NF3510PQ

nFore Wi-Fi /BT Combo Module
Hardware Specification Data Sheet

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1 FUNCTIONAL FEATURES

The NF3510PQ is a highly integrated Wi-Fi 6 device enabling Concurrent Dual Wi-Fi (CDW) and Bluetooth (BT) 5.3 operation. Supporting a 1x1 CDW configuration in both the 2.4 GHz and 5 GHz bands, and 2x2 MIMO single-band operation, the System-on-Chip (SoC) provides a peak data rate of 1.2 Gbit/s and implements advanced features including MU-MIMO, OFDMA and Target Wake Time (TWT).

With integrated 2.4 GHz and 5 GHz Tx power amplifiers (PA), Rx low noise amplifiers (LNA) and Tx/Rx switches (T/R SW) as well as a full Bluetooth radio, the NF3510PQ simplifies the design and minimizes the PCB area.

The NF3510PQ implements advanced Wi-Fi and Bluetooth co-existence hardware in conjunction with algorithms to optimize collaborative performance. In addition, support for external radio co-existence (e.g. cellular) is provided through an external interface.

AEC-Q100 Grade 3 compliant, the NF3510PQ provides multiple host interface options for the Wi-Fi radios (PCIe) and Bluetooth radio (UART) to provide a flexible design for easy integration into demanding automotive applications.

Let all of the system high design flexibility, short development cycle, and quick time-to-market.

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General Features

- Support Wi-Fi 6
- IEEE 802.11ax compliant
- Data rate of up to 1.2 Gbps
- Support 20, 40, and 80MHz channels.
- Full IEEE 802.11 a/b/g/n lengacy compatibility with enhanced performance
- WPA, WPA2(Personal) and WPA3(Personal)support for powerful encryption and authentication
- Reference WLAN subsystem provides Wi-Fi Protected Setup(WPA)
- Provisioned for low energy angle-of-arrival applications
- Complies with Bluetooth Core Specification Version 5.3 with provisions for supporting future specifications
- Bluetooth Class1 or Class2 transmitter operation
- Interface support, host controller interface(HCI) using high-speed UART interface and PCM for audio data
- Low-power dissipation
- Integrated Buck regulator for core power supply
- Sleep and standby modes for low-power operation
- Separate power island for independent enable/disable of Bluetooth radio3
- Independent ARM-based Wi-Fi and Bluetooth CPUs
- Support for reference clock signal from external crystal or external crystal oscillator
- Built-in Buck DC2DC Converter(1.8V)
- LGA module suitable for Surface Mounted Technology (SMT)
- Iron Shielding case
- LGA-96 package
- Dimension(Iron Shielding Case) : 17.4mm(L) x 16.7mm(W) x 3.3mm(H)
- Operating Voltage : VBAT : 3.0 to 3.6V ; VIO: 1.7 to 3.6V
- RoHS / REACH Compliant
- Automotive Level

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2.1.1 WLAN Features

- IEEE 802.11ax compliant
- Data rate of up to 1.2 Gbps
- Support 20, 40, and 80MHz channels for 2X2 WLAN core(1024 QAM modulation)
- Full IEEE 802.11 a/b/g/n legacy compatibility with enhanced performance
- Fast VSDB(Virtual simultaneous dual-band
- On-Module power amplifiers and low-noise amplifiers for both bands.
- PCIe mode complies with PCI Express base specification revision 2.0 for x1 lan and power management running at Gen2 speeds
- Security:
- WPA, WAPI STA, and WPA2(Personal) and WPA3(Personal)support for powerful encryption and authentication
- AES and TKIP in hardware for faster data encryption and IEEE802.11i compatibility
- Reference WLAN subsystem provides Wi-Fi Protected Setup(WPA)
- Operation frequency: 2412MHz-2462MHz, 5150MHz-5250MHz, 5725MHz-5850MHz

2.1.2 Bluetooth BR/EDR Features

- Bluetooth 5.3 specification support
- Bluetooth Class 1.5 and Class 2
- Single-ended, shared Tx/Rx path for Bluetooth
- Pulse Code Modulation (PCM) interface for voice applications
- Inter-IC Sound (I2S) interface for audio applications
- Baseband/radio BDR/EDR packet types—1 Mbit/s (GFSK), 2 Mbit/s (/4-DQPSK), 3 Mbit/s (8DPSK)
- Fully functional Bluetooth baseband—AFH, forward error correction, header error control, access code correlation, CRC, encryption bit stream generation, and whitening3
- Adaptive Frequency Hopping (AFH) using Packet Error Rate (PER)
- Interlaced scan
- Simultaneous active ACL connection support
- Automatic ACL packet type selection
- Full master and slave piconet support
- Scatternet support
- UART HCI transport layer
- HCI layer to interface with profile stack
- SCO/eSCO links with hardware accelerated audio signal processing and hardware7 supported PPEC algorithm for speech quality improvement
- All standard SCO/eSCO voice coding
- Advanced Audio Distribution Profiles (A2DP)
- All standard pairing, authentication, link key, and encryption operations
- Standard Bluetooth power saving mechanisms (sniff modes, and sniff sub-rating)
- Enhanced Power Control (EPC)c
- Channel Quality Driven Data Rate (CQDDR).
- Narrow band speech (NBS)/Wide band speech (WBS) sample rate conversion
- Operation frequency: 2402MHz-2480MHz

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2.1.3 Bluetooth Low Energy Features

- Broadcaster, Observer, Central, Peripheral roles
- Supports link layer topology to be master and slave (connects up to 16 links)
- Shared RF with BDR/EDR
- AES encryption
- Intelligent Adaptive Frequency Hopping (AFH)
- LE Privacy 1.2
- LE Secure Connection
- LE Data Length Extension
- LE Advertising Extension
- LE Long Range
- Direction Finding—Connectionless Angle of Departure (AoD)
- Direction Finding—Connection-oriented Angle of Arrival (AoA)
- Operation frequency: 2402MHz-2480MHz

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3 MODULE SPECIFICATION

3.1 Absolute Maximum Ratings

Over operating free-air temperature range

Characteristics	Value	Unit
DC supply for VBAT and PA driver supply	-0.5 to +6.0	V
DC supply voltage for digital I/O	-0.5 to 1.89	V
Storage Temperature Range	-55 to +125	°C
Operating Temperature Range	-40 to +85	°C

3.2 Recommended Operating Conditions

The NF3510PQ requires one power supplies:

Power Supply	Voltage		
	Min.	Typ.	Max.
VBAT	3.0V	3.3V	3.6V
VIO	1.7V	1.8V/3.3V	3.6V

NF3510PQ is functional across this range of voltage. Optional RF performance spcified in the data sheets, however, is guaranteed only for 3.0V < VBAT<3.6V

The NF3510PQ ESD Specification:

Pin Type	Symbol	Condition	ESD Rating	Unit
ESD, Handling Reference: NQY00083,Section 3.4, Group D9, Table B	ESD_HAND_HBM	Human body model contact discharge per JEDEC EID/JESD22-A114:	-2k ~ +2k	V
CDM	ESD_HAND_CDM	charged device model (CDM) - all pins	-500 ~ +500	V
		charged device model (CDM) - corner pins	-750 ~ +750	V

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3.3 RF Characteristic

3.3.1 WLAN RF Characteristics

General Performance					
Parameter	**Condition**	**Min**	**Typ**	**Max**	**Unit**
Frequency Range	2.4G Wi-Fi	2400		2500	MHz
	5G Wi-Fi	4900		5850	MHz

2.4GHz DSSS and HR/DSSS(CCK) Transmitter
- IEEE 802.11b DSSS and HR/DSSS modulation

General Performance					
Parameter	**Condition**	**Min**	**Typ**	**Max**	**Unit**
RMS Transmit power (Radiation performance)	11Mbps CCK	9	14	19	dBm

2.4GHz OFDM Transmitter
- IEEE 802.11g and IEEE 802.11n(HT 20/40 module MCS0 to MCS7) OFDM modulation

General Performance					
Parameter	**Condition**	**Min**	**Typ**	**Max**	**Unit**
RMS Transmit power (Radiation performance)	OFDM, 64-QAM(3/4)	7	12	17	dBm
	OFDM, 64-QAM(5/6)	7	12	17	dBm
RMS EVM	OFDM, 64-QAM(3/4)			-25	dB
	OFDM, 64-QAM(5/6)			-27	dB

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2.4GHz DSSS and HR/DSSS(CCK) Receiver
- IEEE 802.11b DSSS and HR/DSSS modulation

General Performance					
Parameter	**Condition**	**Min**	**Typ**	**Max**	**Unit**
RX sensitivity (Radiation performance)	1Mbps DSSS (1)			-95	dBm
	2Mbps DSSS (1)			-92	dBm
	5.5Mbps CCK (1)			-91	dBm
	11Mbps CCK (1)			-87	dBm
Maximum input level	DSSS (1)		2.7		dBm
	CCK (1)		2.7		dBm

2.4GHz OFDM Receiver
- IEEE 802.11g and IEEE802.11n(HT20/40 modes MCS0 to MCS7 800ns Guard Interval non-STBC) OFDM modulation

General Performance					
Parameter	**Condition**	**Min**	**Typ**	**Max**	**Unit**
Maximum input level (Radiation performance)	Normal/Extreme	-20			dBm
RX sensitivity (Radiation performance) (IEEE 802.11b)	1Mbps			-95	dBm
	2Mbps			-92	dBm
	5.5Mbps			-91	dBm
	11Mbps			-87	dBm
RX sensitivity (Radiation performance) (IEEE 802.11g)	6Mbps(1)			-90	dBm
	9Mbps(1)			-89	dBm
	12Mbps(1)			-87	dBm
	18Mbps(1)			-85	dBm
	24Mbps(1)			-82	dBm
	36Mbps(1)			-78	dBm
	48Mbps(1)			-74	dBm
	54Mbps(1)			-73	dBm
RX sensitivity (Radiation performance) (IEEE 802.11n)	MCS0(2) (HT20)			-89	dBm
	MCS1(2) (HT20)			-87	dBm
	MCS2(2) (HT20)			-85	dBm
	MCS3(2) (HT20)			-81	dBm
	MCS4(2) (HT20)			-79	dBm
	MCS5(2) (HT20)			-75	dBm
	MCS6(2) (HT20)			-73	dBm
	MCS7(2) (HT20)			-72	dBm

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Unless otherwise stated, all specifications are at 25°C, nominal voltage, at the Module output ports.

General Performance

Parameter	Condition	Min	Typ	Max	Unit
Receiver adjacent channel interference rejection (IEEE 802.11b)	1Mbps		53		dB
	2Mbps		53		dB
	5.5Mbps		49		dB
	11Mbps		49		dB
Receiver adjacent channel interference rejection (IEEE 802.11g)	6Mbps(4)		31		dB
	9Mbps(4)		37		dB
	12Mbps(4)		35		dB
	18Mbps(4)		32		dB
	24Mbps(4)		26		dB
	36Mbps(4)		23		dB
	48Mbps(4)		19		dB
	54Mbps(4)		27		dB
Receiver adjacent channel interference rejection (IEEE 802.11n) HT20	MCS0(5)		42		dB
	MCS1(5)		42		dB
	MCS2(5)		39		dB
	MCS3(5)		36		dB
	MCS4(5)		33		dB
	MCS5(5)		30		dB
	MCS6(5)		29		dB
	MCS7(5)		25		dB
Receiver maximum input level	802.11b		2.7		dBm
	802.11g		-1.3		dBm
	MCS0-7		-2.3		dBm
	MCS8-9		-6.8		dBm

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5GHz OFDM Transmitter

- IEEE 802.11a and IEEE 802.11n(HT 20/40 module MCS0 to MCS7) OFDM modulation(VHT20/40, VHT80 modes MCS0 to MCS9)

General Performance					
Parameter	**Condition**	**Min**	**Typ**	**Max**	**Unit**
RMS Transmit power (Radiation performance)	OFDM, 64-QAM(3/4)(5/6)	7	12	17	dBm
	OFDM, 256-QAM(3/4)(5/6)	5	10	15	dBm
RMS EVM	OFDM, 64-QAM(3/4)			-25	dB
	OFDM, 64-QAM(5/6)			-27	dB
	OFDM, 256-QAM(3/4)			-30	dB
	OFDM, 256-QAM(5/6)			-32	dB

5GHz OFDM Receiver

- IEEE 802.11a and IEEE802.11n(HT20/40 modes MCS0 to MCS7) and IEEE802.11as OFDM modulation (HT20/HT40, VHT80 modes MCS0 to MCS9)

General Performance					
Parameter	**Condition**	**Min**	**Typ**	**Max**	**Unit**
Maximum input level (Radiation performance)	Normal/Extreme	-30			dBm
RX sensitivity (Radiation performance) (IEEE 802.11a)	6Mbps(1)			-89	dBm
	9Mbps(1)			-88	dBm
	12Mbps(1)			-86	dBm
	18Mbps(1)			-84	dBm
	24Mbps(1)			-81	dBm
	36Mbps(1)			-78	dBm
	48Mbps(1)			-84	dBm
	54Mbps(1)			-72	dBm
RX sensitivity (Radiation performance) (IEEE 802.11n) LDPC waveform	MCS0(2) (HT20)			-89	dBm
	MCS1(2) (HT20)			-86	dBm
	MCS2(2) (HT20)			-84	dBm
	MCS3(2) (HT20)			-81	dBm
	MCS4(2) (HT20)			-78	dBm
	MCS5(2) (HT20)			-74	dBm
	MCS6(2) (HT20)			-73	dBm
	MCS7(2) (HT20)			-71	dBm

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General Performance

Parameter	Condition	Min	Typ	Max	Unit
RX sensitivity (Radiation performance) (IEEE 802.11n) LDPC waveform	MCS0(2) (HT40)			-89	dBm
	MCS1(2) (HT40)			-86	dBm
	MCS2(2) (HT40)			-84	dBm
	MCS3(2) (HT40)			-81	dBm
	MCS4(2) (HT40)			-78	dBm
	MCS5(2) (HT40)			-74	dBm
	MCS6(2) (HT40)			-73	dBm
	MCS7(2) (HT40)			-71	dBm
RX sensitivity (Radiation performance) (IEEE 802.11ac) LDPC waveform	MCS0(2) (VHT20)			-89	dBm
	MCS1(2) (VHT20)			-86	dBm
	MCS2(2) (VHT20)			-85	dBm
	MCS3(2) (VHT20)			-81	dBm
	MCS4(2) (VHT20)			-78	dBm
	MCS5(2) (VHT20)			-74	dBm
	MCS6(2) (VHT20)			-73	dBm
	MCS7(2) (VHT20)			-71	dBm
	MCS8(2) (VHT20)			-71	dBm
	MCS9(2) (VHT20)			-67	dBm
RX sensitivity (Radiation performance) (IEEE 802.11ac) LDPC waveform	MCS0(2) (VHT40)			-86	dBm
	MCS1(2) (VHT40)			-83	dBm
	MCS2(2) (VHT40)			-82	dBm
	MCS3(2) (VHT40)			-78	dBm
	MCS4(2) (VHT40)			-76	dBm
	MCS5(2) (VHT40)			-72	dBm
	MCS6(2) (VHT40)			-70	dBm
	MCS7(2) (VHT40)			-69	dBm
	MCS8(2) (VHT40)			-65	dBm
	MCS9(2) (VHT40)			-63	dBm
RX sensitivity (Radiation performance) (IEEE 802.11ac) LDPC waveform	MCS0(2) (VHT80)			-83	dBm
	MCS1(2) (VHT80)			-80	dBm
	MCS2(2) (VHT80)			-79	dBm
	MCS3(2) (VHT80)			-75	dBm
	MCS4(2) (VHT80)			-73	dBm
	MCS5(2) (VHT80)			-69	dBm
	MCS6(2) (VHT80)			-68	dBm
	MCS7(2) (VHT80)			-66	dBm
	MCS8(2) (VHT80)			-62	dBm
	MCS9(2) (VHT80)			-60	dBm

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General Performance

Parameter	Condition	Min	Typ	Max	Unit
Receiver adjacent channel interference rejection (IEEE 802.11a)	6Mbps(4)		23		dB
	9Mbps(4)		29		dB
	12Mbps(4)		29		dB
	18Mbps(4)		26		dB
	24Mbps(4)		24		dB
	36Mbps(4)		20		dB
	48Mbps(4)		18		dB
	54Mbps(4)		15		dB
Receiver adjacent channel interference rejection (IEEE 802.1n) HT20	MCS0(5)		29		dB
	MCS1(5)		27		dB
	MCS2(5)		24		dB
	MCS3(5)		24		dB
	MCS4(5)		18		dB
	MCS5(5)		16		dB
	MCS6(5)		13		dB
	MCS7(5)		9		dB
Receiver maximum input level	802.11a		-4		dBm
	MCS0~7		-4		dBm
	MCS8~9		-7		dBm

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3.3.2 Bluetooth RF Characteristics

Basic Data Rate – TX Performance

Parameter	Conditions	Min	Typ	Max	Unit
RF frequency range	--	2.4	--	2.5	GHz
Output power @pin	Class 1	--	13	--	dBm
	Class 1	--	10	--	dBm
Gain range	Class 1	--	30	--	dB
Gain resolution	--	--	0.5	--	dB
Spurious emission (BDR) (in-band)	±500 kHz	--	-20	--	dBc
	±2 MHz	--	-33	--	dBm
	±3 MHz	--	-45	--	dBm
Spurious emission (EDR) (in-band)	±1 MHz	--	-26	--	dBc
	±1.5 MHz	--	-29	--	dBm
	±2.5 MHz	--	-40	--	dBm
Spurious emission (out-of-band)	30–88 MHz	--	-65	-41.25	dBm
	88–960 MHz	--	-65	-41.25	dBm
	0.96–20 GHz All frequencies in this range < -41.25 dBm, except at 2x Bluetooth channel frequency. Measured at pin without external filter.	--	-35	-25	dBm
	Restricted—2.38–2.39 GHz	--	-55	-41.25	dBm
	Restricted—2.4835–2.6 GHz	--	-50	-41.25	dBm
Out-of-band/ Cellular band noise	GSM850 (869–894 MHz)	--	-140	--	dBm/Hz
	GSM900 (925–960 MHz)	--	-140	--	dBm/Hz
	GSM DCS (1805–1880 MHz)	--	-135	--	dBm/Hz
	GSM PCS (1930–1990 MHz)	--	-135	--	dBm/Hz
	GPS (1575.42 ±1.023 MHz)	--	-140	--	dBm/Hz
	WCDMA Band I (2110–2170 MHz)	--	-130	--	dBm/Hz
	WCDMA Band V (869–894 MHz)	--	-140	--	dBm/Hz

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Parameter	Conditions	Min	Typ	Max	Unit
Bluetooth Class 1					
Transmit Output Power (TRM/CA/01/C)	DH5	--	12.7	--	dBm
Power Control (TRM/CA/03/C)	--	--	4.5	--	dB
Frequency Range (TRM/CA/04/C)	Freq Low	--	2400.9	--	MHz
	Freq High	--	2481.1	--	MHz
-20 dB Bandwidth (TRM/CA/05/C)	DH5	--	954.2	--	MHz
Modulation Characteristics (TRM/CA/07/C)	Delta F1 avg	--	164.2	--	kHz
	Delta F2 max Threshold	--	100	--	%
	Delta F2/Delta F1	--	0.9	--	
	Delta F2 avg	--	148.6	--	kHz
ICFT (TRM/CA/08/C)	DH1	--	0.9	--	kHz
Carrier frequency drift (TRM/CA/09/C)	Max Drift - DH1	--	3	--	kHz
	Drift Rate - DH1	--	0.3	--	kHz
	Max Drift - DH3	--	1.8	--	kHz
	Drift Rate - DH3	--	0.6	--	kHz
	Max Drift - DH5	--	2.4	--	kHz
	Drift Rate - DH5	--	-1.4	--	kHz
EDR relative power (TRM/CA/10/C)	2DH5	--	0.2	--	dB
	3DH5	--	0.2	--	dB
EDR carrier frequency stability and modulation accuracy (TRM/CA/11/C)	2DH5 Peak DEVM	--	0.11	--	
	2DH5 RMS DEVM	--	0.04	--	
	3DH5 Peak DEVM	--	0.11	--	
	3DH5 RMS DEVM	--	0.04	--	
Diff. phase encoding (TRM/CA/12/C)	2DH5	--	100	--	%
	3DH5	--	100	--	%

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Parameter	Conditions	Min	Typ	Max	Unit
Bluetooth Class 2					
Transmit Output Power (TRM/CA/01/C)	DH5	--	4.9	--	dBm
Power Control (TRM/CA/03/C)	--	--	4.7	--	dB
Frequency Range (TRM/CA/04/C)	Freq Low	--	--	--	MHz
	Freq High	--	--	--	MHz
-20 dB Bandwidth (TRM/CA/05/C)	DH5	--	955.1	--	MHz
Modulation Characteristics (TRM/CA/07/C)	Delta F1 avg	--	163	--	kHz
	Delta F2 max Threshold	--	100	--	%
	Delta F2/Delta F1	--	0.9	--	
	Delta F2 avg	--	148.5	--	kHz
ICFT (TRM/CA/08/C)	DH1	--	-2.2	--	kHz
Carrier frequency drift (TRM/CA/09/C)	Max Drift - DH1	--	1.8	--	kHz
	Drift Rate - DH1	--	1	--	kHz
	Max Drift - DH3	--	1.2	--	kHz
	Drift Rate - DH3	--	-0.5	--	kHz
	Max Drift - DH5	--	2.4	--	kHz
	Drift Rate - DH5	--	0.5	--	kHz
EDR relative power (TRM/CA/10/C)	2DH5	--	0.2	--	dB
	3DH5	--	0.2	--	dB
EDR carrier frequency stability and modulation accuracy (TRM/CA/11/C)	2DH5 Peak DEVM	--	0.1	--	
	2DH5 RMS DEVM	--	0.04	--	
	3DH5 Peak DEVM	--	0.1	--	
	3DH5 RMS DEVM	--	0.04	--	
Diff. phase encoding (TRM/CA/12/C)	2DH5	--	100	--	%
	3DH5	--	100	--	%

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Basic Data Rate – RX Performance

Parameter	Conditions	Min	Typ	Max	Unit
RF frequency range	--	2.4	--	2.5	GHz
IF frequency	--	--	2	--	MHz
Input IP3 (@ maximum gain of 72 dB)	--	--	-19	--	dBm
Out-of-band blocking	30–2000 MHz	--	-12.5	--	dBm
	2–2.399 GHz	--	-12.4	--	dBm
	2.484–3 GHz	--	-18	--	dBm
	3–12.75 GHz	--	-2.6	--	dBm
RSSI Range	Resolution = 1 dB	--	-90	0	dBm
Return loss	Measured at the device pin	--	--	-10	dB
Sensitivity (RCV/CA/01/C & RCV/CA/02/C & RCV/CA/07/C)	DH5	--	-95.3	--	dBm
	2DH5	--	-93.6	--	dBm
	3DH5	--	-86.5	--	dBm
Intermodulation Performance (RCV/CA/05/C)		--	0	--	%
Bluetooth LE Sensitivity (RCV-LE/CA/02/C)	LE1M	--	-96.8	--	dBm
	LE2M	--	-95.1	--	dBm
	LR2	--	-98.2	--	dBm
	LR8	--	-105.3	--	dBm

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Parameter	Conditions	Min	Typ	Max	Unit
	DH1- Co-Channel interference, C/I co-channel	--	9	--	dB
	DH1- Adjacent (1 MHz) interference, C/I 1MHz	--	-10	--	dB
	DH1- Adjacent (2 MHz) interference, C/I 2MHz	--	-47	--	dB
	DH1- Adjacent (2 MHz) interference, C/I >= 3MHz	--	-53.5	--	dB
	DH1- Image frequency Interference C/I Image Channel	--	-28	--	dB
	DH1- Adjacent (1 MHz) interference to in-band mirror frequency, C/I Image±1MHz	--	-44	--	dB
	2DHx- Co-Channel interference, C/I co-channel	--	9	--	dB
	2DHx- Adjacent (1 MHz) interference, C/I 1 MHz	--	-12	--	dB
	2DHx- Adjacent (2 MHz) interference, C/I 2 MHz	--	-46.5	--	dB
C/I performance (RCV/CA/03/C)	2DHx- Adjacent (2 MHz) interference, C/I >= 3 MHz	--	-53	--	dB
	2DHx- Image frequency Interference C/I Image Channel	--	-29	--	dB
	2DHx- Adjacent (1 MHz) interference to in-band mirror frequency, C/I Image ± 1 MHz	--	-44.5	--	dB
	3DHx- Co-channel interference,e C/I co-channel	--	16	--	dB
	3DHx- Adjacent (1 MHz) interference, C/I 1 MHz	--	-7	--	dB
	3DHx- Adjacent (2 MHz) interference, C/I 2 MHz	--	-40.5	--	dB
	3DHx- Adjacent (2 MHz) interference, C/I >= 3 MHz	--	-48	--	dB
	3DHx- Image frequency Interference C/I Image Channel	--	-22	--	dB
	3DHx- Adjacent (1 MHz) interference to in-band mirror frequency, C/I Image ± 1 MHz	--	-41	--	dB

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Parameter	Conditions	Min	Typ	Max	Unit
C/I performance (RCV/CA/09/C)	LE1M- Co-channel interference, C/I co-channel	--	8	--	dB
	LE1M- Adjacent (1 MHz) interference, C/I 1 MHz	--	-5	--	dB
	LE1M- Adjacent (2 MHz) interference, C/I 2MHz	--	-43.5	--	dB
	LE1M- Adjacent (2 MHz) interference, C/I >= 3 MHz	--	-51.9	--	dB
	LE1M- Image frequency Interference, C/I Image Channel	--	-29	--	dB
	LE1M- Adjacent (1 MHz) interference to in-band mirror frequency, C/I Image ± 1 MHz	--	-38	--	dB
	LE2M- Co-channel interference, C/I co-channel	--	6	--	dB
	LE2M- Adjacent (2 MHz) interference, C/I 2 MHz	--	-26.3	--	dB
	LE2M- Adjacent (4 MHz) interference, C/I 4 MHz	--	-51.5	--	dB
	LE2M- Adjacent (6 MHz) interference, C/I 6 MHz	--	--	--	dB
	LE2M- Image frequency Interference C/I Image Channel	--	-30	--	dB
	LE2M- Adjacent (2 MHz) interference to in-band mirror frequency, C/I Image ± 2 MHz	--	-36.5	--	dB
	LR2- Co-channel interference, C/re I co-channel	--	8	--	dB
	LR2- Adjacent (1 MHz) interference, C/I 1 MHz	--	-7.5	--	dB
	LR2- Adjacent (2 MHz) interference, C/I 2MHz	--	-47.5	--	dB
	LR2- Adjacent (2 MHz) interference, C/I > = 3 MHz	--	-55.2	--	dB
	LR2- Image frequency Interference, C/I Image Channel	--	-29	--	dB

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Parameter	Conditions	Min	Typ	Max	Unit
C/I performance (RCV/CA/09/C) (continued)	LR8- Co-channel interference, C/I co channel	--	6.3	--	dB
	LR8- Adjacent (1 MHz) interference, C/I 1 MHz	--	-8.7	--	dB
	LR8- Adjacent (2 MHz) interference, C/I 2MHz	--	-51.1	--	dB
	LR8- Adjacent (2 MHz) interference, C/I >= 3 MHz	--	-61.1	--	dB
	LR8- Image frequency interference, C/I image channel	--	-31	--	dB
	LR8- Adjacent (1 MHz) interference to in-band mirror frequency, C/I image ± 1 MHz	--	-41.2	--	dB

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3.3.3 BLE RF Characteristics

BLE – RF Performance

Parameter	Conditions	Min	Typ	Max	Unit
Bluetooth LE					
Bluetooth LE output power (TRM/-LE/CA/01/C)	LE1M	--	10.7	--	dBm
	LE2M	--	10.7	--	dBm
	LR2	--	10.7	--	dBm
	LR8	--	10.7	--	dBm
Bluetooth LE modulation charateristics (TRM-LE/CA/05/C)	Delta F1 avg - LE 1M	--	250.5	--	kHz
	Delta F2/Delta F1- LE 1M	--	0.9	--	
	Delta F2 avg- LE 1M	--	224.4	--	kHz
	Delta F1 avg - LE 2M	--	493.5	--	kHz
	Delta F2/Delta F1- LE 2M	--	0.9	--	
	Delta F2 avg- LE 2M	--	472.9	--	kHz
Bluetooth LE carrier frequency drift (TRM-LE/CA/06/C)	Max Drift - LE1M	--	3.48	--	kHz
	Drift Rate - LE1M	--	0.79	--	kHz
	Max Drift - LE2M	--	4.4	--	kHz
	Drift Rate - LE2M	--	1.21	--	kHz
	Max Drift - LR2	--	0.99	--	kHz
	Drift Rate - LR2	--	1.35	--	kHz
	Max Drift - LR8	--	0.85	--	kHz
	Drift Rate - LR8	--	1.2	--	kHz
Frequency accuracy (TRM-LE/ CA/BV-06-C)	LE1M	--	24.4	--	kHz
	LE2M	--	22.7	--	kHz
	LR2	--	24.8	--	kHz
	LR8	--	24.9	--	kHz

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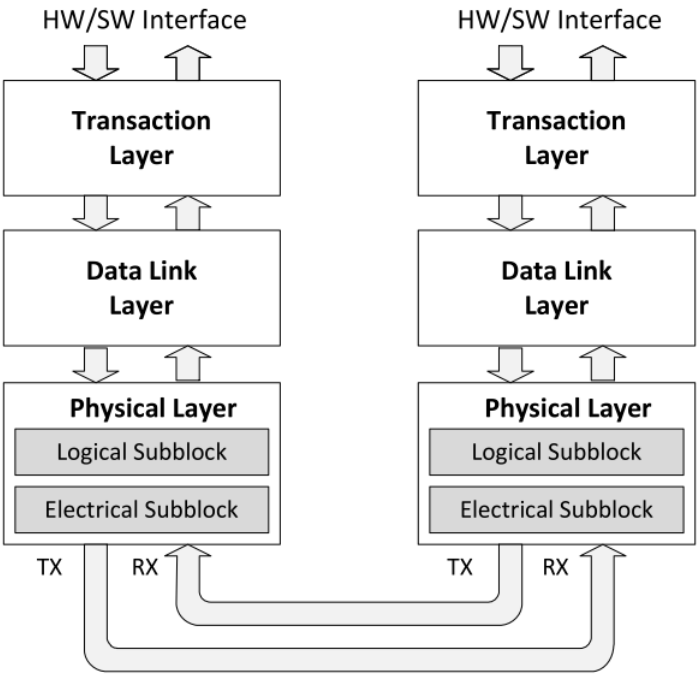
4 AC Specifications

4.1 PCI Express Interface

PCI Express(PCIe) core on NF3510PQ is a high-performance serial I/O interconnect that is protocol compliant and electrically compatible with the PCI Express Base Specification v2.0 running at Gen2 speeds. This core contains all the necessary blocks, including logical and electrical functional subblocks to perform PCIe functionality and maintain high-speed links, using existing PCI system configuration software implementions without modification.

Organization of the PCIe core is in logical layers:Transaction Layer, Data Link Layer, and Physical Layer, as show follows. A configuration or link management block is provided for enumerating the PCIe configuration space and supporting generation and reception of System Management Messages by communicating with PCIe layers

Each layer is partition into dedicated transmit and receive units that allow piont-to-point communication between the host and NF3510PQ. The tansmit side processes outbound packets whereas the receive side processes inbound packets. Packets are formed and generated in the Transaction and Data Link Layer for indicated the packet type and other optional fields.



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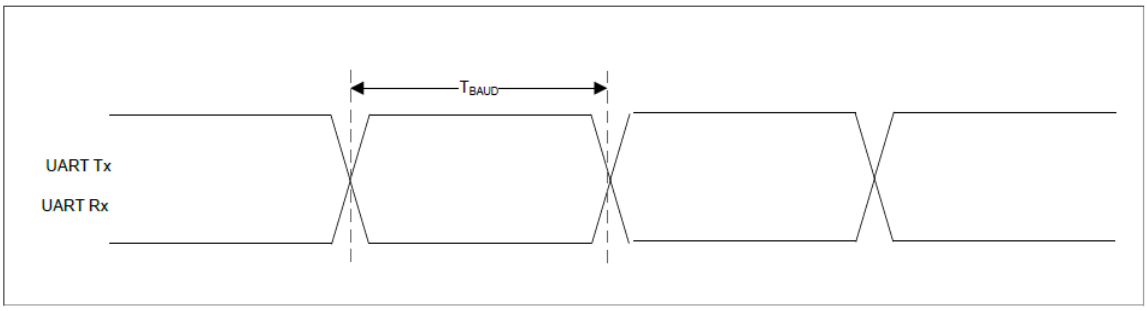
4.2 UART Interface Timing



Symbol	Parameter	Condition	Min	Typ	Max	Unit
T_{BAUD}	Baud rate	40 MHz input clock	250	--	--	ns

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4.3 BT Audio Codec/PCM/I2S

4.3.1 I2S Interface

- I2S (Inter-IC Sound) interface for audio data connection to Analog-to-Digital Converters (ADC) and Digital-to-Analog Converters (DAC)
- Master and slave mode for I2S, MSB, LSB audio interfaces
- Tri-state I2S interface compatibility
- I2S pins shared with PCM pins

4.3.2 PCM Interface

- Master or slave mode
- PCM bit width size of 8 bits or 16 bitsre
- Up to 4 slots with configurable bit width and start positions
- Tri-state PCM interface capability
- PCM short frame and long frame 1 synchronization

PCM pins shared with I2SThe PCM interface supports two modes of operation:

- PCM Master
- PCM Slave

In PCM master mode, the interface generates a 2MHz or a 2.048MHz PCM_CLK and an 8kHz/16kHz PCM_SYNC signal.

When in PCM slave mode, PCM_CLK and PCM_SYNC are inputs. The external PCM master must supply a clock in the range of 512kHz to 4.096MHz.

The PCM interface consists of up to four PCM slots (time divided), preceded by a PCM synchronization signal, and each PCM slot is 16 bit wide. The slots can be separated in time, but not required to follow immediately after one another, The timing is relative to PCM_CLK.

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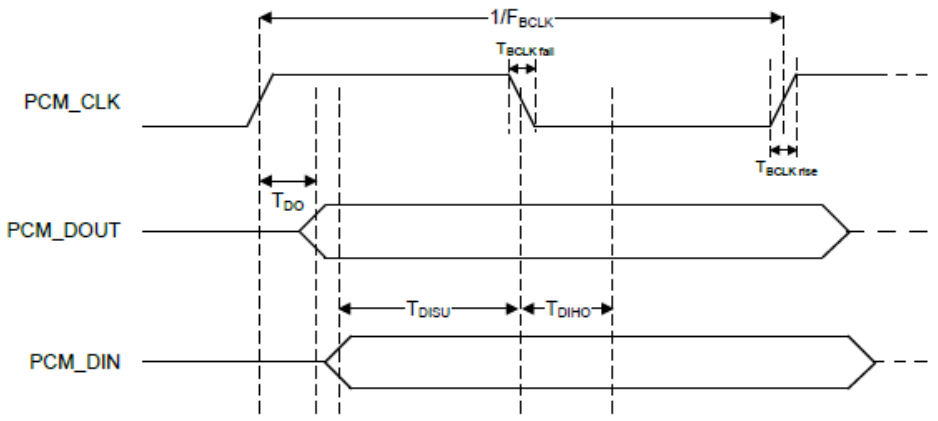
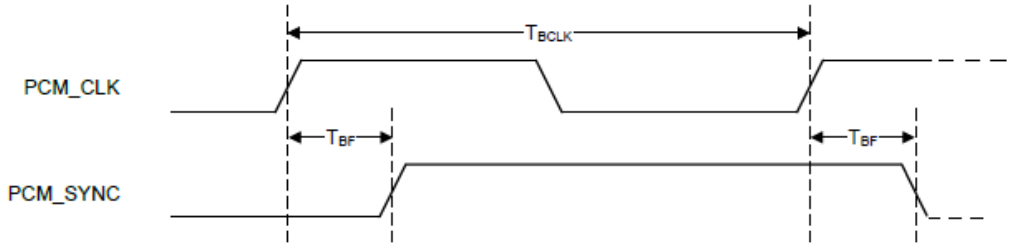
PCM timing specification diagram for data signals - Master Mode



PCM timing specification diagram for data signals—Master mode



PCM timing specification diagram for PCM_SYNC signal—Master mode

Symbol	Parameter	Condition	Min	Typ	Max	Unit
F_{BCLK}	Bit clock frequency	--	2	2/2.048	2.048	MHz
Duty $Cycle_{BCLK}$	Bit clock duty cycle	--	0.4	0.5	0.6	--
$T_{BCLK\ rise/fall}$	PCM_CLK rise/fall time	--	--	3	--	ns
T_{DO}	Delay from PCM_CLK rising edge to PCM_DOUT rising edge	--	--	--	15	ns
T_{DISU}	Setup time for PCM_DIN before PCM_CLK falling edge	--	20	--	--	ns
T_{DIHO}	Hold time for PCM_DIN after PCM_CLK falling edge	--	15	--	--	ns
T_{BF}	Delay from PCM_CLK rising edge to PCM_SYNC rising edge	--	--	--	15	ns

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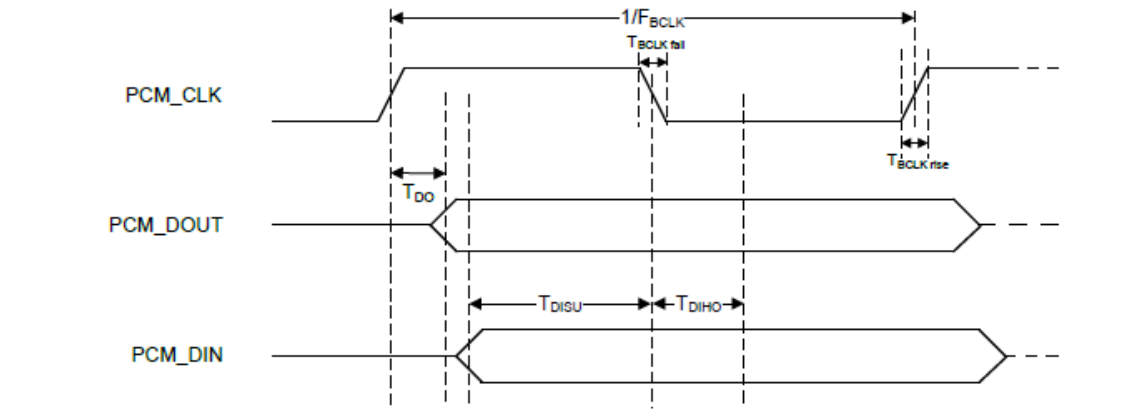
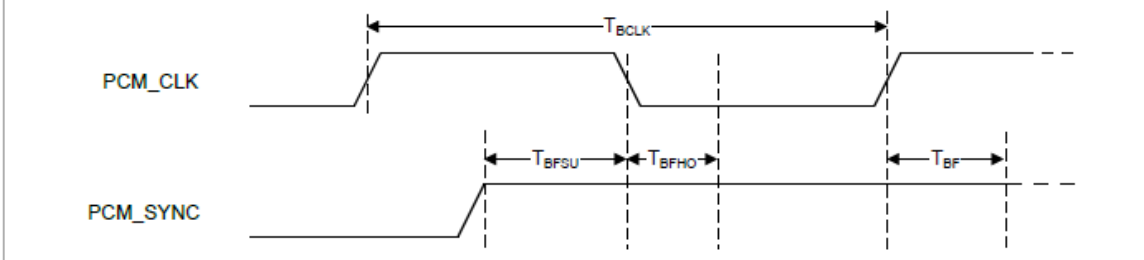
PCM timing specification diagram for data signals - Slave Mode



PCM timing specification diagram for data signals—Slave mode



PCM timing specification diagram for PCM_SYNC signal—Slave mode

Symbol	Parameter	Condition	Min	Typ	Max	Unit
F_{BCLK}	Bit clock frequency	--	0.512	2/2.048	4	MHz
Duty $Cycle_{BCLK}$	Bit clock duty cycle	--	0.4	0.5	0.6	--
$T_{BCLK\ rise/fall}$	PCM_CLK rise/fall time	--	--	3	--	ns
T_{DO}	Delay from PCM_CLK rising edge to PCM_DOUT rising edge	--	--	--	30	ns
T_{DISU}	Setup time for PCM_DIN before PCM_CLK falling edge	--	15	--	--	ns
T_{DIHO}	Hold time for PCM_DIN after PCM_CLK falling edge	--	10	--	--	ns
T_{BFSU}	Setup time for PCM_SYNC before PCM_CLK falling edge	--	15	--	--	ns
T_{BFHO}	Hold time for PCM_SYNC after PCM_CLK falling edge	--	10	--	--	ns

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4.4 Electrical Characteristics

4.4.1 Absolute Maximum Ratings and Recommended Operating Conditions

Absolute Maximum Ratings

Rating	Symbol	MIN	MAX	Unit
DC Supply for VBAT and PA driver Supply(a)	VBAT	-	3.96	V
DC Supply Voltage for digital I/O	VIO	-	3.96	V
Storage temperature	Tj	-55	+125	˚C

Operating Ratings

Parameter	Symbol	Minimum	Typical	Maximum	Unit
DC Supply voltage for VBAT	VBAT	3.0		3.6	V
DC Supply voltage for digital I/O	VIO	1.7		3.6	V
VIO = 3.3V					
Input high voltage	VIH	0.7 X VIO			V
Input low voltage	VIL	-0.4		0.3 X VIO	V
Output high voltage	VOH	VIO-0.4			V
Output Low voltage	VOL			0.4	V
VIO = 1.8V					
Input high voltage	VIH	0.7 X VIO			V
Input low voltage	VIL	-0.4		0.3 X VIO	V
Output high voltage	VOH	VIO-0.4			V
Output Low voltage	VOL			0.4	V

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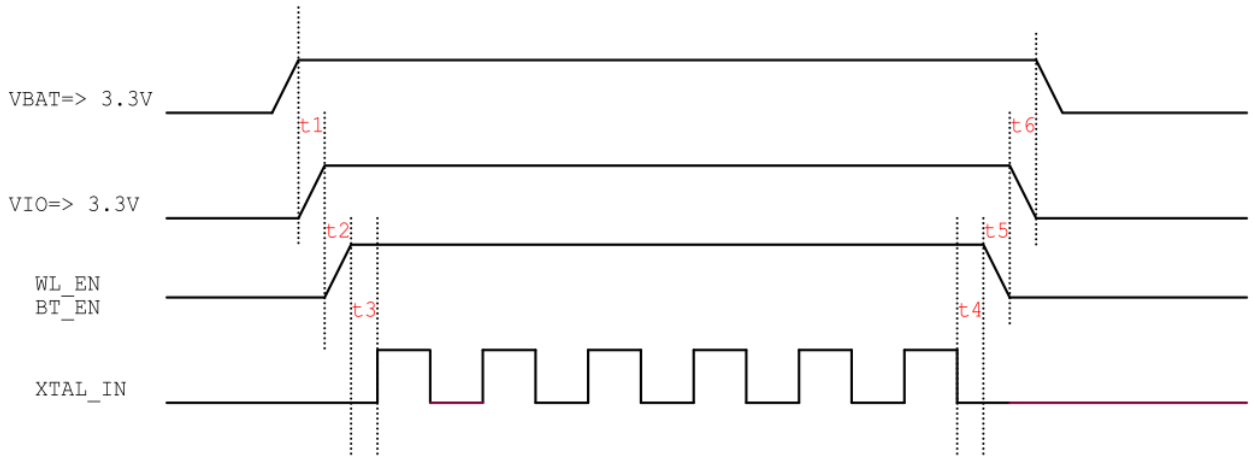
4.4.2 Power Up/Down Sequence



Symbol	Parameter	Min	Max	Unit
t1	VIO valid to VBAT is asserted	0	-	ms
t2	VBAT valid to WL_EN/BT_EN is asserted	10	-	ms
t3	WL_EN/BT_EN valid to XTAL_IN is asserted	10	-	ms
t4	WL_EN/BT_EN de-assert to XTAL_IN ramping-down	10	-	ms
t5	WL_EN/BT_EN de-assert to VBAT ramping-down	10	-	ms
t6	VBAT de-assert to VIO ramping-down	0	-	ms

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4.4.3 Power Consumption

NF3510PQ Module Power Consumption:

	Voltage	Power Consumption(mA)(Max)
VBAT	3.3V	1550
VIO	3.3V	50
VIO	1.8V	50

Testing Condition:
- Peak current during CDW operation

NF3510PQ Module Power Consumption:
1550 mA @ VBAT(Maximum) and 50 mA @ VIO(Maximum)

Suggest customer design power capacity are 2000 mA@VBAT and 200 mA @ VIO for NF3510PQ Module.

Parameter		VBAT (3.3V)	VDDIO (3.3V)
Status	**Mode**	**Power consumption (Max.)**	**Power consumption (Max.)**
Power on	Normal	140mA	50mA
I.MAX8 PCIE bridge to NF3510PQ	Normal	160mA	50mA
Load Driver	Normal	460mA / 1.55A	50mA
Complete Driver on	Normal	460mA	50mA
Turn on STA	STA	480mA	50mA
Scanning	STA	740mA	50mA
Scan successful	STA	340mA	50mA
Connected	STA (2.4G)	480mA	50mA
Connected	STA (5G)	920mA	50mA
Iperf	STA (2.4G)	480mA	50mA
Iperf	STA (5G)	940mA	50mA
Turn on AP	AP	480mA	50mA
Turn on AP	AP	800mA	50mA
Connected	AP (2.4G)	480mA	50mA
Connected	AP (5G)	880mA	50mA
Iperf	AP (2.4G)	500mA	50mA
Iperf	AP (5G)	940mA	50mA
AP (Iperf-5G) + STA (Scan)	AP (5G)	1A	50mA

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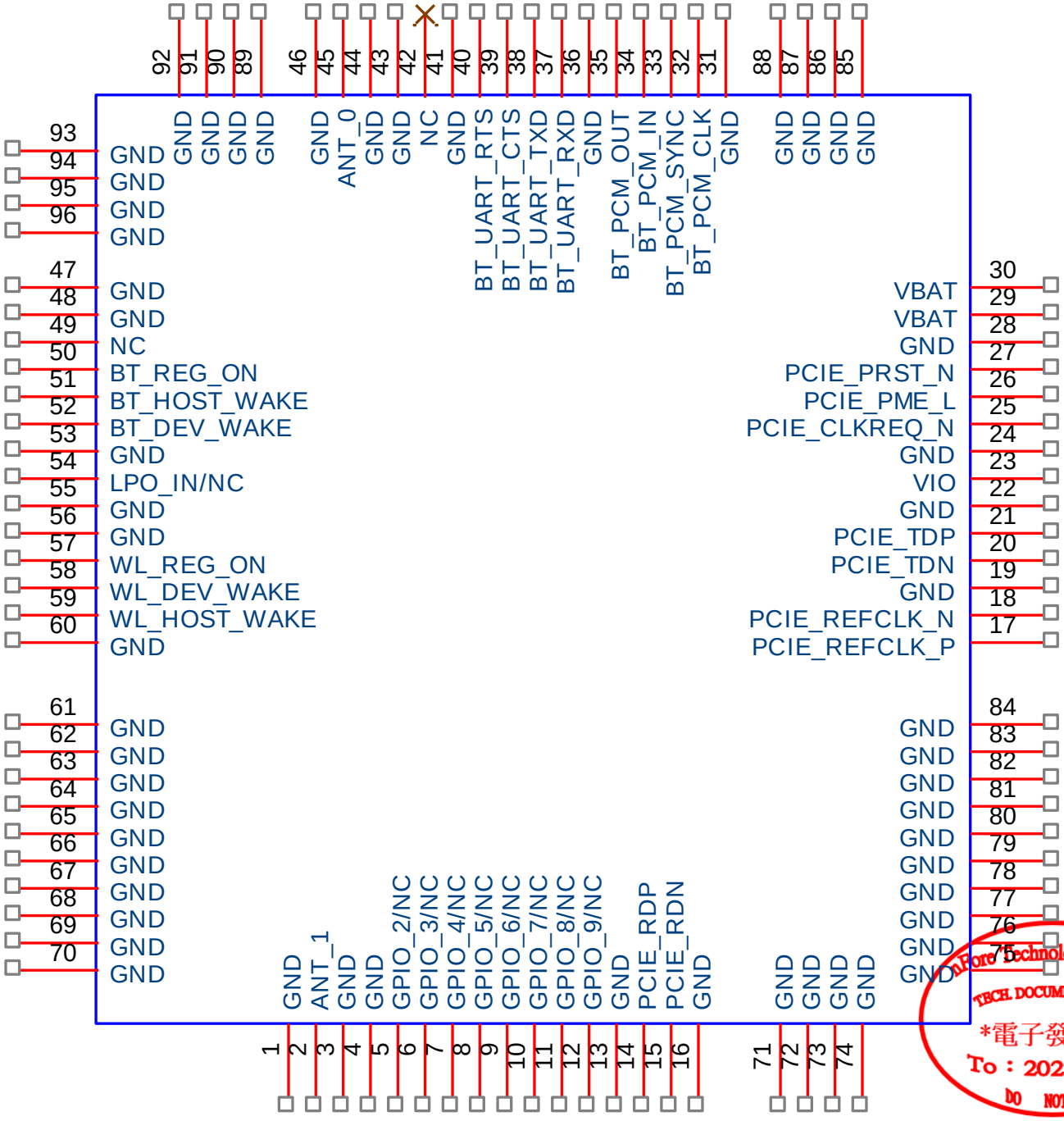
5 Package Information

5.1 Signal Layout (Top View)



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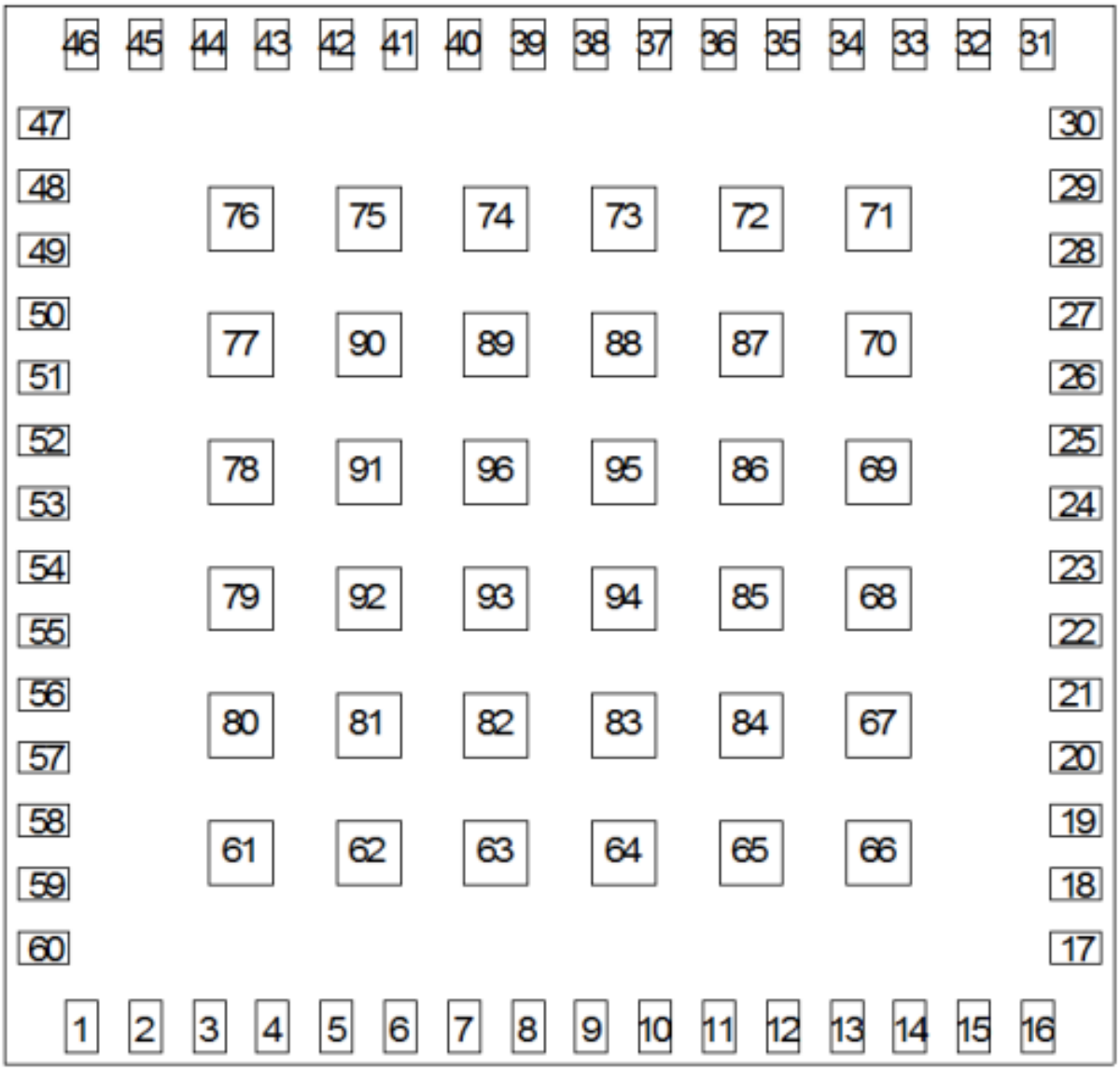
Pin Assignment (Top View)



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Pin Description

No.	Name	Type	Description
1	GND	GND	GROUND
2	ANT_1	RF	WIFI 5G and Bluetooth RF in/out port for chain 1
3	GND	GND	GROUND
4	GND	GND	GROUND
5	GPIO_2/NC	F	Not Connected
6	GPIO_3/NC	F	Not Connected
7	GPIO_4/NC	F	Not Connected
8	GPIO_5/NC	F	Not Connected
9	GPIO_6/NC	F	Not Connected
10	GPIO_7/NC	F	Not Connected
11	GPIO_8/NC	F	Not Connected
12	GPIO_9/NC	F	Not Connected
13	GND	GND	GROUND
14	PCIE_RXP	I	PCI Express Receive Data—Positive (Impedance Control: 85 Ohm +-20%)
15	PCIE_RXN	I	PCI Express Receive Data—Negative (Impedance Control: 85 Ohm +-20%)
16	GND	GND	GROUND
17	PCIE_REFCLK_P	I	PCI Express Differential Clock Input—Positive. (Impedance Control: 100 Ohm +-20%)
18	PCIE_REFCLK_N	I	PCI Express Differential Clock Input—Negative (Impedance Control: 100 Ohm +-20%)
19	GND	GND	GROUND
20	PCIE_TDN	O	PCI Express Transmit Data—Negative (Impedance Control: 85 Ohm +-20%)
21	PCIE_TDP	O	PCI Express Transmit Data—Positive (Impedance Control: 85 Ohm +-20%)
22	GND	GND	GROUND
23	VIO	PI	3.3V(Input); Connect to 3.3V external power 1.8V(Input); Connect to 1.8V external power
24	GND	GND	GROUND
25	PCIE_CLQREQ_N	O	PCIE clock request (input/output) (active low) NOTE: An external pull-up (on host side) is required.
26	PCIE_PME_L	O	PCIE wake signal (input/output) (active low) NOTE: An external pull-up (on host side) is required.
27	PCIE_PRST_N	I	PCIE system reset(input)(active low). PCIE host indication to reset the device.
28	GND	GND	GROUND
29	VBAT	PI	Module Main Power Input (3.3V)

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30	VBAT	PI	Module Main Power Input (3.3V)
31	GND	GND	GROUND
32	BT_PCM_CLK	I/O	PCM clock; can be master (output) or slave (input).
33	BT_PCM_SYNC	I/O	PCM sync; can be master (output) or slave (input).
34	BT_PCM_IN	I	PCM data input.
35	BT_PCM_OUT	O	PCM data output.
36	GND	GND	GROUND
37	BT_UART_RXD	I	UART serial input. Serial data input for the HCI UART interface.
38	BT_UART_TXD	O	UART serial output. Serial data output for the HCI UART interface.
39	BT_UART_CTS	I	UART clear-to-send. Active-low clear-to-send signal for the HCI UART interface.
40	BT_UART_RTS	O	UART request-to-send. Active-low request-to-send signal for the HCI UART interface.
41	GND	GND	GROUND
42	NC	F	Not Connected
43	GND	GND	GROUND
44	GND	GND	GROUND
45	ANT_0	RF	WIFI 2.4G/5G in/out port for chain 0
46	GND	GND	GROUND
47	GND	GND	GROUND
48	GND	GND	GROUND
49	NC	F	Not Connected
50	BT_REG_ON	I	BT Independent Reset(Lo to Hi, Keep Hi)
51	BT_HOST_WAKE	O	Host wake-up: Signal from the module to the host indicating that the module requires attention.
52	BT_DEV_WAKE	I	Bluetooth device wake-up: Signal from the host to the module indicating that the host requires attention.
53	GND	GND	GROUND
54	LPO_IN/NC	F	Not Connected
55	GND	GND	GROUND
56	GND	GND	GROUND
57	WL_REG_ON	I	WLAN independent Reset(Lo to Hi, Keep Hi)
58	WL_DEV_WAKE	I/O	Programmable GPIO Pin
59	WL_HOST_WAKE	I/O	Programmable GPIO Pin

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60	GND	GND	GROUND
61-96	GND	GND	GROUND

PI= Power Input; PO=Power Output; I/O=Bi-directional; I=Input; O=Output; RF=RF Pin; GND=Ground
F=Floating (Not Connected)

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5.2 Ordering Information

The NF3510PQ may be ordered as follows:
■ NF3510PQ (2.4GHz/5GHz, LGA-64)

5.3 Package Marking

Manufacture Factory: Taiwan Chia-Yi(台灣嘉義廠)

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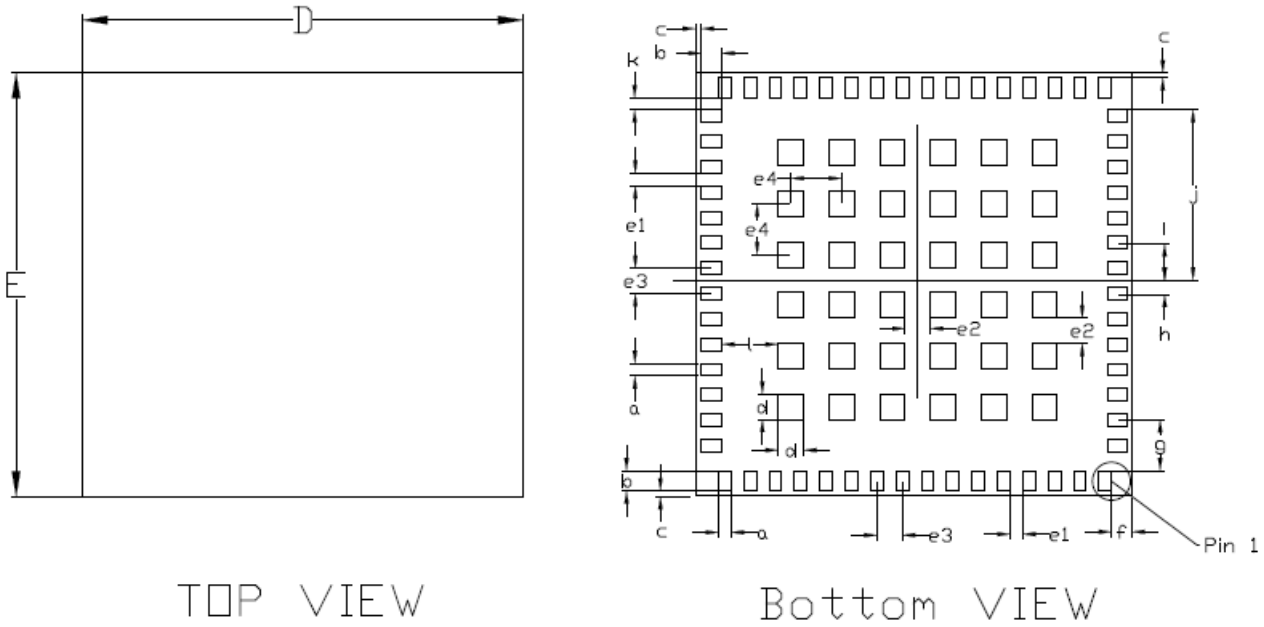
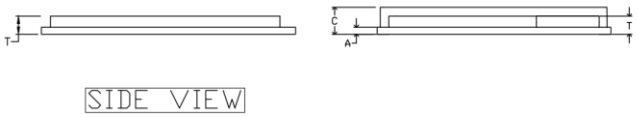
6 MECHANICAL CHARACTERISTICS

NF3510PQ Footprint Layout Guide (Top View)



(mm)	Min	Normal	Max
D	17.1	17.4	17.7
E	16.4	16.7	17
a	0.45	0.5	0.55
b	0.75	0.8	0.85
c	0.15	0.2	0.25
d	0.95	1	1.05
f	0.9	0.95	1
g	1.8	1.85	1.9
h	0.45	0.5	0.55
i	1.45	1.5	1.55
j	6.7	6.75	6.8
k	0.55	0.6	0.65
l	2.15	2.2	2.25
e1	0.4	0.5	0.6
e2	0.9	1	1.1
e3	0.9	1	1.1
e4	1.9	2	2.1
A	1.1	1.2	1.3
C	3.2	3.3	3.4
T	2	2.1	2.2



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模塊板彎，板翹規範(Module bowing, twisting Criteria) ：<0.1mm (Smaller than 0.1mm)

7 SMT and Baking Recommendation

7.1 Baking Recommendation

■ Baking condition：

-Follow MSL Level 3 to do baking process.

-After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be

a) Mounted within 168 hours of factory conditions ≤ 30°C/60% RH, or

b) Stored at <10% RH.

-Devices require bake, before mounting, if Humidity Indicator Card is >10%, where read at 23± 5℃.

<u>If baking is required, Devices shall be baked for 5 hrs at 100 °C.</u>

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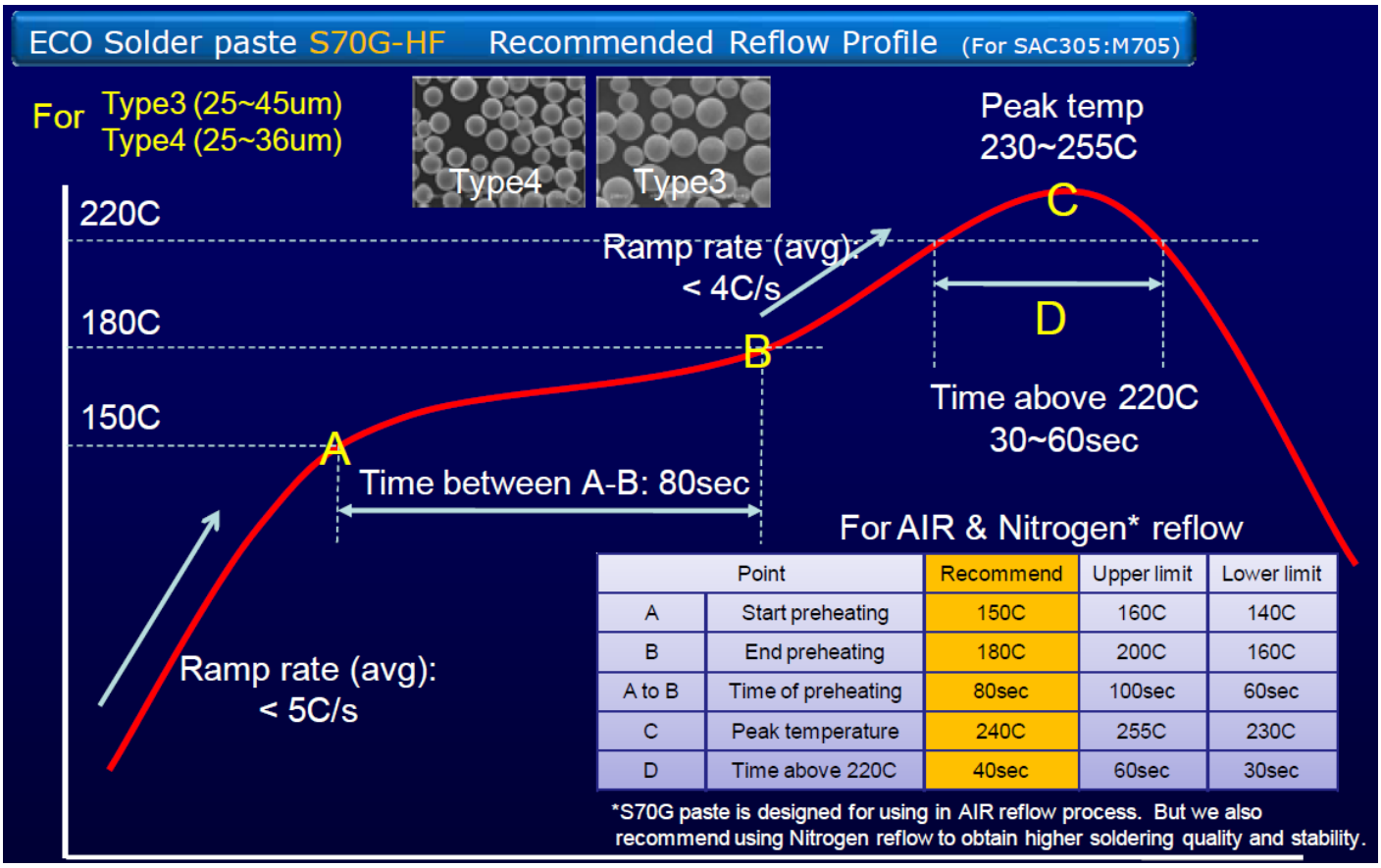
7.2 SMT Recommendation

■ **Recommended Reflow profile：**



Point		Recommend	Upper limit	Lower limit
A	Start preheating	150C	160C	140C
B	End preheating	180C	200C	160C
A to B	Time of preheating	80sec	100sec	60sec
C	Peak temperature	240C	255C	230C
D	Time above 220C	40sec	60sec	30sec

Note: (1) Reflow soldering is recommended three times maximum.

(2) Add Nitrogen while Reflow process： SMT solder ability will be better.

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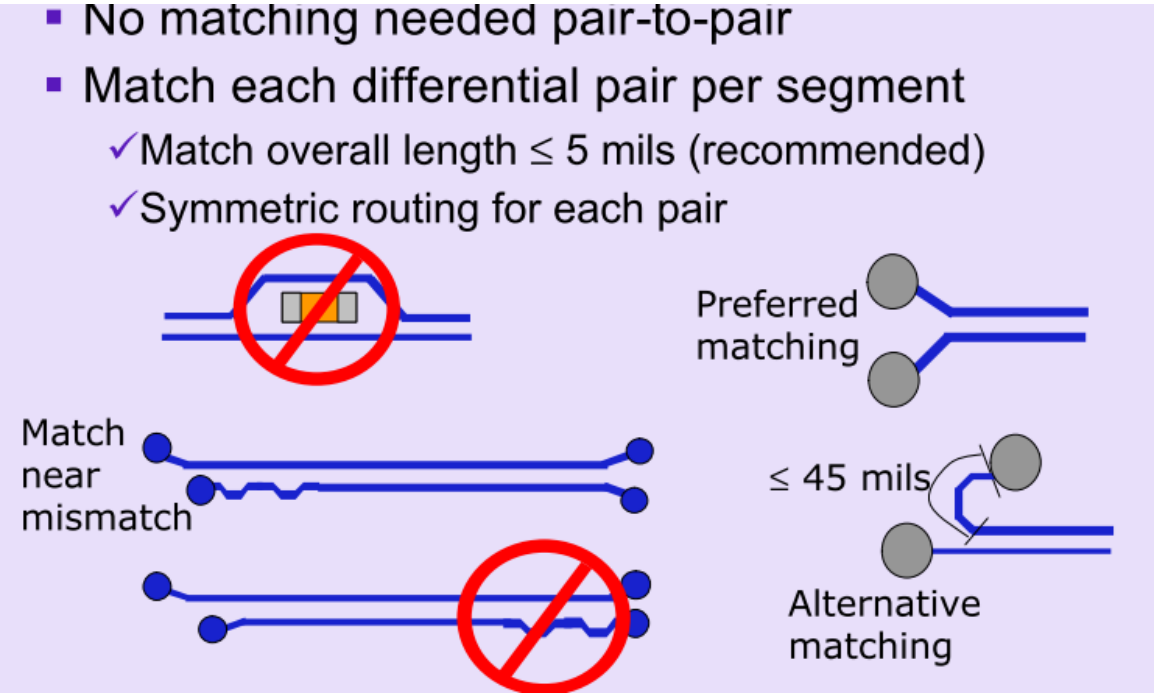
8 PCB Layout Recommendation

8.1 Antenna

Antenna trace impedance should be adjusted to 50 Ω. The area above (or under) the RF antenna trace should be free from other traces.

8.2 PCIE Lines Layout Guideline



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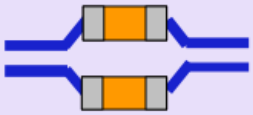
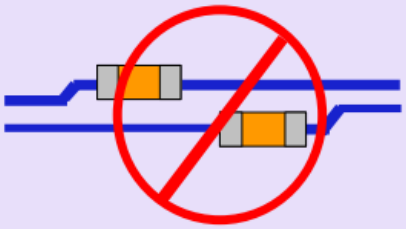
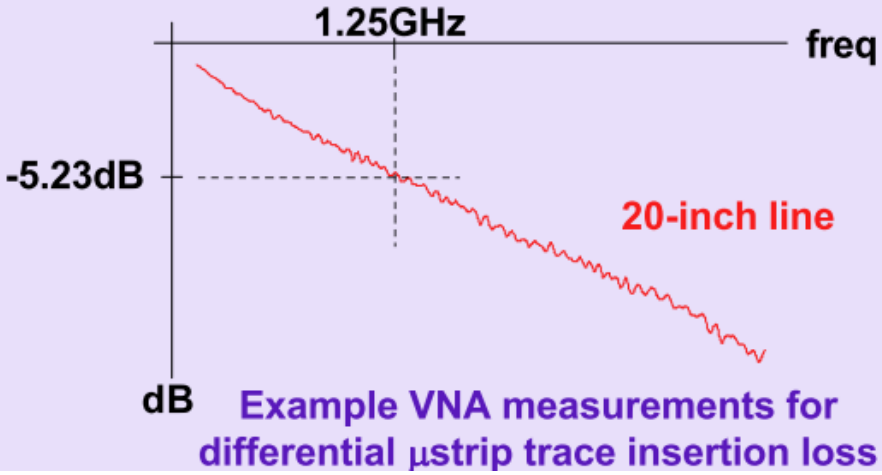
- Size: 0402 best, 0603 ok
- No 0805 size or C-packs
- Symmetric placement best





- Cap size: 0.1uF best
- Same sizes for both D+/D-
- Cap location:
  - ✓Along Tx pairs on system board
  - ✓Along Tx pairs on add-in card

- Longer trace length ⇒ loss ↑
  - ✓~0.25 to 0.35 dB inherent loss per inch for FR4 microstrip traces at 1.25GHz
- Manage trace lengths to minimize loss
  - ✓Example: 12" board, 3.5" add-in card lengths



The following PCIE line routing must obey the following rule to prevent overshoot/undershoot, as these lines drive 8mA
PCIE_TXN,PCIE_TXN; PCIE_RXN,PCIE_TXN; PCIE_REFCLKN, PCIE_REFCLKN.
These pins are differential signals.
The route length of these signals be less than 10 cm and the pair line impedance are 100Ω

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8.3 HCI Lines Layout Guideline

The following HCI line routing must obey the following rule to prevent overshoot/undershoot, as these lines drive 4 ~ 8mA
HCI_RX_BT
HCI_TX_BT
HCI_CTS_BT
HCI_RTS_BT
The route length of these signals be less than 15 cm

8.4 PCM Lines Layout Guideline

The following HCI line routing must obey the following rule to prevent overshoot/undershoot, as these lines drive 4 mA
AUD_FSYNC_BT(PCM_SYNC)
AUD_CLK_BT(PCM_CLK)
AUD_OUT_BT(PCM_OUT)
AUD _IN_BT(PCM_IN)
The route length of these signals be less than 15 cm

8.5 RTC Clock(32.768kHz) Lines Layout Guideline

Follow the same guidelines recommended for the fast clock, It is extremely important that the RTC_CLK trace not be routed next to any digital signals and near the analog audio signals. Furthermore, no digital signals should be routed above or below the RTC_CLK trace to avoid coupling.

8.6 Power Trace Lines Layout Guideline

- VBAT Trace Width: 40mil
- VIO Trace Width: 20mil

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8.7 Ground Lines Layout Guideline

- A Complete Ground in Ground Layer.
- Add Ground Through Holes to NF3510PQ Module Ground Pads
- Decoupling Capacitors close to NF3510PQ Module Power and Ground Pads

CE DOC

Hereby, nFore Technology Co., Ltd. declares that the radio equipment type NF3510PQ is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the following internet address: http://www.nforetek.com.tw/.

CE warning

RF exposure information: The Maximum Permissible Exposure (MPE) level has been calculated based on a distance of 20cm between the device and the human body. To maintain compliance with RF exposure requirement, use product that maintain a 20cm distance between the device and human body.

5GHz product for indoor used only

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FCC regulatory conformance

FCC ID: W3GNF3510PQ

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.
(2) This device must accept any interference received, including interference that may cause undesired operation.
NOTE: 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 or more 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

NOTE: Unauthorized changes will result in loss of device operating privileges.

RF Exposure

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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IC regulatory conformance

IC: 29587-NF3510PQ

This device complies with CAN ICES-003 (B)/NMB-003(B).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.
Cet appareil est conforme à la norme CAN ICES-003 (B)/NMB-003 (B).
Cet appareil contient des émetteurs / récepteurs exempt (s) de licence qui sont conformes aux RSS exemptes de licence d'Innovation, Sciences et Développement économique Canada. Son fonctionnement est soumis aux deux conditions suivantes:

(1) Cet appareil ne doit pas provoquer d'interférences.
(2) Cet appareil doit accepter toute interférence, y compris les interférences susceptibles de provoquer un fonctionnement indésirable de l'appareil.

RF Exposure
This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
Cet équipement est conforme aux limites d’exposition aux rayonnements de la IC établies pour unenvironnement non contrôé. Cet équipement doit être installé et fonctionner à au moins 20cm de distance d’un radiateur ou de votre corps.

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ORIGINAL EQUIPMENT MANUFACTURER (OEM) NOTES

OEM must certify the final end product to comply with unintentional radiators (FCC Sections 07 and 15.109) before declaring compliance of the final product to Part 15 of the FCC rules and regulations. Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change.

The OEM must comply with the FCC labeling requirements. If the module's label is not visible when installed, then an additional permanent label must be applied on the outside of the finished product which states: "Contains transmitter module FCC ID: W3GNF3510PQ". Additionally, the following statement should be included on the label and in the final product's user manual: "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 interferences, and

(2) this device must accept any interference received, including interference that may cause undesired operation."

The module is limited to installation in mobile or fixed applications. Separate approval is required for all other operating configurations, including portable configuration with respect to Part 2.1093 and different antenna configurations.

A module or modules can only be used without additional authorizations if they have been tested and granted under the same intended end-use operational conditions, including simultaneous transmission operations. When they have not been tested and granted in this manner, additional testing and/or FCC application filing may be required. The most straightforward approach to address additional testing conditions is to have the grantee responsible for the certification of at least one of the modules submit a permissive change application. When having a module grantee file a permissive change is not practical or feasible, the following guidance provides some additional options for host manufacturers. Integrations using modules where additional testing and/or FCC application filing(s) may be required are: (A) a module used in devices requiring additional RF exposure compliance information (e.g., MPE evaluation or SAR testing); (B) limited and/or split modules not meeting all of the module requirements; and (C) simultaneous transmissions for independent collocated transmitters not previously granted together.

This Module is full modular approval, it is limited to OEM installation ONLY.

Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change. (OEM) Integrator has to assure compliance of the entire end product include the integrated Module. Additional measurements (15B) and/or equipment authorizations (e.g. Verification) may need to be addressed depending on co-location or simultaneous transmission issues if applicable. (OEM) Integrator is reminded to assure that these installation instructions will not be made available to the end user

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IC labeling requirement for the final end product:

The final end product must be labeled in a visible area with the following

"Contains IC: 29587-NF3510PQ"

The Host Marketing Name (HMN) must be indicated at any location on the exterior of the host product or product packaging or product literature, which shall be available with the host product or online.

Unauthorized modifications could void the user's authority to operate the equipment.

This radio transmitter [lC: 29587-NF3510PQ] 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.

Frequency range	Manufacturer	Peak gain	Impedance	Antenna type
2400-2483.5MHz	WALSIN TECHNOLOGY CORPORATION	1.91dBi	50Ω	External Antenna
5150-5250MHz 5725-5850MHz	WALSIN TECHNOLOGY CORPORATION	4.5dBi	50Ω	External Antenna

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Requirement per KDB996369 D03

2.2 List of applicable FCC rules

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power, spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See also Section 2.10 below concerning the need to notify host manufacturers that further testing is required.3
Explanation: This module meets the requirements of FCC part 15C(15.247). part 15E(15.407)

2.3 Summarize the specific operational use conditions

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to-point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in 5 GHz DFS bands.
Explanation: The module has the trace antenna designs, and the antenna use a permanently attached antenna which is unique, The designed antenna meets the hardware module's requirements via the connection between ipex connector and module.

2.4 Limited module procedures

If a modular transmitter is approved as a "limited module," then the module manufacturer is responsible for approving the host environment that the limited module is used with. The manufacturer of a limited module must describe, both in the filing and in the installation instructions, the alternative means that the limited module manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions. A limited module manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.
This limited module procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.
Explanation: The module is not a limited module.

2.5 Trace antenna designs

For a modular transmitter with trace antenna designs, see the guidance in Question 11 of KDB Publication 996369 D02 FAQ – Modules for Micro-Strip Antennas and traces. The integration information shall include for the TCB review the integration instructions for the following aspects:
layout of trace design, parts list (BOM), antenna, connectors, and isolation requirements.
a) Information that includes permitted variances (e.g., trace boundary limits, thickness, length, width, shape(s), dielectric constant, and impedance as applicable for each type of antenna);
b) Each design shall be considered a different type (e.g., antenna length in multiple(s) of frequency,

the wavelength, and antenna shape (traces in phase) can affect antenna gain and must be considered);
c) The parameters shall be provided in a manner permitting host manufacturers to design the printed circuit (PC) board layout;
d) Appropriate parts by manufacturer and specifications;
e) Test procedures for design verification; and
f) Production test procedures for ensuring compliance.
The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.
Explanation: Yes, The module with trace antenna designs, and this manual has been shown the layout of trace design, antenna, connectors, and isolation requirements.

2.6 RF exposure considerations

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person's body); and (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).
Explanation: This module complies with FCC RF radiation exposure limits set forth for an uncontrolled environment, This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body." This module is designed to comply with the FCC statement, FCC ID is: W3GNF3510PQ.

2.7 Antennas

A list of antennas included in the application for certification must be provided in the instructions. For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that for example an "omni-directional antenna" is not considered to be a specific "antenna type")).
For situations where the host product manufacturer is responsible for an external connector, for example with an RF pin and antenna trace design, the integration instructions shall inform the installer that unique antenna connector must be used on the Part 15 authorized transmitters used in the host product. The module manufacturers shall provide a list of acceptable unique connectors.
Explanation: The module has the trace antenna designs, and the antenna use a permanently attached antenna which is unique, The designed antenna meets the hardware module's requirements via the connection between ipex connector and module.

2.8 Label and compliance information

Grantees are responsible for the continued compliance of their modules to the FCC rules. This includes advising host product manufacturers that they need to provide a physical or e-label stating "Contains FCC ID" with their finished product. See Guidelines for Labeling and User Information for RF Devices – KDB Publication 784748.
Explanation: The host system using this module, should have label in a visible area indicated the following texts: "Contains FCC ID: W3GNF3510PQ, Contains IC: 29587-NF3510PQ"

2.9 Information on test modes and additional testing requirements5

Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.
The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.
Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer's determination that a module as installed in a host complies with FCC requirements.
Explanation: Top band can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

2.10 Additional testing, Part 15 Subpart B disclaimer

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) 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. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.
Explanation: The module without unintentional-radiator digital circuity, so the module does not require an evaluation by FCC Part 15 Subpart B. The host should be evaluated by the FCC Subpart B.