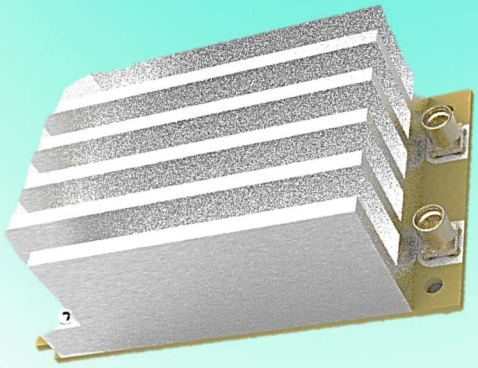
vizmo
FREEDOM FROM WIRES

axE2-2400

INTEGRATION GUIDE



Last updated: Nov-23-25

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1. Introduction

axE2-2400 is an IEEE 802.11 b/g/n/ac/ax miniPCIe Radio Module that operates in the ISM band from 2400 to 2483.5 MHz. It comes in the standard MiniPCIe form factor and supports a single-lane PCIe Gen3 interface for easy integration into OEM host systems. The transceiver module is powered by Qualcomm QCN9072 enterprise network processor, ensuring high performance in 2.4 GHz ISM frequency band operating within temperature range of -40˚C to +85˚C.

2. Technical Specifications

Chipset	QUALCOMM QCN-9072-1
EEPROM	2-Mbit serial I²C bus EEPROM
Host Interface	Mini PCIe interface with PCIe 3.0
Operating System	Linux, supports open source **ath11K** Linux driver
Security	AES-CCMP at 128/256 bits, AES-GCMP at 128/256 bits WEP, TKIP hardware encryption, WAPI-2 hardware encryption WPA/WPA2-Personal/WPA2-Enterprise and WPA3 Personal
Operating frequency	2400 MHz to 2483.5MHz
Data rate-11b/g Data rate-11n Data rate-11ac Data rate-11ax	1 Mbps, 2 Mbps, 5.5 Mbps, 6 Mbps, 9Mbps, 12Mbps, 18 Mbps, 24Mbps, 36Mbps, 48Mbps, 54Mbps MCS0, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6, MCS7 MCS0, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6, MCS7, MCS8, MCS9, MCS10, MCS11 MCS0, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6, MCS7, MCS8, MCS9, MCS10, MCS11
Channel BW	5/10/20/40 MHz
Operating Voltage	3.3V DC / 5V DC (through miniPCIe connector pins 45,47,49,51 for RF FEM)
Total DC Power Consumption	7 Watts in 2x2 MIMO mode
RF Antenna connector	x2 MMCX Female (Jack), Straight connectors
Mechanical Dimension	(L) 73.8 mm x (W) 68.9 mm x (W) 11.3 mm

3. MiniPCIe (Gold Finger) Pin-out

Pin#	Pin Description	Pin Description	Pin#
1	WAKE_L (3.3V TOLERANT)	3.3V	2
3	NC	GND	4
5	NC	NC	6
7	CLKREQ_L, connected to GND through a pull-down resistor of 0 Ohms.	NC	8
9	GND	NC	10
11	REFCLK-	NC	12
13	REFCLK+	NC	14
15	GND	NC	16
MECHANICAL KEY			
17	NC	GND	18
19	NC	W_DISABLE_L (Pulled up to 3.3V)	20
21	GND	PCIE_RESET_L (3.3V TOLERANT)	22
23	PERN0	3.3V	24
25	PERP0	GND	26
27	GND	NC	28
29	GND	NC	30
31	PETN0	NC	32
33	PETP0	GND	34
35	GND	NC	36
37	NC	NC	38
39	3.3V	GND	40
41	3.3V	NC	42
43	GND	NC	44
45	5V (FOR RF FEM)	NC	46
47	5V (FOR RF FEM)	NC	48
49	5V (FOR RF FEM)	GND	50
51	5V (FOR RF FEM)	3.3V	52

4. Hardware Integration

4.1 Antenna Ports

4.2 DC Voltages

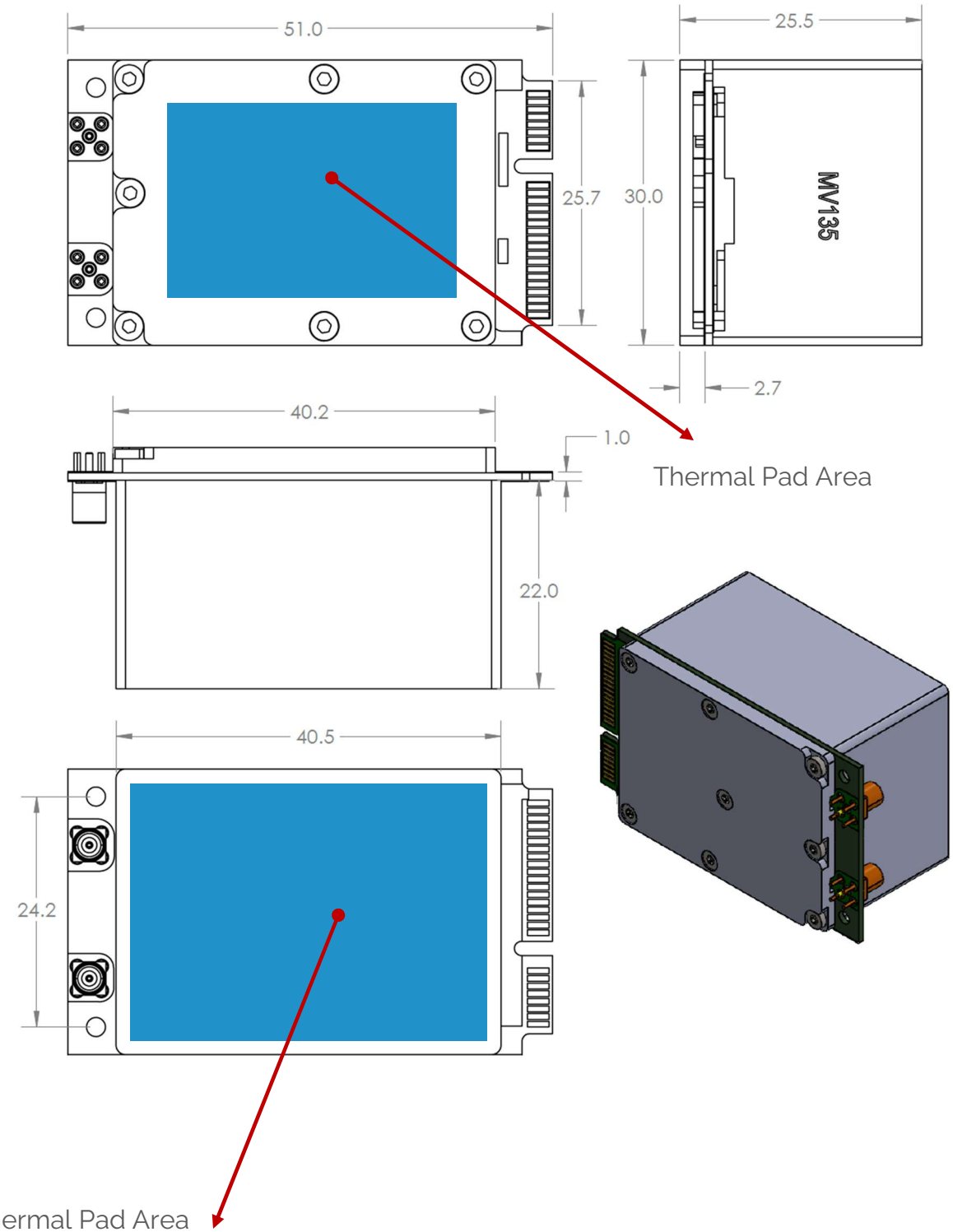
a. WAKE_L and PCIE_RESET_L are 3.3V tolerant signals. These signals require a pull-up resistor of at least 10 Kohms on the host. If your host requires these signals to be 1.8V tolerant, please contact enquiry@vizmonet.com for customization.
b. Pins 45, 47, 49, 51 drive RF FEM power supply and require 5V from host.
c. Peak DC Power Consumption is around 7 Watts, when operating in Continuous Transmit mode with 99% Duty cycle.

5. Thermal Management

Proper thermal management is essential when integrating the radio module into the host system. Vizmonet offers several customization options for heatsinks and shield covers to fit your host design.

In environments lacking a metallic heat-dissipation surface, the minimum heatsink area required is 40.5 mm × 30 mm × 22 mm, as shown below. For these cases, Vizmonet provides the module with a factory-fitted heatsink.

If your host system requires thinner heatsinks, ensure adequate heat dissipation through the enclosure. In such scenarios, thermal pads should be used on both the top and sides.



This side has maximum Heat dissipation

6. Software Integration (OpenWrt)

In OpenWrt, Qualcomm Wi-Fi chips using the ath11k driver (e.g. QCN9074 802.11ax radios) rely on a board data file (board-2.bin) for calibration and regulatory data. This board-2.bin is a container holding multiple BDFs (Board Data Files), each indexed by a unique "board ID" (often derived from the Wi-Fi Module during PCI qmi messaging). The ath11k driver will look up the appropriate entry in board-2.bin based on the Wi-Fi module's identifiers.

- ✓ Board-ID for axE2-2400 is 0xA6
- ✓ BDF for axE2-2400 is bdwlan.ba6

At Vizmonet, we consistently maintain the board-2.bin file by updating the BDFs for each product, which is available upon request.

The following steps outlines the critical elements that should be taken care of during integration axE2-2400 with the host system.

1. Reach out to Vizmonet (enquiry@vizmonet.com) & receive the latest board-2.bin file, that includes BDFs for all Vizmonet 11ax Wi-Fi modules.

2. **During an OpenWrt Build (Preferred):**
   If you are building a custom OpenWrt image: - Using the files/overlay: Create the directories to match the firmware path and drop in your file. In the OpenWrt build root, put the new file as:
   files/lib/firmware/ath11k/QCN9074/hw1.0/board-2.bin
   (Create the folders files/lib/firmware/ath11k/QCN9074/hw1.0 if they don't exist.) When you build the image, OpenWrt will include this file, overriding the default one from the ath11kfirmware-qcn9074 package. This approach ensures your changes survive upgrades, since the file is baked into the firmware image. It also adheres to OpenWrt's structure – the file will end up in the correct path
   (/lib/firmware/ath11k/QCN9074/hw1.0/board-2.bin)
   where the driver expects it.

3. **On a Running System (Hot-fix):**
   If you need to test quickly on an already installed OpenWrt or don't want to rebuild everything: - Backup and replace: SSH into the device and navigate to /lib/firmware/ath11k/QCN9074/hw1.0.
   Backup the current board file: mv board-2.bin board-2.bin_stock
   Then copy the new board-2.bin to this directory (e.g. using scp from your PC to the router). – Reload the driver: Unload and reload ath11k to pick up the new board file:

```
rmmod ath11k_pci && rmmod ath11k      # remove ath11k modules
modprobe ath11k_pci                   # reload ath11k (which will load the
                                        new board-2.bin)
```

(Alternatively, a simple reboot will also force the firmware to load anew.)

Verify operation: Check dmesg after reloading. The previous "failed to fetch board data" errors should be gone. You should see messages about the board file being loaded, e.g. "*ath11k_pci 0000:01:00.0: board file successfully loaded*". Then confirm that the Wi-Fi interface comes up (e.g. wifi status or ip link shows the wireless interface).

Note: This manual method is good for testing. However, if you **sysupgrade** OpenWrt, your change will be lost unless you include it in the build or backup the file. For persistent deployment, use the build integration (explained in step-2) or include a script in /etc/rc.local to copy over the board file on boot.

Revision History

Nov-10-25
First Release

Nov-23-25
Added Software Integration