 1.53dBi  | 2.22dBi | 2.11dBi |
| Average Antenna Gain dBi | -0.14dBi | 0.49dBi | 0.36dBi |

### 8.2 2.4GHz Radiated Performance



### 8.3 Antenna S11 measuring data



## 9 Ordering Information

| Part Number  | Product Description                                                |
|--------------|--------------------------------------------------------------------|
| 453-00197R   | Module, BL54H20 (Nordic nRF54H20), Chip antenna, Tape/Reel         |
| 453-00198R   | Module, BL54H20 (Nordic nRF54H20), MHF4 Connector, Tape/Reel       |
| 453-00197C   | Module, BL54H20 (Nordic nRF54H20), Chip antenna, Cut Tape          |
| 453-00198C   | Module, BL54H20 (Nordic nRF54H20), MHF4 Connector, Cut Tape        |
| 453-00197-K1 | Development kit, Module BL54H20 (Nordic nRF54H20), Chip antenna    |
| 453-00198-K1 | Development kit, Module BL54H20 (Nordic nRF54H20) – MHF4 Connector |

## 10 Regulatory

### 10.1 Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

**FCC Caution:** Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the

following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**IMPORTANT NOTE:**

**FCC Radiation Exposure Statement:**

The product comply with the US portable RF exposure limit set forth for an uncontrolled environment and are safe for intended operation as described in this manual. The further RF exposure reduction can be achieved if the product can be kept as far as possible from the user body or set the device to lower output power if such function is available.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

## Integration instructions for host product manufacturers

### Applicable FCC rules to module

FCC Part 15.247

### Summarize the specific operational use conditions

This device is intended only for OEM integrators under the following conditions:

- 1) The transmitter module may not be co-located with any other transmitter or antenna

As long as 1 condition above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

**IMPORTANT NOTE:** In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization. The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

### Limited module procedures

Not applicable

### Trace antenna designs

Not applicable

### RF exposure considerations

Co-located issue shall be met as mentioned in "Summarize the specific operational use conditions".

Product manufacturer shall provide below text in end-product manual

"FCC Radiation Exposure Statement:

The product comply with the US portable RF exposure limit set forth for an uncontrolled environment and are safe for intended operation as described in this manual. The further RF exposure reduction can be achieved if the product can be kept as far as possible from the user body or set the device to lower output power if such function is available."

### Antennas

| Manufacture / Part Number  | Type            | Connector         | Gain(dBi) |
|----------------------------|-----------------|-------------------|-----------|
| Ezurio / EBL2400A1-10MH4L  | PCB Dipole      | IPEX MHF4         | 2         |
| Ezurio / 001-0022          | FlexPIFA        | IPEX MHF4L        | 2         |
| Mag.Layers / 0600-00057    | Dipole          | IPEX MHF4         | 2.32      |
| Ezurio / EFA2400A3S-10MH4L | FlexPIFA        | IPEX MHF4L        | 2         |
| Ezurio / EFG2401A3S-10MH4L | i-FlexPIFA      | IPEX MHF4L        | 2         |
| Ezurio / 0600-00061 (NFC)  | Coiled Inductor | FFC/FPC Connector | -         |
| Ignion / NN02-101          | Chip loop       | NA                | 2.4       |

### Label and Compliance Information

Product manufacturers need to provide a physical or e-label stating

"Contains FCC ID: SQG-BL54H20" with finished product

### Information on Test Modes and Additional Testing Requirements

Test tool: PuTTY, Version:0.60 shall be used to set the module to transmit continuously.

**Additional Testing, Part 15 Subpart B Disclaimer**

The module is only FCC authorized for the specific rule parts listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed

## 10.2 Industry Canada statement:

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

- (1) This device may not cause interference
- (2) This device must accept any interference, including interference that may cause undesired operation of the device

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- (1) L'appareil ne doit pas produire de brouillage;
- (2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

### Radiation Exposure Statement:

This equipment complies with Canada radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

### Déclaration d'exposition aux radiations:

Cet équipement est conforme Canada limites d'exposition aux radiations dans un environnement non contrôlé. Cet équipement doit être installé et utilisé à distance minimum de 20cm entre le radiateur et votre corps.

This device is intended only for OEM integrators under the following conditions:

- 1) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 1 condition above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes:

- 1) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 1 condition ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

### IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

### NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

## End Product Labeling

The final end product must be labeled in a visible area with the following: "Contains IC:3147A-BL54H20".

### Plaque signalétique du produit final

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 3147A-BL54H20".

## Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

## Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.

Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

This radio transmitter [IC: 3147A-BL54H20] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Le présent émetteur radio [IC: 3147A-BL54H20] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

| Manufacture / Part Number  | Type            | Connector         | Gain(dBi) |
|----------------------------|-----------------|-------------------|-----------|
| Ezurio / EBL2400A1-10MH4L  | PCB Dipole      | IPEX MHF4         | 2         |
| Ezurio / 001-0022          | FlexPIFA        | IPEX MHF4L        | 2         |
| Mag.Layers / 0600-00057    | Dipole          | IPEX MHF4         | 2.32      |
| Ezurio / EFA2400A3S-10MH4L | FlexPIFA        | IPEX MHF4L        | 2         |
| Ezurio / EFG2401A3S-10MH4L | i-FlexPIFA      | IPEX MHF4L        | 2         |
| Ezurio / 0600-00061 (NFC)  | Coiled Inductor | FFC/FPC Connector | -         |
| Ignion / NN02-101          | Chip loop       | NA                | 2.4       |

### 10.3 Europe – EU Declaration of Conformity

This device complies with the essential requirements of the Radio Equipment directive: 2014 / 53 / EU. The following test methods have been applied in order to prove presumption of conformity with the essential requirements of the Radio Equipment directive: **2014 / 53 / EU**:

EN 300 328 V2.2.2

(BS)EN 50385 2017

(BS)EN 50665 2017

(BS)EN 62311 2008

EN 300 330 V2.1.1

EN 301 489-1 V2.2.3

EN 301 489-3 V2.3.2

EN 301 489-17 V3.3.1

IEC 62368-1:2018; ; and/or

(BS) EN IEC 62368-1:2020+A11:2020

2400-2483.5GHz: 9.98dbm

BT LE: 9.96dbm

SW version: v0.5.1

RF exposure statement

The minimum distance between the user and/or any bystander and the radiating structure of the transmitter is 20cm.

## 11 Additional Information

Please contact your local sales representative or our support team for further assistance:

|                          |                                                                                               |
|--------------------------|-----------------------------------------------------------------------------------------------|
| <b>Headquarters</b>      | Ezurio<br>50 S. Main St. Suite 1100<br>Akron, OH 44308 USA                                    |
| <b>Website</b>           | <a href="http://www.ezurio.com">http://www.ezurio.com</a>                                     |
| <b>Technical Support</b> | <a href="http://www.ezurio.com/resources/support">http://www.ezurio.com/resources/support</a> |
| <b>Sales Contact</b>     | <a href="http://www.ezurio.com/contact">http://www.ezurio.com/contact</a>                     |

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