Engineering Analysis MPE for ERM2, 5 GHz Transceiver

FCC ID: RAR20031001
BelAir Networks

This analysis was performed as part of the FCC certification requirements for spread spectrum devices, according to the requirements of: FCC part 15, and FCC OET Bulletin 65 “Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields”.

- Module RAR20031001 will be mounted in BelAir Networks host units and will be professionally installed (Fixed) to provide a minimum separation distance from all persons as detailed in co-location compliance tables below.
- Module RAR20031001 may be co-located with other modules in BelAir Networks products as shown in the co-location compliance tables below. Worst-case configurations are shown below.
- This device will only be operated according to the exposure conditions described in this application.
- End users and installers will be provided with antenna installation and transmitter operating conditions for satisfying RF exposure compliance.

The measured worst-case transmit power yielding the worst-case EIRP were used for the MPE calculations. Calculations were performed based on FCC OET Bulletin 65. The calculations are performed based on the following formula provided in OET 65:

$S = EIRP / (4\pi R^2)$.

Co-location compliance for multiple frequency exposure criteria to the power density exposure limit is detailed in the table below. This calculation is a worst-case analysis since it assumes all devices are continuously transmitting. The device utilizes the 802.11 WLAN protocol which operates in time-division duplex (TDD) mode, so the transmit duty cycle can never be 100% in normal operation. It is also assumed that all directional antennas are aligned to point in the same direction so that power from all radios add.

The following tables outlines the MPE analysis for various combinations of radios and antenna the RAR20004001 can be used with:

BA200

Case I: 3 X RAR20031001 5.725 - 5.850 GHz 19 dBi or less antennas-1 X RAR20000003

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios								
Safety Distance:	50 cm	(19.7 inches)						
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001				
35.5	0.113	1	39	0.253	3	0.871	1	Complies

Case II: 3 X RAR20031001 5.725 - 5.850 GHz with 23, 28, 30 dBi antennas and 1 X RAR20000003

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios								
Safety Distance:	160 cm	(63.0 inches)						
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001				
35.5	0.011	1	50	0.311	3	0.944	1	Complies

Case IIIa: 2 X RAR20031001 5.725 - 5.850 GHz with 19 dBi or less antennas and 1 X RAR20000003 and 1 X RAR20004001 or 1 X RAR20008001 (10 dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.11a Public Service Radios											
Safety Distance:	45 cm	(17.7 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20008001				
35.5	0.139	1	39	0.312	2	34	0.099	1	0.862	1	Complies

Case IIIb: 2 X RAR20031001 5.725 - 5.850 GHz with 19 dBi or less antennas and 1 X RAR20000003 and 1 X RAR20004001 or 1 X RAR20008001 (25 dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.11a Public Service Radios											
Safety Distance:	90 cm	(35.4 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20008001				
35.5	0.035	1	39	0.078	2	49	0.780	1	0.971	1	Complies

Case IVa: 2 X RAR20031001 5.725 - 5.850 GHz with 23, 28, 30 dBi antennas and 1 X RAR20000003 and 1 X RAR20004001 or 1 X RAR20008001 (10dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.11a Public Service Radios											
Safety Distance:	130 cm	(51.2 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20008001				
35.5	0.017	1	50	0.471	2	34	0.012	1	0.970	1	Complies

Case IVb: 2 X RAR20031001 5.725 - 5.850 GHz with 23, 28, 30 dBi antennas and 1 X RAR20000003 and 1 X RAR20004001 or 1 X RAR20008001 (25dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.11a Public Service Radios											
Safety Distance:	155 cm	(61.0 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20008001				
35.5	0.012	1	50	0.331	2	49	0.263	1	0.937	1	Complies

Case Va: 1 X RAR20031001 5.725 - 5.850 GHz with 19 dBi or less antennas and 1 X RAR20000003 and 2 X RAR20006001 or 2 X RAR20007001 (15 dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.16 WCS band Radios											
Safety Distance:	45 cm	(17.7 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20006001				
35.5	0.139	1	39	0.312	2	36	0.156	1	0.920	1	Complies

Case Vb: 1 X RAR20031001 5.725 - 5.850 GHz with 19 dBi or less antennas and 1 X RAR20000003 and 2 X RAR20006001 or 2 X RAR20007001 (25dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.16 WCS band Radios											
Safety Distance:	90 cm	(35.4 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20006001				
35.5	0.035	1	39	0.078	1	46	0.391	2	0.895	1	Complies

Case VIa: 2 X RAR20031001 5.725 - 5.850 GHz with 23, 28, 30 dBi antennas and 1 X RAR20000003 and 1 X RAR20006001 or 1 X RAR20007001 (15 dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.16 WCS band Radios											
Safety Distance:	130 cm	(51.2 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20006001				
35.5	0.017	1	50	0.471	2	36	0.019	1	0.977	1	Complies

Case VIb: 2 X RAR20031001 5.725 - 5.850 GHz with 23, 28, 30 dBi antennas and 1 X RAR20000003 and 1 X RAR20006001 or 1 X RAR20007001 (25dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.16 WCS band Radios											
Safety Distance:	140 cm	(55.1 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20006001				
35.5	0.014	1	50	0.406	2	46	0.162	1	0.988	1	Complies

BA100

Case VIIa: 1X RAR20031001 5.725 - 5.850 GHz with 19 dBi or less antennas and 1 X RAR20000003 and 1 X RAR20008001 (10 dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.11a Public Service Radios											
Safety Distance:	35 cm	(13.8 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20008001				
35.5	0.230	1	39	0.516	1	34	0.163	1	0.910	1	Complies

Case VIIb: 1X RAR20031001 5.725 - 5.850 GHz with 19 dBi or less antennas and 1 X RAR20000003 and 1 X RAR20008001 (25 dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.11a Public Service Radios											
Safety Distance:	90 cm	(35.4 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20008001				
35.5	0.035	1	39	0.078	1	49	0.780	1	0.893	1	Complies

Case VIIIa: 1X RAR20031001 5.725 - 5.850 GHz with 23, 28, 30 dBi antennas and 1 X RAR20000003 and 1 X RAR20008001(10dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.11a Public Service Radios											
Safety Distance:	95 cm	(37.4 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of	Total Density [mW/cm^2]	Limit: General Population / [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20008001				
35.5	0.031	1	50	0.882	1	34	0.022	1	0.935	1	Complies

Case VIIIb: 1X RAR20031001 5.725 - 5.850 GHz with 23, 28, 30 dBi antennas and 1 X RAR20000003 and 1 X RAR20008001(25dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.11a Public Service Radios											
Safety Distance:	125 cm	(49.2 inches)									
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Number of Radios	Density for co- [mW/cm^2]	Population / Uncontrolled [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20008001				
35.5	0.018	1	50	0.509	1	49	0.405	1	0.932	1	Complies

Case IXa: 1X RAR20031001 5.725 - 5.850 GHz with 19 dBi or less antennas and 1 X RAR20008001 and 1 X RAR20006001 or 1 X RAR20007001 (15 dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.16 WCS band Radios										
Safety Distance:	30 cm	(11.8 inches)								
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20006001				
35.5	0.314	1	35	0.280	1	36	0.352	1	0.945	1	Complies

Case IXb: 1X RAR20031001 5.725 - 5.850 GHz with 19 dBi or less antennas and 1 X RAR20008001 and 1 X RAR20006001 or 1 X RAR20007001 (25 dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.16 WCS band Radios										
Safety Distance:	65 cm	(25.6 inches)								
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20006001				
35.5	0.067	1	35	0.060	1	46	0.750	1	0.876	1	Complies

Case Xa: 1X RAR20031001 5.725 - 5.850 GHz with 23, 28, 30 dBi antennas and 1 X RAR20000003 and 1 X RAR20006001 or 1 X RAR20007001(15 dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.16 WCS band Radios										
Safety Distance:	95 cm	(37.4 inches)								
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20006001				
35.5	0.031	1	50	0.882	1	36	0.035	1	0.948	1	Complies

Case Xb: 1X RAR20031001 5.725 - 5.850 GHz with 23, 28, 30 dBi antennas and 1 X RAR20000003 and 1 X RAR20006001 or 1 X RAR20007001(25dBi)

Co-location Compliance for Integrated 802.11b/g & 802.11a Radios & 802.16 WCS band Radios										
Safety Distance:	110 cm	(43.3 inches)								
Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Worst-case Total EIRP [dBm]	Max Power Density [mW/cm^2]	Maximum Number of Radios	Total Density for co-located radios [mW/cm^2]	Limit: General Population / Uncontrolled Exposure [mW/cm^2]	Result
	RAR20000003			RAR20031001			RAR20006001				
35.5	0.023	1	50	0.658	1	46	0.262	1	0.943	1	Complies

The equipment therefore fulfills the requirements on power density for general population/uncontrolled exposure and therefore complies with the requirements of FCC Bulletin 65.

The following worst case summary table will be incorporated in BelAir Networks installation procedures.

Minimum Safety Distances

Radios with ERM2 RAR20031001

Product	**Standard Antennas**				**High Gain Antennas**			
RF boards : All valid combinations	**ERM2**	ARM3C	PSM1,2	WRM1,2	**ERM2**	ARM3C	PSM1,2	WRM1,2
BelAir50, BelAir 100,100T,100S	up to 19 dBi	Any	10 dbi	15 dbi	up to 30 dBi	Any	25 dBi	25 dBi
Distance	**35 cm (13.8 in)**				**125 cm (49.2 in)**			
BelAir 200	up to 19 dBi	Any	10 dbi	15 dbi	up to 30 dBi	Any	25 dBi	25 dBi
Distance	**50 cm (19.7 in)**				**160 cm (63 in)**			

ARM3C :RAR20000003 PSM1,2:RAR20004001, RAR20008001 WRM1,2 : RAR20006001, RAR20007001