

# WNFQ-291BEI(BT)

WiFi 7 2x2 MU-MIMO

802.11be Tri-band 2.4GHz/5GHz/6GHz

Industrial-Grade, 2T2R Wi-Fi+BT 5.4 M.2 module



## Industrial-Grade Wi-Fi +Bluetooth Combo Solution M.2 Module

WNFQ-291BEI(BT), first Qualcomm based WiFi-7 (802.11be) module in M.2 2230 E key formfactor, running PCIe (Wifi) and USB (Bluetooth), supports DBDC (Dual-band, Dual-concurrent) mode, but with Tri-band capability (2.4GHz, 5GHz, and 6GHz). WNFQ-291BEI(BT) is able to concurrently run 2.4GHz with 5GHz, or 6GHz, and support full IEEE802.11 be/ax/ac/a/b/g/n protocol, up to 320MHz mode.

WNFQ-291BEI(BT) designed with 2 spatial streams (2T2R, or 2x2) in MU-MIMO mode. With a standard M.2 E key 2230 formfactor, WNFQ-291BEI(BT) can accommodate to all existing platform that has M.2 Adaptor pre-integrated, no extra work with platform design.

Software wise WNFQ-291BEI(BT) support Windows, with Linux (Open Source) in the near future. The module is capable to run on both x86 platform and ARM based platform, and supports STA mode and Soft AP Mode\*, recommend to run on application includes: digital signage/POS, rugged computer / tablets, fanless automation PC and other industrial environment applications that requires high speed data transmission.

### Embedded Application

Applications include IPC/ Advertising machine/ OTT/ IPTV/ DVB/ STB / DV/ Mini Driving Recorder/ Intelligent Projector Pico/ VR/ AR terminal/ POS machine/ Vehicle mounted front/ Rear Terminal UAV/ Robot/ Intelligent Gateway/ Smart city and other electronic products.

### Key Feature

- WLAN Tri-band 2X2 802.11 be/ax/ac/a/b/g/n WiFi 7
- Support Multi-link Operation (MLO)
- Supports WLAN 20/40MHz at 2.4GHz and 20/40/80/160 MHz at 5GHz/ up to 320 MHz at 6GHz
- Dual Band Simultaneous (DBS) up to 2.4 GHz 2x2 40 MHz + 5 GHz 2x2 160 MHz / 6 GHz 2x2 160 MHz
- High Band Simultaneous (HBS) up to 5 GHz/6 GHz 2x2 160MHz + 5 GHz/6 GHz 2x2 160 MHz
- Supports PCIe Gen3 2-lane interface for WLAN

**Specification**

<b>Standards</b>	IEEE 802.11be/ax/ac/a/b/g/n (2T2R) Bluetooth V5.4,V5.3,V5.2, V5.1, V5.0, V4.2, V4.1, V4.0LE, V3.0, V2.1+EDR
<b>Chipset</b>	Qualcomm WCN7851
<b>Data Rate</b>	802.11b: 11Mbps 802.11a/g: 54Mbps 802.11n: MCS0~15 802.11ac: MCS0~9 802.11ax: MCS0~13 802.11be: MCS0~13 Bluetooth: 1 Mbps, 2Mbps and Up to 3Mbps
<b>Operating Frequency</b>	IEEE 802.11 be/ax/ac/a/b/g/n ISM Band, 2.412GHz~2.483GHz, 5.150GHz~5.850GHz ,5.925~7.125GHz *Subject to local regulations
<b>Interface</b>	WLAN: PCIe Bluetooth: USB
<b>Form Factor</b>	M.2 2230 E Key
<b>Antenna</b>	2 x IPEX MHF4 connectors Ant 1: WLAN/BT Ant 2 : WLAN/BT
<b>Modulation</b>	Wi-Fi: 802.11b: DSSS (DBPSK, DQPSK, CCK) 802.11g: OFDM (BPSK, QPSK, 16-QAM, 64-QAM) 802.11n: OFDM (BPSK, QPSK, 16-QAM, 64-QAM) 802.11a: OFDM (BPSK, QPSK, 16-QAM, 64-QAM) 802.11ac: OFDM (BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM) 802.11ax: OFDMA (BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM, 4096-QAM) 802.11be: OFDMA (BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM, 4096-QAM) BT: Header: GFSK Payload 2M: $\pi/4$ -DQPSK Payload 3M: 8-DPSK

<b>Power Consumption</b>	11be TX mode: 1250 mA (MAX) RX mode: 1200 mA (MAX)
<b>Operating Voltage</b>	DC 3.3V
<b>Operating Temperature Range</b>	-40°C ~+85°C (Operating)
<b>Storage Temperature Range</b>	-45°C~+90°C
<b>Humidity (Non-Condensing)</b>	5%~90% (Operating) 5%~90% (Storing)
<b>Dimension L x W x H (in mm)</b>	30mm(± 0.15mm) x 22mm(± 0.15mm) x 2.5mm(± 0.3mm)
<b>Weight (g)</b>	3.42g
<b>Driver Support</b>	Win11/Linux (Open Source)
<b>Security</b>	WPS2.0, WAPI, WPA, WPA2, WPA3

### OUTPUT POWER & SENSITIVITY

#### 802.11b

Data Rate	Tx $\pm$ 2dBm	Rx Sensitivity
11Mbps	18 dBm	$\leq$ -89.5 dBm

#### 802.11g

Data Rate	Tx $\pm$ 2dBm	Rx Sensitivity
54Mbps	16 dBm	$\leq$ -76 dBm

#### 802.11n / 2.4GHz

	Data Rate	Tx $\pm$ 2 dBm (1TX)	Tx $\pm$ 2 dBm (2TX)	Rx Sensitivity
HT20	MCS7	14 dBm	17dBm	$\leq$ -76 dBm
	MCS7	13.5 dBm	16.5 dBm	$\leq$ -74 dBm

#### 802.11a

Data Rate	Tx $\pm$ 2dBm	Rx Sensitivity
54Mbps	15 dBm	$\leq$ -74 dBm

#### 802.11n / 5GHz

	Data Rate	Tx $\pm$ 2 dBm (1TX)	Tx $\pm$ 2 dBm (2TX)	Rx Sensitivity
HT20	MCS7	14 dBm	17.5 dBm	$\leq$ -74 dBm
	MCS7	13.5 dBm	16.5 dBm	$\leq$ -71.5 dBm

#### 802.11ac

	Data Rate	Tx $\pm$ 2 dBm (1TX)	Tx $\pm$ 2 dBm (2TX)	Rx Sensitivity
VHT40	MCS9	12.5 dBm	15.5 dBm	$\leq$ -65.5 dBm
	MCS9	12 dBm	15 dBm	$\leq$ -62 dBm

#### 802.11ax / 2.4 GHz

	Data Rate	Tx $\pm$ 2 dBm (1TX)	Tx $\pm$ 2 dBm (2TX)	Rx Sensitivity
HE40	MCS11	11.5 dBm	14.5 dBm	$\leq$ -63 dBm

#### 802.11ax / 5GHz

	Data Rate	Tx $\pm$ 2 dBm (1TX)	Tx $\pm$ 2 dBm (2TX)	Rx Sensitivity
HE80	MCS11	11.5 dBm	14.5 dBm	$\leq$ -58 dBm
	MCS11	11.5 dBm	14.5 dBm	$\leq$ -54.5 dBm

802.11ax / 6GHz				
	Data Rate	Tx ± 2 dBm (1TX)	Tx ± 2 dBm (2TX)	Rx Sensitivity
HE80	MCS11	10.5 dBm	13.5 dBm	≤ -57 dBm
	MCS11	10.5 dBm	13.5 dBm	≤ -53.5 dBm

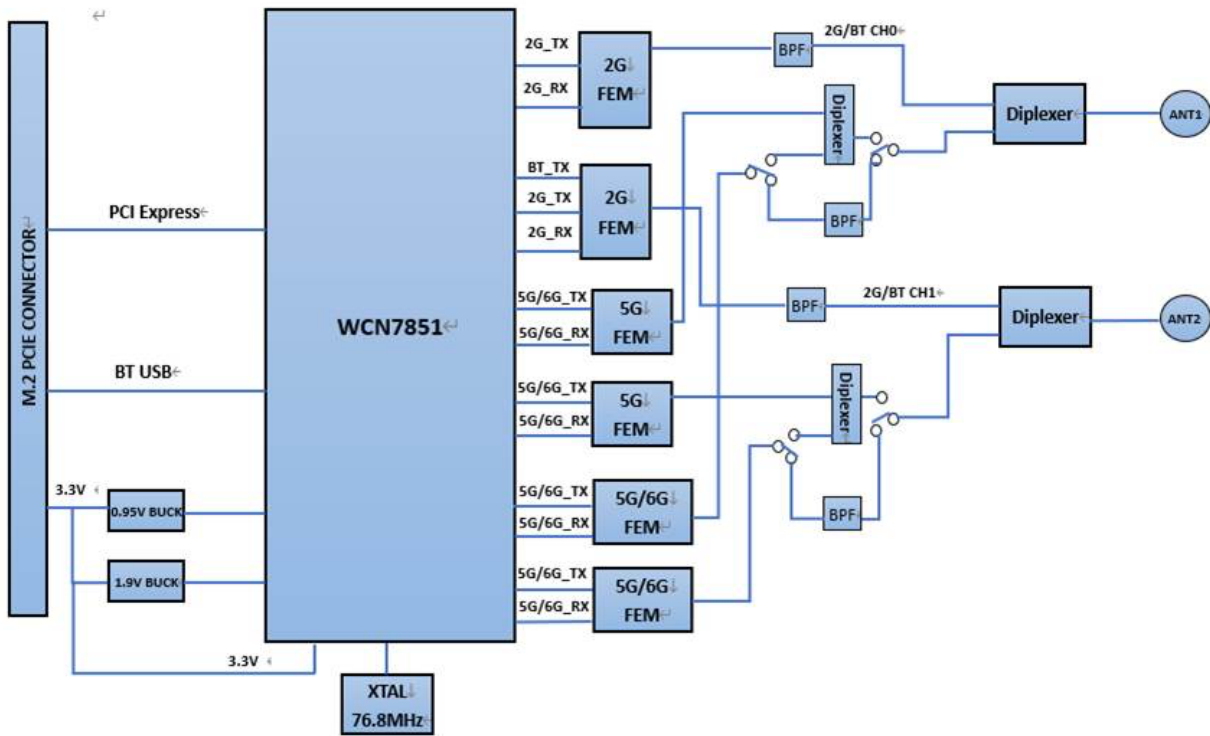
802.11be / 2.4 GHz				
	Data Rate	Tx ± 2 dBm (1TX)	Tx ± 2 dBm (2TX)	Rx Sensitivity
EHT40	MCS13	11 dBm	14 dBm	≤ -57.5 dBm

802.11be / 5GHz				
	Data Rate	Tx ± 2 dBm (1TX)	Tx ± 2 dBm (2TX)	Rx Sensitivity
EHT80	MCS13	11 dBm	14 dBm	≤ -52 dBm
	MCS13	11 dBm	14 dBm	≤ -49 dBm

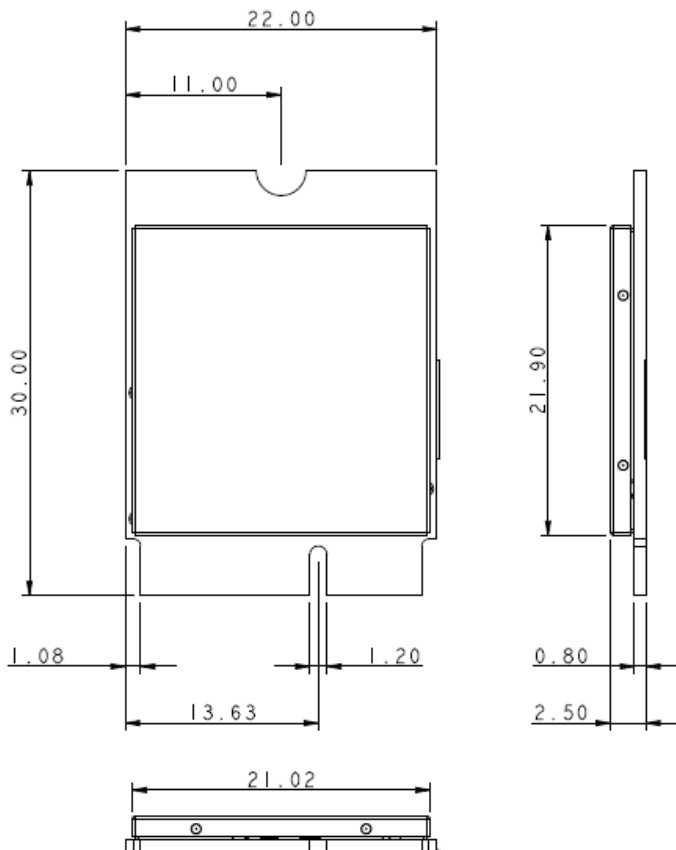
802.11be/ 6GHz				
	Data Rate	Tx ± 2 dBm (1TX)	Tx ± 2 dBm (2TX)	Rx Sensitivity
EHT80	MCS13	10 dBm	13 dBm	≤ -50.5 dBm
EHT160	MCS13	10 dBm	13 dBm	≤ -48 dBm
EHT320	MCS13	9 dBm	12 dBm	≤ -45 dBm

Bluetooth		
Data Rate	Tx ± 2dBm (Class I and Class II Device)	Rx Sensitivity
3M bps	10 ≤ Output Power ≤ 16 dBm	BER < 0.1% Typical: -97 dBm
1M bps	2 ≤ Output Power ≤ 8 dBm	BLE 1Mbps (PER < 30.8%) Typical: -98 dBm
2M bps	2 ≤ Output Power ≤ 8 dBm	BLE 2Mbps (PER < 30.8%) Typical: -94 dBm

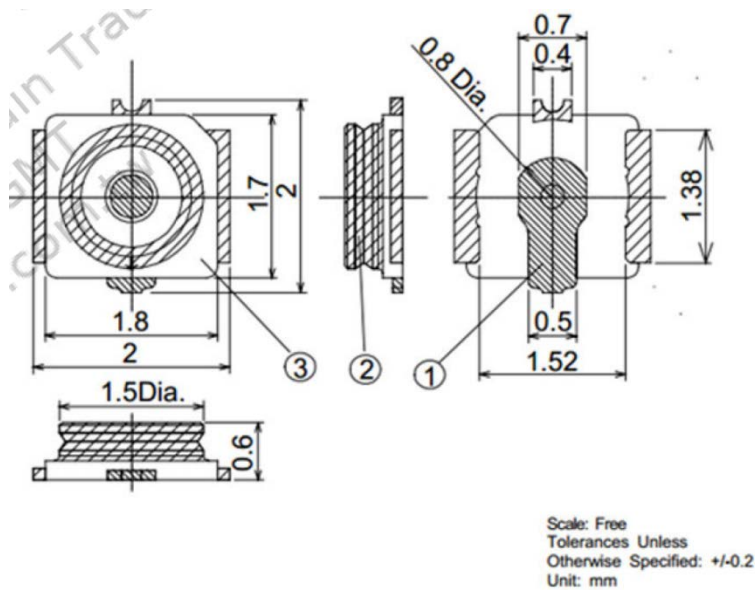
### Block Diagram



### Mechanical Dimension (mm)



### MHF4 connector spec.



### Pin Assignment

The following section illustrate signal pin-outs for the module connector.

TOP			
Pin#	Pin Name	Type	Description
1	GND	G	Ground connections
3	USB_D+	I/O	USB serial differential data Positive
5	USB_D-	I/O	USB serial differential data Negative
7	GND	G	Ground connections
9	SDIO_CLK/SYSCLK	NC	No Connection
11	SDIO_CMD	NC	No Connection
13	SDIO_DATA0 (0/1.8V)	NC	No Connection
15	SDIO_DATA1 (0/1.8V)	NC	No Connection
17	SDIO_DATA2 (0/1.8V)	NC	No Connection
19	SDIO_DATA3 (0/1.8V)	NC	No Connection
21	SDIO_WAKE# (0/1.8V)	NC	No Connection
23	SDIO_RESET#/TX_BLANKING(0/1.8V)	NC	No Connection
25	NOTCH FOR KEY E	NC	No Connection
27	NOTCH FOR KEY E	NC	No Connection
29	NOTCH FOR KEY E	NC	No Connection
31	NOTCH FOR KEY E	NC	No Connection
33	GND	G	Ground connections
35	PERp0	I	PCI Express receive data-Positive

TOP			
Pin#	Pin Name	Type	Description
37	PERn0	I	PCI Express receive data-Negative
39	GND	G	Ground connections
41	PETp0	O	PCI Express transmit data- Positive
43	PETn0	O	PCI Express transmit data- Negative
45	GND	G	Ground connections
47	REFCLKp0	I	PCI Express differential clock input- Positive
49	REFCLKn0	I	PCI Express differential clock input- Negative
51	GND	G	Ground connections
53	CLKREQ0# (3.3V)	OD	PCIe clock request
55	PEWAKE0# (3.3V)	OD	PCIe wake signal
57	GND	G	Ground connections
59	RESERVED/PERp1	I	PCI Express receive data-Positive
61	RESERVED/PERn1	I	PCI Express receive data-Negative
63	GND	G	Ground connections
65	RESERVED/PETp1	O	PCI Express receive data-Positive
67	RESERVED/PETn1	O	PCI Express receive data-Negative
69	GND	G	Ground connections
71	RESERVED/REFCLKp1	NC	No Connection
73	RESERVED/REFCLKn1	NC	No Connection
75	GND	G	Ground connections

## Pin Assignment

The following section illustrate signal pin-outs for the module connector.

BOTTOM			
Pin#	Pin Name	Type	Description
2	3.3 V	P	VDD system power supply input
4	3.3 V	P	VDD system power supply input
6	WLAN_LED_1#	NC	No Connection
8	PCM_CLK/I2S_SCK (1.8V)	I	Bluetooth PCM clock or I2S continuous serial clock for audio
10	PCM_SYNC/I2S_WS (1.8V)	I	Bluetooth PCM synchronous SYNC or I2S word select for audio

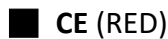


BOTTOM			
Pin#	Pin Name	Type	Description
12	PCM_OUT/I2S_SD_OUT (1.8V)	O	Bluetooth PCM synchronous data output or I2S serial data output for audio
14	PCM_IN/I2S_SD_IN (1.8V)	I	Bluetooth PCM synchronous data input or I2S serial data input for audio
16	LED_2#	NC	No Connection
18	VIO_CFG	G	NC for 1.8 V I/O, GND for 3.3 V I/O
20	UART_WAKE# (3.3V)	NC	No Connection
22	UART_TXD(0/1.8V)	NC	No Connection
24	NOTCH FOR KEY E	NC	No Connection
26	NOTCH FOR KEY E	NC	No Connection
28	NOTCH FOR KEY E	NC	No Connection
30	NOTCH FOR KEY E	NC	No Connection
32	UART_RXD (0/1.8V)	NC	No Connection
34	UART_RTS (0/1.8V)	NC	No Connection
36	UART_CTS (0/1.8V)	NC	No Connection
38	VENDOR DEFINED	NC	No Connection
40	VENDOR DEFINED	NC	No Connection
42	VENDOR DEFINED	NC	No Connection
44	COEX3 (0/1.8V)	NC	No Connection
46	COEX_TXD (0/1.8V)	NC	No Connection
48	COEX_RXD (0/1.8V)	NC	No Connection
50	SUSCLK (0/3.3V)	NC	No Connection
52	PERST0# (0/3.3V)	I	WLAN PCIe reset signal is an input signal
54	W_DISABLE2# (0/3.3V)	I	Bluetooth enable signal. It is an input, active high to enable Bluetooth operation
56	W_DISABLE1# (0/3.3V)	I	It is an interrupt pin to the WLAN CPU. When WLAN detects an interrupt, it turns off WLAN MAC/PHY/RF for power save application.
58	I2C_DATA (0/3.3V)	NC	No Connection
60	I2C_CLK (0/3.3V)	NC	No Connection
62	ALERT#	NC	No Connection
64	RESERVED	NC	No Connection
66	UIM_SWP/PERST1#	NC	No Connection
68	UIM_POWER_SNK/CLKREQ1#	NC	No Connection

70	UIM_POWER_SRC/GPIO_1/PEWAKE1#	NC	No Connection
72	3.3 V	P	VDD system power supply input
74	3.3 V	P	VDD system power supply input

Note: Power (P), Ground (G), Open-Drain (OD), Input (I), Output (O), Do Not Connect (DNC), No Connection (NC)

### Certification


**FCC**

**CE (RED)**

**IC**

**MIC**

**NCC**

**ASNZS**

### Ordering Information

Product Name	Part Number	Description
WNFQ-291BEI(BT)	R9701B10003	11be/ax/ac/a/b/g/n 2T2R Wi-Fi+BT M.2 Module

### Optional Accessory

Product Name	Part Number	Description
AD-513AX	R3410A14056	Dipole Antenna,3.11dBi/4.53dBi 2.4G/5G~6GHz,RP-SMA(M)connector
AD-510AX	R3410A10051	Dipole Antenna,2.27dBi /2.88dBi /3.52dBi 2.4G/5G_6GHz, RP-SMA(M) connector
AD-512AX	R3410A10052	Dipole Antenna,2.35dBi /3.0dBi /3.02dBi 2.4G/5G_6GHz,RP-SMA(M) connector
AD-516AX	R3410A14057	Dipole Antenna,3.11dBi/ 4.53dBi 2.4G/5G_6GHz, I-PEXMHF4 connector
CBIRF-NE150	R3470300025	RF Cable, I-PEXMHF4 to RP-SMA(F); L150mm; Coaxial 0.81 Black
CBIRF-NE250	R3470300026	RF Cable, I-PEXMHF4 to RP-SMA(F); L250mm; Coaxial 0.81 Black