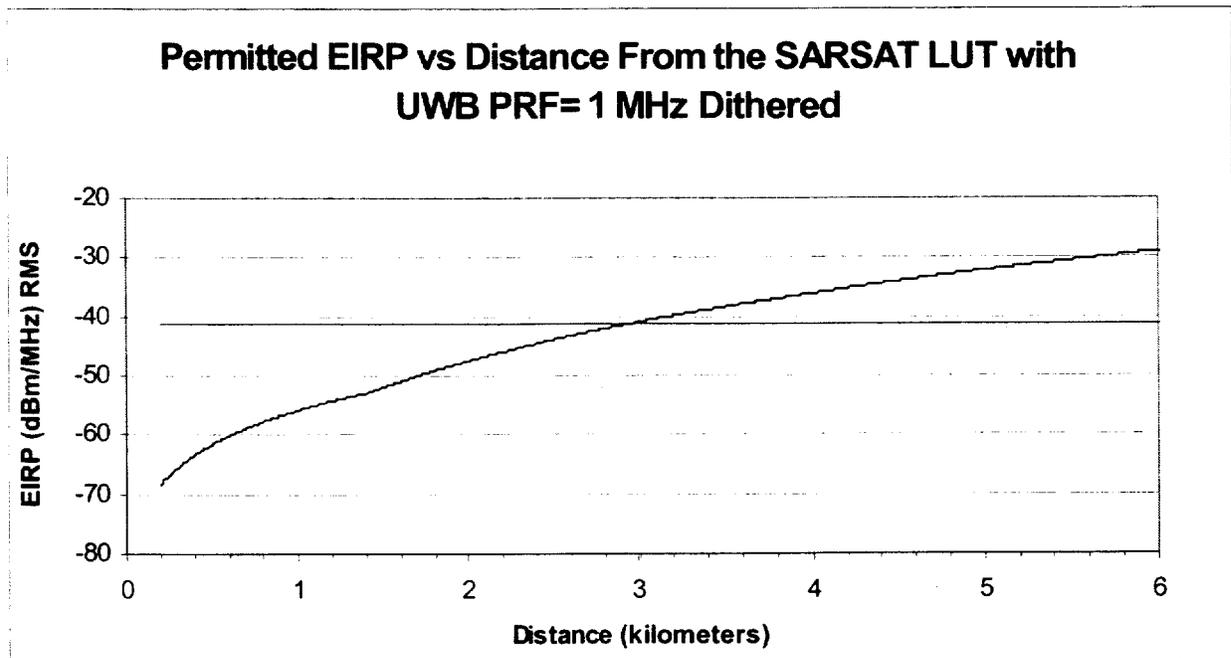


**TABLE 4-38a**  
**Dithered UWB Signal into SARSAT LUT Receiver (UWB Height = 2m)**

PRF (MHz)	Average BWCF (dB)	Maximum Permitted UWB EIRP (dBm)	Delta Reference Level (dB)	Distance Where Permitted UWB EIRP equals -41.3 dBm/MHz RMS (km)
.001	-1.0	-68.4	-27.1	2.9
.01	-1.0	-68.4	-27.1	2.9
.1	-1.0	-68.4	-27.1	2.9
1	-1.0	-68.4	-27.1	2.9
10	-1.0	-68.4	-27.1	2.9
100	-1.0	-68.4	-27.1	2.9
500	-1.0	-68.4	-27.1	2.9



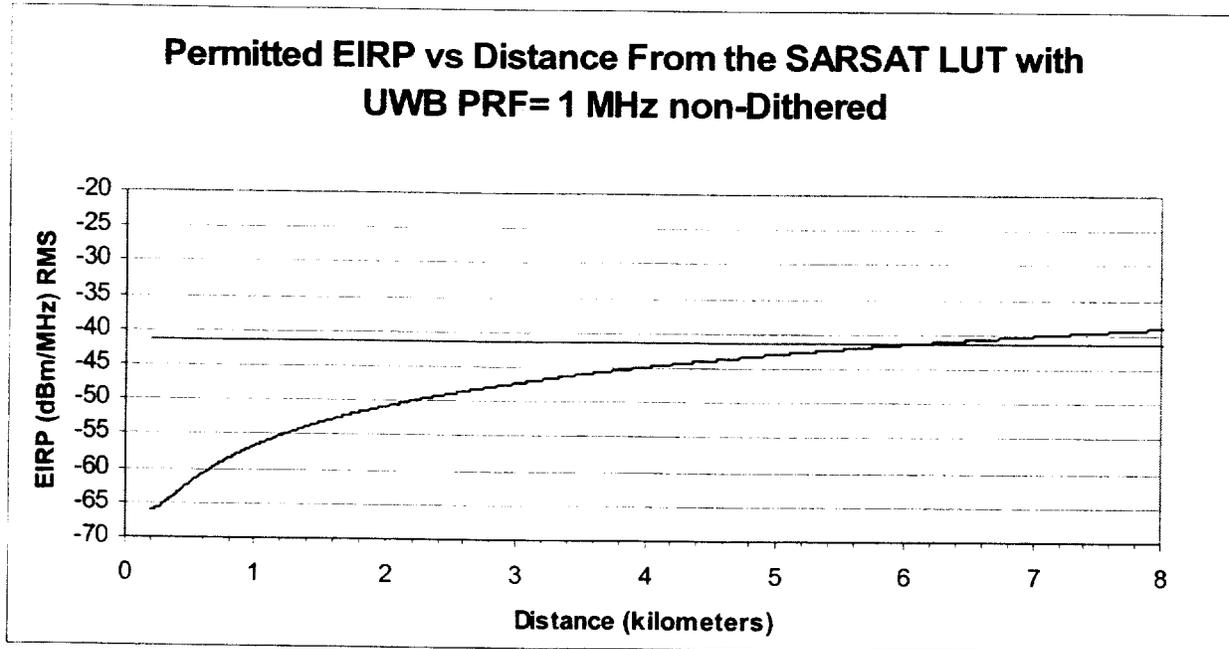
**Figure 4-14a. Maximum Permitted UWB EIRP for Dithered PRF of 1 MHz (UWB Height = 2m).**

Analyses was also performed for a UWB height of 30m. The results for a non-dithered UWB signal analyses are shown in TABLE 4-39a.

**TABLE 4-39a**  
**Non-Dithered UWB Signal into SARSAT LUT Receiver (UWB Height = 30m)**

PRF (MHz)	Average BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
001	-1.0	-65.0	-23.7	5.5
.01	-1.0	-65.0	-23.7	5.5
.1	-1.0	-65.0	-23.7	5.5
1	0.0	-66.0	-24.7	6.1
10	0.0	-66.0	-24.7	6.1
100	0.0	-66.0	-24.7	6.1
500	0.0	-66.0	-24.7	6.1

These results show that for PRFs at and below 0.1 MHz the maximum permitted UWB EIRP is -65.0 dBm/MHz, which is 23.7 dB below the reference level. For PRFs at and above 1 MHz the level is -66.0 dBm/MHz, which is 24.7 dB below the reference level. The separation distance for a UWB device with an EIRP equal to the reference level and a SARSAT LUT is 5.5 km for UWB PRFs at and below 0.1 MHz and 6.1 km for PRFs at and above 1 MHz. A graph of the maximum permitted UWB EIRP versus distance is shown in Figure 4-15a for a non-dithered PRF of 1 MHz and a UWB height of 30 meters.



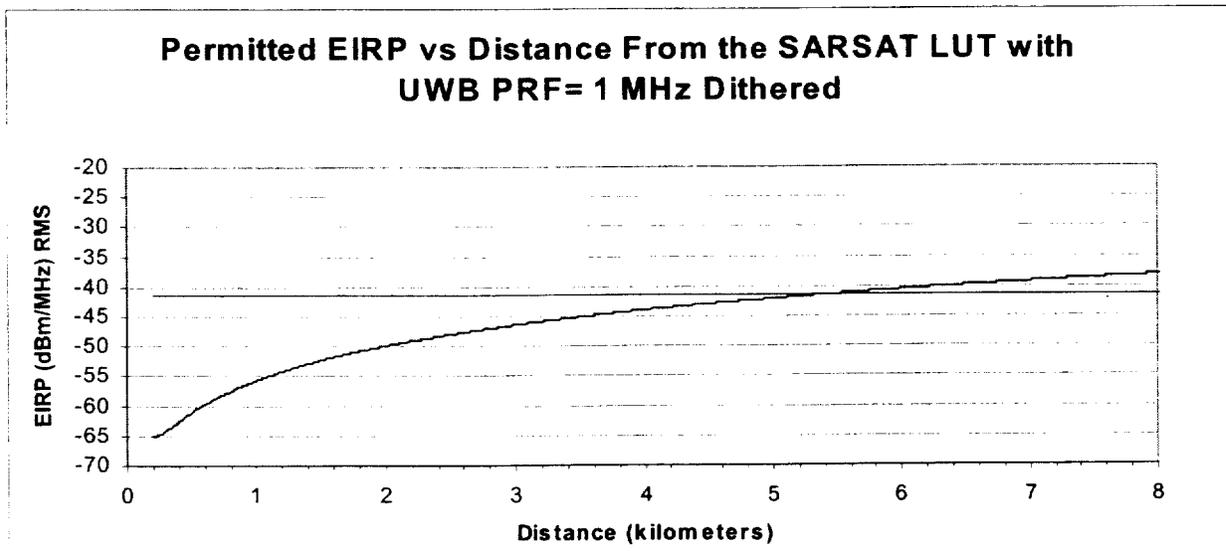
**Figure 4-15a. Maximum Permitted UWB EIRP for non-Dithered PRF of 1MHz (UWB Height =30m).**

The results for a dithered UWB signal analyses are shown in TABLE 4-40a for a UWB height of 30 meters.

**TABLE 4-40a**  
**Dithered UWB Signal into SARSAT LUT Receiver (UWB Height = 30m)**

PRF (MHz)	Average BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	-1.0	-65.0	-23.7	5.5
.01	-1.0	-65.0	-23.7	5.5
.1	-1.0	-65.0	-23.7	5.5
1	-1.0	-65.0	-23.7	5.5
10	-1.0	-65.0	-23.7	5.5
100	-1.0	-65.0	-23.7	5.5
500	-1.0	-65.0	-23.7	5.5

These results show that the maximum permitted UWB EIRP is -65.0 dBm regardless of the PRF, which is 23.7 dB below the reference level. The separation distance for a dithered UWB device with an EIRP equal to the reference level and a SARSAT LUT is 5.5 km regardless of the UWB PRF. A graph of the maximum permitted UWB EIRP versus distance is shown in Figure 4-16a for a dithered PRF of 1 MHz and a UWB height of 30 meters.



**Figure 4-16a. Maximum Permitted UWB EIRP for Dithered PRF of 1MHz (UWB Height =30m).**

### Discussion of Single Entry Results

These results indicate that operation of a UWB device at a power level of -41.3 dBm/MHz RMS in the vicinity of a SARSAT LUT and within the 1544-1545 MHz

frequency band would exceed the current interference protection requirements. UWB devices operating at that power level would add to the system noise, rendering the SARSAT LUT less capable of receiving distress alert transmissions from satellites relayed from maritime, aviation, and land users.

Four factors significantly influence these results, namely, the LUT antenna height, LUT antenna tilt angle, the height of the UWB device, and the UWB PRF. When the LUT antenna and the UWB device are operating in the same horizontal plane, the vertical elevation angle between them is zero degrees which results in a greater LUT antenna gain. The analytical model takes into account the height of the LUT, the height of the UWB device, and the LUT tilt angle to compute the LUT antenna gain, which is then used in the UWB interference calculations. A higher antenna gain results in a lower maximum permitted UWB EIRP and increases the separation distance when the EIRP is equal to the reference level.

Using the average BWCF in this analyses results in a small BWCF of -1.0 dB. This equates to separation distances of up to 6.1 km if they are operated in the main beam of the LUT. In Section 4.10b the analyses is based on a peak BWCF, which results in significantly larger separation distances and/or stricter limits on the UWB EIRP.

#### 4.9.b SARSAT LUT (1544-1545 MHz)

Analyses of potential interference from a single UWB device into a SARSAT LUT receiver was performed using the methodology described in Section 3, the SARSAT LUT characteristics given in Appendix A, and the analysis parameters shown in TABLE 4-36b. The SARSAT LUT antenna height in TABLE 4-36b is a typical value.

**TABLE 4-36b  
UWB and SARSAT LUT Analysis Parameters**

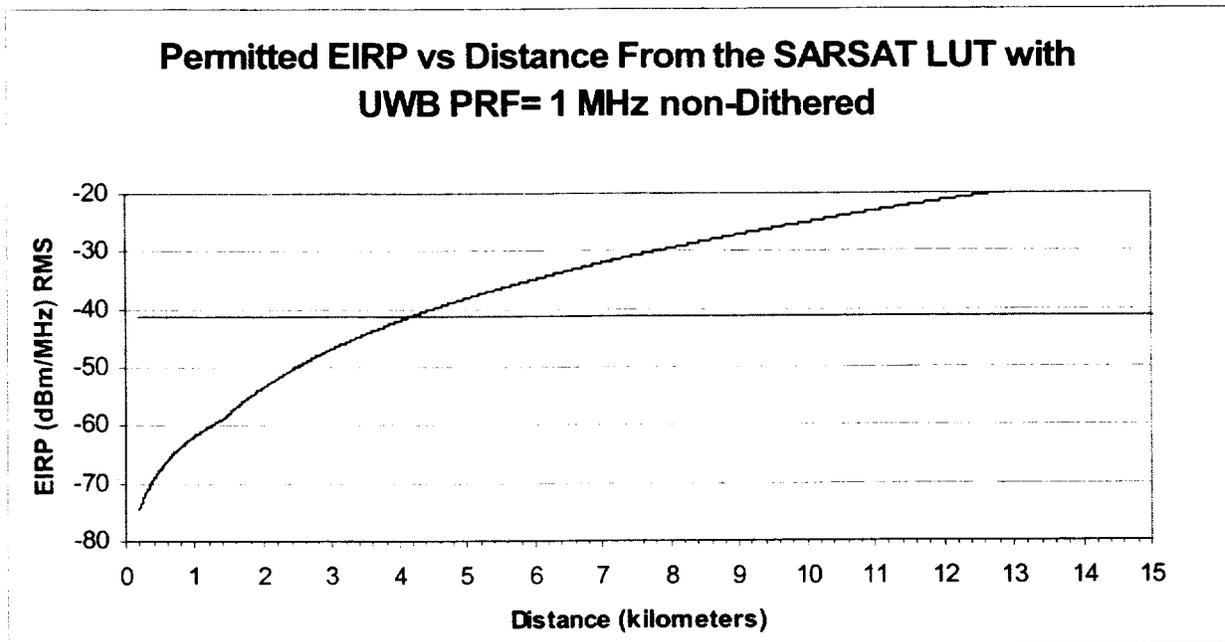
Parameter	Value
Protection Criteria	I/N = -9 dB peak interference
Antenna Height	12 meters
Antenna Tilt Angle	0 degrees
UWB Device Height	2 meters, 30 meters
Measurement Bandwidth	1 MHz
Reference Power Level	-41.3 dBm/MHz average (RMS), EIRP

The results for a non-dithered UWB signal analyses are shown in TABLE 4-37b for a UWB height of 2 meters. These results show that the SARSAT LUT interference protection criteria is exceeded for all UWB PRFs in TABLE 4-37b. The maximum permitted UWB EIRP ranges from -104.4 dBm for a PRF of 0.001 MHz to -69.4 dBm for a PRF of 500 MHz. These levels are 63.1 and 28.1 dB below the reference level. For UWB devices with an EIRP equal to the reference level, the distance separations range

from beyond 15 km for a PRF of 0.001 MHz to 3.1 km for a PRF of 500 MHz to satisfy the SARSAT LUT interference protection criteria. A graph of the maximum permitted UWB EIRP versus distance is shown in Figure 4-13b for a non-dithered PRF of 1 MHz and a UWB height of 2 meters.

**TABLE 4-37b**  
**Non-Dithered UWB Signal into SARSAT LUT Receiver (UWB Height = 2m)**

PRF (MHz)	Peak BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	35.0	-104.4	-63.1	>15
.01	25.0	-94.4	-53.1	12.0
.1	15.0	-84.4	-43.1	7.3
1	5.0	-74.4	-33.1	4.2
10	0.0	-69.4	-28.1	3.1
100	0.0	-69.4	-28.1	3.1
500	0.0	-69.4	-28.1	3.1



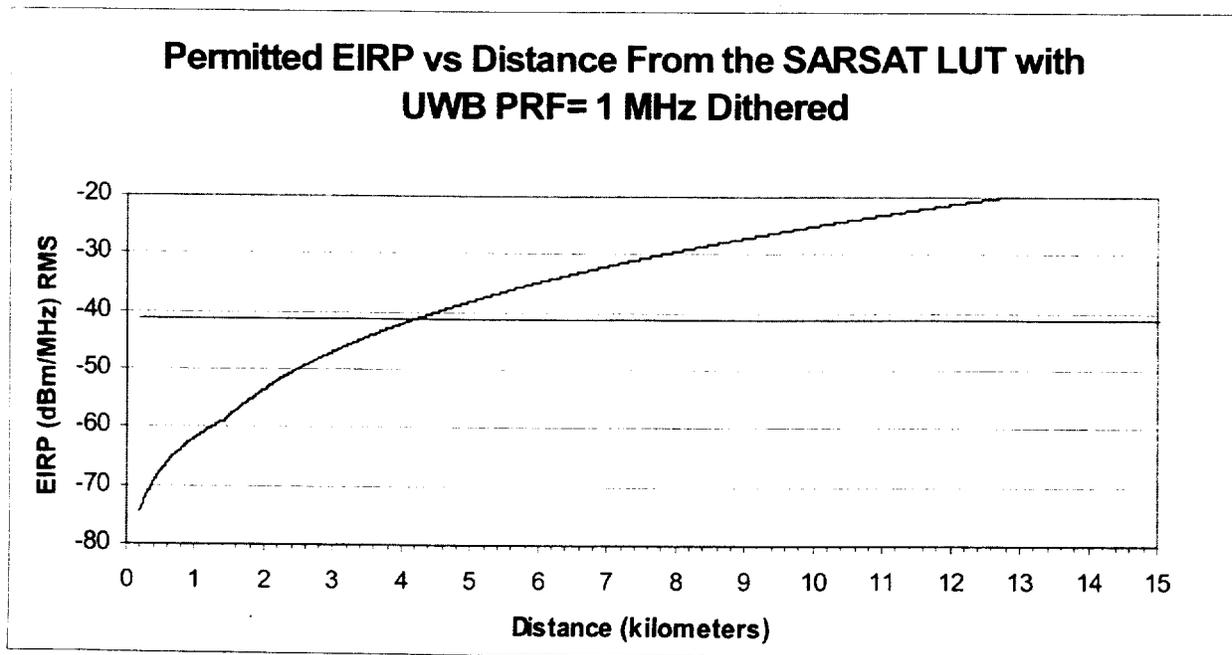
**Figure 4-13b. Maximum Permitted UWB EIRP for non-Dithered PRF of 1 MHz (UWB Height = 2m).**

The results for a dithered UWB signal analyses are shown in TABLE 4-38b for a UWB height of 2 meters. These results show that the SARSAT LUT interference protection criteria is exceeded for all UWB PRFs in TABLE 4-38b. The maximum permitted UWB EIRP ranges from -104.4 dBm for a PRF of 0.001 MHz to -68.4 dBm for

a PRF of 500 MHz. These levels are 63.1 and 27.1 dB below the reference level. For UWB devices with an EIRP equal to the reference level, the distance separations range from beyond 15 km for a PRF of 0.001 MHz to 2.9 km for a PRF of 500 MHz km to satisfy the SARSAT LUT interference protection criteria. A graph of the maximum permitted UWB EIRP versus distance is shown in Figure 4-14b for a dithered PRF of 1 MHz and a UWB height of 2 meters.

**TABLE 4-38b**  
**Dithered UWB Signal into SARSAT LUT Receiver (UWB Height = 2m)**

PRF (MHz)	Peak BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	35.1	-104.4	-63.1	>15
.01	25.1	-94.4	-53.1	12.0
.1	15.1	-84.4	-43.1	7.3
1	5.1	-74.4	-33.1	4.2
10	-1.0	-68.4	-27.1	2.9
100	-1.0	-68.4	-27.1	2.9
500	-1.0	-68.4	-27.1	2.9



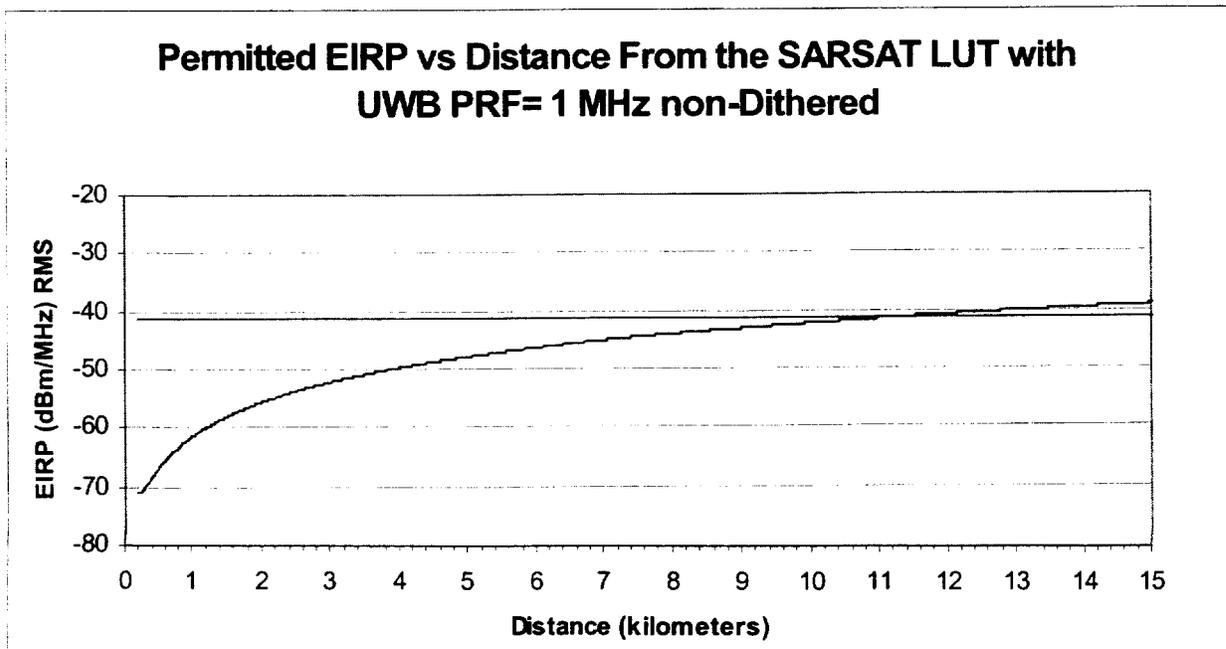
**Figure 4-14b. Maximum Permitted UWB EIRP for Dithered PRF of 1 MHz (UWB Height = 2m).**

Analyses was also performed for a UWB height of 30 meters. The results for a non-dithered UWB signal analyses are shown in TABLE 4-39b.

**TABLE 4-39b**  
**Non-Dithered UWB Signal into SARSAT LUT Receiver (UWB Height = 30 m)**

PRF (MHz)	Peak BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	35.0	-100.90	-59.6	>15
.01	25.0	-90.9	-49.6	>15
.1	15.0	-80.9	-39.6	>15
1	5.0	-70.9	-29.6	11.3
10	0.0	-65.9	-24.6	6.1
100	0.0	-65.9	-24.6	6.1
500	0.0	-65.9	-24.6	6.1

These results show that the SARSAT LUT interference protection criteria is exceeded for all UWB PRFs in TABLE 4-39b. The maximum permitted UWB EIRP ranges from -101 dBm for a PRF of 0.001 MHz to -66 dBm for a PRF of 500 MHz. These levels are 59.6 and 24.6 dB below the reference level. For UWB devices with an EIRP equal to the reference level, the distance separations range from beyond 15 km for a PRF of 0.001 MHz to 6.1 km for a PRF of 500 MHz to satisfy the SARSAT LUT interference protection criteria. A graph of the maximum permitted UWB EIRP versus distance is shown in Figure 4-15b for a non-dithered PRF of 1 MHz and a UWB height of 30 meters.



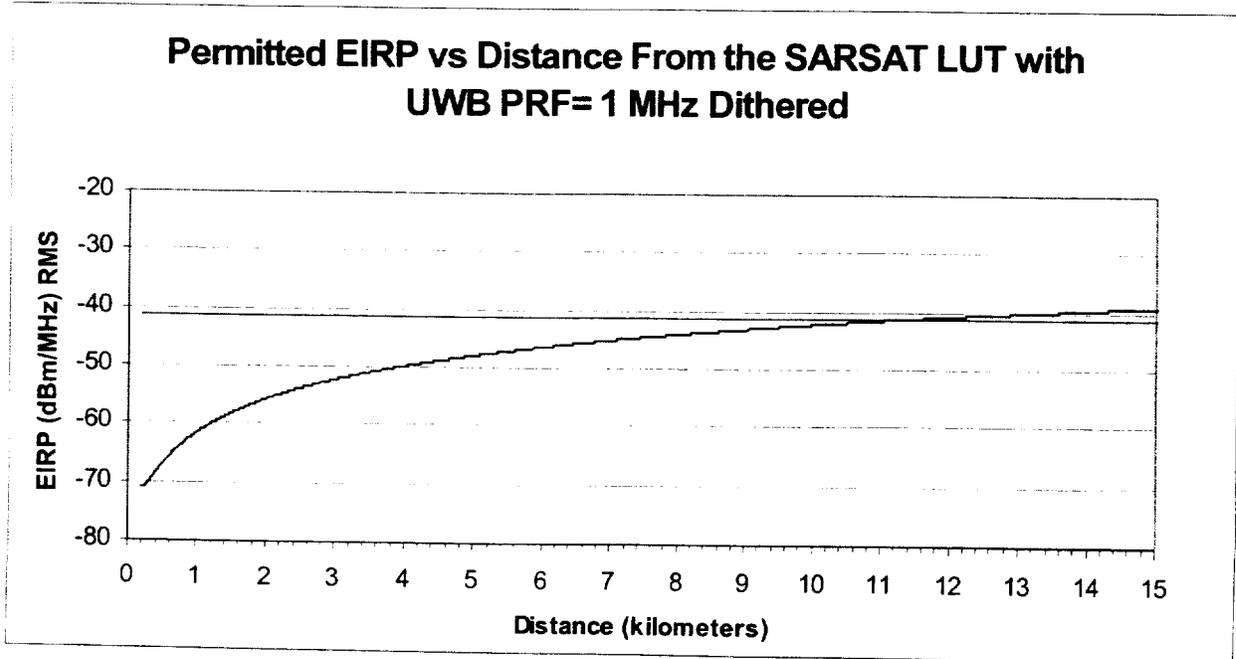
**Figure 4-15b. Maximum Permitted UWB EIRP for non-Dithered PRF of 1MHz (UWB Height =30 m).**

The results for a dithered UWB signal analyses are shown in TABLE 4-40b for a UWB height of 30 meters.

**TABLE 4-40b**  
**Dithered UWB Signal into SARSAT LUT Receiver (UWB Height = 30 m)**

PRF (MHz)	Peak BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	35.1	-100.9	-59.6	>15
.01	25.1	-90.9	-49.6	>15
.1	15.1	-80.9	-39.6	>15
1	5.1	-70.9	-29.6	11.4
10	-1.0	-64.9	-23.6	5.4
100	-1.0	-64.9	-23.6	5.4
500	-1.0	-64.9	-23.6	5.4

These results show that the SARSAT LUT interference protection criteria is exceeded for all UWB PRFs in TABLE 4-40b. The maximum permitted UWB EIRP ranges from -100.9 dBm for a PRF of 0.001 MHz to -64.9 dBm for a PRF of 500 MHz. These levels are 59.6 and 23.6 dB below the reference level. For UWB devices with an EIRP equal to the reference level, the distance separations range from beyond 15 km for a PRF of 0.001 MHz to 5.4 km for a PRF of 500 MHz to satisfy the SARSAT LUT interference protection criteria. A graph of the maximum permitted UWB EIRP versus distance is shown in Figure 4-16b for a dithered PRF of 1 MHz and a UWB height of 30 meters.



**Figure 4-16b. Maximum Permitted UWB EIRP for Dithered PRF of 1MHz (UWB Height = 30 m).**

### Discussion of Single Entry Results

These results indicate that operation of a UWB device at a power level of -41.3 dBm/MHz RMS in the vicinity of a SARSAT LUT and within the 1544-1545 MHz frequency band would exceed the current interference protection requirements. UWB devices operating at that power level would add to the system noise, rendering the SARSAT LUT less capable of receiving distress alert transmissions from satellites relayed from maritime, aviation, and land users.

Four factors significantly influence these results, namely, the LUT antenna height, LUT antenna tilt angle, the height of the UWB device, and the UWB PRF. When the LUT antenna and the UWB device are operating in the same horizontal plane, the vertical elevation angle between them is zero degrees which results in a greater LUT antenna gain. The analytical model takes into account the height of the LUT, the height of the UWB device, and the LUT tilt angle to compute the LUT antenna gain, which is then used in the UWB interference calculations. A higher antenna gain results in a lower maximum permitted UWB EIRP and increases the separation distance when the EIRP is equal to the reference level.

The PRF of the UWB device determines the BWCF in the analyses. At low UWB PRFs the BWCF is large which makes the maximum permitted UWB EIRP lower and increases the separation distances when the UWB EIRP is equal to the reference level.

### 4.10 4 GHz EARTH STATION (3750 MHz)

This analysis of the 4 GHz Earth station consists of four subsections. As with the SARSAT LUT, the 4 GHz Earth station analyses consider protection criteria with an average (RMS) interference power and peak interference coupled with antenna elevation angles at 5 and 20 degrees.

#### 4.10.a 4 GHz Earth Station (3750 MHz with 5 Degree Elevation)

Analyses of potential interference from a single UWB device into a 4 GHz Earth station receiver was performed using the methodology described in Section 3, the 4 GHz Earth station characteristics given in Appendix A, and the analysis parameters shown in TABLE 4-41a. The 4 GHz Earth station radar antenna height in TABLE 4-41a is a typical value.

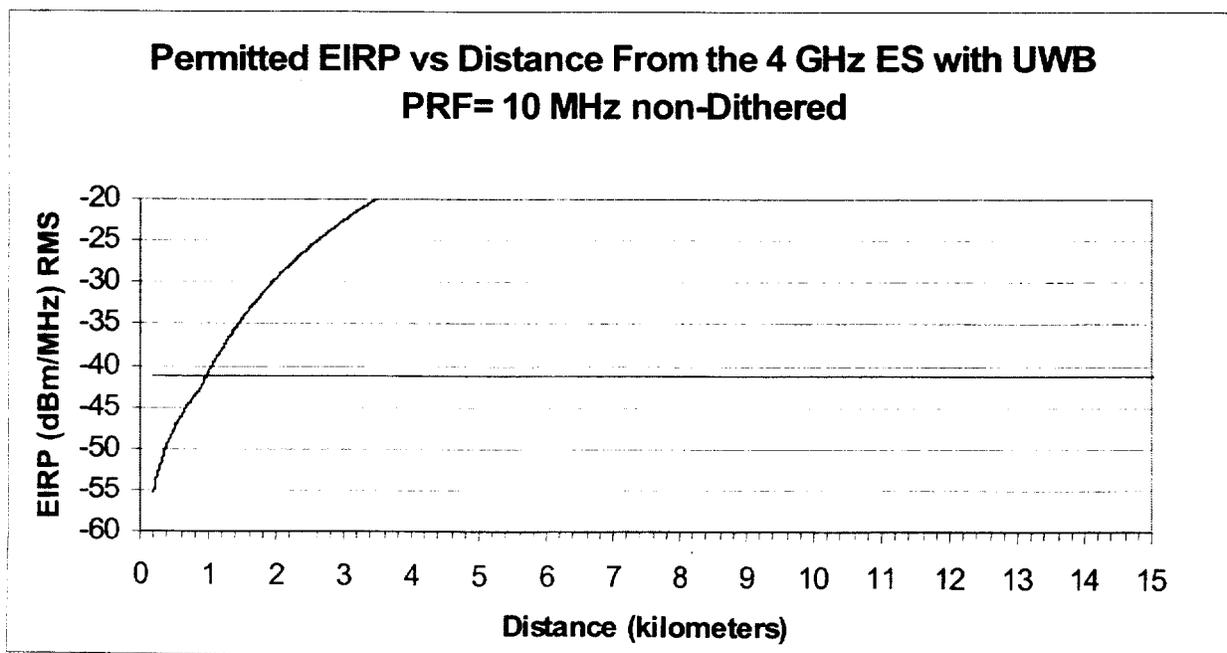
**TABLE 4-41a**  
**UWB and 4 GHz Earth Station Analysis Parameters**

Parameter	Value
Protection Criteria	I/N = -10 dB (average (RMS) interference power)
Antenna Height	3 meters
Antenna Tilt Angle	5 degrees above horizon
UWB Device Height	2 meters
Measurement Bandwidth	1 MHz

The results for a non-dithered UWB signal analyses are shown in TABLE 4-42a for a UWB height of 2 meters. These results show that the 4 GHz Earth station interference protection criteria is exceeded with UWB PRFs slightly above 10 MHz. For PRFs slightly above 10 MHz the maximum permitted EIRP is -34.8 dBm, which is 6.5 dB above the reference level. For UWB devices with PRFs at or below 10 MHz and the UWB EIRP equal the reference level, the distance separations range from 200 to 630 meters to satisfy the 4 GHz Earth station interference protection criteria. A graph of the maximum permitted UWB EIRP for a non-dithered PRF of 10 MHz versus distance is shown in Figure 4-18a.

**TABLE 4-42a**  
**Non-Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht = 2m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
0.001	16.0	-50.8	-9.5	0.63
0.01	16.0	-50.8	-9.5	0.63
0.1	16.0	-50.8	-9.5	0.63
1	16.0	-40.8	-9.5	0.63
10	6.0	-42.3	0.5	0.2
100	0.0	-34.8	6.5	0.2
500	0.0	-34.8	6.5	0.2

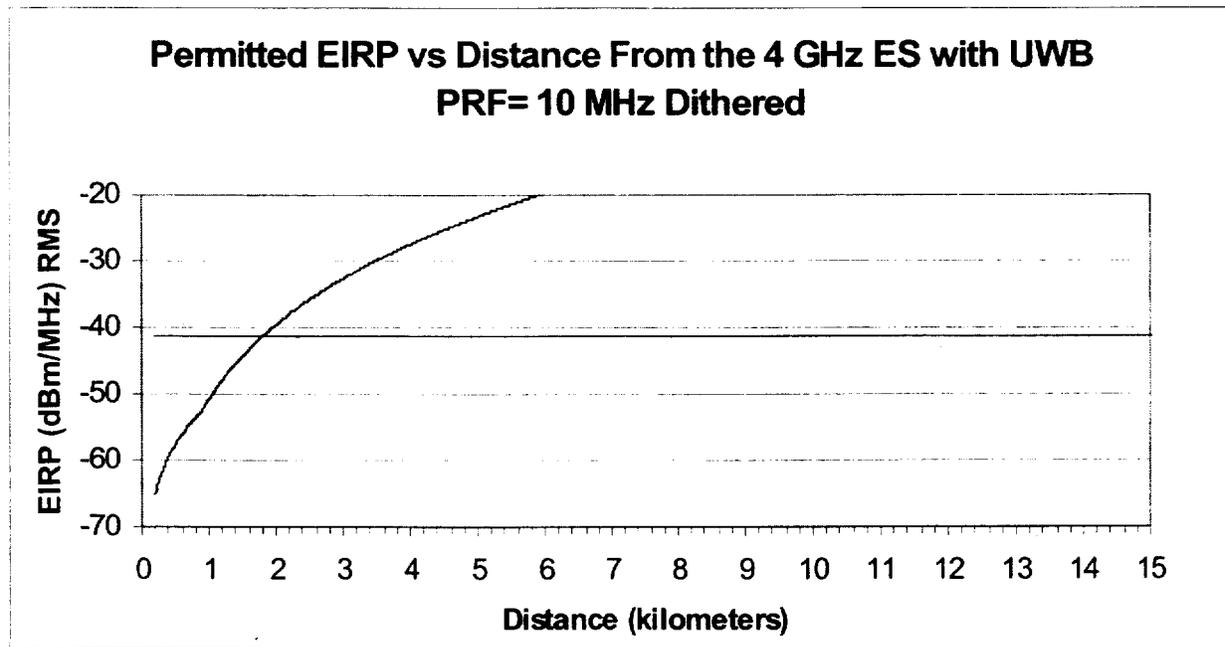


**Figure 4-18a. Maximum Permitted UWB EIRP for Dithered PRF of 10 MHz (UWB Height = 2m).**

The results for a dithered UWB signal are shown in TABLE 4-43a for a UWB height of 2 meters. The results for a dithered signal show that the maximum allowable UWB EIRP is below the reference level for all PRFs in TABLE 4-43a. The distance separation is 630 meters to satisfy the 4 GHz Earth station interference protection criteria with the UWB EIRP equal to the reference level. A graph of the maximum permitted UWB EIRP for a dithered PRF of 10 MHz versus distance is shown in Figure 4-19a.

**TABLE 4-43a**  
**Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht = 2m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
0.001	16.0	-50.8	-9.5	0.63
0.01	16.0	-50.8	-9.5	0.63
0.1	16.0	-50.8	-9.5	0.63
1	16.0	-50.8	-9.5	0.63
10	16.0	-50.8	-9.5	0.63
100	16.0	-50.8	-9.5	0.63
500	16.0	-50.8	-9.5	0.63



**Figure 4-19a. Maximum Permitted UWB EIRP for Dithered PRF of 10 MHz (UWB Height = 2m).**

Analyses was also performed for a UWB height of 30m. The results for a non-dithered UWB signal are shown in TABLE 4-44a.

**TABLE 4-44a**  
**Non-Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht =30m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS (km)
0.001	16.0	-76.6	-35.3	1.01
0.01	16.0	-76.6	-35.3	1.01
0.1	16.0	-76.6	-35.3	1.01
1	16.0	-76.6	-35.3	1.01
10	6.0	-66.6	-25.3	0.56
100	0.0	-60.6	-19.3	0.44
500	0.0	-60.6	-19.3	0.44

The table shows that the maximum permitted UWB EIRP ranges from -76.6 dBm for a PRF of .001 MHz to -60.6 dBm for a PRF of 500 MHz. The separation distances range from beyond 1 km to 0.44 km to satisfy the Earth station interference protection criteria when the UWB EIRP is equal to the reference level.

The results for a dithered signal and a UWB height of 30 meters are shown in TABLE 4-45a. The table shows that the maximum permitted UWB EIRP ranges from -78.1 dBm for all PRFs. The separation distance is 1.13 km to satisfy the Earth station interference protection criteria when the EIRP is equal to the reference level. A graph of the maximum permitted UWB EIRP for a 10 MHz dithered PRF versus distance for a UWB height of 30 meters is shown in Figure 4-20a.

**TABLE 4-45a**  
**Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht =30m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference level (dB)	Distance Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS (km)
0.001	16.0	-76.6	-35.3	1.01
0.01	16.0	-76.6	-35.3	1.01
0.1	16.0	-76.6	-35.3	1.01
1	16.0	-76.6	-35.3	1.01
10	16.0	-76.6	-35.3	1.01
100	16.0	-76.6	-35.3	1.01
500	16.0	-76.6	-35.3	1.01

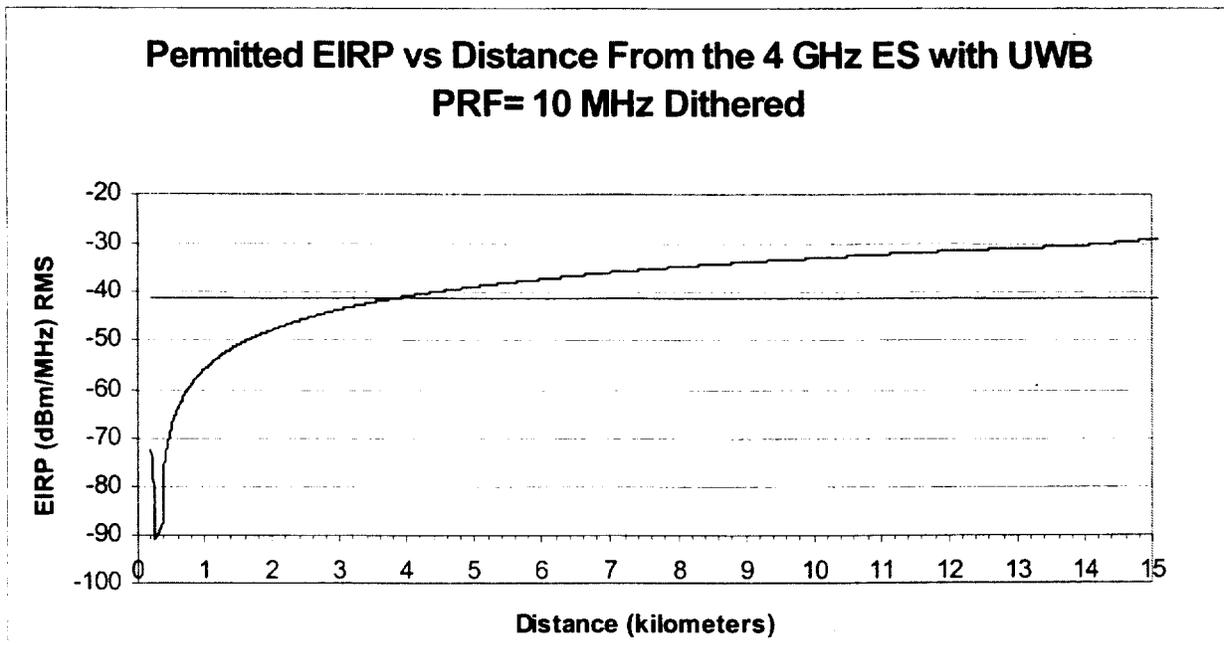


Figure 4-20a. Maximum Permitted UWB EIRP for Dithered PRF of 10 MHz (UWB Height = 30m).

### Discussion of Single Entry Results

These results indicate that operation of UWB devices at an average (RMS) power level of -41.3 dBm in the vicinity of 4 GHz Earth station and at 3750 MHz would exceed current interference protection requirements. UWB devices operating at that power level would add to the system noise, rendering the Earth station less capable of receiving satellite downlink transmissions.

Four factors significantly influence these results, namely, the Earth station antenna height, Earth station antenna tilt angle, the height of the UWB device, and the UWB PRF. When the Earth station antenna and the UWB device align such that main beam coupling occurs, the Earth station antenna will gather more UWB interference than the case of sidelobe coupling, which raises the overall noise power level. This effect is shown in Figure 4-20a. For compatible operations, this requires a lower permitted UWB EIRP and a longer separation distance than the Earth station and the UWB device coupling off axis. The Earth station antenna gathers less UWB interference when sidelobe coupling occurs which will allow a higher UWB EIRP and shorten the separation distance.

The PRF of the UWB device determines the BWCF in the analyses. At low UWB PRFs the BWCF is large which makes the maximum permitted UWB EIRP lower and increases the separation distances when the UWB EIRP is equal to the reference level.

#### 4.10b 4 GHz Earth Station (Peak Power BWCF, 3750 MHz with 5 Degree Elevation)

Analyses of potential interference from a single UWB device into a 4 GHz Earth station receiver was performed using the methodology described in Section 3, the 4 GHz Earth station characteristics given in Appendix A, and the analysis parameters shown in TABLE 4-41b. The 4 GHz Earth station radar antenna height in TABLE 4-41b is a typical value.

**TABLE 4-41b  
UWB and 4 GHz Earth Station Analysis Parameters**

Parameter	Value
Protection Criteria	I/N = -10 dB (peak interference power)
Antenna Height	3 meters
Antenna Tilt Angle	5 degrees above horizon
UWB Device Height	2 meters
Measurement Bandwidth	1 MHz
Reference Power Level	-41.3 dBm/MHz average (RMS), EIRP

The results for a non-dithered UWB signal analyses are shown in TABLE 4-42b for a UWB height of 2 meters. These results show that the 4 GHz Earth station interference protection criteria is exceeded with UWB PRFs at or below 10 MHz. For PRFs above 10 MHz the maximum permitted EIRP is -34.8 dBm, which is 6.5 dB above the reference level. For UWB devices with PRFs at or below 10 MHz and the UWB EIRP equal the reference level, the distance separations range from 1.0 km to 12.3 km to satisfy the 4 GHz Earth station interference protection criteria. A graph of the maximum permitted UWB EIRP for a non-dithered PRF of 10 MHz versus distance is shown in Figure 4-18b.

**TABLE 4-42b  
Non-Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht = 2m)**

PRF (MHz)	Peak BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	69.0	-103.8	-62.5	12.3
.01	59.0	-93.8	-52.5	8.4
.1	49.0	-83.8	-42.5	5.1
1	39.0	-73.8	-32.5	3.0
10	19.0	-53.8	-12.5	1.0
100	0.0	-34.8	6.5	NA
500	0.0	-34.8	6.5	NA

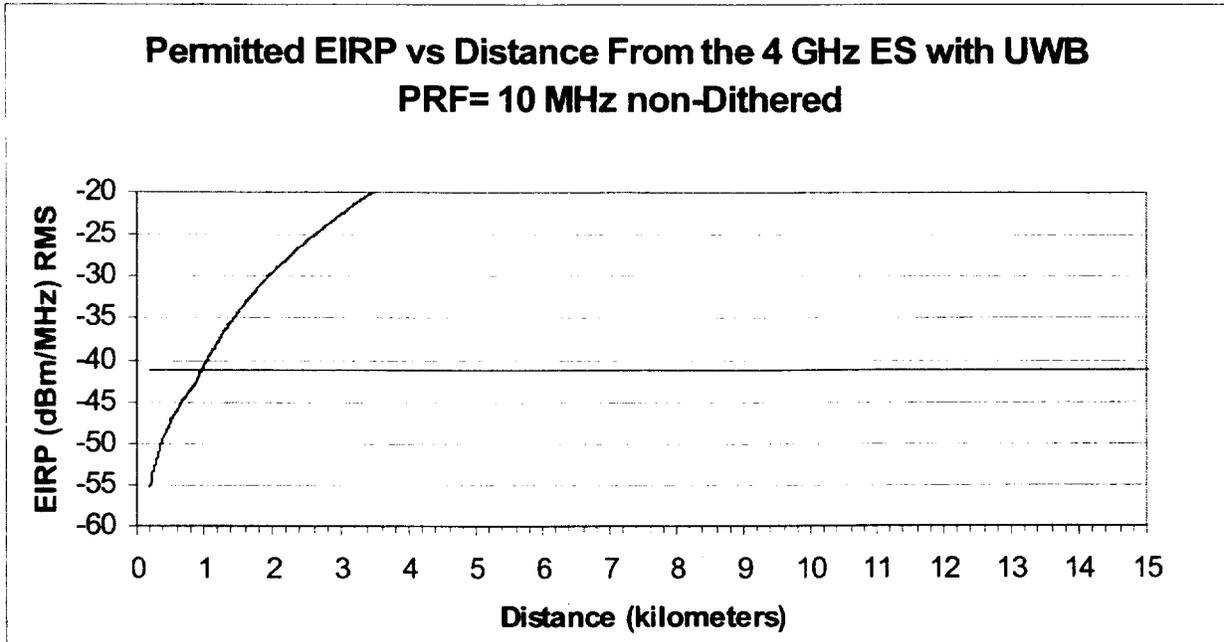
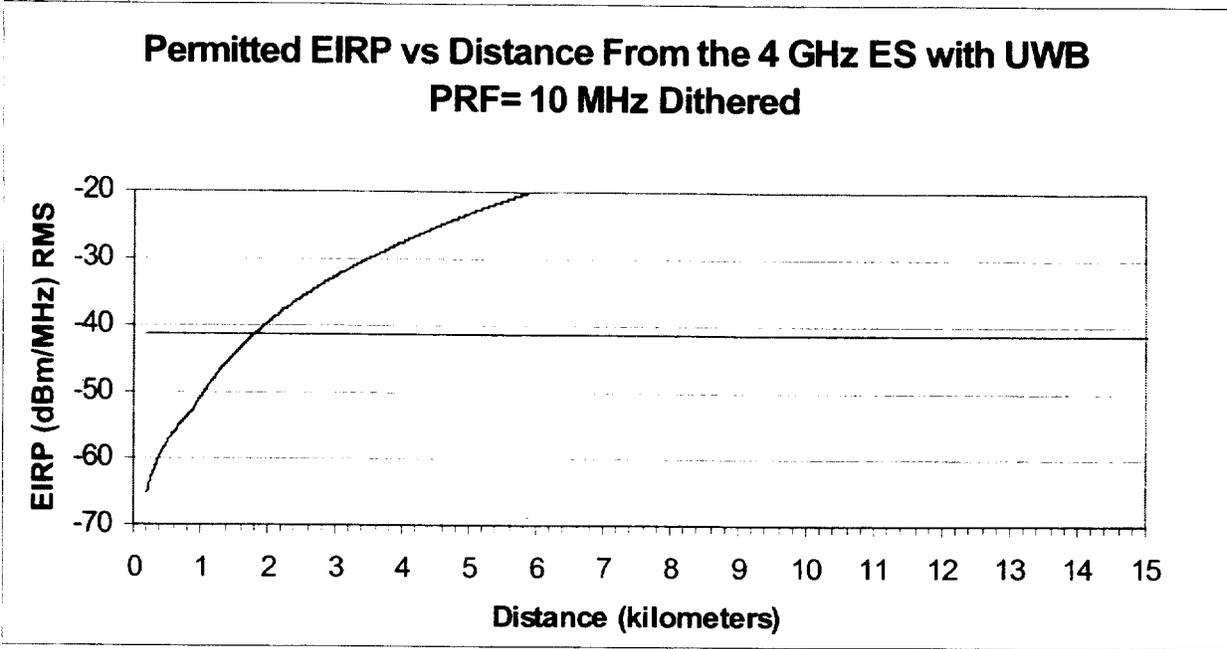


Figure 4-18b. Maximum Permitted UWB EIRP for Dithered PRF of 10 MHz (UWB Height = 2m).

The results for a dithered UWB signal are shown in TABLE 4-43b for a UWB height of 2 meters. The results for a dithered signal show that the maximum allowable UWB EIRP is below the reference level for all PRFs in TABLE 4-43b. The distance separations range from 0.60 km to 13.2 km to satisfy the 4 GHz Earth station interference protection criteria with the UWB EIRP equal to the reference level. A graph of the maximum permitted UWB EIRP for a dithered PRF of 10 MHz versus distance is shown in Figure 4-19b.

**TABLE 4-43b  
Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Height = 2m)**

PRF (MHz)	Peak BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	69.0	-103.8	-62.5	13.2
.01	59.0	-93.8	-52.5	8.4
.1	49.0	-83.8	-42.5	5.1
1	39.0	-73.8	-32.5	3.0
10	29.0	-63.8	-22.5	1.7
100	19.0	-53.8	-12.5	1.0
500	16.0	-50.8	-9.5	.60



**Figure 4-19b. Maximum Permitted UWB EIRP for Dithered PRF of 10 MHz (UWB Height = 2m).**

Analyses was also performed for a UWB height of 30 meters. The results for a non-dithered UWB signal are shown in TABLE 4-44b.

**TABLE 4-44b  
Non-Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Height = 30 m)**

PRF (MHz)	Peak BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	69.0	-129.6	-88.3	>15
.01	59.0	-119.6	-78.3	>15
.1	49.0	-109.6	-68.3	>15
1	39.0	-99.6	-58.3	10.1
10	19.0	-79.6	-38.3	1.3
100	0.0	-60.6	-19.3	.44
500	0.0	-60.6	-19.3	.44

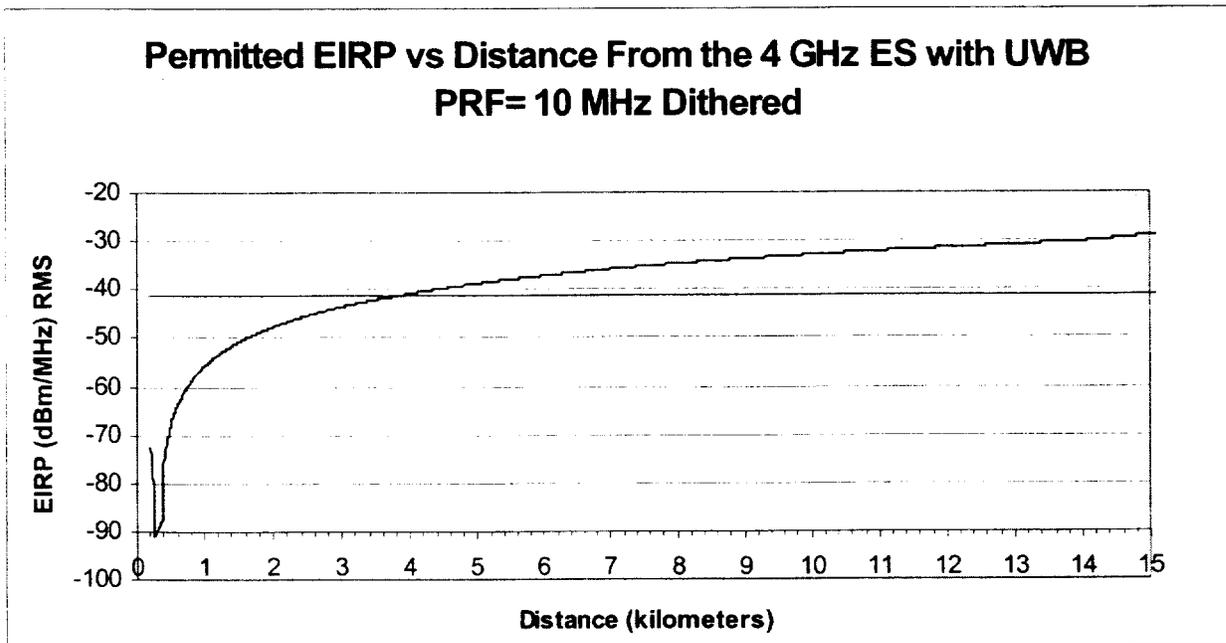
The table shows that the maximum permitted UWB EIRP ranges from -129.6 dBm for a PRF of 0.001 MHz to -60.6 dBm for a PRF of 500 MHz. The separation distances range from beyond 15 to 0.44 km to satisfy the Earth station interference protection criteria when the UWB EIRP is equal to the reference level.

The results for a dithered signal and a UWB height of 30 meters are shown in TABLE 4-45b.

**TABLE 4-45b**  
**Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Height = 30 m)**

PRF (MHz)	Peak BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	69.0	-129.6	-88.3	>15
.01	59.0	-119.6	-78.3	>15
.1	49.0	-109.6	-68.3	>15
1	39.0	-99.6	-58.3	10.2
10	29.0	-89.6	-48.3	3.3
100	19.0	-79.6	-38.3	1.3
500	16.0	-76.6	-35.3	1.0

The table shows that the maximum permitted UWB EIRP ranges from -129.6 dBm for a PRF of 0.001 MHz to -76.6 dBm for a PRF of 500 MHz. The separation distances range from beyond 15 to 1.0 km to satisfy the Earth station interference protection criteria when the EIRP is equal to the reference level. A graph of the maximum permitted UWB EIRP for a 10 MHz dithered PRF versus distance for a UWB height of 30 meters is shown in Figure 4-20b.



**Figure 4-20b. Maximum Permitted UWB EIRP for Dithered PRF of 10 MHz (UWB Height = 30m).**

**Discussion of Single Entry Results**

These results indicate that operation of UWB devices at a peak power level of -41.3 dBm in the vicinity of 4 GHz Earth station and at 3750 MHz would exceed current interference protection requirements. UWB devices operating at that power level would add to the system noise, rendering the Earth station less capable of receiving satellite downlink transmissions.

Four factors significantly influence these results, namely, the Earth station antenna height, Earth station antenna tilt angle, the height of the UWB device, and the UWB PRF. When the Earth station antenna and the UWB device align such that main beam coupling occurs, the Earth station antenna will gather more UWB interference than the case of sidelobe coupling, which raises the overall noise power level. This effect is shown in Figure 4-20b. For compatible operations, this requires a lower permitted UWB EIRP and a longer separation distance than the Earth station and the UWB device coupling off axis. The Earth station antenna gathers less UWB interference when sidelobe coupling occurs which will allow a higher UWB EIRP and shorten the separation distance.

The PRF of the UWB device determines the BWCF in the analyses. At low UWB PRFs the BWCF is large which makes the maximum permitted UWB EIRP lower and increases the separation distances when the UWB EIRP is equal to the reference level.

**4.10c 4 GHz Earth Station (3750 MHz with 20 Degree Elevation)**

Analyses of potential interference from a single UWB device into a 4 GHz Earth station receiver with an elevation angle of 20 degrees was performed using the methodology described in Section 3, the 4 GHz Earth station characteristics given in Appendix A, and the analysis parameters shown in TABLE 4-41c. The 4 GHz Earth station radar antenna height in TABLE 4-45c is a typical value.

**TABLE 4-41c  
UWB and 4 GHz Earth Station Analysis Parameters**

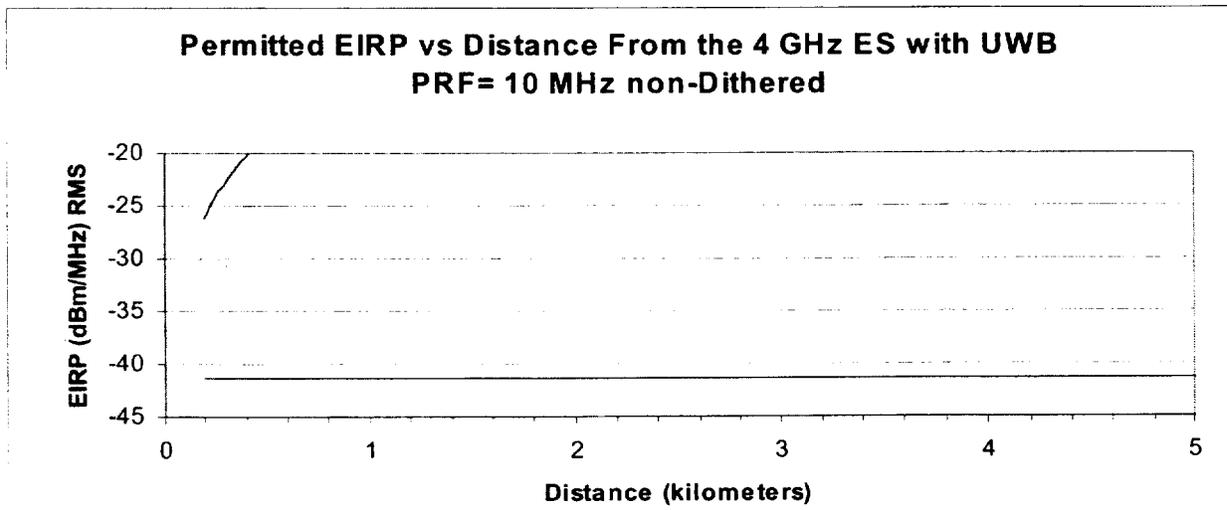
Parameter	Value
Protection Criteria	I/N = -10 dB (average (RMS) interference power)
Antenna Height	3 meters
Antenna Tilt Angle	20 degrees above horizon
UWB Device Height	2 meters
Measurement Bandwidth	1 MHz
Reference Power Level	-41.3 dBm/MHz average (RMS), EIRP

The results for a non-dithered UWB signal analyses are shown in TABLE 4-42c for a UWB height of 2 meters. These results show that the 4 GHz Earth station interference protection criteria is not exceeded for any UWB PRF at separation distance. This is indicated in the table by NA in the separation distance column. A graph of the maximum permitted UWB EIRP for a non-dithered PRF of 10 MHz versus distance is shown in

Figure 4-18c. As shown in graph, the maximum permitted EIRP is above the -41.3 dBm EIRP reference level.

**TABLE 4-42c**  
**Non-Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht = 2m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
0.001	16.0	-36.2	5.1	NA
0.01	16.0	-36.2	5.1	NA
0.1	16.0	-36.2	5.1	NA
1	16.0	-36.2	5.1	NA
10	6.0	-26.2	15.1	NA
100	0.0	-20.2	21.1	NA
500	0.0	-20.2	21.1	NA



**Figure 4-18c. Maximum Permitted UWB EIRP for non-Dithered PRF 10 MHz (UWB Ht = 2m).**

The results for a dithered UWB signal are shown in TABLE 4-43c for a UWB height of 2 meters. These results show that the 4 GHz Earth station interference protection criteria is not exceeded for any UWB PRF.

**TABLE 4-43c**  
**Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht = 2m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS (km)
0.001	16.0	-36.2	5.1	NA
0.01	16.0	-36.2	5.1	NA
0.1	16.0	-36.2	5.1	NA
1	16.0	-36.2	5.1	NA
10	16.0	-36.2	5.1	NA
100	16.0	-36.2	5.1	NA
500	16.0	-36.2	5.1	NA

Analyses was also performed for a UWB height of 30m. The results for a non-dithered UWB signal are shown in TABLE 4-44c. These results show that the 4 GHz Earth station interference protection criteria is only exceeded for by a marginal amount (0.3 dB) fro UWB PRFs of 1 MHz or less.

**TABLE 4-44c**  
**Non-Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht = 30m)**

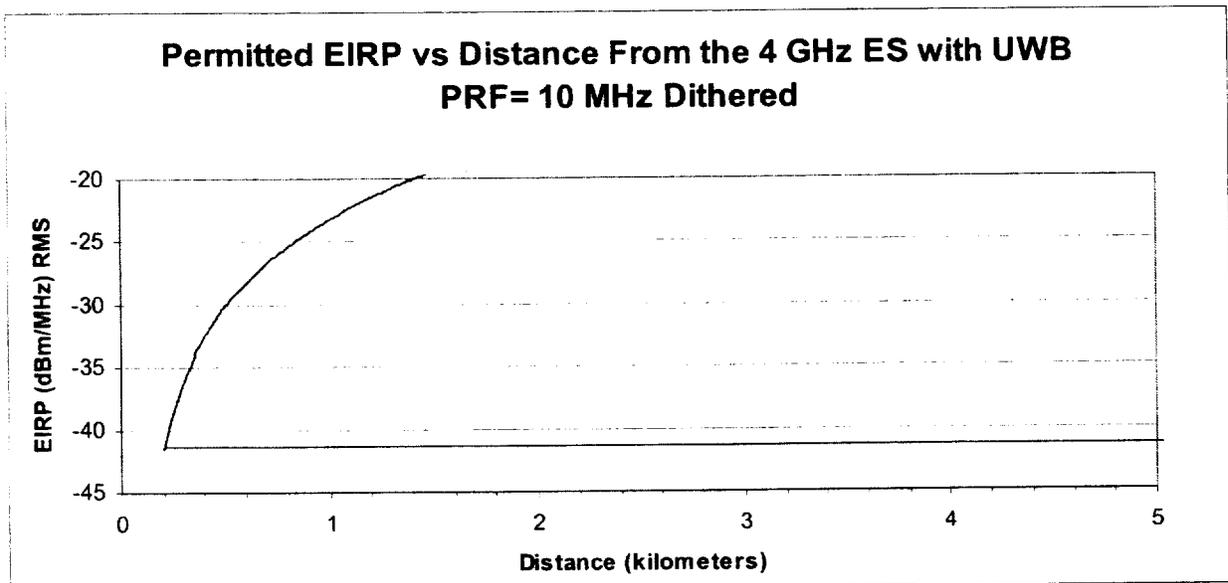
PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
0.001	16.0	-41.6	-0.3	.2
0.01	16.0	-41.6	-0.3	.2
0.1	16.0	-41.6	-0.3	.2
1	16.0	-41.6	-0.3	.2
10	6.0	-31.6	9.7	NA
100	0.0	-25.6	15.7	NA
500	0.0	-25.6	15.7	NA

The results for a dithered signal and a UWB height of 30 meters are shown in TABLE 4-45c and again shows that the interference criteria is not exceeded.

**TABLE 4-45c**  
**Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht = 30m)**

<b>PRF (MHz)</b>	<b>BWCF (dB)</b>	<b>Maximum Permitted UWB EIRP (dBm/MHz) RMS</b>	<b>Delta Reference Level (dB)</b>	<b>Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS</b>
0.001	16.0	-41.6	-0.3	NA
0.01	16.0	-41.6	-0.3	NA
0.1	16.0	-41.6	-0.3	NA
1	16.0	-41.6	-0.3	NA
10	16.0	-41.6	-0.3	NA
100	16.0	-41.6	-0.3	NA
500	16.0	-41.6	-0.3	NA

A graph of the maximum permitted UWB EIRP for a non-dithered PRF of 10 MHz versus distance is shown in Figure 4-19c. As shown in graph, the maximum permitted EIRP is only slightly below the -41.3 dBm EIRP reference level for separation distances of less than 200 meters.



**Figure 4-19c. Maximum Permitted UWB EIRP for Dithered PRF of 10 MHz UWB Height = 30m.**

### **Discussion of Single Entry Results**

These results indicate that operation of UWB devices at a average power level of -41.3 dBm in the vicinity of 4 GHz Earth station and at 3750 MHz and an antenna elevation angle of 20 degrees would not exceed current interference protection requirements as long as separation distances are approximately 200 meters.

**4.10d 4 GHz Earth Station (Peak Power BWCF, 3750 MHz with 20 Degree Elevation)**

Analyses of potential interference from a single UWB device into a 4 GHz Earth station receiver was performed using the methodology described in Section 3, the 4 GHz Earth station characteristics given in Appendix A, and the analysis parameters shown in TABLE 4-41d. The 4 GHz Earth station radar antenna height in TABLE 4-41d is a typical value.

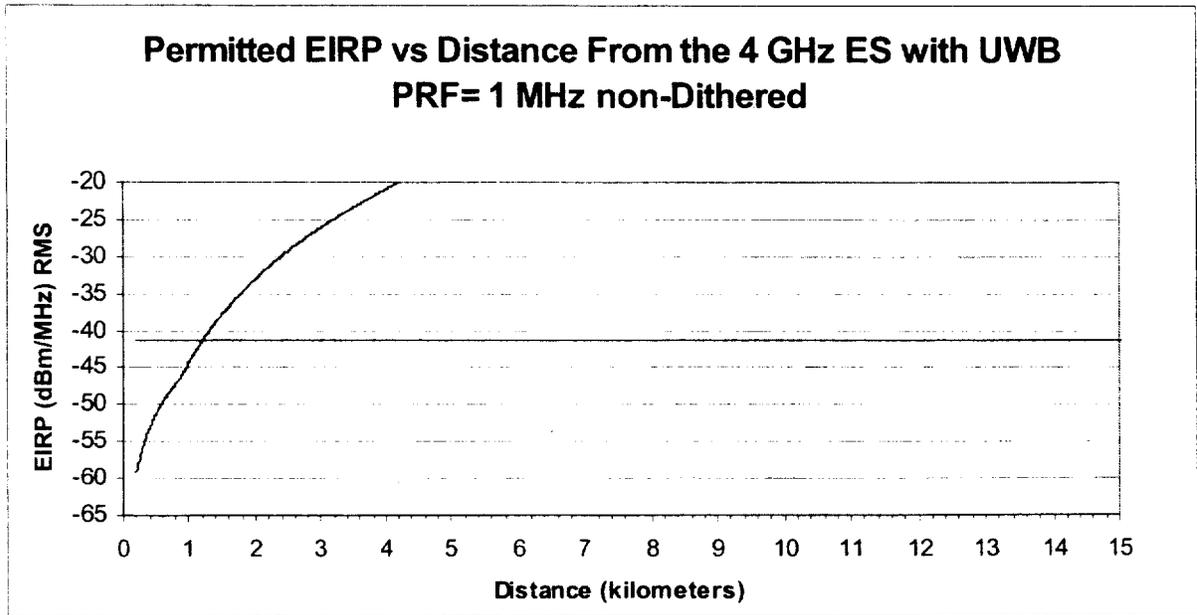
**TABLE 4-41d  
UWB and 4 GHz Earth Station Analysis Parameters**

Parameter	Value
Protection Criteria	I/N = -10 dB (peak interference power)
Antenna Height	3 meters
Antenna Tilt Angle	20 degrees above horizon
UWB Device Height	2 meters
Measurement Bandwidth	1 MHz
Reference Power Level	-41.3 dBm/MHz average (RMS), EIRP

The results for a non-dithered UWB signal analyses are shown in TABLE 4-42d for a UWB height of 2 meters. These results show that the 4 GHz Earth station interference protection criteria is exceeded with UWB PRFs at or below 1 MHz. For PRFs above 10 MHz the maximum permitted EIRP is -34.8 dBm, which is 6.5 dB above the reference level. For UWB devices with PRFs at or below 10 MHz and the UWB EIRP equal the reference level, the distance separations range from 1.0 km to 12.3 km to satisfy the 4 GHz Earth station interference protection criteria. A graph of the maximum permitted UWB EIRP for a non-dithered PRF of 10 MHz versus distance is shown in Figure 4-18d.

**TABLE 4-42d  
Non-Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht = 2m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm)	Delta Reference Level (dB)	Distance Where Permitted UWB EIRP equals -41.3 dBm/MHz RMS (km)
.001	69.0	-89.2	-47.9	6.6
.01	59.0	-79.2	-37.9	3.9
.1	49.0	-69.2	-27.9	2.2
1	39.0	-59.2	-17.9	1.2
10	19.0	-39.2	2.1	NA
100	0.0	-20.2	21.1	NA
500	0.0	-20.2	21.2	NA



**Figure 44-18d. Maximum Permitted UWB EIRP for non-Dithered PRF of 1 MHz (UWB Height = 2 m).**

The results for a dithered UWB signal are shown in TABLE 4-43d for a UWB height of 2 meters. The results for a dithered signal show that the maximum allowable UWB EIRP is below the reference level for PRFs less than 100 Mz. The distance separations range from .05 km to 6.6 km to satisfy the 4 GHz Earth station interference protection criteria with the UWB EIRP equal to the reference level. A graph of the maximum permitted UWB EIRP for a dithered PRF of 10 MHz versus distance is shown in Figure 4-19d.

**TABLE 4-43d  
Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB H t= 2m)**

<b>PRF (MHz)</b>	<b>BWCF (dB)</b>	<b>Maximum Permitted UWB EIRP (dBm)</b>	<b>Delta Reference Level (dB)</b>	<b>Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS</b>
.001	69.0	-89.2	-47.9	6.6
.01	59.0	-79.2	-37.9	3.9
.1	49.0	-69.2	-27.9	2.2
1	39.0	-59.2	-17.9	1.2
10	29.0	-49.2	-7.9	0.5
100	19.0	-39.2	2.1	NA
500	16.0	-36.2	5.2	NA

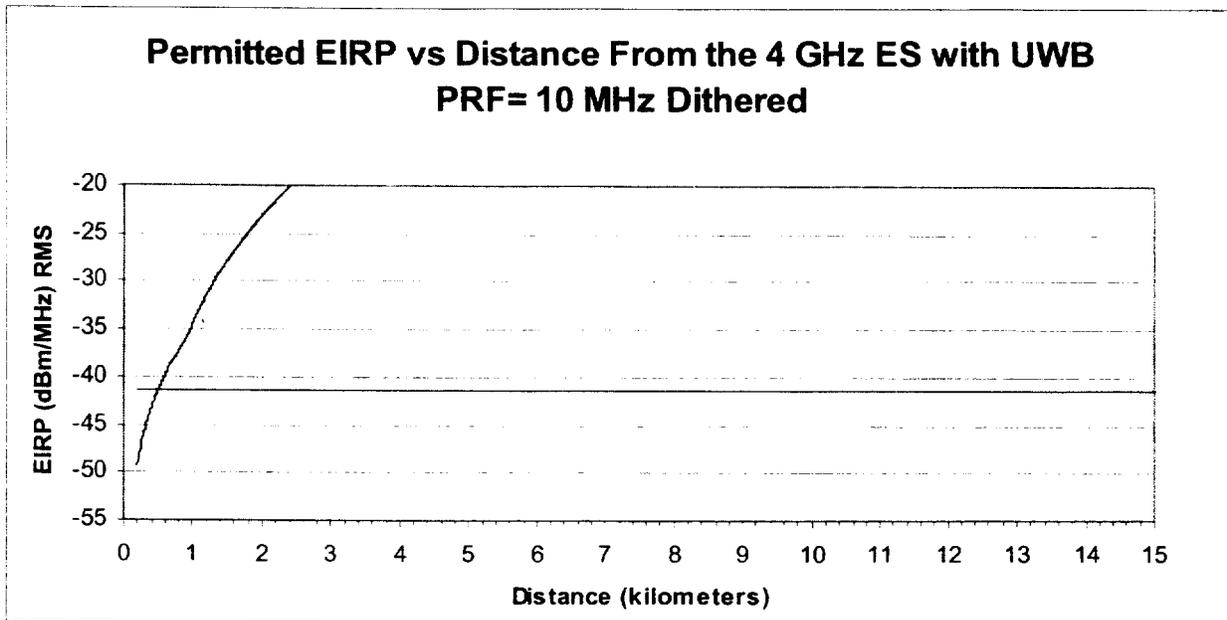


Figure 4-19d. Maximum Permitted UWB EIRP for Dithered 10 MHz UWB (Height = 2m).

Analyses was also performed for a UWB height of 30m. The results for a non-dithered UWB signal are shown in TABLE 4-44d.

**TABLE 4-44d**  
Non-Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht = 30m)

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm)	Delta Reference Level (dB)	Distance Where Permitted UWB EIRP equals - 41.3 dBm/MHz RMS (km)
.001	69.0	-94.6	-53.3	>15
.01	59.0	-84.6	-43.3	>15
.1	49.0	-74.6	-33.3	5.2
1	39.0	-64.6	-23.3	1.7
10	19.0	-44.6	-3.3	.25
100	0.0	-25.6	15.7	NA
500	0.0	-25.6	15.7	NA

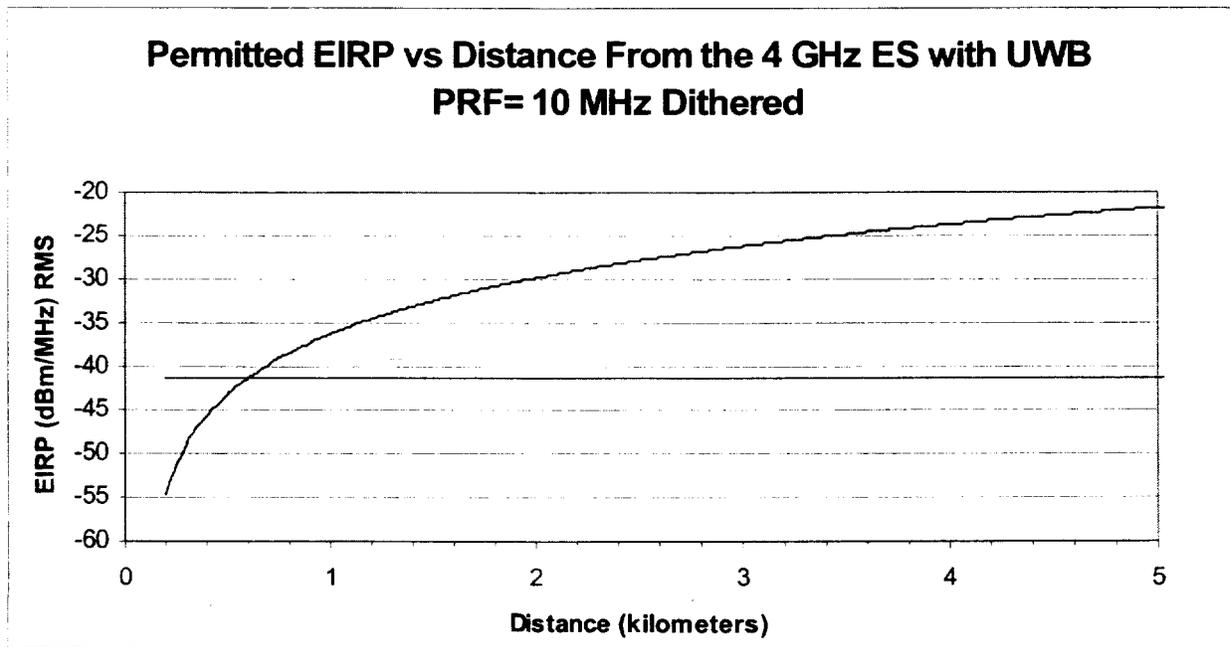
The TABLE shows that the maximum permitted UWB EIRP ranges from -94.6 dBm for a PRF of .001 MHz to -25.6 dBm for a PRF of 500 MHz. The separation distances range from beyond 15 to .25 km to satisfy the Earth station interference protection criteria when the UWB EIRP is equal to the reference level for PRFs below 10 MHz.

The results for a dithered signal and a UWB height of 30 meters are shown in TABLE 4-45d.

**TABLE 4-45d**  
**Dithered UWB Signal into 4 GHz Earth Station Receiver (UWB Ht =30m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm)	Delta Reference Level (dB)	Distance Where Permitted UWB EIRP Equals - 41.3 dBm/MHz RMS (km)
.001	69.0	-94.6	-53.3	>15
.01	59.0	-84.6	-43.3	>15
.1	49.0	-74.6	-33.3	5.3
1	39.0	-64.6	-23.3	1.7
10	29.0	-54.6	-13.3	0.6
100	19.0	-44.6	-3.3	0.25
500	16.0	-41.6	-0.3	0.2

The table shows that the maximum permitted UWB EIRP ranges from -94.6 dBm for a PRF of .001 MHz to -41.6 dBm for a PRF of 500 MHz. The separation distances range from beyond 15 to 0.2 km to satisfy the Earth station interference protection criteria when the EIRP is equal to the reference level. A graph of the maximum permitted UWB EIRP for a 10 MHz dithered PRF versus distance for a UWB height of 30 meters is shown in Figure 4-20d.



**Figure 4-20d. Maximum Permitted UWB EIRP for Dithered PRF of 10 MHz UWB Height = 30m.**

## **Discussion of Single Entry Results**

These results indicate that operation of UWB devices at a peak power level of -41.3 dBm in combination with PRFs below about 10 MHz, in the vicinity of 4 GHz Earth station and at 3750 MHz would exceed current interference protection requirements. UWB devices operating at that power level would add to the system noise, rendering the Earth station less capable of receiving satellite downlink transmissions.

Four factors significantly influence these results, namely, the Earth station antenna height, Earth station antenna tilt angle, the height of the UWB device, and the UWB PRF. When the Earth station antenna and the UWB device align such that main beam coupling occurs, the Earth station antenna will gather more UWB interference than the case of sidelobe coupling, which raises the overall noise power level. This effect is shown in Figure 4-3d. For compatible operations, this requires a lower permitted UWB EIRP and a longer separation distance than the Earth station and the UWB device coupling off axis. The Earth station antenna gathers less UWB interference when sidelobe coupling occurs which will allow a higher UWB EIRP and shorten the separation distance.

The PRF of the UWB device determines the BWCF in the analyses. At low UWB PRFs the BWCF is large which makes the maximum permitted UWB EIRP lower and increases the separation distances when the UWB EIRP is equal to the reference level.

#### 4.11 TDWR RADAR (5600-5650 MHz)

Analyses of potential interference from a single UWB device into a TDWR receiver was performed using the methodology described in Section 3, the TDWR characteristics given in Appendix A, and the analysis parameters shown in TABLE 4-46. The TDWR radar antenna height in TABLE 4-46 is the average height of all the TDWR radars in the GMF of frequency assignments.

**TABLE 4-46  
UWB and TDWR Analysis Parameters**

Parameter	Value
Protection Criteria	I/N = -6 dB (average (RMS) interference power)
Radar Antenna Height	27 meters
Radar Tilt Angle	.2 degrees
UWB Device Height	2 meters, 30 meters
Reference Bandwidth	1 MHz
Reference Power Level	-41.3 dBm/MHz average (RMS), EIRP

The results for a non-dithered UWB signal analyses are shown in TABLE 4-47 for a UWB height of 2 meters. These results show that the TDWR interference protection is met with a UWB EIRP of -34.9 dBm or less for UWB PRFs at and below 0.1 MHz. This level is 6.4 dB above the -41.3 dBm/MHz RMS reference level. For PRFs above 0.1 MHz the maximum permitted UWB EIRP is -35.3 dBm which is 6 dB above the reference level. A graph of the maximum permitted UWB EIRP versus distance is shown in Figure 4-21 for a non-dithered PRF of 1 MHz and a UWB height of 2 meters.

**TABLE 4-47  
Non-Dithered UWB Signal into TDWR Receiver (UWB Height = 2m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	-0.4	-34.9	6.4	NA
.01	-0.4	-34.9	6.4	NA
.1	-0.4	-34.9	6.4	NA
1	0.0	-35.3	6.0	NA
10	0.0	-35.3	6.0	NA
100	0.0	-35.3	6.0	NA
500	0.0	-35.3	6.0	NA

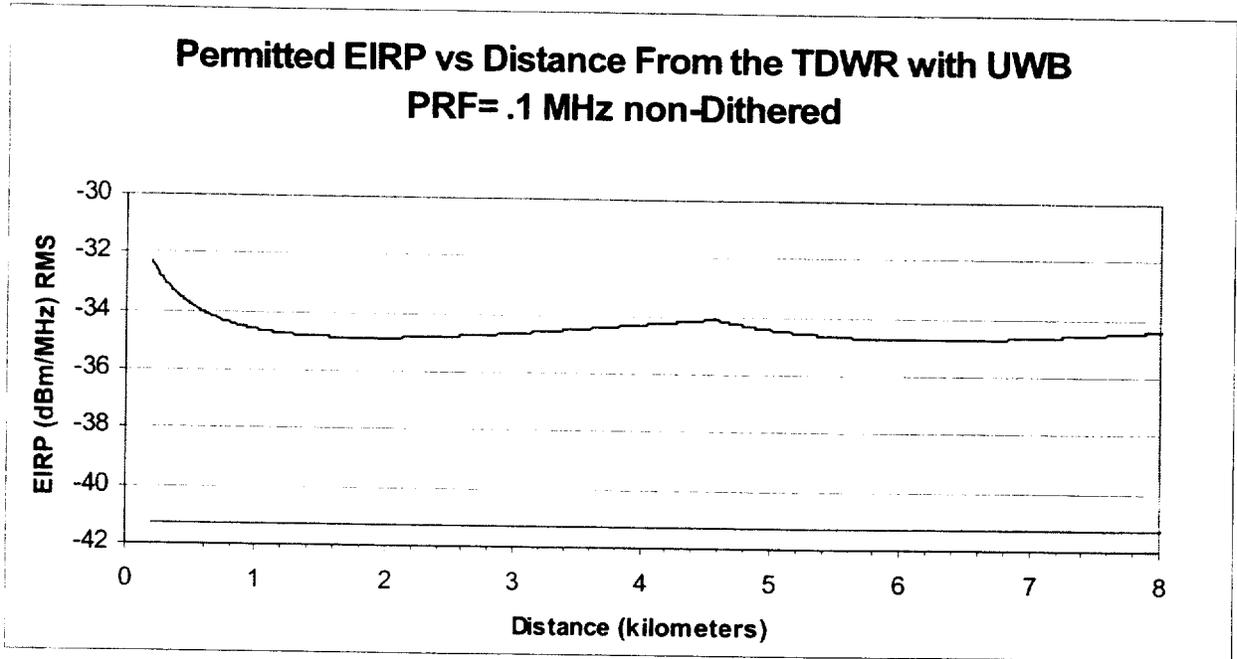


Figure 4-21. Maximum Permitted UWB EIRP for non-Dithered PRF of 1 MHz (UWB Height = 2m).

Above a PRF of 0.1 MHz, the BWCF is equal to zero and the graph will change. It is shown below in Figure 4-22.

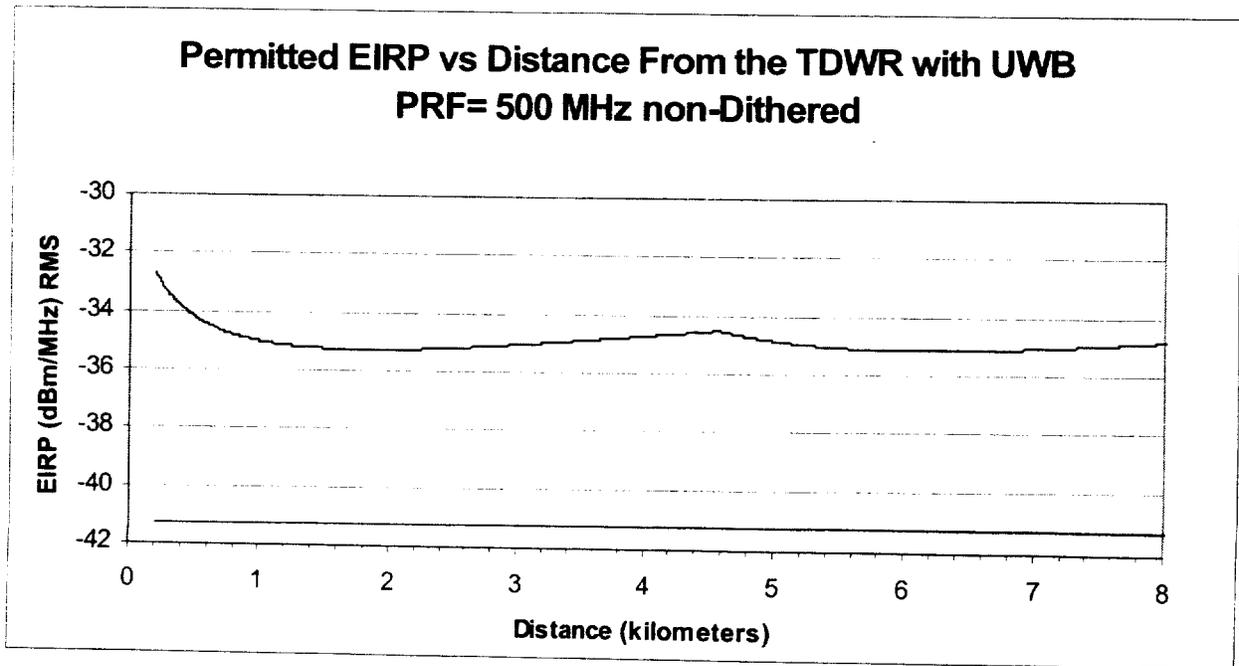
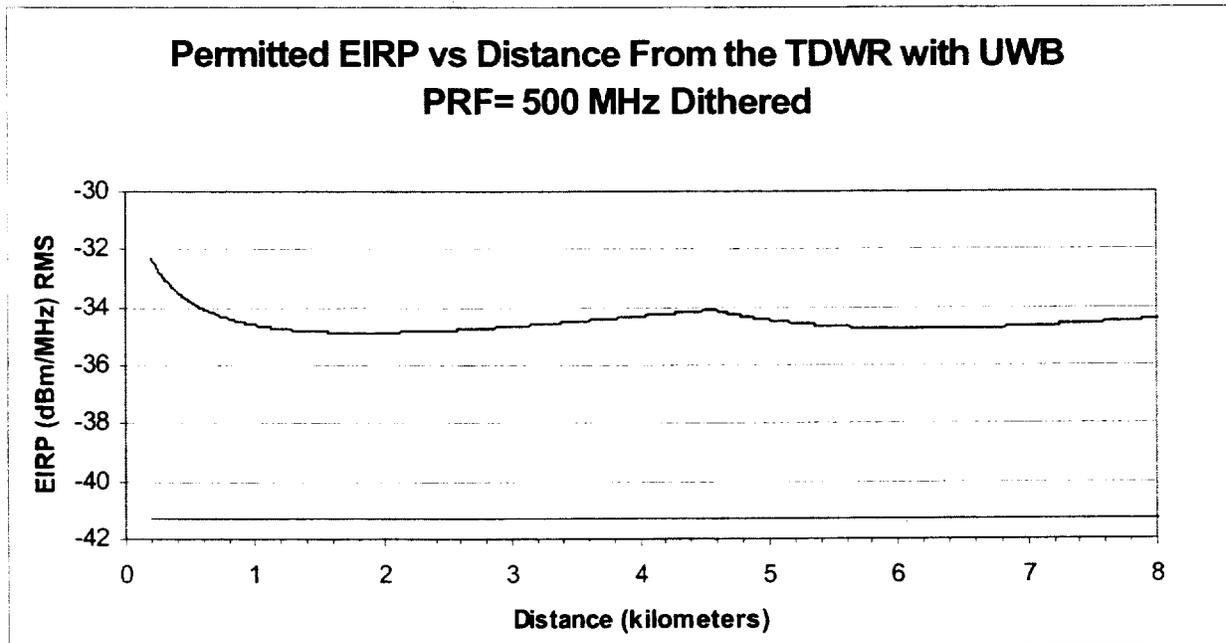


Figure 4-22 Maximum Permitted UWB EIRP for non-Dithered PRF of 500 MHz (UWB Height = 2m).

The results for a dithered UWB signal analyses are shown in TABLE 4-48 for a UWB height of 2 meters. The results show that the maximum allowable UWB EIRP is -34.9 dBm regardless of the PRF. The permitted UWB EIRP level is 6.4 dB above the -41.3 dBm/MHz RMS reference level. A graph of the maximum permitted dithered UWB EIRP versus distance is shown in Figure 4-23 for a PRF of 500 MHz and a UWB height of 2 meters.

**TABLE 4-48**  
**Dithered UWB Signal into TDWR Receiver (UWB Height = 2m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	-0.4	-34.9	6.4	NA
.01	-0.4	-34.9	6.4	NA
.1	-0.4	-34.9	6.4	NA
1	-0.4	-34.9	6.4	NA
10	-0.4	-34.9	6.4	NA
100	-0.4	-34.9	6.4	NA
500	-0.4	-34.9	6.4	NA



**Figure 4-23 . Maximum Permitted UWB EIRP for Dithered PRF (UWB Height = 2m).**

Analyses was also performed for a UWB height of 30 meters. The results for a non-dithered UWB signal analyses are shown in TABLE 4-49. The results show that the maximum permitted UWB EIRP is -62.9 dBm for PRFs at and below 0.1 MHz. For PRFs

above 0.1 MHz the maximum permitted UWB EIRP is -63.3 dBm. These levels are 21.6 and 22 dB below the reference level. The separation distances for the TDWR and a UWB device with an EIRP equal to the reference level is 6.0 km for PRFs at and below 0.1 MHz and 6.2 km for PRFs above 0.1 MHz.

**TABLE 4-49**  
**Non-Dithered UWB Signal into TDWR Receiver (UWB Height = 30 m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	-0.4	-62.9	-21.6	6.0
.01	-0.4	-62.9	-21.6	6.0
.1	-0.4	-62.9	-21.6	6.0
1	0.0	-63.3	-22.0	6.2
10	0.0	-63.3	-22.0	6.2
100	0.0	-63.3	-22.0	6.2
500	0.0	-63.3	-22.0	6.2

The results for a dithered UWB signal analyses are shown in TABLE 4-50 for a UWB height of 30 meters. The results show that the maximum permitted UWB EIRP is -62.9 dBm for regardless of the PRFs. The separation distance for the TDWR and a dithered UWB device with an EIRP equal to the reference level is 6.0 km.

**TABLE 4-50**  
**Dithered UWB Signal into TDWR Receiver (UWB Height = 30 m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	-0.4	-62.9	-21.6	6.0
.01	-0.4	-62.9	-21.6	6.0
.1	-0.4	-62.9	-21.6	6.0
1	-0.4	-62.9	-21.6	6.0
10	-0.4	-62.9	-21.6	6.0
100	-0.4	-62.9	-21.6	6.0
500	-0.4	-62.9	-21.6	6.0

A graph of the maximum permitted UWB EIRP versus distance is shown in Figure 4-24 for a dithered PRF of 500 MHz and UWB height of 30 meters.

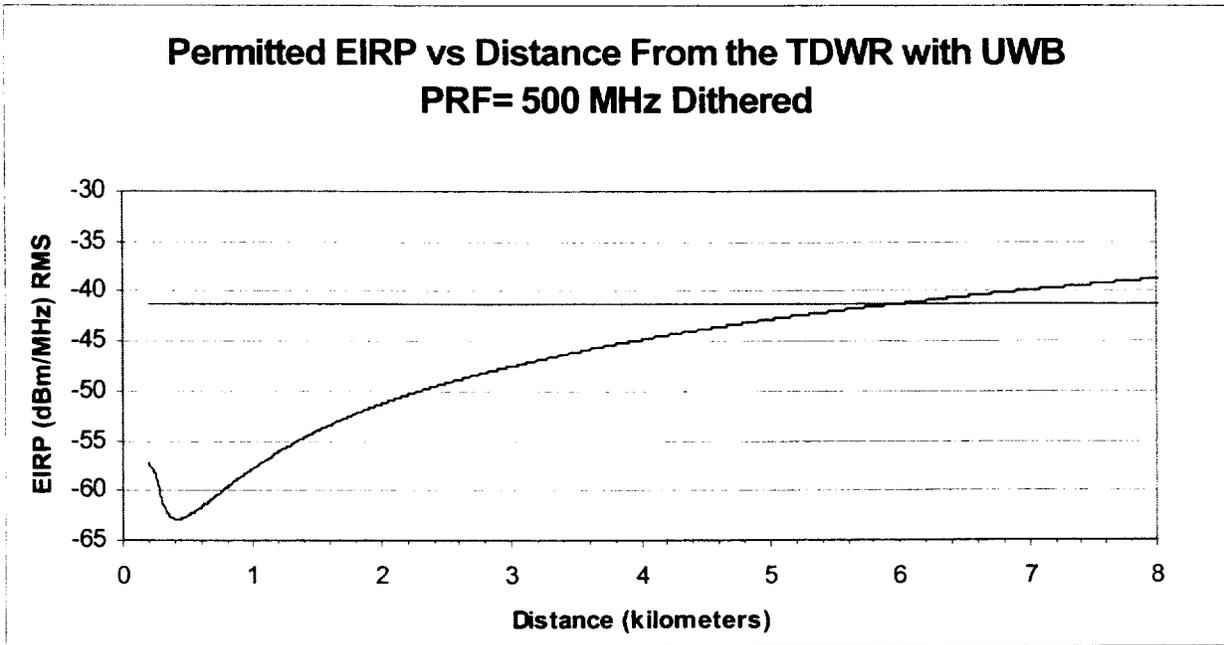


Figure 4-24 Maximum Permitted UWB EIRP for UWB Height =30 m.

### Discussion of Single Entry Results

These results indicate that operation of a UWB device at a power level of -41.3 dBm/MHz RMS in the vicinity of TDWR radars and within the 5600-5650 MHz frequency band would not exceed current interference protection requirements if the UWB device were operating at 2 meters above the ground. However, UWB devices operating at that power level at a height close to the height of the TDWR antenna would add to the system noise, rendering the radar less capable of monitoring the atmosphere for weather events.

Three factors significantly influence these results, namely, the radar antenna height, radar antenna tilt angle, and the height of the UWB device. When the radar antenna and the UWB device are operating in the same horizontal plane, the vertical elevation angle between them is zero degrees which results in a greater radar antenna gain. The analytical model takes into account the height of the radar, the height of the UWB device, and the radar tilt angle to compute the radar antenna gain, which is then used in the UWB interference calculations. For example, when the UWB height is 2 meters and the distance is 1 km, the off-axis + tilt angle is -1.6 degrees and the radar antenna gain is 26.8 dBi. However, for a UWB height of 30 meters and a distance of 1 km, the off-axis + tilt angle is 0 degrees and the radar antenna gain is 50 dBi.

A higher radar antenna gain raises the UWB interference power level in the radar receiver. For compatible operations, this requires a lower maximum permitted UWB EIRP and a longer separation distance to satisfy the receiver's protection criteria.

#### 4.12 MARITIME RADIONAVIGATION RADAR (2900–3100 MHz)

Analyses of potential interference from a single UWB device into a maritime radionavigation radar receiver was performed using the methodology described in Section 3, the maritime radionavigation radar characteristics given in Appendix A, and the analysis parameters shown in TABLE 4-51.

**TABLE 4-51  
UWB and Maritime Radionavigation Radar Analysis Parameters**

Parameter	Value
Protection Criteria	I/N = -10 dB (average (RMS) interference power)
Radar Antenna Height	20 meters
Radar Tilt Angle	0 degrees
UWB Device Height	2 meters, 30 meters
Reference Bandwidth	1 MHz
Reference Power Level	-41.3 dBm/MHz average (RMS), EIRP

The results for a non-dithered UWB signal analyses are shown in TABLE 4-52 for a UWB height of 2 meters. These results show that the maritime radionavigation radar interference protection is met with a UWB EIRP of -56.3 dBm or less for UWB PRFs at and below 1 MHz. This level is 15.0 dB below the -41.3 dBm/MHz RMS reference level. For PRFs above 1 MHz the maximum permitted UWB EIRP is -50.3 dBm which is 9 dB below the reference level.

The separation distance for a UWB device with an EIRP equal to the reference level and a maritime radionavigation radar is 1.2 km for PRFs at and below 1 MHz and 0.60 km for PRFs above 1 MHz.

**TABLE 4-52  
Non-Dithered UWB Signal into  
Maritime Radionavigation Radar Receiver (UWB Height = 2m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	6.0	-56.3	-15.0	1.2
.01	6.0	-56.3	-15.0	1.2
.1	6.0	-56.3	-15.0	1.2
1	6.0	-56.3	-15.0	1.2
10	0.0	-50.3	-9.0	.60
100	0.0	-50.3	-9.0	.60
500	0.0	-50.3	-9.0	.60

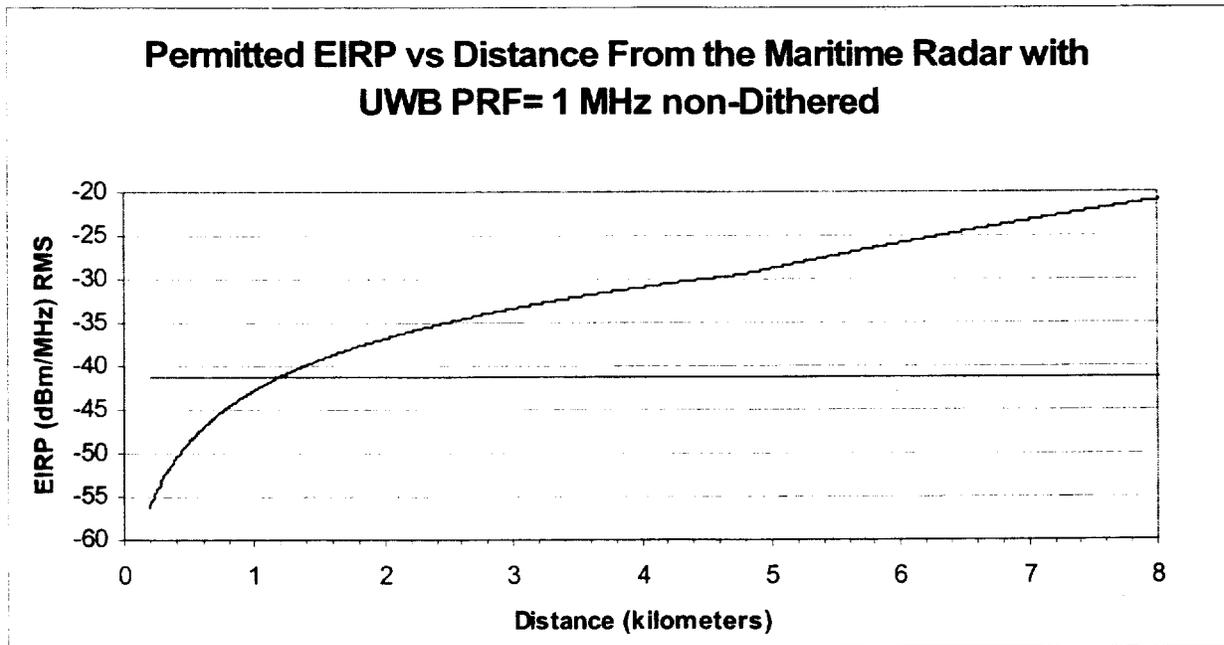
The results for a dithered UWB signal analyses are shown in TABLE 4-53 for a UWB height of 2 meters. The results show that the maximum allowable UWB EIRP is -56.3 dBm regardless of the PRF. The maximum permitted UWB EIRP level is 15.0 dB

below the reference level. The separation distance to satisfy the marine receiver protection criteria is 1.2 km when the UWB EIRP is equal to the reference level.

**TABLE 4-53**  
**Dithered UWB Signal into**  
**Maritime Radionavigation Radar Receiver (UWB Height = 2m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	6.0	-56.3	-15.0	1.2
.01	6.0	-56.3	-15.0	1.2
.1	6.0	-56.3	-15.0	1.2
1	6.0	-56.3	-15.0	1.2
10	6.0	-56.3	-15.0	1.2
100	6.0	-56.3	-15.0	1.2
500	6.0	-56.3	-15.0	1.2

A graph of the maximum permitted UWB EIRP is shown below in Figure 4-25 for a non-dithered PRF of 1 MHz.



**Figure 4-25 Maximum Permitted UWB EIRP for non-Dithered PRF of 1 MHz (UWB Height = 2m).**

The results for a non-dithered UWB signal analyses are shown in TABLE 4-54 for a UWB height of 30 meters. These results show that the maritime radionavigation radar

interference protection is met with a UWB EIRP of -56.8 dBm or less for UWB PRFs at and below 1 MHz. This level is 15.5 dB below the -41.3 dBm/MHz RMS reference level. For PRFs above 1 MHz the maximum permitted UWB EIRP is -50.8 dBm which is 9.5 dB below the reference level.

The separation distance for a UWB device with an EIRP equal to the reference level and a maritime radionavigation radar is 1.2 km for PRFs at and below 1 MHz and 0.6 km for PRFs above 1 MHz.

**TABLE 4-54**  
**Non-Dithered UWB Signal into**  
**Maritime Radionavigation Radar Receiver (UWB Height = 30 m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	6.0	-56.8	-15.5	1.2
.01	6.0	-56.8	-15.5	1.2
.1	6.0	-56.8	-15.5	1.2
1	6.0	-56.8	-15.5	1.2
10	0.0	-50.8	-9.5	.60
100	0.0	-50.8	-9.5	.60
500	0.0	-50.8	-9.5	.60

The results for a dithered UWB signal analyses are shown in TABLE 4-55 for a UWB height of 30 meters. The results show that the maximum allowable UWB EIRP is -56.8 dBm regardless of the PRF. The maximum permitted UWB EIRP level is 15.5 dB below the reference level. The separation distance to satisfy the marine receiver protection criteria is 1.2 km when the UWB EIRP is equal to the reference level.

**TABLE 4-55**  
**Dithered UWB Signal into**  
**Maritime Radionavigation Radar Receiver (UWB Height = 30 m)**

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	6.0	-56.8	-15.5	1.2
.01	6.0	-56.8	-15.5	1.2
.1	6.0	-56.8	-15.5	1.2
1	6.0	-56.8	-15.5	1.2
10	6.0	-56.8	-15.5	1.2
100	6.0	-56.8	-15.5	1.2
500	6.0	-56.8	-15.5	1.2

### **Discussion of Single Entry Results**

These results indicate that operation of a UWB device at a power level of -41.3 dBm/MHz RMS in the vicinity of maritime radionavigation radars and within the 2900-3100 MHz frequency band would exceed current maritime radionavigation radar receiver interference protection requirements. This may result in the ship's captain or navigator being unable to pilot the ship using radar as a guidance tool in inclement weather and/or foggy conditions. The separation distance may be up to 1.2 km for low UWB PRFs, which may be unobtainable for ships operating in narrow waterways and UWB devices located on shore.

### **4.13 SINGLE UWB DEVICE SUMMARY TABLES**

TABLE 4-56 shows the maximum permitted UWB EIRP for UWB heights of 2 and 30 meters for average UWB interference power. The table also shows the minimum required separation distance to satisfy the receiver's protection criteria when the UWB EIRP is equal to the reference level of -41.3/1MHz dBm RMS.

TABLE 4-57 shows the maximum permitted UWB EIRP for UWB heights of 2 and 30 meters for peak UWB interference power. The table also shows the minimum required separation distance to satisfy the receiver's protection criteria when the UWB EIRP is equal to the reference level of -41.3/1MHz dBm RMS.

**TABLE 4-56**  
**Summary Assessment of Effects of UWB Devices on Federal Systems**  
**For Average Power Interactions<sup>34</sup>**

SYSTEM	Freq. (MHz)	UWB PRF (MHz)	Non-Dithered		Dithered					
			UWB Ht = 2m		UWB Ht = 30m		UWB Ht = 2m		UWB Ht = 30m	
			Maximum Permitted EIRP (dBm/MHz) RMS	Separation Distance (km) for EIRP=-41.3 dBm/MHz RMS	Maximum Permitted EIRP (dBm/MHz) RMS	Separation Distance (km) for EIRP=-41.3 dBm/MHz RMS	Maximum Permitted EIRP (dBm/MHz) RMS	Separation Distance (km) for EIRP=-41.3 dBm/MHz RMS	Maximum Permitted EIRP (dBm/MHz) RMS	Separation Distance (km) for EIRP=-41.3 dBm/MHz RMS
DME Interrogator Airborne Rcvr	960-1215	≤0.1 >1	-46 -47	0.0 0.0			-46 -46	0.08 0.08		
DME Ground Transponder Rcvr	1025-1150	≤0.1 >1	-63 -64	0.2 0.2	-56 -57	0.26 0.29	-63 -63	0.26 0.26	-56 -56	0.26 0.26
ATCRBS Ground Interrogator Rcvr	1090	≤1 >10	-31 -21	NA NA	-45 -36	0.27 NA	-31 -31	NA NA	-45 -45	0.27 0.27
ATCRBS Airborne Transponder Rcvr	1030	≤1 >10	-44 -37	0.0 NA			-44 -44	0.02 0.02		
ARSR-4	1240-1370	≤0.1 >0.1	-60 -61	5.5 6.1	-80 -82	>15 >15	-60 -60	5.5 5.5	-80 -80	>15 >15
SARSAT LUT	1544-1545	≤0.1 >1	-68 -69	2.9 3.1	-65 -66	5.5 6.1	-68 -68	2.9 2.9	-65 -65	5.5 5.5
ASR-9	2700-2900	≤0.1 >1	44 -46	0.8 1.1	-64 -66	1.3 1.5	-44 -44	0.8 0.8	-65 -65	1.3 1.3
NEXRAD	2700-2900	≤0.1 >1	-39 -42	NA 1.4	-73 -76	5.8 7.9	-39 -39	NA NA	-73 -73	5.8 5.8
Maritime Radars	2900-3100	≤1 >10	-56 -50	1.2 0.6	-57 -51	1.2 0.6	-56 -56	1.2 1.2	-57 -57	1.2 1.2
FSS Earth Station (20° Elevation - Common For Domestic Satellites)	3700-4200	≤1 10 ≥100	-36 -26 -20	NA NA NA	-42 -32 -26	.20 NA NA	-36 -36 -36	NA NA NA	-42 -42 -42	.20 .20 .20
FSS Earth Station (5° Elevation - More Likely For International Satellites)	3700-4200	≤1 10 ≥100	-51 -41 -35	0.6 NA NA	-77 -67 -61	1.0 0.6 0.4	-51 -51 -51	0.60 0.63 0.63	-77 -77 -77	1.0 1.0 1.0
CW Radar Altimeters at Minimum Altitude	4200-4400	≤0.1 >1	25 14	NA NA			25	NA NA		
Pulsed Radar Altimeters at Minimum Altitude	4200-4400	≤1 10 ≥10	14.3 24.3 29.0	NA NA NA			14 14 14	NA NA NA		
MLS	5030-5091	≤0.1 >1	-45 -54	0.07 0.1			-45 -45	0.07 0.07		
TDWR	5600-5650	≤1 >10	-35 -35	NA NA	-63 -63	6.0 6.0	-35 -35	NA NA	-63 -63	6.0 6.0

<sup>34</sup> Notes: (1) The calculations were made at UWB PRF Values of, 0.001, 0.01, 0.1, 1, 10, 100, and 500 MHz. When the distance values and Maximum EIRP values were the same for a range were the same, they were grouped together to save space in the table. Thus, for the first row, the calculations for PRF values of 0.001, 0.01, and 0.1 MHz were the same and are shown in the row labeled ≤0.1 MHz, while the calculations for 1, 10, 100, and 500 were the same and are shown in the row labeled ≥1 MHz. (2) The shaded areas represent implausible scenarios where the UWB and aircraft would be at the same altitude (i.e., a collision course). (3) The symbol NA indicates that the reference level requires no separation distance beyond the limits of the model, which are usually 100-200 meters.

**TABLE 4-57**  
**Summary Assessment of Effects of UWB Devices on Federal Systems**  
**For Peak Power Interactions with Digitally Modulated Systems<sup>35</sup>**

SYSTEM	Freq. (MHz)	UWB PRF (MHz)	Non-Dithered				Dithered			
			UWB Ht = 2m		UWB Ht = 30m		UWB Ht = 2m		UWB Ht = 30m	
			Maximum Permitted EIRP (dBm/MHz) RMS	Separation Distance (km) for EIRP=-41.3 dBm/MHz RMS	Maximum Permitted EIRP (dBm/MHz) RMS	Separation Distance (km) for EIRP=-41.3 dBm/MHz RMS	Maximum Permitted EIRP (dBm/MHz) RMS	Separation Distance (km) for EIRP=-41.3 dBm/MHz RMS	Maximum Permitted EIRP (dBm/MHz) RMS	Separation Distance (km) for EIRP=-41.3 dBm/MHz RMS
SARSAT LUT Ground Station	1544-1545	0.001	-104	>15	-101	>15	-104	>15	-101	>15
		0.01	-94	12.0	-91	>15	-94	12.0	-91	>15
		0.1	-84	7.3	-81	>15	-84	7.3	-81	>15
		1	-74	4.2	-71	11.3	-74	4.2	-71	11.4
		>10	-69	3.1	-66	6.1	-68	2.9	-65	5.4
FSS Earth Station (20° Elevation – Common For Domestic Satellites)	3700-4200	0.001	-89	6.6	-95	>15	-89	6.6	-95	>15
		0.01	-79	3.9	-85	>15	-79	3.9	-85	>15
		0.1	-69	2.2	-75	5.3	-69	2.2	-75	5.3
		1	-59	1.2	-65	1.7	-59	1.2	-65	1.7
		10	-39	NA	-45	0.25	-50	0.5	-55	0.6
FSS Earth Station (5° Elevation – More Likely For International Satellites)	3700-4200	0.001	-104	12.3	-130	>15	-104	13.2	-130	>15
		0.01	-94	8.4	-120	>15	-94	8.4	-120	>15
		0.1	-84	5.1	-110	>15	-84	5.1	-110	>15
		1	-74	3.0	-100	10.1	-74	3.0	-100	10.2
		10	-54	1.0	-80	1.3	-64	1.7	-90	3.3
		100	-35	NA	-61	0.44	-54	1.0	-80	1.3
		500	-35	NA	-61	0.44	-51	0.6	-77	1.0

<sup>35</sup> The shaded areas are for PRF values that would result in peak to average power levels greater than 30 dB.