Datasheet

BL54L15 Series

Version 1.1

Revision History

Version	Date	Notes	Contributor(s)	Approver
0.1	10 June 2024	Initial PRELIMINARY release.	Raj Khatri	Jonathan Kaye
0.2	2 Oct 2024	Updated pin list names and notes below table1. Added section External Antenna Integration with BL54L15 MHF4 variant (453-00044) Added section on Programmability.	Raj Khatri	Jonathan Kaye
0.3	24 Oct 2024	Removed Medium voltage mode (VDDM_nRF) from Specification Summary table and updated Normal voltage mode (VDD_nRF) operating range from 1.7V-2.6V to 1.7V-3.6V. Updated Block Diagram and Pin-out for 39 connection pins. Updated SCH symbol to remove pin40. Updated pin list in Table 1 (removed pin 40 VDDM_nRF). Updated BL54L15 Power Supply Updated Table 4 external antenna Mag Layers EDA-8709-2G4C1-B27-CY antenna gain from 2dBi to 2.32dBi.	Raj Khatri	Jonathan Kaye
0.4	6 Dec 2024	Updated maximum Tx power to +7 dBm.	Dave Drogowski	Jonathan Kaye
0.5	11 Dec 2024	Updated sensitivity value Added trace antenna performance	Louis Chang	Jonathan Kaye
0.6	16 Dec 2024	Updated maximum Tx power to +6 dBm.	Louis Chang	Jonathan Kaye
1.0	16 Dec 2024	Initial release	Dave Drogowski	Jonathan Kaye
1.1	19 Dec 2024	Updated maximum Tx power to +7 dBm.	Louis Chang	Jonathan Kaye
1.2	13 Jan 2025	Updated title of 7.4 Updated some typo	Louis Chang	

Contents

1 Overview and Key Features 5
1.1 Features and Benefits 5
1.2 Application Areas 5
2 Specification 6
2.1 Specification Summary 6
3 Hardware Specifications 9
3.1 Block Diagram and Pin-out 9
3.2 Pin Definitions 10
3.3 Electrical Specifications 13
3.3.1 Absolute Maximum Ratings 13
3.3.2 Recommended Operating Parameters 14
3.4 Clocks 14
3.4.1 HFXO - 32MHz crystal oscillator and nRF54L15 internal load capacitor TBD pF mandatory setting 14
3.4.2 LFCLK – Low Frequency clock source 14
3.4.3 Other Internal Clocks 15
3.5 BL54L15 Power Supply 15
4 Programmability 16
4.1 BL54L15 Default Firmware 16
4.2 BL54L15 Firmware Options 16
5 Peripherals 17
6 Mandatory SW requirements related to hardware 18
6.1 32MHz crystal internal load capacitor setting of TBD pF 18
7 Hardware Integration Suggestions 18
7.1 Circuit 18
7.2 PCB Layout on Host PCB - General 19
7.3 PCB Layout on Host PCB for the 453-00001 19
7.3.1 Antenna Keep-out on Host PCB 19
7.3.2 Antenna Keep-out and Proximity to Metal or Plastic 19
7.4 External Antenna Integration with BL54L15 MHF4 variant (453-00044) 20
8 Mechanical Details 20
8.1 BL54L15 Mechanical Details 20
8.2 Host PCB Land Pattern and Antenna Keep-out for the 453-00001 22
9 On -Board PCB Trace Antenna Characteristics 23
9.1 Summary of Antenna Performance 23
9.2 2.4GHz Radiated Performance 23
9.3 Antenna S11 measuring data 24
10 Regulatory 25
10.1 Federal Communication Commission Interference Statement 25
10.2 Industry Canada statement: 27
10.3 Europe – EU Declaration of Conformity 29
11 Ordering Information 30

12 Additional Information.....31

1 Overview and Key Features

Experience a new pinnacle of performance, efficiency, and security with our new BL54L15 series, built on Nordic Semiconductor's powerful **nRF54** silicon. Elevating what you know and love from the nRF52 series, this next generation redefines Bluetooth LE and 802.15.4 solutions. Unleashing enhanced processing power, expanded memory, and innovative peripherals, the BL54L15 is the ultimate choice for low power connectivity.

Powered by **Nordic's nRF54L15** SoC, our compact BL54L15 modules deliver secure and robust Bluetooth LE and 802.15.4 with flexible programming via Nordic's nRF Connect SDK or Ezurio Canvas Software Suite.

Featuring a **128MHz ARM Cortex M33** and **128MHz RISC-V coprocessor**, supported by 1.5 MB non-volatile memory and 256 KB RAM, the BL54L15 modules offer double the processing power (vs prior BL654 – nRF52840). The BL54L15 series brings out all nRF54L15 hardware features and capabilities including up to **+7 dBm** transmit power, **1.7V – 3.6V** supply considerations, and **NFC A-Tag** implementation.

It's further enhanced with state-of-the-art security and is designed for PSA Certified level 3 and supports services such as Secure Boot, Secure Firmware Update, Secure Storage plus protection from physical attacks.

Note: BL54L15 hardware provides all functionality of the nRF54L15 chipset used in the module design. This is a hardware datasheet only – it does not cover the software aspects of the BL54L15. This is to acknowledge that information in this datasheet is referenced from the nRF54L15 datasheet.

1.1 Features and Benefits

- **Nordic nRF54L15** – 6x6 mm QFN48 with 31 GPIOs utilized.
- **Multi-protocol support:** Bluetooth 5.4 LE, 802.15.4 (Thread/Matter)
- **Cortex M33** processor core: 128 MHz ARM Cortex M33
- **RISC-V** co-processor core: 128 MHz VPR
- **Memory:** 1.5MB non-volatile memory, 256 KB RAM
- **High Speed Peripherals**: - HS-SPI/UART, software defined peripherals on 128 MHz VPR, GPIO - 1x 64 MHz Port, 1.7 – 3.6V, 11 GPIOs
- **Low Leakage Peripherals:** 2x QDEC, 7x Timer, Global RTC, 2x WDT, NFC A-Tag, TEMP, I2S, COMP, 3x PWM, LPCOMP, 14-bit 8CH ADC, 5x TWI/SPI/UART, GPIO (2x 16 MHz Port (P0, P1), 20 GPIO's, 1.7-3.6V, 31 GPIO)
- **Antenna choice** – integrated pre-certified **PCB Trace antenna** or external antenna support via **MHF4 connector**
- **Ultra-small footprint** (14 mm x 10 mm x 1.6 mm)
- **Extended** Industrial **Temperature Rating** (-40° to +105 °C)
- **Bluetooth LE**: Peripheral/Central, 2 Mbps (high throughput), LE Coded (long range), AoA/AoD, Mesh
- Firmware Over the Air **(FOTA)** via MCUboot and nRF Connect SDK
- **Hostless operation** – Multi Core MCU reduces BOM
- **Fully featured development kits** to jump start Bluetooth LE development
- Mechanically same form factor as **BL652 Series**

1.2 Application Areas

- Building Automation
- Security
- Medical Peripherals
- Industrial Sensors

2 Specification

2.1 Specification Summary

Categories/Feature	Implementation
Wireless Specification	
Bluetooth®	Bluetooth 5.4 – Single mode • GATT client/server – Any adopted/custom services • Central/Peripheral roles • Bluetooth LE mesh • 2M PHY • LE Coded PHY • LE Advertising Extensions • LE secure connections • Data packet length extensions • LE privacy v1.2 • LE ping • DTM Firmware (Test Modes)
IEEE 802.15.4-2006 PHY	2405–2480 MHz IEEE 802.15.5-2006 radio transceiver, implementing IEEE 802.15.5-2006 compliant • 250kbps, 2450MHz, O-QPSK PHY • Channels 11-26. Channel 11 2405MHz and CH26 2480MHz. • Clear channel assessment (CCA) • Energy detection (ED) scan • CRC generation
Nordic proprietary 1Mbps, 2Mbps, 4Mbps modes radio	2402–2480 MHz Nordic proprietary 1Mbps and 2Mbps modes radio transceiver • 1Mbps nRF proprietary mode (ideal transmitter) • 2Mbps nRF proprietary mode (ideal transmitter) • 4Mbps nRF proprietary mode (ideal transmitter)
Frequency	2.402 - 2.480 GHz for BLE (CH0 to CH39) 2.405 - 2.480 GHz for IEEE 802.15.4-2006 PHY (CH11 to CH26)
Raw Data Rates	1 Mbps BLE (over-the-air) 2 Mbps BLE (over-the-air) 125 kbps BLE (over-the-air) 500 kbps BLE (over-the-air) 250 kbps IEEE 802.15.4 802.15.4-2006 (over-the-air) Nordic proprietary 1Mbps, 2Mbps and 4Mbps modes (over-the-air)
Maximum Transmit Power Setting	+7 dBm Conducted 453-00001 (Integrated antenna) (Exclude antenna gain) +7 dBm Conducted 453-00044 (External antenna) (Test at MHF4 connector)
Minimum Transmit Power Setting	-8 dBm (to +7dBm in <1dB steps)
Receive Sensitivity[1] (≤37byte packet for BLE)	BLE 1 Mbps (BER=1E-3) -94 dBm typical BLE 2 Mbps -92 dBm typical BLE 125 kbps -102 dBm typical BLE 500 kbps -98 dBm typical IEEE 802.15.4-2006 250kbps TBD dBm typical
Link Budget (conducted)	101 dB @ BLE 1 Mbps (TX power used is 7dBm) 109 dB @ BLE 125 kbps (TX power used is 7dBm)
NFC	
NFC-Type 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

Note1 Known Noise on channels 2432MHz and 2464MHz degrades receiver sensitivity, in which sensitivity are not within the typical value

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.

Host Interfaces and Peripherals	Application Core (High Performance)	Software defined peripheral Core (ultra-low power)
Total		31 x multifunction I/O lines
Two co-processors	Arm Cortex-M33 with DSP, FPU, TrustZone support. 1524KB non-voltaile RRAM 256KB RAM L1 cache 128MHz clock Uses voltage and clock frequency scaling	RISC-V CPU (VPR) fast lightweight peripheral processor (FLPR) dedicated for software defined peripherals 16MHz clock
GPIO		Up to 31 multifunction GPIO's
	64MHz 1.7-3.6V GPIO port P2.00-P2.10	16MHz 1.7-3.6V GPIO port P1.00-P1.14; P0.00-P0.04
ADC (14-bit)	14-bit 20KS/s with oversampling 12-bit 250KS/s 10-bit 2MS/s AIN0-AIN7 pins upto 8 programmable gain channels	
Global RTC (GRTC)		Implements full real time clock and calendar as shared system time. Can run in System OFF mode. Ultra low power, 1us resolution, 52bits wide, uses 16MHz clock, 32.76kHz when other power modes.
RTC		2x low power runs off LFCLK
High Speed SPI/UART	1 x	
SPI/UART/TWI		4x
PWM		3x 4channel PWM
I2S		1x I2S (Inter-IC sound interface)
PDM		1x PDM (Pulse code modulation interface) for digital microphones
TIMER		7x Timer (32bit)
QDEC		2x QDEC (Quadrature decoder)
COMP		1x COMP (comparator)
LPCOMP		1x LPCOMP (low power comparator)
TEMP		1x Temperature sensor Temperature range equal to operating temperature range
WDT		2x WDT (Watchdog timer)
NFC A-Tag		1x
Wakeup pins		20x
External optional 32.768 kHz crystal		Not needed for normal radio operation. 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	**Via SWD (JTAG) 2 wire interface**
Options	**Nordic nRFConnect SDK:** Software/Support available from Nordic directly https://devzone.nordicsemi.com/ **Canvas SW Suite**: Software/ Support available from https://www.ezurio.com/canvas/software-suite
FW upgrade	Via SWD (JTAG) 2 wire interface or UART
Supply Voltage	Normal Voltage Mode (VDD, VDDM_nRF): 1.7V-3.6V (Internal DCDC convertor or LDO)
Power Consumption	
Active Modes Peak Current (for maximum Tx power +7dBm) – Radio only	TBD mA peak Tx (with DCDC)
Active Modes Peak Current (for Tx power -8dBm) – Radio only	TBD mA peak Tx (with DCDC)
Active Modes Average Current	Depends on many factors.
Ultra-low Power Modes	System ON Idle: TBD uA (wake on any event) System OFF: TBD uA (wake on reset)
Antenna Options	
Internal	PCB Trace antenna – on-board (**453-00001 variant)**
External	Connection via *on module* IPEX MHF4 (**453-00044 variant)**
Physical	
Dimensions	14mm x 10mm x 1.6mm Pad Pitch – 0.75 mm 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
Miscellaneous	
Lead Free	Lead-free and RoHS compliant
Warranty	One-Year Warranty
Development Tools	
Development Kit	Development kit per module SKU (453-00001-K1 and 453-00044-K1 respectively)
Development Tools	Nordic nRFConnect - Android and iOS applications UART firmware upgrade Xbit Tools and utilities
Bluetooth®	Full Bluetooth SIG Declaration ID
FCC/ISED/CE/MIC/RCM/UKCA	All BL54L15 Series

3 Hardware Specifications

3.1 Block Diagram and Pin-out

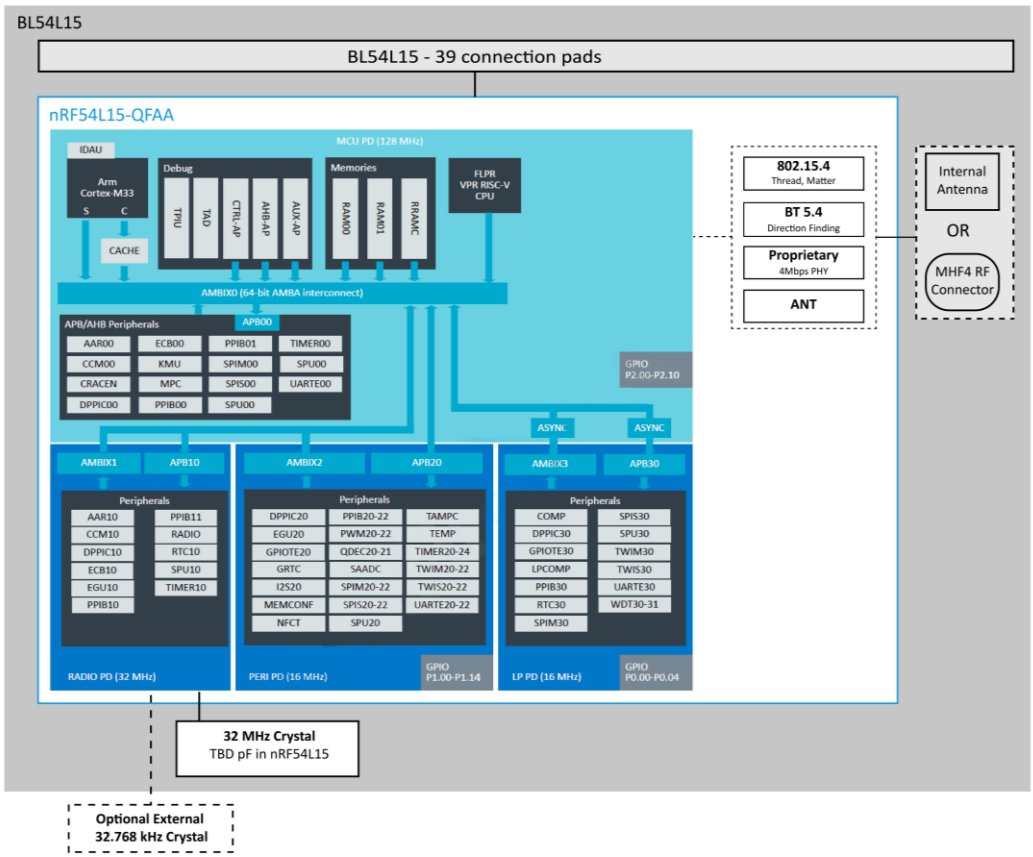


Figure 1: BL54L15 HW block diagram

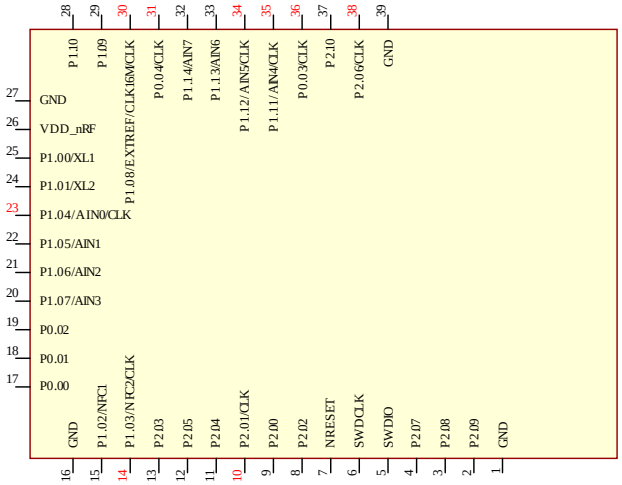


Figure 2: Top view - Schematic symbol for 453-00001 BL54L15 Module (Nordic nRF54L15) - Integrated PCB Trace Antenna variant or 453-00044 MHF4 RF connector variant

3.2 Pin Definitions

Table 1: Pin definitions

Pin #	Pin Name (red coloured pins for clock for interfaces, trace)	nRF54L15 QFN48 Pin	nRF54L15 QFN48 Name	Description	Example usage
1	GND	-	VSS		
2	P2.09	20	P2.09/TRACEDATA[2]/SPI.SDI/SDO	General purpose I/O Trace data SPIM SDI SPIS SDI UARTE CTS	 Trace SPIM00/SPIM21 SPIS00/SPIS21 UARTE00/UARTE21
3	P2.08	19	P2.08/TRACEDATA[1]/SPI.SDI/SDO	General purpose I/O Trace data SPIM SDO SPIS SDO UARTE TXD	 Trace SPIM00/SPIM21 SPIS00/SPIS21 UARTE00/UARTE21
4	P2.07	18	P2.07/TRACEDATA[0]/SWO/SPI.DCX	General purpose I/O Trace data Serial wire output (SWO) SPIM DCX UARTE RXD	 Trace Trace SPIM00/SPIM21 UARTE00/UARTE21
5	SWDIO	25	SWDIO	Serial Wire Debug IO for debug and programming	
6	SWDCLK	26	SWDCLK	Serial Wire Debug clock input for debug and programming	
7	NRESET	30	nRESET	Pin RESET with internal pull-up resistor (13k Ohms). System Reset (Active Low).	

Pin #	Pin Name (red coloured pins for clock for interfaces, trace)	nRF54L15 QFN48 Pin	nRF54L15 QFN48 Name	Description	Example usage
8	P2.02	13	P2.02/SPI.SDI/SDO	General purpose I/O SPIM SDO SPIS SDO UARTE TXD QSPI D0 Serial wire output (SWO)	 SPIM00/SPIM20 SPIS00/SPIS20 UARTE00/UARTE20 FLPR Trace
9	P2.00	11	P2.00/SPI.DCX	General purpose I/O SPIM DCX UARTE RXD QSPI D3	 SPIM00/SPIM20 UARTE00/UARTE20 FLPR (QSPI)
10	P2.01/CLK	12	P2.01/SPI.SCK	General purpose I/O SPIM SCK SPIS SCK QSPI SCK	Clock pin SPIM00/SPIM20 SPIS00/SPIS20 FLPR
11	P2.04	15	P2.04/SPI.SDI/SDO	General purpose I/O SPIM SDI SPIS SDI UARTE CTS QSPI D1	 SPIM00/SPIM20 SPIS00/SPIS20 UARTE00/UARTE20 FLPR
12	P2.05	16	P2.05/SPI.CS	General purpose I/O SPIM CS UARTE RTS QSPI CS	 SPIM00/SPIM20 UARTE00/UARTE20 FLPR
13	P2.03	14	P2.03	General purpose I/O QSPI D2	 FLPR
14	P1.03/NFC2/CLK	4	P1.03/NFC2	General purpose I/O Dedicated pin for NFC input	Clock pin
15	P1.02/NFC1	3	P1.02/NFC1	General purpose I/O Dedicated pin for NFC input	
16	GND				
17	P0.00	23	P0.00	General purpose I/O	
18	P0.01	24	P0.01	General purpose I/O	
19	P0.02	27	P0.02	General purpose I/O	
20	P1.07/AIN3	8	P1.07/AIN3/TAMPC	General purpose I/O TAMPC active shield 1 input Analog input	 TAMPC
21	P1.06/AIN2	7	P1.06/AIN2/TAMPC	General purpose I/O TAMPC active shield 1 output Analog input	 TAMPC
22	P1.05/AIN1	6	P1.05/AIN1/TAMPC	General purpose I/O TAMPC active shield 0 input RADIO DFEGPIO Analog input	 TAMPC RADIO
23	P1.04/AIN0/CLK	5	P1.04/AIN0/TAMPC	General purpose I/O TAMPC active shield 0 output Analog input	Clock pin TAMPC
24	P1.01/XL2	2	P1.01/XL2	General purpose I/O	Ezurio Devkit: Optional 32.768kHz crystal pad XL2, XL1 and

Pin #	Pin Name (red coloured pins for clock for interfaces, trace)	nRF54L15 QFN48 Pin	nRF54L15 QFN48 Name	Description	Example usage
				General purpose I/O Connection for 32.768kHz crystal	associated 9pF load capacitor inside nRF54L15 chipset.
25	P1.00/XL1	1	P1.00/XL1	General purpose I/O Connection for 32.768kHz crystal	Ezurio Devkit: Optional 32.768kHz crystal pad XL2, XL1 and associated 9pF load capacitor inside nRF54L15 chipset.
26	VDD_nRF	48	VDD	1.7V-3.6V input for Normal Voltage Mode where connect external supply to VDD_nRF(pin26). See 3.5 BL54L15 Power Supply	
27	GND				
28	P1.10	38	P1.10/TAMPC	General purpose I/O TAMPC active shield 2 input RADIO DFEGPIO	 TAMPC RADIO
29	P1.09	37	P1.09/TAMPC	General purpose I/O TAMPC active shield 2 output RADIO DFEGPIOO	 TAMPC RADIO
30	P1.08/EXTREF/CLK16M/CLK	9	P1.08/CLK16M/TAMPC	General purpose I/O GRTC HF clock output External reference for SAADC	Clock pin
31	P0.04/CLK	29	P0.04/GRTC_CLKOUT32K	General purpose I/O GRTC LF clock output	Clock pin GRTC
32	P1.14/AIN7	42	P1.14/AIN7	General purpose I/O RADIO DFEGPIO Analog input	 RADIO
33	P1.13/AIN6	41	P1.13/AIN6	General purpose I/O RADIO DFEGPIO Analog input	 RADIO
34	P1.12/AIN5/CLK	40	P1.12/AIN5	General purpose I/O TAMPC active shield 3 input RADIO DFEGPIO Analog input	Clock pin TAMPC RADIO
35	P1.11/AIN4/CLK	39	P1.11/AIN4	General purpose I/O TAMPC active shield 3 output RADIO DFEGPIO Analog input	Clock pin TAMPC RADIO
36	P0.03/CLK	28	P0.03/GRTC_PWMOUT	General purpose I/O GRTC PWM output	Clock pin GRTC
37	P2.10	21	P2.10/TRACEDATA[3]/SPIM.CS	General purpose I/O Trace SPIM CS UARTE RTS	 Trace SPIM00/SPIM21 UARTE00/UARTE21
38	P2.06/CLK	17	P2.06/TRACECLK/SPI.SCK	General purpose I/O SPIM SCK SPIS SCK Trace clock	Clock pin SPIM00/SPIM21 SPIS00/SPIS21 Trace
39	GND				
Pin Definition Notes:					

Pin #	Pin Name (red coloured pins for clock for interfaces, trace)	nRF54L15 QFN48 Pin	nRF54L15 QFN48 Name	Description	Example usage
	Note 1 GPIO	**GPIO = General Input or Output (GPIO level voltage tracks VDD pin). AIN =Analog input.** 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. **Must connect all GND pads to host board PCB GND plane.**			
	Note2 Clock for serial interfaces or trace	Some peripherals (SPI, TWI, PDM, I2S, TRACE, GRTC) have clock signals. Dedicated clock pins have been optimized to ensure correct timing relationship between clock and data signal for these peripherals. Pins that can be used as clock signals are shown with pin name in red colour. The peripheral data signal must be configured to use pins close to the clock pin. This ensures that the internal paths from the peripheral to the pin have the same delay, so that the data and clock signals reach the pins at the same time. For high-speed signals, the printed circuit board (PCB) layout must use short PCB traces of identical length. This makes sure any delays are kept to a minimum and it assures close to identical delay and clock path.			
	Note 3 Dedicated pins	**UARTE20/21:** Can use any pin son GPIO port P1. Can be connected across power domains to dedicated pin on P2. **SPIM00:** Has dedicated pins on GPIO port P2. For 32MHz operation, the pins must be configured using extra high drive E0/E1 configuration. **SPIM20/21:** Can use any pin son GPIO port P1. Can be connected across power domains to dedicated pin on P2. **SPIS20/21:** Can use any pin son GPIO port P1. Can be connected across power domains to dedicated pin on P2. **TRACE:** Has dedicated pins on GPIO port P2. For 32MHz operation, the pins must be configured using extra high drive E0/E1 configuration. **GRTC:** Has dedicated pins for clock and PWM output. **TAMPC:** Has dedicated pins for active shield inputs and outputs. **FLPR:** Uses dedicated pins on GPIO port P2 for emulated peripherals such as QSPI. **RADIO:** Uses dedicated pins on GPIO port P1 for antenna switch control (DFEGPIO for direction finding). **NFC:** Uses dedicated pins listed in pin definitions table1.			
	Note 4 SWDIO / SWCLK / nRESET / VDD / GND	Customer MUST bring out SWDIO, SWCLK, nRESET, VDD, GND for programming purposes.			

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
Supply Voltages			
VDD_nRF	TBD	TBD	V
Voltage at GND pin	TBD	0	V
I/O pin voltage			
Voltage at GPIO pin (at VDD≤3.6V)	TDB	TBD	V
NFC antenna pin current (NFC1/2)	-	TBD	mA
Radio RF input level	-	TBD	dBm
Environmental			
Storage temperature	-40	+105	ºC
MSL (Moisture Sensitivity Level)	-	4	-
ESD (as per EN301-489)			
Conductive		4	kV
Air Coupling		8	kV
Flash Memory (Endurance) (Note 2)	TBD		Write/erase cycles
Flash Memory (Retention)	TBD years at TBD ºC		years at TBD ºC

Absolute maximum Ratings Notes:	
Note 1	The absolute maximum rating for VDD pin (max) is TBD V for the BL54L15.
Note 2	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_nRF (independent of DCDC) supply range	1.7		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)² 10uS	-	TBD	TBD	mS
VDD supply rise time (0V to 1.7V)²>10mS	-	TBD	TBD	mS
Operating Temperature Range	-40	+25	+105	ºC

Recommended Operating Parameters Notes:	
Note 1	This is the maximum VDD_nRF 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.

3.4 Clocks

3.4.1 HFXO - 32MHz crystal oscillator and nRF54L15 internal load capacitor TBD pF mandatory setting

The BL54L15 module contains the 32 MHz crystal, but the load capacitors to create 32MHz crystal oscillator circuit are inside the nRF54L15 chipset. Customer MUST set the internal nRF54L15 capacitors to TBD pF (for proper operation of the 32 MHz crystal circuit).

The 32 MHz crystal inside the BL54L15 module is a high accuracy crystal (±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 nRF54L15 (and does not require additional external components) with an accuracy ±250 ppm (after calibration of LFRC at least every eight seconds using the HFXO as a reference oscillator).

LFXO (32.768kHz crystal oscillator): For higher LFCLK accuracy (greater than ±250ppm accuracy is required), the low frequency crystal oscillator (LFXO) must be used. To use LFXO, a 32.768kHz crystal must be connected between the XL1 and XL2 pins and the load capacitance between each crustal terminal and ground. Optionally internal (to nRF54L15) 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 (LFXO) is designed to work with external sources

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 turned on in the system.

3.4.3 Other Internal Clocks

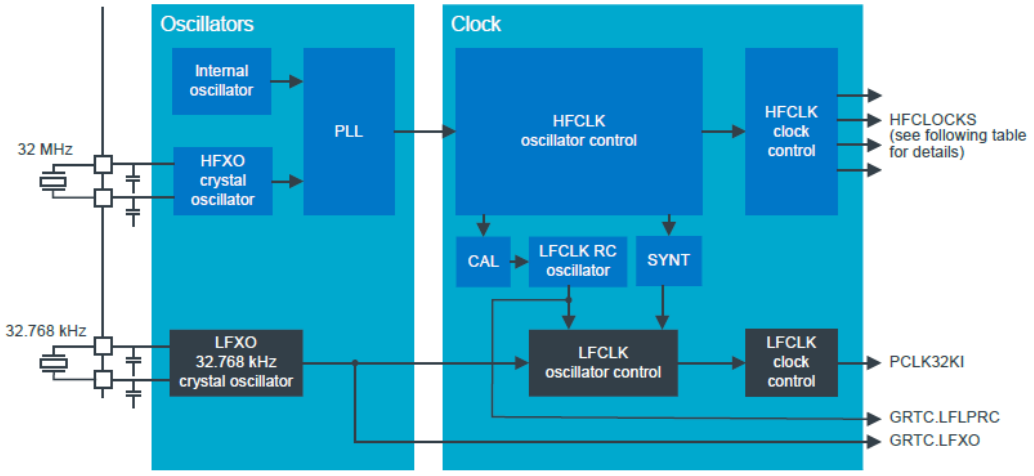


Figure 3: nRF54L15 Clock System Overview (adapted from Nordic)

3.5 BL54L15 Power Supply

Normal voltage mode power supply mode is entered when the external supply voltage (1.7V-3.6V) is connected to both VDD_nRF pin (pin26). See Figure 4.

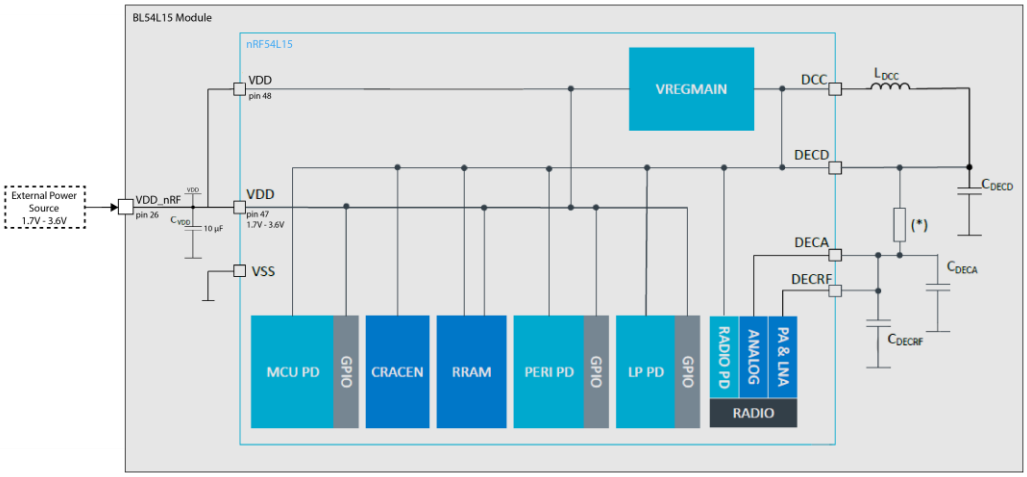


Figure 4: Normal Voltage Mode

4 Programmability

4.1 BL54L15 Default Firmware

The BL54L15 module is shipped from Ezurio manufacturing facilities with no firmware programmed.

4.2 BL54L15 Firmware Options

Firmware for use with the BL54L15 can be divided into the following types.

- **Bootloader** – This is the application that resides on the Application Core used to perform firmware updates of the Application and FLPR cores.

  The MCU Boot or Trusted Firmware M Bootloaders are recommended to be used as the basis for the BL54L15 Bootloader functionality.

- **Application** – This is the main application running on the Application core. In interfaces with the integrated radio stack(s) and provides supplementary functionality in addition to the time critical activities performed for radio activity.

- **Software Defined Peripheral** – This is the application running on the RISC-V FLPR core.

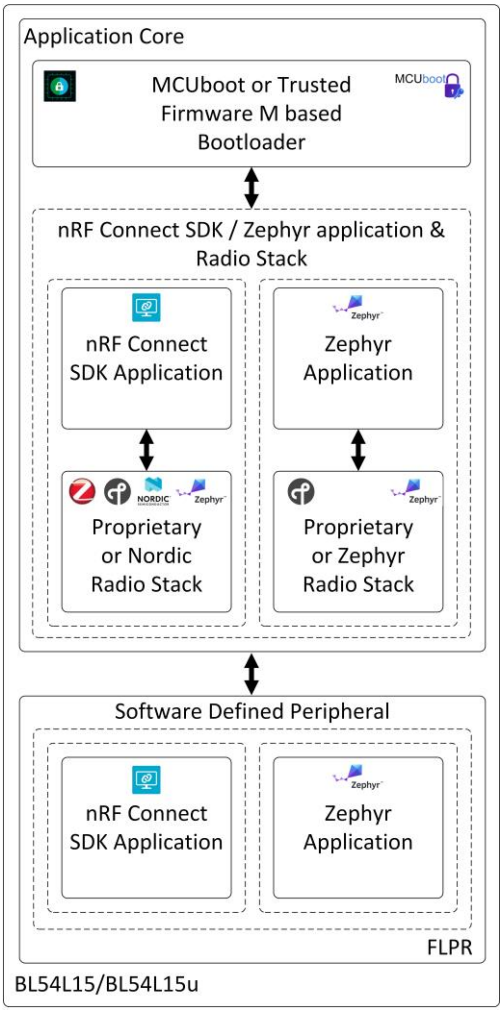


Figure 5: Functional SW block diagram for BL54L15 series module

5 Peripherals

Feature		Module	
		BL54L15	BL54L15u
		nRF54L15-QFAA	nRF54L15-CAAA
Memory	Non-volatile memory (RRAM)	1524 KB	
	Random access memory (RAM)	256 KB	
Radio	Bluetooth Low Energy	Yes	
	Bluetooth Low Energy Coded PHY (Long range)	Yes	
	Bluetooth Constant Tone Extension (Direction-finding)	Yes	
	IEEE 802.15.4	Yes	
GPIO pins	GPIO pins	31	32
	Wakeup-pins	20	21
	Analog input pins	8	
	GPIO voltage	VDD (1.7V-3.6V)	
Peripherals	Timers (TIMER)	7	
	Real-time counter (RTC)	2	
	Global real-time counter (GRTC)	Yes	
	Serial interfaces (UART, SPI, TWI)	5	
	Temperature sensor	Yes	
	Comparator (COMP)	Yes	
	Analog-to-digital converter (ADC)	Yes	
	Quadrature decoder (QDEC)	2	
	Inter-IC sound interface (I2S)	2	
	Near-field communication (NFC)	Yes	
	Pulse density modulation interface (PDM)	2	
	Pulse-width modulator (PWM)	3	
	Watchdog timer (WDT)	2	
Security	Active tamper shield pin pairs (in/out)	4	
	Glitch detectors	Yes	
	Key management unit	Yes	
	Encryption accelerator	Yes	
Debug	ITM parallel trace	Yes	No

6 Mandatory SW requirements related to hardware

6.1 32MHz crystal internal load capacitor setting of TBD pF

MANDATORY. BL54L15 module contains the 32 MHz crystal but the load capacitors to create 32 MHz crystal oscillator circuit are inside the nRF54L15 chipset. Customer MUST set the internal nRF54L15 capacitors to TBD pF (for proper operation of the 32 MHz crystal circuit in the BL54L15 module).

7 Hardware Integration Suggestions

7.1 Circuit

The BL54L15 is easy to integrate, requiring one mandatory external 10uF capacitor on customers board and apart from that those components which customer require for development and in your end application.

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

Checklist (for Schematic):

- **BL54L15 power supply:**

  Normal voltage mode power supply mode is entered when the external supply voltage (1.7V-3.6V) is connected to both VDD_nRF pin (pin26).

  External power source should be within the operating range, rise time and noise/ripple specification of the BL54L15. Add decoupling capacitors for filtering the external source. Power-on reset circuitry within BL54L15 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.

已註解 [RK1]: @Dave Drogowski updated this datasheet, this text was wrong, now placed correct text, please clean.

- **AIN (ADC) and GPIO pin IO voltage levels**
  BL54L15 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. nRF54L15 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.
- **QSPI, High Speed SPI, High speed TWI (I2C, 1Mbps) and Trace**
  High-Speed SPI, TWI 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 BL54L15 (nRF54L15-QFAA)).
- **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 nRF54L15-QFAA or discrete capacitors outside BL54L15 (nRF54L15-QFAA) whose values should be tuned to meet all specification for frequency and oscillation margin.

7.2 PCB Layout on Host PCB - General

Checklist (for PCB):

- MUST locate BL54L15 module close to the edge of PCB (mandatory for the 453-00001 for on-board PCB trace 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, VDDM 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 BL54L15 development board).

7.3 PCB Layout on Host PCB for the 453-00001

7.3.1 Antenna Keep-out on Host PCB

The 453-00001 has an integrated PCB trace antenna and its performance is sensitive to host PCB. It is critical to locate the 453-00001 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 453-00001***. 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 453-00001 module on the edge of the host PCB, preferably in the edge center.
- The BL54L15 development board (453-00001-K1) has the 453-00001 module on the edge of the board (not in the corner). The antenna keep-out area is defined by the BL54L15 development board which was used for module development and antenna performance evaluation is shown in Figure 6, where the antenna keep-out area is ~5mm wide, ~28.6mm long; with PCB dielectric (no copper) height ~1.57mm sitting under the 453-00001 PCB trace antenna module.
- The 453-00001 PCB trace antenna is tuned when the 453-00001 is sitting on development board (host PCB) with size of 113 mm x 63.5 mm x 1.6mm.
- A different host PCB thickness dielectric will have small effect on antenna.
- The antenna-keep-out defined in the 6.2 Host PCB Land Pattern and Antenna Keep-out for the 453-00001 section.
- Host PCB land pattern and antenna keep-out for the BL54L15 applies when the 453-00001 is placed in the edge of the host PCB preferably in the edge center. Figure 6 shows an example.

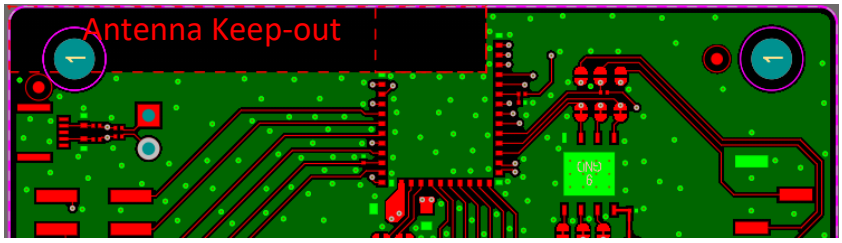


Figure 6: PCB trace Antenna keep-out area (shown in red), corner of the BL54L15 development board for the 453-00001 module.

Antenna Keep-out Notes:	
Note 1	The BL54L15 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 453-00001 on host PCB.

7.3.2 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 453-00001 PCB trace monopole 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).

7.4 External Antenna Integration with BL54L15 MHF4 variant (453-00044)

Please refer to the regulatory sections for FCC, ISED, CE, MIC, UKCA and RCM details of use of BL54L15 with external antennas in each regulatory region.

The BL54L15 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 BL54L15 MHF4 module variant module (453-00044)

已註解 **[RK2]:** To be checked with JK.

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	PIFA	IPEX MHF4L	-	2 dBi
Mag.Layers	EDA-8709-2G4C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2.32 dBi	-
Ezurio	mFlexPIFA	EFA2400A3S-10MH4L	PIFA	IPEX MHF4L	-	2 dBi
Ezurio	i-FlexPIFATM Mini Series	EFG2401A3S-10MH4L	i-FlexPIFA	IPEX MHF4L	-	2 dBi
Ezurio	Ezurio NFC	0600-00061	NFC	N/A	-	-

8 Mechanical Details

8.1 BL54L15 Mechanical Details

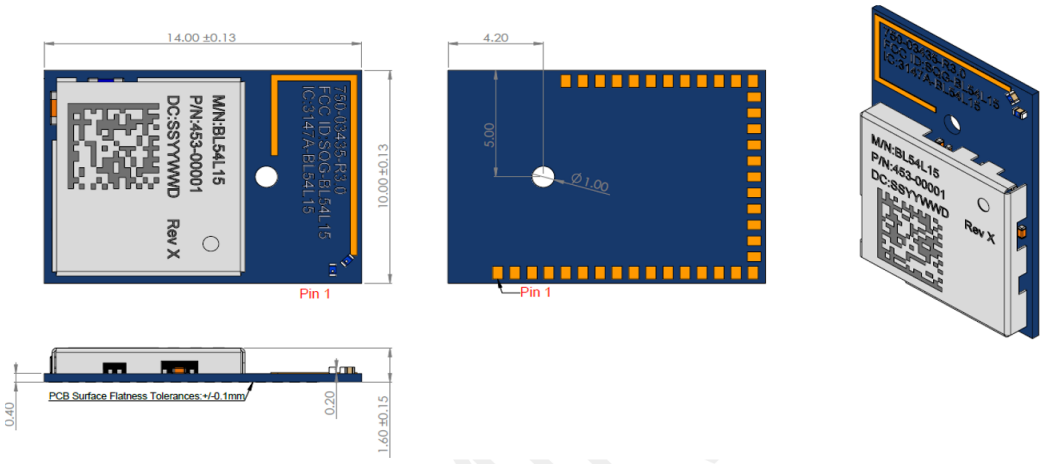


Figure 7: Mechanical Details – Internal Antenna variant module (453-00001)

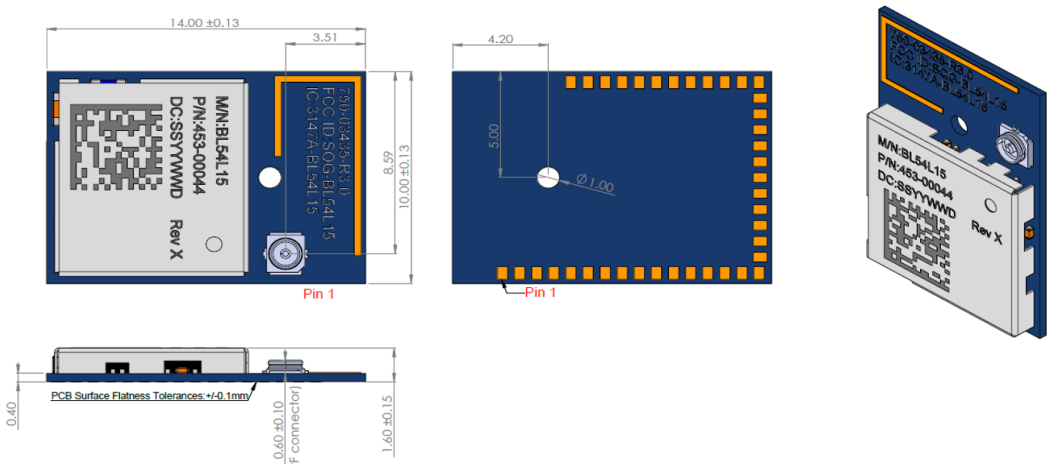
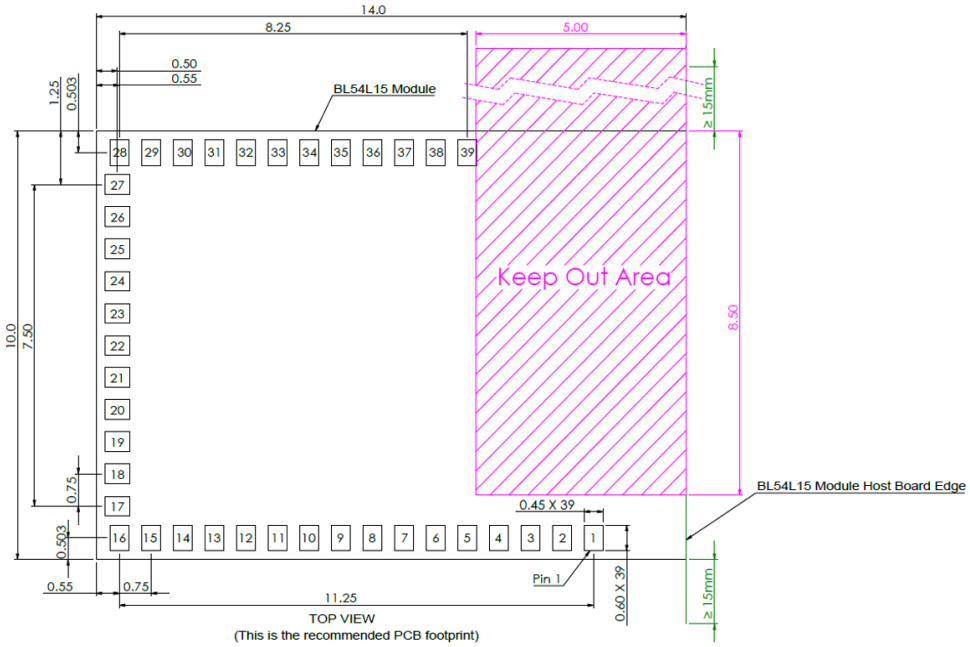


Figure 8: Mechanical Details – MHF4 RF connector variant module (453-00044)

3D models for BL54L15 Module, MHF4 (453-00044) and BL54L15 Module, PCB printed (453-00001) on the BL54L15 product page – https://www.ezurio.com/product/bl54l15-series-bluetooth-le-80215-4-nfc

8.2 Host PCB Land Pattern and Antenna Keep-out for the 453-00001

PCB footprint - BL54L15 (DXF and Altium format) and SCH Symbol - BL54L15 (Altium format) can be found on the BL54L15 product page – https://www.ezurio.com/product/bl54l15-series-bluetooth-le-80215-4-nfc



All dimensions are in mm.

Figure 9: Land pattern and Keep-out for the 453-00001

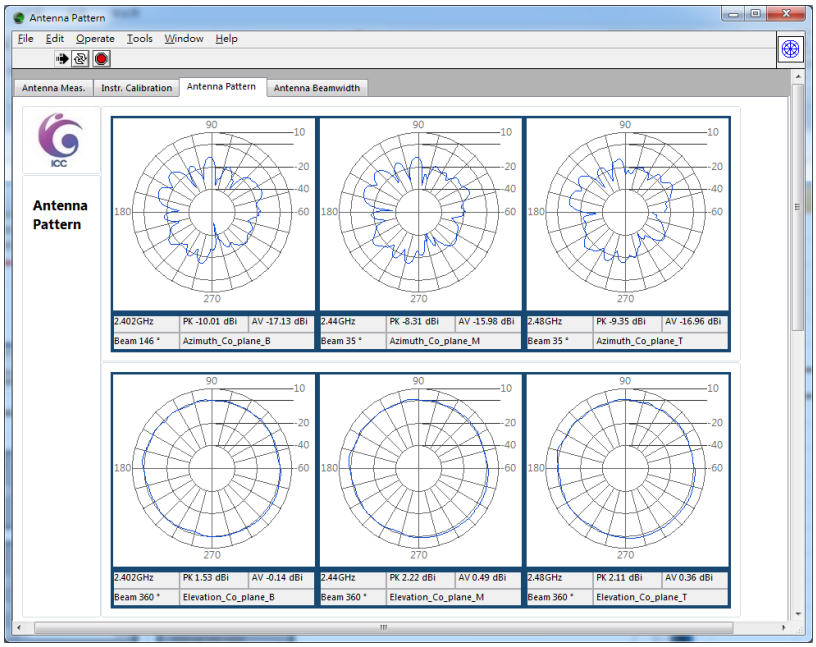
Host PCB Land Pattern and Antenna Keep-out for the 453-000xx Notes:	
Note 1	Ensure there is no copper in the antenna 'keep out area' on any layers of the host PCB. Also keep all mounting hardware or any metal clear of the area (Refer to 7.3.2) to reduce effects of proximity detuning the antenna and to help antenna radiate properly.
Note 2	For the best on-board antenna performance, the module 453-00001 MUST be placed on the edge of the host PCB and preferably in the edge centre and host PCB, the antenna "Keep Out Area" is extended (see Note 4).
Note 3	BL54L15 development board has the 453-00001 placed on the edge of the PCB board (and not in corner) for that the Antenna keep out area is extended down to the corner of the development board, see section 8.2 Host PCB Land Pattern and Antenna Keep-out for the 453-00001.
Note 4	Ensure that there is no exposed copper under the module on the host PCB.
Note 5	You may modify the PCB land pattern dimensions based on their experience and/or process capability.

9 On -Board PCB Trace Antenna Characteristics

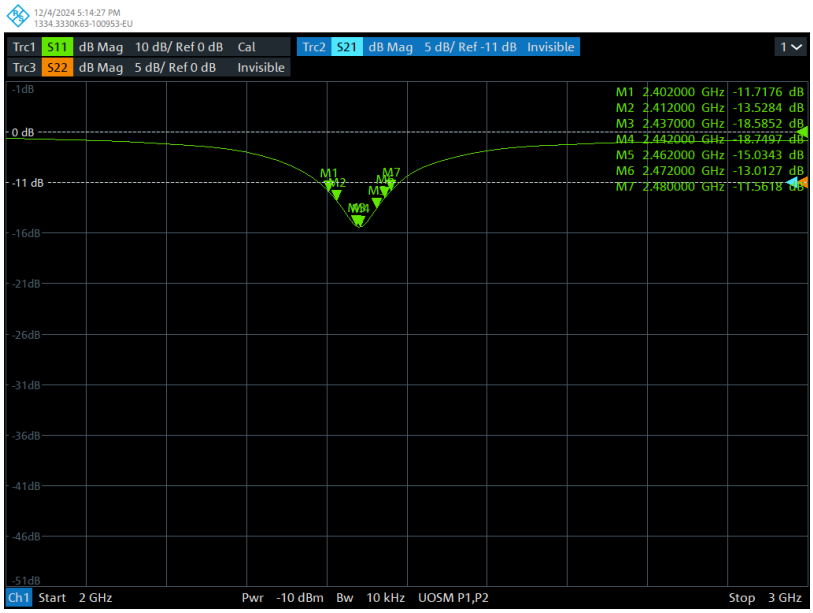
9.1 Summary of Antenna Performance

	2402MHz		2440MHz		2480MHz	
	Peak	**Avg**	**Peak**	**Avg**	**Peak**	**Avg**
453-00001 PCB trace antenna	+0.2dBi	-4.24dBi	+1.49dBi	-3.19dBi	+1.39dBi	-3.27dBi

9.2 2.4GHz Radiated Performance



9.3 Antenna S11 measuring data



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	-
Ezurio / BL54L15 Printed PCB Antenna	Printed PCB	NA	0

Label and Compliance Information
Product manufacturers need to provide a physical or e-label stating
"Contains FCC ID: SQG-BL54L15" 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:

The product comply with the Canada 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.

Déclaration d'exposition aux radiations:
Le produit est conforme aux limites d'exposition pour les appareils portables RF pour les Etats-Unis et le Canada établies pour un environnement non contrôlé. Le produit est sûr pour un fonctionnement tel que décrit dans ce manuel. La réduction aux expositions RF peut être augmentée si l'appareil peut être conservé aussi loin que possible du corps de l'utilisateur ou que le dispositif est réglé sur la puissance de sortie la plus faible si une telle fonction est disponible.

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-BL54L15".

Plaque signalétique du produit final

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 3147A-BL54L15".

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-BL54L15 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-BL54L15] 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	-
Ezurio / BL54L15 Printed PCB Antenna	Printed PCB	NA	0

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 62497:2010

(BS)EN 50663 2017

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: 9.55dbm

BT LE: 9.58dbm

SW version: V0.5.6

RF exposure statement

The product comply with the RF exposure limit and is 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.

11 Ordering Information

Part Number	Product Description
453-00001R	Module, BL54L15, (Nordic nRF54L15), Trace antenna, Tape/Reel
453-00044R	Module, BL54L15, (Nordic nRF54L15), MHF4 Connector, Tape/Reel
453-00001C	Module, BL54L15, (Nordic nRF54L15), Trace antenna, Cut Tape
453-00044C	Module, BL54L15, (Nordic nRF54L15), MHF4 Connector, Cut Tape
453-00001-K1	Development kit, Module, BL54L15 (Nordic nRF54L15), Trace antenna
453-00044-K1	Development kit, Module, BL54L15 (Nordic nRF54L15), MHF4 Connector

12 Additional Information

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

Headquarters	Ezurio 50 S. Main St. Suite 1100 Akron, OH 44308 USA
Website	http://www.ezurio.com
Technical Support	http://www.ezurio.com/resources/support
Sales Contact	http://www.ezurio.com/contact

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