vizmo
FREEDOM FROM WIRES

BlackPepper 4

DATASHEET

BKP-N2N2-2409

IEEE 820.11 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

Business Eminence Awards 2020 Singapore

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

SWaP-C Optimized Design

M3 Holes x4 offer
ease of mounting &
Military-grade
Vibration Resilience

MMCX Antenna Connectors

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 NAND Flash RAM	SPI Flash, 16MB NAND Flash, 256 MB 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 Operating frequency – 11 b/g/n	2400 MHz to 2483.5 MHz (2S, MIMO) 902 MHz to 928 MHz (2S, MIMO)
Data rate - 1S, SISO Data rate - 2S, MIMO	1 Mbps, 2 Mbps, 5.5Mbps, 111 Mbps (11b) 6Mbps, 9Mbps, 12Mbps, 24Mbps, 36Mbps, 48Mbps,54Mbps (11g) 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 Channel BW – 900 MHz	5 MHz/10 MHz/20 MHz /40 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	x4 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-N2N2-2409	BlackPepper 4, Dual Independent, 2x2 MIMO, IEEE 802.11 b/g/n, 2.4 GHz, 900 MHz Bands, 29 dBm

RADIO SPECIFICATION

TX/RX Specification – 2412 MHz to 2462 MHz

Sensitivity tested in ART Mode, PSR >=95%, Chain0+Chain1
TX Power per chain (SISO mode) 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%, Chain0+Chain1
TX Power per chain (SISO mode) and Sensitivity Tolerance = +/- 2 dBm
Current consumption is measured at the input of the SBC with the 900 MHz radio module connected to it. The current consumption figures are then adjusted so that they only include extra current drawn by the 900 MHz radio module

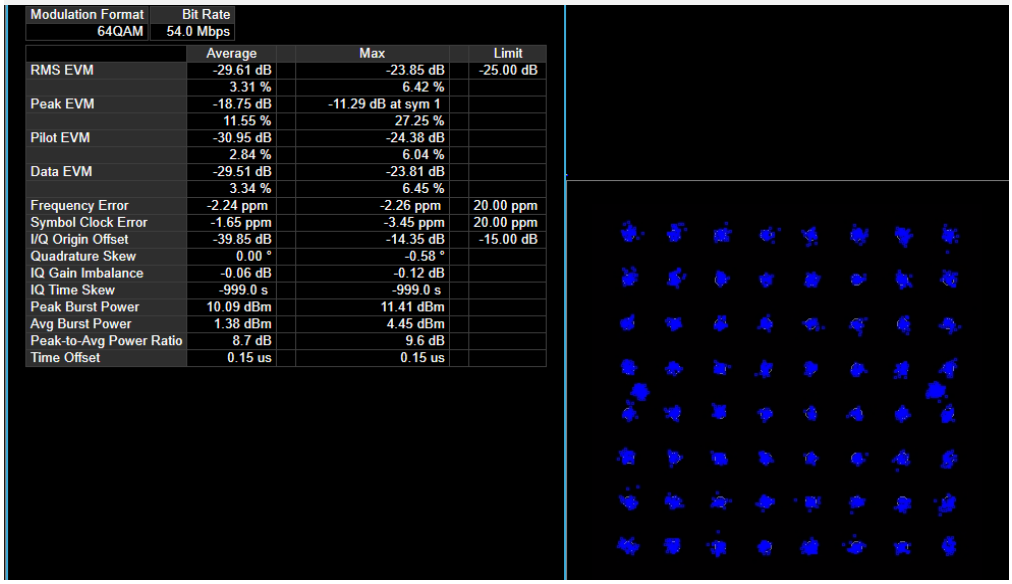
Data Rate	TX Power per chain (dBm)	DC Power at 24V (W)	RX Sensitivity (dBm)
54 Mbps	20	4.3	-77
48 Mbps	22	4.8	-80
36 Mbps	24	5.3	-82
24 Mbps	26	6.7	-85
18 Mbps	26	6.7	-87
12Mbps	26	6.7	-89
9 Mbps	26	6.7	-92
6 Mbps	26	6.7	-94
11 Mbps	26	6.7	-88
5.5 Mbps	26	6.7	-93
2 Mbps	26	6.7	-95
1 Mbps	26	6.7	-96
HT20-MCS7	20	4.3	-68
HT20-MCS6	21	4.5	-70
HT20-MCS5	21	4.5	-74
HT20-MCS4	24	5.3	-78
HT20-MCS3	26	6.7	-81
HT20-MCS2	26	6.7	-84
HT20-MCS1	26	6.7	-89
HT20-MCS0	26	6.7	-91

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

EVM PERFORMANCE

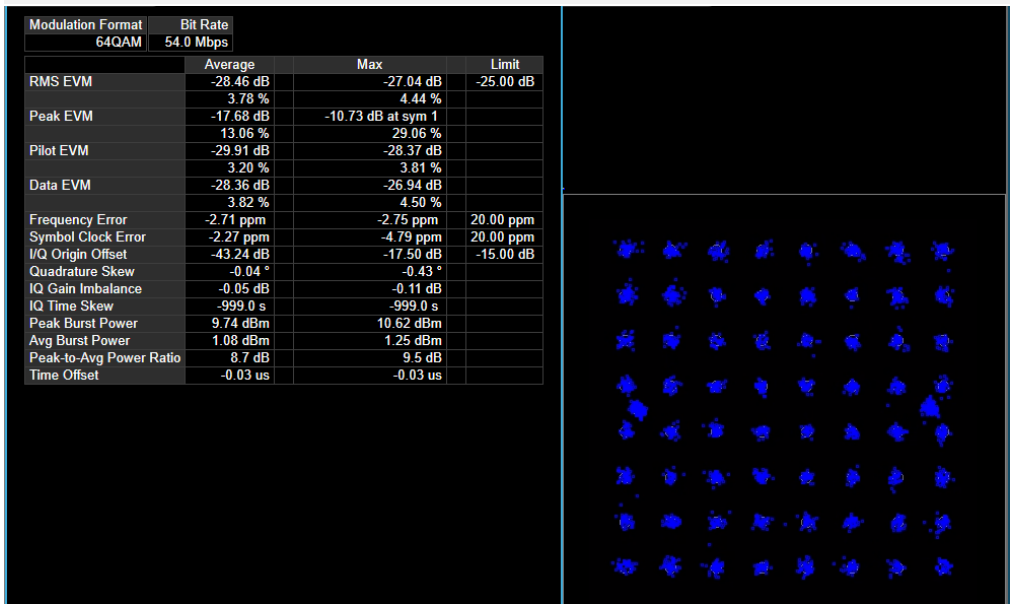
Frequency = 912 MHz, 802.11g, 54 Mbps, CH0



Modulation Format	Bit Rate
64QAM	54.0 Mbps

	Average	Max	Limit
RMS EVM	-29.61 dB	-23.85 dB	-25.00 dB
	3.31 %	6.42 %	
Peak EVM	-18.75 dB	-11.29 dB at sym 1	
	11.55 %	27.25 %	
Pilot EVM	-30.95 dB	-24.38 dB	
	2.84 %	6.04 %	
Data EVM	-29.51 dB	-23.81 dB	
	3.34 %	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, 802.11g, 54 Mbps, CH1



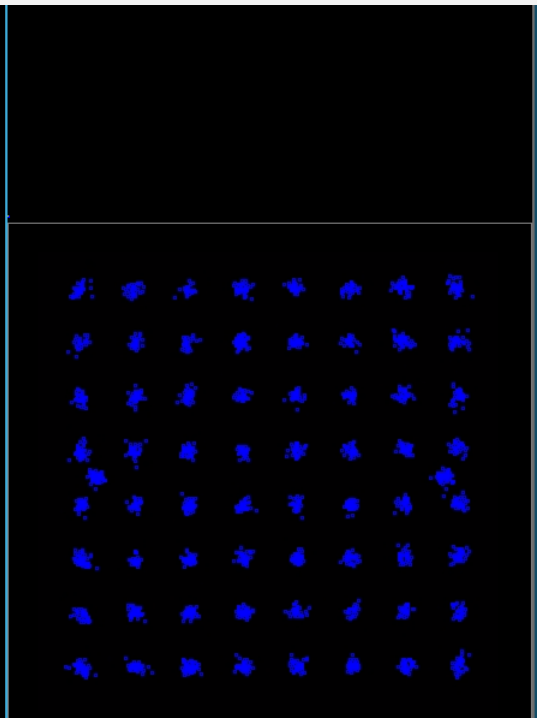
Modulation Format	Bit Rate
64QAM	54.0 Mbps

	Average	Max	Limit
RMS EVM	-28.46 dB	-27.04 dB	-25.00 dB
	3.78 %	4.44 %	
Peak EVM	-17.68 dB	-10.73 dB at sym 1	
	13.06 %	29.06 %	
Pilot EVM	-29.91 dB	-28.37 dB	
	3.20 %	3.81 %	
Data EVM	-28.36 dB	-26.94 dB	
	3.82 %	4.50 %	
Frequency Error	-2.71 ppm	-2.75 ppm	20.00 ppm
Symbol Clock Error	-2.27 ppm	-4.79 ppm	20.00 ppm
I/Q Origin Offset	-43.24 dB	-17.50 dB	-15.00 dB
Quadrature Skew	-0.04 °	-0.43 °	
IQ Gain Imbalance	-0.05 dB	-0.11 dB	
IQ Time Skew	-999.0 s	-999.0 s	
Peak Burst Power	9.74 dBm	10.62 dBm	
Avg Burst Power	1.08 dBm	1.25 dBm	
Peak-to-Avg Power Ratio	8.7 dB	9.5 dB	
Time Offset	-0.03 us	-0.03 us	

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

Modulation Format	Bit Rate
64QAM	65.0 Mbps

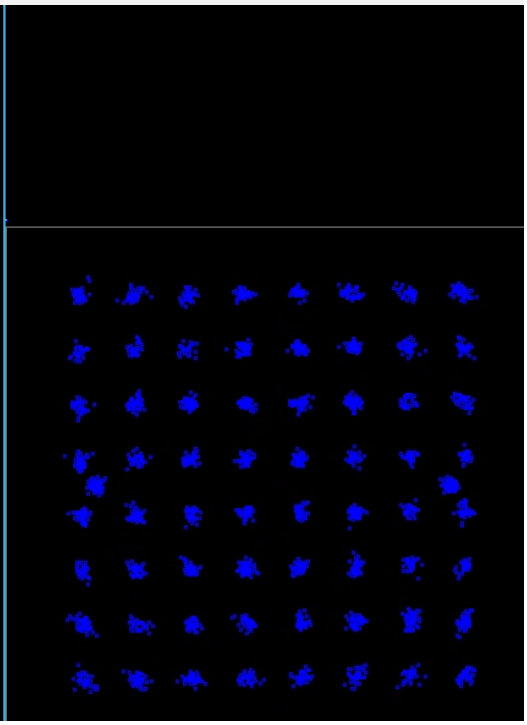
	Average	Max	Limit
RMS EVM	-29.52 dB	-28.29 dB	-27.00 dB
	3.34 %	3.85 %	
Peak EVM	-19.15 dB	-16.00 dB at sym 12	
	11.03 %	15.85 %	
Pilot EVM	-30.81 dB	-29.22 dB	
	2.88 %	3.46 %	
Data EVM	-29.44 dB	-28.17 dB	
	3.37 %	3.90 %	
Frequency Error	-2.85 ppm	-2.88 ppm	25.00 ppm
Symbol Clock Error	-2.63 ppm	-5.15 ppm	25.00 ppm
I/Q Origin Offset	-31.99 dB	-30.70 dB	-15.00 dB
Quadrature Skew	0.23 °	0.39 °	
IQ Gain Imbalance	-0.10 dB	-0.12 dB	
IQ Time Skew	1.947 ps	72.25 ps	
Peak Burst Power	10.23 dBm	11.15 dBm	
Avg Burst Power	1.46 dBm	1.58 dBm	
Peak-to-Avg Power Ratio	8.8 dB	9.7 dB	
Time Offset	0.18 us	0.18 us	



Frequency = 912 MHz, 802.11n, MCS7 (65Mbps), CH1

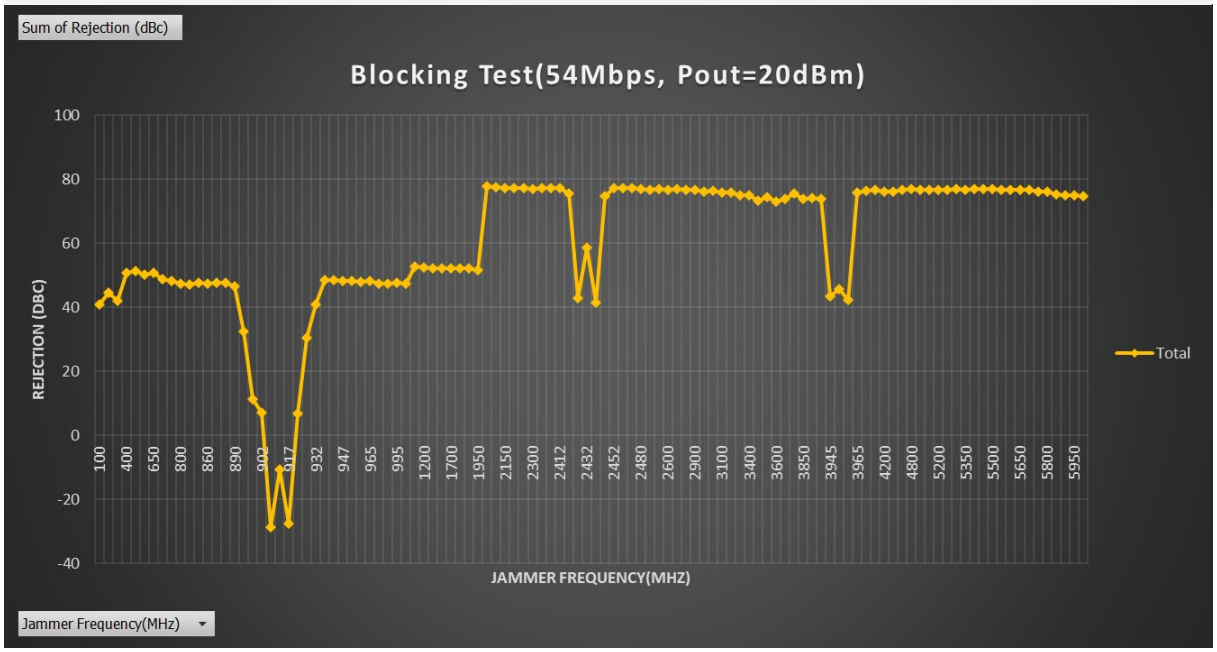
Modulation Format	Bit Rate
64QAM	65.0 Mbps

	Average	Max	Limit
RMS EVM	-28.76 dB	-27.07 dB	-27.00 dB
	3.65 %	4.43 %	
Peak EVM	-17.82 dB	-14.14 dB at sym 41	
	12.86 %	19.63 %	
Pilot EVM	-30.10 dB	-28.52 dB	
	3.13 %	3.75 %	
Data EVM	-28.68 dB	-26.97 dB	
	3.68 %	4.48 %	
Frequency Error	-2.64 ppm	-2.67 ppm	25.00 ppm
Symbol Clock Error	-2.29 ppm	-5.97 ppm	25.00 ppm
I/Q Origin Offset	-38.11 dB	-17.50 dB	-15.00 dB
Quadrature Skew	0.32 °	0.51 °	
IQ Gain Imbalance	-0.06 dB	-0.10 dB	
IQ Time Skew	107.7 ps	193.1 ps	
Peak Burst Power	9.72 dBm	10.74 dBm	
Avg Burst Power	1.04 dBm	1.19 dBm	
Peak-to-Avg Power Ratio	8.7 dB	9.6 dB	
Time Offset	-0.15 us	-0.15 us	



Interference Desensitization

Frequency = 912 MHz, 802.11g, 54 Mbps



Data rate vs Attenuation (MIMO)

Frequency = 912 MHz, 802.11 b/g/n mode, MIMO

Att (dB)	BW (MHz)	WR (Mbps)	BW (MHz)	WR (Mbps)	BW (MHz)	WR (Mbps)
86	20	144.4	10	72.2	5	36.1
106	20	57.7	10	39	5	19.5
120	20	11	10	7.2	5	3.6

Legends
Att – RF Attenuation between Transmitter and Receiver
BW – Channel Bandwidth
WR – Working Rate

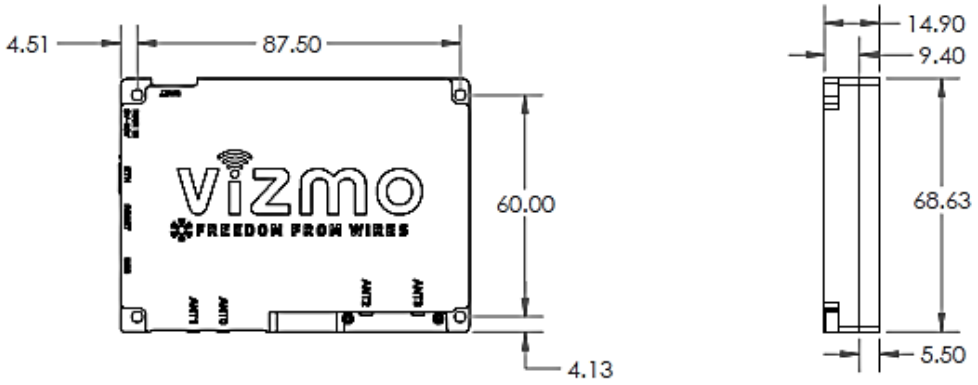
CONNECTION DETAILS

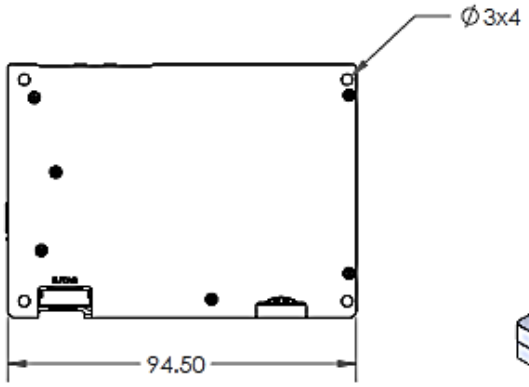
REF	PART
1	MMCX Connector, 2.4 GHz
2	MMCX Connector, 2.4 GHz
3	MMCX Connector, 900 MHz
4	MMCX Connector, 900 MHz
5	Power Connector, JST SM04B-GHS-TB
6	Ethernet Connector, HIROSE IX60G-A-10P
7	USB Connector for thumb drive
8	RGB LED
9	USB Micro-B Connector for UART
10	JST SM08B-GHS-TB for EJTAG (On bottom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

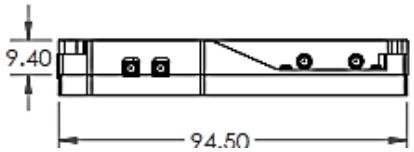
CONNECTION PIN-OUT

PIN#	PIN DESCRIPTION
Ant-0	2.4 GHz Ant-0
Ant-1	2.4 GHz Ant-1
Ant-2	900 MHz Ant-0
Ant-3	900 MHz Ant-1
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

MECHANICAL DIMENSIONS







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