Evaluation of RF Exposure for Q2698 Wireless Modem as a Mobile Device

In this application we seek modular approval to the Q2698 wireless modem for use in mobile configuration.

Part I: FCC requirement
Based on the FCC OET Bulletin 65 Supplement C and 47 CFR §2.1091, we have concluded that the Q2698 will comply with the FCC rules on RF exposure for mobile devices if the antenna gain does not exceed 7.5 dBi in cellular band and 3.5 dBi in PCS band. The following analysis will demonstrate such compliance. The analysis will be done in two US bands.

Operation in cellular band (824 – 849 MHz)

The peak conducted output power of Q2698 in Cellular band is 32.65 dBm. Take the worst case as an example, in which an antenna with 7.5 dBi gain is used. The resulted power density at a distance of 20 cm can be deducted as follows:

$$EIRP = Pcond + 7.5$$
$$Power\ Density = EIRP*DutyCycle/(4\pi R^2)$$

The table below shows the different MPE levels in different time slot configurations:

	Max Pcond (dBm)	Max EIRP (dBm)	Max EIRP (mW)	Dute Cycle	MPE (mW/ cm^2)
1 Time Slot	32.44	39.94	9862.79	12.5%	0.245
2 Time Slots	32.65	40.15	10351.42	25%	0.515
3 Time Slots	30	37.5	5623.41	37.5%	0.420
4 Time Slots	29	36.5	4466.84	50%	0.444

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

$$MPE\ limit = 824/1500 = 0.55\ mW/cm^2$$

As we can see the resulted power density is below the MPE limit, therefore Q2698 in Cellular band is compliant with the FCC rules on RF exposure.

Operation in PCS band (1850 – 1910 MHz)

The peak conducted output power of Q2698 in PCS band is 29.4 dBm. Take the worst case as an example, in which an antenna with 3.5 dBi gain is used. The resulted ERP can be expressed as follows:

$$ERP = 29.4 + 3.5 – 2.15 = 30.75\ dBm\ (1.19\ W) < 3\ W$$

The FCC OET Bulletin 65 Supplement C states that mobile devices identified in 47 CFR §2.1091 that operate at frequencies above 1.5 GHz with an ERP of 3.0 watts or more are required to

perform routine environmental evaluation for RF exposure prior to equipment authorization or use; otherwise, they are categorically excluded.

As we can see this resulted ERP is below 3 W, therefore routine environmental evaluation for RF exposure prior to equipment authorization or use for Q2698 in PCS band is categorically excluded.

Part II: IC requirement

Power Density= 0.515m W/cm^2 =5.15W/ m^2 (Worse case) When operate in cellular band (824 – 849 MHz) if the device antenna gain does not exceed 7.5 dBi in cellular band.

Power Density= 0.095m W/cm^2 =0.95W/ m^2 (Worse case) When operate in PCS band (1850 – 1910 MHz) if the device antenna gain does not exceed 3.5 dBi in PCS band. The table below shows the different MPE levels in different time slot configurations:

	Max Pcond (dBm)	Max EIRP (dBm)	Max EIRP (mW)	Dute Cycle	MPE (mW/ cm^2)
1 Time Slot	29.4	32.9	1949.84	12.5%	0.048
2 Time Slots	29.3	32.8	1905.46	25%	0.095
3 Time Slots	27	30.5	1122.02	37.5%	0.084
4 Time Slots	25	28.5	707.95	50%	0.070

AS IC RSS-102 requirement, RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment) listed below:

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/ m^2)	Averaging Time (minutes)
0.003-1	280	2.19	-	6
1-10	280/f	2.19/f	-	6
10-30	28	2.19/f	-	6
30-300	28	0.073	2*	6
300-1500	1.585 f 0.5	0.0042 f 0.5	f/150	6
1500-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/f 1.2
150000-300000	0.158 f 0.5	4.21 x 10-4 f 0.5	6.67 x 10-5 f	616000/f 1.2

Note: f is frequency in MHz.
* Power density limit is applicable at frequencies greater than 100 MHz.

The RF Field Strength limit for General Population/Uncontrolled Exposure is shown in the RSS-102 and can be calculated as follows:

Cellular band limit = 824/150 = 5.5 W/m^2

PCS band limit =10W/ m^2

As we can see the resulted power density is below the MPE limit, therefore Q2698 is compliant with the IC rules on RF exposure.