



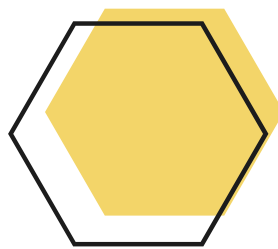
BlackPepper 4 DATASHEET

BKP-N2N1-2409



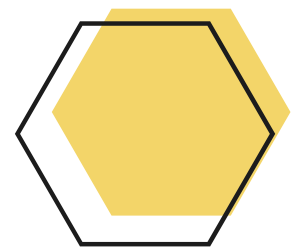
IEEE 802.11 b/g/n

High-Performance, Dual independent Radio operating in ISM 2.4 GHz license-free Band and 900 MHz ISM Band, 2x2 MIMO



Optimized SWaP-C

Size, Weight, Power, Cost
Optimized Radio Module



Industrial grade

-40 deg C to +85 deg C
operation temperature

dun & bradstreet



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HW REV# 01.00
Last updated on Jun-22-24

SWaP-C Optimized Design



Industry Standard Connectors for Power, USB and Ethernet Signals



TECHNICAL SPECIFICATION

RADIO MODULE – GENERAL INFO	
Radio chipset	Qualcomm QCA 9550-AT4B (CPU) & AR 8033-AL1B (Ethernet PHY) Qualcomm AR 9592-AR1B
NOR Flash	SPI Flash, 16MB
NAND Flash	NAND Flash, 256 MB
RAM	DDR2, 200 MHz, 256 MB (64Mx16x2)
Operating System	Linux, OPENWRT, supports open source ath9K Linux driver
Security	128-bit AES, WEP, TKIP and WAPI hardware encryption Support for IEEE 802.11d, e, h, i standards Small packet size (96 Bytes) in AES encryption at full packet rate Loopback mode to assist FIPS AES certification
Operating frequency – 11 b/g/n	2400 MHz to 2483.5 MHz (2S, MIMO)
Operating frequency – 11 b/g/n	902 MHz to 928 MHz (1S, SISO)
Data rate - 1S, SISO	1 Mbps, 2 Mbps, 5.5Mbps, 111 Mbps (11b) 6Mbps, 9Mbps, 12Mbps, 24Mbps, 36Mbps, 48Mbps, 54Mbps (11g)
Data rate - 2S, MIMO	MCS0, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6, MCS7 (11n, 1S,SISO) MCS8, MCS9, MCS10, MCS11, MCS12, MCS13, MCS14, MCS15 (11n,2S,MIMO)
Channel BW – 2.4 GHz	5 MHz/10 MHz/20 MHz /40 MHz
Channel BW – 900 MHz	5 MHz/10 MHz/20 MHz
Compliance	RoHS, MIL-STD-810G Shock & Vibration
MAC ID	74E277 Series
INTERFACE SPECIFICATIONS	
Power	DC in
Operating Voltage	9V to 30V
RF Antenna connector	x3 MMCX Female (Jack) connectors
ENVIRONMENTAL SPECIFICATIONS	
Operating Temperature Range	-40 deg C to +85 deg C
PHYSICAL SPECIFICATIONS	
Mechanical Dimension	(L) 94.5 mm x (W) 68.6 mm x (D) 14.9 mm
Weight	115 g
REGULATORY INFORMATION	
Compliance	In Progress
PACKAGING INFORMATION	
No of units	TBD

ORDERING INFORMATION

BKP-N2N1-2409

BlackPepper 4, Dual Independent,
IEEE 802.11 b/g/n, 2.4 GHz (2S, MIMO), 900 MHz (1S, SISO) Bands, 29 dBm

RADIO SPECIFICATION

TX/RX Specification – 2412 MHz to 2462 MHz

TX Power and Sensitivity Tolerance = +/- 2 dBm

Current consumption is measured at the input of the module, powered by 24V DC and it includes idle current drawn by the system.

Data Rate	TX Power per chain (dBm)	Current 24V (A)	RX Sensitivity (dBm)
54 Mbps	20	0.230	-80
48 Mbps	21	0.245	-81
36 Mbps	23	0.265	-88
24 Mbps	25	0.290	-89
18 Mbps	25	0.290	-92
12Mbps	25	0.290	-94
9 Mbps	25	0.290	-95
6 Mbps	26	0.300	-96
11 Mbps	26	0.300	-91
5.5 Mbps	26	0.300	-96
2 Mbps	26	0.300	-98
1 Mbps	26	0.300	-99
HT20-MCS7	19	0.220	-74
HT20-MCS6	20	0.230	-75
HT20-MCS5	21	0.245	-76
HT20-MCS4	22	0.255	-81
HT20-MCS3	24	0.270	-85
HT20-MCS2	24	0.270	-89
HT20-MCS1	24	0.270	-91
HT20-MCS0	26	0.300	-93
HT40-MCS7	19	0.220	-71
HT40-MCS6	20	0.230	-72
HT40-MCS5	21	0.245	-73
HT40-MCS4	22	0.255	-78
HT40-MCS3	24	0.270	-82
HT40-MCS2	24	0.270	-86
HT40-MCS1	24	0.270	-88
HT40-MCS0	26	0.300	-90

TX/RX Specification – 902 MHz to 928 MHz

Sensitivity tested in ART Mode, PSR >=95%

TX Power and Sensitivity Tolerance = +/- 2 dBm

Current consumption is measured at the input of the SBC with the mini-PCIe radio module connected to it. The current consumption figures are then adjusted so that they only include extra current drawn by the mini-PCIe radio module.

Data Rate	TX Power per chain (dBm)	DC Power at 24V (W)	RX Sensitivity (dBm)
54 Mbps	20	2.2	-74
48 Mbps	22	2.4	-77
36 Mbps	24	2.6	-79
24 Mbps	26	2.9	-82
18 Mbps	26	2.9	-84
12Mbps	26	2.9	-86
9 Mbps	26	2.9	-89
6 Mbps	26	2.9	-91
11 Mbps	29	4.3	-85
5.5 Mbps	29	4.3	-90
2 Mbps	29	4.3	-92
1 Mbps	29	4.3	-93
HT20-MCS7	20	2.2	-65
HT20-MCS6	21	2.3	-67
HT20-MCS5	21	2.3	-71
HT20-MCS4	24	2.6	-75
HT20-MCS3	26	2.9	-78
HT20-MCS2	26	2.9	-81
HT20-MCS1	26	2.9	-86
HT20-MCS0	29	4.3	-88

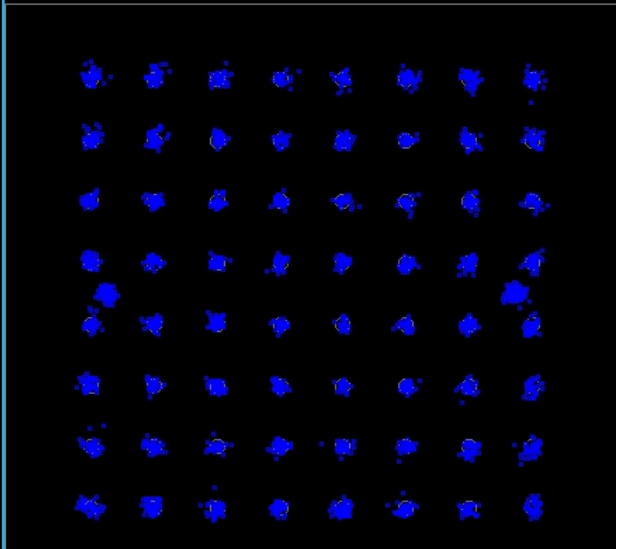
Channel Mapping – 902 MHz to 928 MHz

BASE BAND (MHz)	OP FREQ (MHz)	CH BW (MHz)	STANDARD (11b/g/n)
2427	907	5/10	11g/n
2432	912	5/10/20	11b/g/n
2437	917	5/10/20	11b/g/n
2442	922	5/10	11g/n

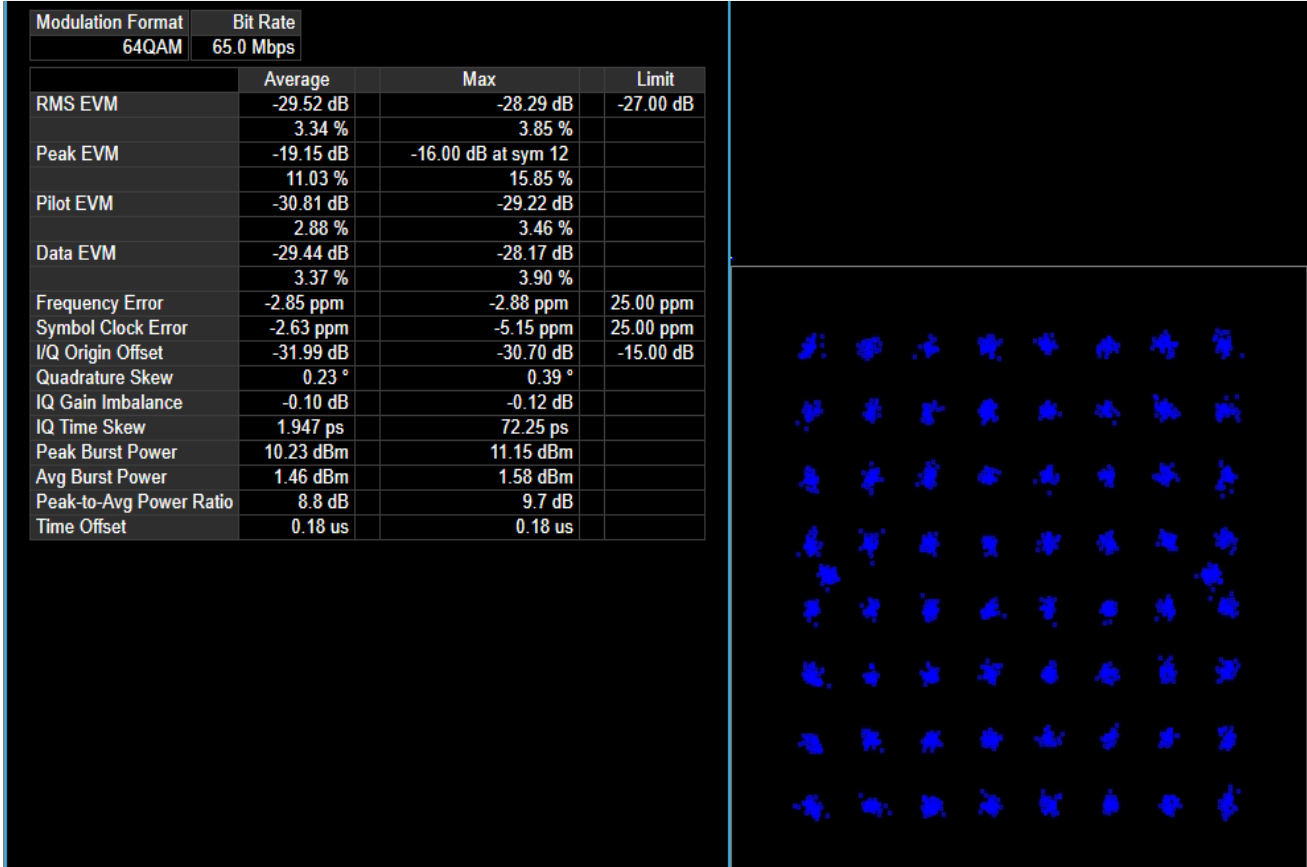
TX EVM PERFORMANCE, 900 MHz

Frequency = 912 MHz, 802.11g, 54 Mbps

Modulation Format	Bit Rate		
64QAM	54.0 Mbps		
	Average	Max	Limit
RMS EVM	-29.61 dB 3.31 %	-23.85 dB 6.42 %	-25.00 dB
Peak EVM	-18.75 dB 11.55 %	-11.29 dB at sym 1 27.25 %	
Pilot EVM	-30.95 dB 2.84 %	-24.38 dB 6.04 %	
Data EVM	-29.51 dB 3.34 %	-23.81 dB 6.45 %	
Frequency Error	-2.24 ppm	-2.26 ppm	20.00 ppm
Symbol Clock Error	-1.65 ppm	-3.45 ppm	20.00 ppm
I/Q Origin Offset	-39.85 dB	-14.35 dB	-15.00 dB
Quadrature Skew	0.00 °	-0.58 °	
IQ Gain Imbalance	-0.06 dB	-0.12 dB	
IQ Time Skew	-999.0 s	-999.0 s	
Peak Burst Power	10.09 dBm	11.41 dBm	
Avg Burst Power	1.38 dBm	4.45 dBm	
Peak-to-Avg Power Ratio	8.7 dB	9.6 dB	
Time Offset	0.15 us	0.15 us	

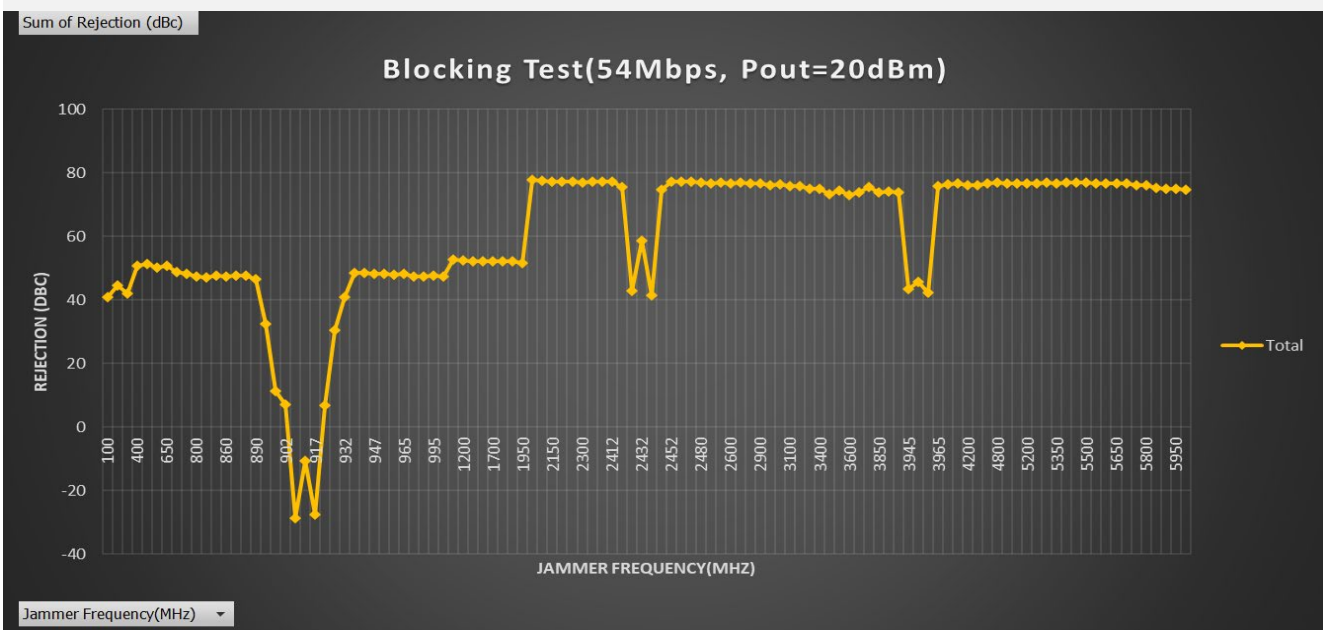


Frequency = 912 MHz, 802.11n, MCS7 (65Mbps), CH0



RX Interference Desensitization, 900 MHz

912 MHz, 802.11g, 54 Mbps



CONNECTION DETAILS



REF	PART
1	MMCX Connector, 2.4 GHz
2	MMCX Connector, 2.4 GHz
3	MMCX Connector, 900 MHz
4	Power Connector, JST SM04B-GHS-TB
5	Ethernet Connector, HIROSE IX60G-A-10P
6	USB Connector for thumb drive
7	RGB LED
8	USB Micro-B Connector for UART
9	JST SM08B-GHS-TB for EJTAG (on bottom side)

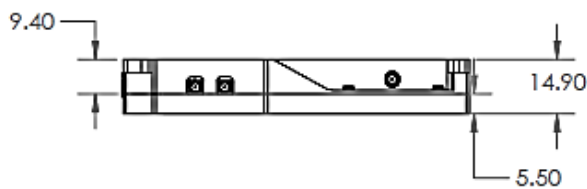
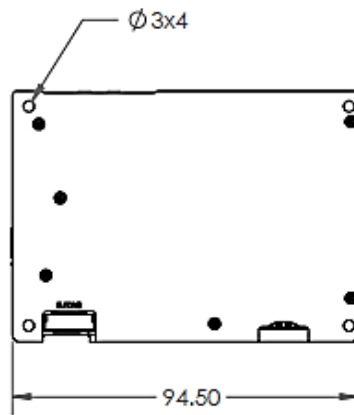
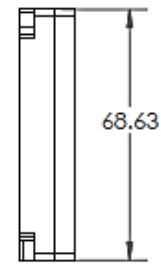
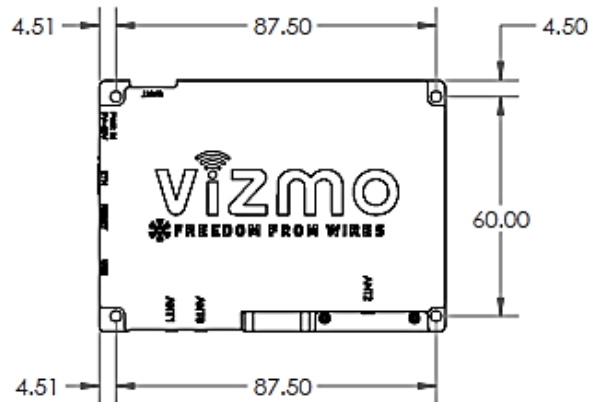
CONNECTION PIN-OUT

PIN#	PIN DESCRIPTION
Ant-0	2.4 GHz Ant-0
Ant-1	2.4 GHz Ant-1
Ant-2	900 MHz Ant-0
JST SM04B-GHS-TB – Pin-1 (from left-to-down on Top side)	9V to 30V DC POWER
JST SM04B-GHS-TB – Pin-2 (from left-to-down on Top side)	9V to 30V DC POWER
JST SM04B-GHS-TB – Pin-3 (from left-to-down on Top side)	GND
JST SM04B-GHS-TB – Pin-4 (from left-to-down on Top side)	GND
JST SM08B-GHS-TB – Pin-1 (from left-to-right on Top side)	GND
JST SM08B-GHS-TB – Pin-2 (from left-to-right on Top side)	EJTAG-TCK
JST SM08B-GHS-TB – Pin-3 (from left-to-right on Top side)	EJTAG-TDI
JST SM08B-GHS-TB – Pin-4 (from left-to-right on Top side)	EJTAG-TDO
JST SM08B-GHS-TB – Pin-5 (from left-to-right on Top side)	EJTAG-TMS
JST SM08B-GHS-TB – Pin-6 (from left-to-right on Top side)	RST_B
JST SM08B-GHS-TB – Pin-7 (from left-to-right on Top side)	2.5V DC
JST SM08B-GHS-TB – Pin-8 (from left-to-right on Top side)	GND

Built-to-Customize™

MECHANICAL DIMENSIONS

DATASHEET
BKP-N2N1-2409



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